EXPEDIENTE PUBLICO

ROL: NOR 01/2000

Materia:

REVISIÓN DE LAS NORMAS PRIMARIAS DE CALIDAD DE AIRE PARA ANHÍDRIDO SULFUROSO (SO2); PATÍCULAS TOTALES EN SUSPENSIÓN (PTS); MONÓXIDO DE CARBONO (CO); OZONO (O3) Y DIÓXIDO DE NITRÓGENO (NO2)

GOBIERNO DE CHILE
COMISION NACIONAL
DEL MEDIO AMBIENTE

Resolución de Inicio: 1514

REPUBLICA DE CHILE
COMISION NACIONAL DEL MEDIO AMBIENTE
PMC

000001

DA INICIO AL PROCESO DE REVISION DE NORMAS PRIMARIAS DE CALIDAD DE AIRE PARA ANHÍDRIDO SULFUROSO (SO2); PARTÍCULAS TOTALES EN SUSPENSIÓN (PTS); MONÓXIDO DE CARBONO (CO); OZONO (O3); Y DIÓXIDO DE NITRÓGENO (NO2).

SANTIAGO, 17 DIC 1999

EXENTA N° 1514

VISTOS:

Lo dispuesto en la Ley N°19.300, sobre Bases del Medio Ambiente; lo prescrito en el Decreto Supremo 93, de 1995, del Ministerio Secretaría General de la Presidencia; el Tercer Programa Priorizado de Normas, publicado en el Diario Oficial de fecha 15 de abril de 1998; y la Resolución Exenta Nº 1215 de fecha 22 de junio de 1978 del Delegado del Gobierno en el Servicio Nacional de Salud.

CONSIDERANDO:

Que en sesión de 27 de marzo de 1998, el Consejo Directivo de la Comisión Nacional del Medio Ambiente, aprobó el Tercer Programa Priorizado de Normas, propuesto por su Director Ejecutivo.

Que con fecha 15 de abril de 1998, se publicó por aviso en extracto en el Diario Oficial el Tercer Programa Priorizado de Normas.

Que dentro de dicho Programa se incluye la revisión de las normas de calidad primaria de aire para Anhídrido Sulfuroso (SO2); Partículas Totales en Suspensión (PTS); Monóxido de Carbono (CO); Ozono (O3); y Dióxido de Nitrógeno (NO2), todas incluidas en la Resolución Nº 1215 de 22 de Junio de 1978 del Delegado del Gobierno en el Servicio Nacional de Salud.

Que de conformidad con lo preceptuado en el artículo 11° del Decreto Supremo 93 de 1995, del Ministerio Secretaría General de la Presidencia, corresponde a esta Dirección Ejecutiva dictar la resolución que da inicio al proceso de elaboración del anteproyecto de revisión norma.

RESUELVO:

1°.- Dése inicio al procedimiento de revisión de las normas primarias de calidad de aire para anhídrido sulfuroso (SO2); partículas totales en suspensión (PTS); monóxido de carbono (CO); ozono (O3); y dióxido de nitrógeno (NO2).

2°.- Fórmese un expediente para la tramitación del proceso de revisión de las referidas normas.

3°.- Fíjase como fecha límite para la recepción de antecedentes sobre los contaminantes a normar, el día número 70, contado desde la fecha de publicación de la presente resolución en un diario o periódico de circulación nacional. Cualquier persona natural o jurídica podrá, dentro del plazo señalado precedentemente, aportar antecedentes técnicos, científicos y sociales sobre las materias a normar.

4°.- Publíquese la presente resolución en el Diario Oficial y en un diario o periódico de circulación nacional.

Anótese, comuníquese, publíquese y archívese.

COMISION NACIONAL DEL MEDIO AMBIENTE
DIRECTOR EJECUTIVO

ALVARO SAPAG RAJEVIC
DIRECTOR EJECUTIVO (s)

17 DIC 1999

Lo que transcribo a Ud.
para su conocimiento
saluda atentamente a Ud.,
RODRIGO A. GONZALEZ P.
Oficial de Partes
Comisión Nacional del
Medio Ambiente (CONAMA)

lvd/rlch

Distribución:
- Organos Competentes de la Administración del Estado
- Departamento Jurídico
- Archivo

SUCEDE

Perro héroe

BUENOS AIRES.- Un perro salvó a un niño argentino de cuatro años que fue atacado por un enjambre de abejas, cubriéndolo con su cuerpo, para luego morir por las picaduras. El valiente can, llamado "Chocolate", se arrojó sobre Kharin Toloza para protegerlo, recibiendo cientos de picaduras. (Reuters)

Gran tumor

CHICAGO.- Un tumor de 91 kilos fue extirpado a una mujer estadounidense, durante una operación de 18 horas en el hospital de la Universidad de Chicago. Lorri Hoogewind, de 40 años, recibió en la intervención varias transfusiones de sangre, equivalentes a seis veces el volumen de sangre de su cuerpo. Sin el tumor benigno, Lorri bajó su peso de 140 a 54 kilos. (Reuters)

Contrato

LONDRES.- Un contrato previo, en el que los empleados que sean amantes de compañeros de trabajo aclaran que la relación es voluntaria, será aplicado por una empresa inglesa fabricante de medicinas. El objetivo es evitar que un final negativo del amor entre colegas termine en cargos de acoso sexual en las oficinas. (Ansa)

REUTERS

Triunfo opositor en Croacia

ZAGREB.- La oposición croata derrotó en las elecciones legislativas del martes a la hasta ahora gobernante ultranacionalista Unión Democrática Croata (HDZ) del recientemente fallecido Presidente Franjo Tudjman. La gran vencedora fue la coalición integrada por el Partido Social Demócrata (SDP) y el Liberal Social (HSLD). "Tendremos que probar que Croacia tiene potenciales económicos y democráticos muy buenos y creo que lo lograremos", señaló el líder del SDP, Ivica Racan, que en la foto (con la botella) se prepara para celebrar junto al líder del HSLD, Drazen Budisa. (Efe)

DENUNCIAN "cataclismo" económico provocado por anterior gobierno

Alianza argentina defiende rol del Estado

Efe
BUENOS AIRES

La Alianza política que gobierna en Argentina denunció que el país fue llevado al "cataclismo" por una "poderosa ideología según la cual el Estado debe retirarse de todo y abandonar las áreas en las cuales tiene misiones indelegables que cumplir".

En un comunicado emitido bajo el título: "Hacia una Argentina solidaria", la coalición defendió la decisión del Presidente Fernando de la Rúa de promover el aumento en diversos impuestos que impactan en mayor medida sobre los ingresos de la clase media, la mayor fuente de votos de la Alianza.

"La lucha contra la exclusión y la injusticia ha comenzado", dice el comunicado difundido con las firmas del ex Presidente (1983-1989) argentino y líder de la Unión Cívica Radical (UCR), Raúl Alfonsín, y de Carlos 'Chacho' Alvarez, actual vicepresidente y jefe del Frente del País Solidario (Frepaso).

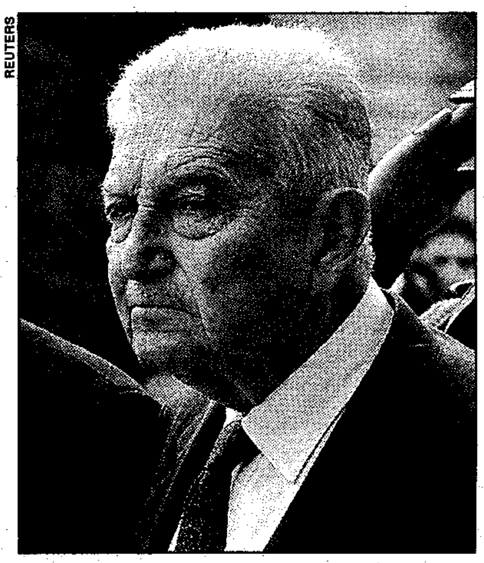
Según la Alianza UCR-Frepaso, la reforma tributaria que aprobó la semana pasada el Parlamento por impulso de De la Rúa busca objetivos simultáneos: "que paguen los que más tienen y que influya positivamente sobre la competitividad, el crecimiento y el empleo".

La reforma tributaria asignó impuestos a diversos productos de consumo y aumentó las tasas de los gravámenes a las ganancias y bienes personales que pagan los sectores de mejores ingresos.

El gobierno planea recaudar unos mil 900 millones de dólares adicionales con esta reforma, a lo que sumará un ahorro de mil 400 millones en el gasto público, con el objetivo de mantener el déficit de las cuentas públicas por debajo del límite de cuatro mil 500 millones de dólares.

Los aliancistas, en una ataque a la administración de Carlos Menem, que gobernó el país hasta el 10 de diciembre, sostuvieron que son conscientes de que hay "millones de argentinos sin trabajo debido a una política económica que destruyó la producción".

REUTERS



Weizman podría renunciar

JERUSALEN.- El Presidente de Israel, Ezer Weizman (foto), enfrenta fuertes presiones para que presente su renuncia, luego que fuera acusado de aceptar secretamente dinero (medio millón de dólares) de parte de un magnate francés siendo funcionario público. Mientras, el ex Primer Ministro israelí y Premio Nobel de la Paz, Simón Peres, se presenta como el más probable sucesor de Weizman en caso de que se concrete la dimisión. Según la prensa local, tanto el actual Premier, el laborista Ehud Barak, como la mayoría de los legisladores israelíes, incluidos muchos opositores, respaldarían a Peres. (Ap, Efe)

VISTAZO

Con honores de reina

MADRID.- Miles de españoles dieron su último adiós a María de las Mercedes de Borbón, madre del Rey Juan Carlos, quien fue sepultada ayer en el Monasterio de El Escorial -unos 50 kilómetros al noroeste de Madrid-, donde descansa su marido Juan de Borbón, fallecido en 1993. La condesa de Barcelona, quien murió el domingo a los 89 años, fue enterrada con honores de reina (aunque su marido nunca llegó a gobernar debido a la permanencia en el poder del dictador Francisco Franco: 1939-1975) en el Panteón de Reyes de El Escorial, por expreso deseo del Rey.

Alerta por plutonio

MEXICO.- La organización ambientalista Greenpeace Latina a los países de América Latina a organizarse para impedir el traslado de un cargamento de plutonio por los mares del Caribe y el Canal de Panamá. El cargamento que denominó "Chernobyl flotante" proviene de Francia y tiene como destino Japón, detalló Greenpeace en un comunicado divulgado en la capital mexicana. Los países de América Latina y los organismos regionales deben exigir respeto a sus declaraciones contra el paso de este tipo de embarques, aseguró Greenpeace.

Chechenia: avance rebelde

NAZRAN.- El ejército ruso reconoció ayer que la situación en Grozny es "extremadamente complicada" tras el éxito de los contraataques chechenos al recuperar varias aldeas cercanas a la capital de la república separatista. Una parte del cuartel general de las Tropas Unificadas confirmó indirectamente la toma de Aljan-Yurt, Aljan -Kalá y Kulari por los guerrilleros, al presentarla como una "intento fallido" rebelde por romper el asedio a Grozny.

Rabinos defienden Golán

JERUSALEN.- Los rabinos israelíes entraron de lleno en la lucha contra la devolución a Siria de las Alturas del Golán, publicando ayer una "halajá" (dictamen rabínico) por el que se prohíbe la entrega de ese territorio. La intervención de los rabinos se produce en momentos en que en Estados Unidos se lleva a cabo la segunda ronda de negociaciones de paz a alto nivel entre Israel y Siria, cuyo tema central es la disputa por el Golán.

"Rabiosa campaña" india

ISLAMABAD.- El ministro de Relaciones Exteriores de Pakistán, Abdul Sattar, criticó ayer duramente a su vecino, la India, y acusó al gobierno de Nueva Delhi de lanzar una "rabiosa campaña de propaganda" para intentar aislar a los paquistaníes (140 millones). Sattar dijo que su país está furioso por el pedido formulado el lunes por el Primer Ministro indio para que se declare a Pakistán un Estados terrorista, tras acusarlo de propiciar el secuestro de un avión de Indian Airlines.

Diario Oficial
5 de enero de 2000

000004

Ministerio Secretaría General de la Presidencia

Comisión Nacional del Medio Ambiente

DA INICIO AL PROCESO DE REVISION DE NORMAS PRIMARIAS DE CALIDAD DE AIRE PARA ANHIDRIDO SULFUROSO (SO2); PARTICULAS TOTALES EN SUSPENSION (PTS); MONOXIDO DE CARBONO (CO); OZONO (O3); Y DIOXIDO DE NITROGENO (NO2)

(Resolución)

Núm. 1.514 exenta.- Santiago, 17 de diciembre de 1999.- Vistos: Lo dispuesto en la ley Nº19.300, sobre Bases del Medio Ambiente; lo prescrito en el decreto supremo 93, de 1995, del Ministerio Secretaría General de la Presidencia; el Tercer Programa Priorizado de Normas, publicado en el Diario Oficial de fecha 15 de abril de 1998; y la resolución exenta Nº1.215 de fecha 22 de junio de 1978 del Delegado del Gobierno en el Servicio Nacional de Salud.

Considerando:

Que en sesión de 27 de marzo de 1998, el Consejo Directivo de la Comisión Nacional del Medio Ambiente, aprobó el Tercer Programa Priorizado de Normas, propuesto por su Director Ejecutivo.

Que con fecha 15 de abril de 1998, se publicó por aviso en extracto en el Diario Oficial el Tercer Programa Priorizado de Normas.

Que dentro de dicho Programa se incluye la revisión de las normas de calidad primaria de aire para Anhídrido Sulfuroso (SO2); Partículas Totales en Suspensión (PTS); Monóxido de Carbono (CO); Ozono (O3); y Dióxido de Nitrógeno (NO2), todas incluidas en la resolución Nº1.215 de 22 de junio de 1978 del Delegado del Gobierno en el Servicio Nacional de Salud.

Que de conformidad con lo preceptuado en el artículo 11º del decreto supremo 93 de 1995, del Ministerio Secretaría General de la Presidencia, corresponde a esta Dirección Ejecutiva dictar la resolución que da inicio al proceso de elaboración del anteproyecto de revisión norma.

R e s u e l v o:

1º.- Dése inicio al procedimiento de revisión de las normas primarias de calidad de aire para anhídrido sulfuroso (SO2); partículas totales en suspensión (PTS); monóxido de carbono (CO); ozono (O3); y dióxido de nitrógeno (NO2).

2º.- Fórmese un expediente para la tramitación del proceso de revisión de las referidas normas.

3º.- Fíjase como fecha límite para la recepción de antecedentes sobre los contaminantes a normar, el día número 70, contado desde la fecha de publicación de la presente resolución en un diario o periódico de circulación nacional. Cualquier persona natural o jurídica podrá, dentro del plazo señalado precedentemente, aportar antecedentes técnicos, científicos y sociales sobre las materias a normar.

4º.- Publíquese la presente resolución en el Diario Oficial y en un diario o periódico de circulación nacional.

Anótese, comuníquese, publíquese y archívese.- Alvaro Sapag Rajevic, Director Ejecutivo (S).

Lo que transcribo a Ud. para su conocimiento.- Saluda atentamente a Ud., Rodrigo A. González P., Oficial de Partes Comisión Nacional del Medio Ambiente (Conama)

OTRAS ENTIDADES

Banco Central de Chile

TIPOS DE CAMBIO Y PARIDADES DE MONEDAS EXTRANJERAS PARA EFECTOS DEL NUMERO 6 DEL CAPITULO I DEL TITULO I DEL COMPENDIO DE NORMAS DE CAMBIOS INTERNACIONALES Y CAPITULO II.B.3. DEL COMPENDIO DE NORMAS FINANCIERAS AL 5 DE ENERO DE 2000

	Tipo de Cambio $ (Nº 6 del C.N.C.I.)	Paridad Respecto US$
Dólar EE.UU. *	529,08	1,000000
Dólar Canadá	364,88	1,450000
Dólar Australia	347,07	1,524400
Dólar Neozelandés	274,80	1,925300
Libra Esterlina	866,49	0,610600
Marco Alemán	278,77	1,897900
Yen Japonés	5,13	103,059000
Franco Francés	83,12	6,365400
Franco Suizo	339,70	1,557500
Franco Belga	13,52	39,145800
Florín Holandés	247,42	2,138400
Lira Italiana	0,28	1878,956400
Corona Danesa	73,22	7,226000
Corona Noruega	66,58	7,946600
Corona Sueca	63,21	8,370000
Peseta	3,28	161,460900
Yuan	63,90	8,279900
Schilling Austria	39,62	13,352900
Markka	91,70	5,769700
EURO	545,22	0,970400
DEG	731,17	0,723608

* Tipo de cambio que rige para efectos del Capítulo II.B.3. Sistemas de reajustabilidad autorizados por el Banco Central de Chile (Acuerdo Nº 05-07-900105) del Compendio de Normas Financieras.

Santiago, enero 4 de 2000.- Miguel Angel Nacrur Gazali, Ministro de Fe.

TIPO DE CAMBIO PARA EFECTOS DEL NUMERO 7 DEL CAPITULO I DEL TITULO I DEL COMPENDIO DE NORMAS DE CAMBIOS INTERNACIONALES

El tipo de cambio "dólar acuerdo" (a que se refiere el inciso primero del Nº 7 del Capítulo I, Título I del Compendio de Normas de Cambios Internacionales), fue de $496,78 por dólar, moneda de los Estados Unidos de América, para el día 4 de enero de 2000.- Miguel Angel Nacrur Gazali, Ministro de Fe.

ACUERDO ADOPTADO POR EL CONSEJO DEL BANCO CENTRAL DE CHILE EN SU SESION Nº 812

(Certificado)

Certifico que el Consejo del Banco Central de Chile en su Sesión Nº 812, celebrada el 29 de diciembre de 1999, adoptó el siguiente Acuerdo:

812-02-991229 - Banco Santiago - Autorización para emitir tarjeta que indica

Se acordó autorizar a Banco Santiago para emitir la tarjeta de crédito que se indica:

Entidad Emisora	Tarjeta a emitir	Modalidad
Banco Santiago	American Express	Nacional e Internacional

Santiago, 29 de diciembre de 1999.- Miguel Angel Nacrur Gazali, Ministro de Fe.

Municipalidades

MUNICIPALIDAD DE LA FLORIDA

MODIFICA ORDENANZA LOCAL Nº 1 SOBRE DERECHOS MUNICIPALES

Núm.- 26.- La Florida, diciembre 22 de 1999.- Vistos: La Ordenanza Local sobre Derechos Municipales Nº 1, de 27 de diciembre de 1996; el Memorándum Nº 1.496 de la Dirección de Tránsito y Transporte Público de fecha 19 de noviembre de 1999; el Ordinario Nº 202 del Alcalde de fecha 15 de diciembre de 1999; el Acuerdo Nº 675 del Concejo Municipal de fecha 16 de diciembre de 1999; el decreto ley Nº 3.063 de "Rentas Municipales" y las facultades que me confiere la ley Nº 18.695 "Orgánica Constitucional de Municipalidades";

Considerando: La necesidad de modificar la Ordenanza Local Nº 1, incorporando un nuevo derecho municipal relacionado al Derecho por Fotografía Digitalizada para el otorgamiento de Licencias de Conducir, dicto la siguiente:

O r d e n a n z a:

Artículo 1º: Modifícase la Ordenanza Local Nº 1 sobre Derechos Municipales, Título IV sobre Tránsito y Transporte Público, en el siguiente sentido:

Agréguese un número 18º al artículo 9º del referido cuerpo normativo:

Nº 18: Derecho por Fotografía Digitalizada para el otorgamiento de Licencias de Conducir: 0,050 U.T.M.

Artículo 2º: La presente modificación empezará a regir a contar del 1º de enero del año 2000.

Anótese, comuníquese, publíquese en el Diario Oficial y hecho, archívese.- Gonzalo Duarte Leiva, Alcalde.- Dina Castillo González, Secretario Municipal.

MUNICIPALIDAD DE LA REINA

MODIFICA ORDENANZA SOBRE DERECHOS, CONCESIONES, PERMISOS Y SERVICIOS

Núm. 996.- La Reina, diciembre 21 de 1999.- Vistos: El decreto alcaldicio Nº 49 de 18 de enero de 1999 que fija el texto refundido, coordinado y actualizado de la Ordenanza de la comuna de La Reina sobre Derechos, Concesiones, Permisos y Servicios; el Acuerdo Nº 668 de fecha 21 de diciembre de 1999 del Concejo Municipal de La Reina; el decreto alcaldicio Nº 111 de fecha 7 de febrero de 1997, sobre subrogancias; los artículos Nº 23 y 41 del decreto ley 3.063 (Ley de Rentas Municipales); y en uso de las atribuciones que me confieren los artículos 17 y 56 de la Ley 18.695 Orgánica Constitucional de Municipalidades.

D e c r e t o:

Modifícase la Ordenanza de la comuna de La Reina sobre Derechos, Concesiones, Permisos y Servicios, de la siguiente manera:

1) Se modifica el artículo 11 de la siguiente manera:
   - En el Nº 5, se reemplaza la expresión "$100" por "$120".
   - En el Nº 6, se reemplaza la expresión "$50" por "$60". Esta modificación surtirá efectos a partir del 1 de marzo del año 2000.
   - En el Nº 7, se reemplaza la expresión "valor anual 3 UTM" por "valor semestral 1,5 UTM"
   - Se agrega el Nº 10, cuyo tenor es el siguiente: "10. Casetas telefónicas, valor mensual 0,5 UTM"
2) Se reemplaza el texto del Nº 2 del artículo 12, por el siguiente: "Puesto de frutas y verduras de la temporada, por mes o fracción, de diciembre a marzo 0,25 UTM".
3) Se elimina el Nº 6 del artículo 12.
4) En el artículo 13, Nº 13, a continuación de la expresión "avant-premier," se elimina el texto y se reemplaza por: "filmaciones u otros similares, por día 0,25 UTM".
5) Se modifica el artículo 15 de la siguiente manera:
   a- Se reemplaza el texto del Nº 8, por el siguiente: "Aprobación de planos para la Ley sobre Copropiedad Inmobiliaria por unidad a vender 0,2 UTM por unidad."
   b- En el Nº 13, se reemplaza la expresión "Venta por pisos" por "Ley sobre Copropiedad Inmobiliaria".
   c- En el Nº 13, donde dice "Modificación de deslindes 1,5% del avalúo fiscal del terreno", se reemplaza por "Modificación de deslindes 1,5% del avalúo fiscal de cada terreno".
6) Se modifica el artículo 17 de la siguiente manera:
   a- En el Nº 1, se reemplaza el guarismo "1,5 UTM" por "3 UTM".
   b- En el Nº 2, se reemplaza el guarismo "1,5 UTM hasta 500 m², 3 UTM sobre 500 m²" por "UTM hasta 500 m², 5 UTM sobre 500 m²".
   c- En el Nº 3, se reemplaza la expresión "5 UTM" por "7 UTM".
   d- En el Nº 4, se reemplaza el texto por el siguiente: "Ocupación de vía pública por particulares con escombros, materiales de construcción, instalaciones de faenas, cierros provisorios, torres, grúas, camiones concreteros u otro tipo de maquinarias o faenas ligadas a la construcción, por cada m² de ocupación los primeros 10 días 0,05 UTM por m².
   El exceso sobre los primeros 10 días deberá cancelar como adicional el equivalente al mismo valor hasta completar los 20 días siguientes y así sucesivamente con un máximo de 30 días.
   Por cada día de exceso sobre los 30 días, se pagará el equivalente a los primeros 10 días.
7) En el artículo 18, se reemplaza el guarismo "3%" por "4%".

20-01-2000

000005

Identificador Interno **16.168**

Número asignado en el Libro **75/fx**

Fecha Ingreso **20-01-2000**

Origen **UNIV. CATOLICA DE CHILE, JEANETTE VEGA**

Tipo Documento : **CARTA 19.01.2000**

Prioridad **NORMAL**

Con Copias .

Destino : **EGAÑA BARAONA RODRIGO**

Dpto./Unidad **DIRECCION EJECUTIVA**

Descripción : REVISIÓN NORMAS PRIMARIAS DE CALIDAD DEL AIRE. AL RESPECTO, DESIGNA COMO REPRESENTANTE ANTE EL COMITÉ REVISOR, A SRA. JEANETTE VEGA Y DR. GONZALO VALDIVIA.

Primera Derivación P. Matus

ENVIADO A JEFE DE

- [ ] Dirección Ejecutiva
- [ ] Fiscalía
- [ ] Administración, Finanzas y Person
- [ ] Evaluación de Impacto Ambiental
- [ ] Descontaminación, Planes y Norma
- [ ] Gestión SINIA y S. de informació
- [ ] Recursos Naturales
- [ ] Participación Ciudadana
- [ ] Economía Ambiental
- [ ] Unidad de Proyectos
- [ ] Asesor Técnico
- [ ] Relaciones Internacionales
- [ ] Política
- [ ] Regiones
- [ ] Comunicaciones
- [ ] Cooperación Internacional
- [ ] Adquisiciones
- [ ] Capacitación
- [ ] Dirección Regional Conama

N° Región

PARA

- [x] Conocimiento
- [ ] Informar al Respecto
- [ ] Dar curso/Tramites
- [x] Resolver
- [ ] Preparar Respuesta
- [ ] Responder Directamente
- [ ] Acuse Recibo
- [ ] Biblioteca
- [ ] Su Opinión
- [ ] Dar Audiencia
- [ ] Dar Difusión
- [ ] Reclasificar
- Otro

TIPO DE DOCUMENTO

- [ ] Secreto
- [ ] Confidencial
- [ ] Reservado
- [ ] Ordinario

Observaciones : ei. —

PLAZO PARA GENERAR ACCIO

Segunda Derivación

ENVIADO A :

Rodrigo

2.-

3.-

Observaciones

PARA	1	2	3
Conocimiento	✓		
Resolver			
Preparar Respuesta			
Adjuntar Antecedentes			
Acusar Recibo			
Dar Difusión			
Visto Bueno			

UNA VEZ HECHO	1	2	3
Devolverme Dcto.			
Reportar Avance			
Archivar			
Otro			

Plazo

Tercera Derivación

ENVIADO A :

PARA

- [ ] Conocimiento
- [ ] Resolver
- [ ] Preparar Respuesta
- [ ] Adjuntar Antecedentes
- [ ] Acusar Recibo
- [ ] Dar Difusión
- [ ] Visto Bueno

UNA VEZ HECHO

- [ ] Devolverme Dcto.
- [ ] Reportar Avance
- [ ] Archivar
- [ ] Otro

OBSERVACIONES

Referencia a : ____________ Archivado en : ____________

20 ENE 2000

Firma responsable

EF. Partes #75

Ingresos

TD #16168.-

000006

PONTIFICIA UNIVERSIDAD CATÓLICA DE CHILE

DEPARTAMENTO SALUD PÚBLICA / FACULTAD DE MEDICINA

Santiago, 19 de Enero del 2000

Sr. Alvaro Sapag Rajevic
Director Ejecutivo (s)
Comisión Nacional del Medio Ambiente
Obispo Donoso Nº 6
Santiago

Re: Revisión normas Primarias de Calidad del Aire

Estimado Sr. Sapag

Mediante la presente informo a Ud. que con mucho gusto participaré como integrante del Comité Ampliado para Revisión de las Normas Primarias de Calidad del Aire. En caso de no poder asistir a alguna de las reuniones, irá en mi reemplazo la el Dr. Gonzalo Valdivia, profesor Auxiliar de este Departamento.

Sin otro particular , le saluda atentamente

DEPARTAMENTO DE SALUD PUBLICA
Facultad de Medicina
Pontificia Universidad Católica de Chile

Jeanette

Dra. Jeanette Vega M.
Profesora Adjunta Asociada
Departamento de Salud Pública

000007

COMISION CHILENA DEL COBRE

V.P.E. N° 034

OFICIO N° - 028

ANT.: ORD.OF. N° 00171

MAT.: Revisión Normas Primarias de Calidad de Aire.-

COMISION NACIONAL DEL MEDIO AMBIENTE
OFICINA DE PARTES Y ARCHIVO
Nº INGRESO: 664/395
FECHA: 20 ENE 2000
DESPACHADO:
OBS.:

SANTIAGO, 19 ENE 2000

DE : VICEPRESIDENTE EJECUTIVO
COMISION CHILENA DEL COBRE

A : DIRECTOR EJECUTIVO
COMISION NACIONAL DEL MEDIO AMBIENTE

De acuerdo a lo solicitado en su oficio de antecedentes, tengo el agrado de informar a usted que, para los efectos de representar a la Comisión Chilena del Cobre en el Comité Operativo que se abocará a la revisión de las Normas Primarias de Calidad de Aire, he resuelto nominar en el carácter de representante oficial al ingeniero de la Dirección de Gestión Estratégica señor Pedro Santic Contreras y como suplente, a la ingeniero de la Dirección de Estudios señora Paula Aranda Ortega.

Sin otro particular saluda atentamente a usted,

COMISION CHILENA DEL COBRE
VICEPRESIDENCIA

EDUARDO TITELMAN GOREN
Vicepresidente Ejecutivo

Casilla 9493 Correo Central
Agustinas 1161 - 4º Piso
Santiago - Chile
Fono: (56 2) 382 8100
Fax : (56 2) 382 8300

INSTITUTO DE INGENIEROS
C H I L E

000008

Santiago, 19 de Enero de 2000

OFICINA DE PARTES Y ARCHIVO
Nº INGRESO: 686 / 411
FECHA: 20 ENE 2000
DESPACHADO:
OBS.:
A. SAPAG
16184

Señor Alvaro Sapag R.
Director Ejecutivo (S)
Comisión Nacional del Medio Ambiente
Presente

De mi consideración:

Por especial encargo del Presidente del Instituto de Ingenieros de Chile Sr. Alvaro Fischer A., tengo el agrado de acusar recibo de su Oficio Ordinario N°000172 de fecha 14.01.2000, por medio del cual se solicita que nuestra Corporación nombre un representante oficial y un reemplazante para integrar el Comité Ampliado que intervendrá en la elaboración de la norma que en el documento se describe.

Conforme a lo solicitado, informo a usted que se ha designado representante oficial al Sr. Roberto Abeliuk, Presidente de la Comisión de Medio Ambiente del Instituto y a la Sra. Marcela Alday, integrante de la Comisión mencionada como reemplazante.

Le saluda con especial atención,

CARLOS GAUTHIER T.
Gerente

C/C: Sr. Roberto Abeliuk.
Sra. Marcela Alday.

SAN MARTIN Nº 352 - CASILLA 487 - TELEFONOS: 6968647 - 6984028 - 6726997 - FAX: 6971136 - SANTIAGO - http.//www.iing.cl - E-MAIL: iing@ict.uchile.cl

000009

I.I.
INSTITUTO DE INGENIEROS
CHILE

Santiago, 19 de Enero de 2000

ID # 16207.

COMISION NACIONAL DEL MEDIO AMBIENTE
OFICINA DE PARTES Y ARCHIVO
FAX:
Nº INGRESO:
FECHA: 20 ENE 2000
DESPACHADO:
OBS.:

Señor Alvaro Sapag R.
Director Ejecutivo (S)
Comisión Nacional del Medio Ambiente
Presente

De mi consideración:

Por especial encargo del Presidente del Instituto de Ingenieros de Chile Sr. Alvaro Fischer A., tengo el agrado de acusar recibo de su Oficio Ordinario Nº000172 de fecha 14.01.2000, por medio del cual se solicita que nuestra Corporación nombre un representante oficial y un reemplazante para integrar el Comité Ampliado que intervenga en la elaboración de la norma que en el documento se describe.

Conforme a lo solicitado, informo a usted que se ha designado representante oficial al Sr. Roberto Abeliuk, Presidente de la Comisión de Medio Ambiente del Instituto y a la Sra. Marcela Alday, integrante de la Comisión mencionada como reemplazante.

Le saluda con especial atención,

CARLOS GAUTHIER T.
Gerente

C/C: Sr. Roberto Abeliuk.
Sra. Marcela Alday.

COMISION NACIONAL DEL MEDIO AMBIENTE
OFICINA DE PARTES Y ARCHIVO
FAX: 83
Nº INGRESO:
FECHA: 24 ENE 2000
DESPACHADO:
OBS.: D-330 16242

000010

Claiss
Centro
Latinoamericano de
Investigación en Sistemas de Salud

Santiago, Enero 21 del 2000

Señor
Alvaro Sapag Rajevic
Director Ejecutivo (S)
Comisión Nacional del Medio Ambiente
Presente

Estimado Señor Sapag::

En atención a su solicitud de nombrar a representantes que participen en el Comité Ampliado que intervenga en la elaboración de las Normas Primarias de Calidad de Aire, confirmo que el representante oficial de Claiss será el Dr. Fernando Muñoz Porras y su reemplazante será quien suscribe.

Sin otro particular, saluda atentamente a Ud.,

Soledad Ulloa Fonseca
Subdirector

Santiago, 20 de Enero de 2000
N° 031/2000

16281
COMISION NACIONAL DEL MEDIO AMBIENTE
OFICINA DE PARTES Y ARCHIVO
N° INGRESO: 775/470
FECHA:
DESPACHADO: 24 ENE 2000
OBS: 25/01/2000 - 8:30

Señor
Rodrigo Egaña B
Director Ejecutivo
Comisión Nacional del Medio Ambiente
Presente:

De nuestra consideración:

Hemos tomado conocimiento, a través de su carta N° 000172, enviada el 14 de enero, del inicio del proceso de revisión de las normas primarias de calidad de aire para anhídrido sulfuroso (SO_2), partículas totales en suspensión (PTS); monóxido de carbono (CO); ozono (O_3) y dióxido de nitrógeno (NO_2).

En consideración a que estas normas en revisión son del mayor interés para el sector minero, quisiéramos solicitar nuestra participación en el Comité Ampliado de la norma de SO2 a través de los señores Fernando Valenzuela, Gerente de Asuntos Ambientales y Regulatorios de Cía. Minera Disputada de Las Condes y el señor Carlos Salvo, Asesor de Asuntos Ambientales y Regulatorios de Cía. Minera Disputada de Las Condes.

Esperando una positiva acogida a nuestra solicitud, saluda atentamente a usted,

Hernán Hochschild Alessandri
Presidente

cc.: Sra, Patricia Matus
Jefe Unidad de Normas y Planes de Descontaminación

000012

CIMAB
FACULTAD DE MEDICINA
UNIVERSIDAD DE CHILE

UNIVERSIDAD DE CHILE
FACULTAD DE MEDICINA

Santiago, 24 de Enero,2000

FD # 16300.-

COMISION NACIONAL DEL MEDIO AMBIENTE
OFICINA DE PARTES Y ARCHIVO
Nº INGRESO: 774 / 469
FECHA: 24 ENE 2000
DESPACHADO:
OBS.: 25/01/2000

Sr. Alvaro Sapag Rajevic
Director Ejecutivo (S)
Comisión Nacional del Medio Ambiente
Obispo Donoso 6, Providencia
PRESENTE

Estimado Sr. Sapag,

En respuesta a su Ord. Of. Nº 172 del 14 de enero del presente año, solicitándome la nominación de un representante oficial y un reemplazante para formar parte del Comité ampliado que intervenga en la revisión de normas primarias de calidad de aire, cumplo en comunicarle que en este caso los nominados son las siguientes personas:

Dr. Manuel Oyarzún Gómez , como representante oficial
Dra. Marta Adonis Parraguez ; como reemplazante.

Lo saluda muy atentamente,

Dr. Manuel Oyarzún G.
Director,
Centro de Investigaciones del Medio Ambiente y Biomedicina (CIMAB),
Facultad de Medicina,
Universidad de Chile.

000013

SOFOFA

16352

COMISION NACIONAL DEL MEDIO AMBIENTE
OFICINA DE PARTES Y ARCHIVO
FAX: 93.-
Nº INGRESO:
FECHA: 26 ENE 2000
DESPACHADO:
OBS.:
A SAPAG R.
1126

Santiago, 26 de Enero de 2000

Señor
Alvaro Sapag R.
Director Ejecutivo (s)
CONAMA
PRESENTE

Estimado señor Director:

En respuesta a su atento Oficio de fecha 14 de Enero de 2000, donde se nos informa de la apertura del proceso de revisión de las normas primarias de calidad de aire para anhídrido sulfuroso (SO2); partículas totales en suspensión (PTS), monóxido de carbono (CO); ozono (O3) y dióxido de nitrógeno (NO2), hemos decidido nominar como representante oficial de la Sociedad de Fomento Fabril, en este proceso a Don **ANIBAL MEGE THIERRY**, y como reemplazante a don JAIME DINAMARCA GÁRATE.

Atentamente,

ANDRÉS CONCHA RODRÍGUEZ
Secretario General

FEDERACION GREMIAL DE LA INDUSTRIA
Edificio de la Industria * Av. Andrés Bello 2777 Piso 3 Las Condes * Fono (56-2) 3913100 * Fax (56-2) 3913200/3913201 * Casilla 37 Correo 35 Tobalaba * Santiago * Chile
http://www.sofofa.cl * e-mail sofofa@sofofa.cl

PONTIFICIA UNIVERSIDAD CATÓLICA DE CHILE
DEPARTAMENTO SALUD PÚBLICA / FACULTAD DE MEDICINA

16368.

Santiago, 19 de Enero del 2000

COMISION NACIONAL DEL MEDIO AMBIENTE
OFICINA DE PARTES Y ARCHIVO
Nº INGRESO: 848 / 515
FECHA: 26 ENE 2000
DESPACHADO:
A. SAPAG P/ comité 1230

Sr. Alvaro Sapag Rajevic
Director Ejecutivo (s)
Comisión Nacional del Medio Ambiente
Obispo Donoso Nº 6
Santiago

Re: Revisión normas Primarias de Calidad del Aire

Estimado Sr. Sapag

Mediante la presente informo a Ud. que con mucho gusto participaré como integrante del Comité Ampliado para Revisión de las Normas Primarias de Calidad del Aire. En caso de no poder asistir a alguna de las reuniones, irá en mi reemplazo la el Dr. Gonzalo Valdivia, profesor Auxiliar de este Departamento.

Sin otro particular , le saluda atentamente

DEPARTAMENTO DE SALUD PUBLICA
Facultad de Medicina
Pontificia Universidad Católica de Chile

Dra. Jeanette Vega M.
Profesora Adjunta Asociada
Departamento de Salud Pública

MARCOLETA 352, TELÉFONO 686 30 38 - 686 68 95, FAX (56-2) 633 18 40, SANTIAGO, CHILE

OFICINA DE PARTES Y ARCHIVO
Nº INGRESO 854 / 521
FECHA: 26 ENE 2000
16 05 512
N. SAPAG

MTT 000015

Ministerio de Transportes y Telecomunicaciones

16372 100

OFICIO ORD. DEN Nº ________/

ANT.: Su Oficio Nº 000171 del 14 de enero de 2000.

MAT.: Designa representantes de esta Cartera de Estado en materia que indica.

SANTIAGO, 25 ENE 2000

DE: SR. VICENTE PARDO DIAZ
SUBSECRETARIO DE TRANSPORTES (S)

A : SR. ALVARO SAPAG RAJEVIC
DIRECTOR EJECUTIVO (S)
COMISIÓN NACIONAL DEL MEDIO AMBIENTE

En atención al oficio citado en ANT., esta Secretaría de Estado, con el ánimo de participar y colaborar en el Comité Operativo para la revisión de las normas Primarias de Calidad del Aire para anhídrido sulfuroso (SO2); partículas totales en suspensión (PTS) monóxido de carbono (CO); ozono (O3) y dióxido de nitrógeno (NO2), ha designado a los siguientes profesionales.

- Sr. Andrés Portales Muñoz
  Ingeniero del Departamento Elaboración de Normas

- Sr. Jaime Retamal Pinto
  Jefe Departamento Elaboración de Normas (en calidad de suplente)

Saluda atentamente a Ud.,

VICENTE PARDO DIAZ
Subsecretario de Transportes
Subrogante

REPUBLICA DE CHILE MINISTERIO DE TRANSPORTES
Sub-Secretario Subrogante

SUBSECRETARIA DE TRANSPORTES
JEFE Departamento Elaboración de Normas
Vº Bº Jefe División Normas y Control

DISTRIBUCIÓN:
- Sr. Alvaro Sapag Rajevic - CONAMA
  Donoso 6º, Providencia
- Gabinete Subsecretario de Transportes
- División de Normas y Control
- Departamento Elaboración de Normas
- Oficina de Partes

DEN 047/00
DNC 078

Comisión Nacional del Medio Ambiente
Consejo Directivo
ASR/PMC

APRUEBASE CREACION DEL COMITE OPERATIVO PARA LA REVISION DE LAS NORMAS PRIMARIAS DE CALIDAD DE AIRE PARA ANHIDRIDO SULFUROSO (SO2), PARTICULAS TOTALES EN SUSPENSIÓN (PTS), MONOXIDO DE CARBONO (CO), OZONO (03) Y DIOXIDO DE NITROGENO (NO2).

Santiago, 27 de enero del 2000

VISTOS: El Tercer Programa Priorizado de Normas, aprobado por el Consejo Directivo el 27 de marzo de 1998, publicado en el Diario Oficial de fecha 15 de abril de 1998, que contempla la revisión de las normas primarias de calidad de aire referenciadas; y

CONSIDERANDO:

Que de acuerdo a lo dispuesto en el artículo 77 de la Ley Nº 19.300 sobre Bases Generales del Medio Ambiente y en el artículo 6º del Decreto Nº 93 de 1995, del Ministerio Secretaría General de la Presidencia, que contiene el Reglamento para la Dictación de Normas de Calidad Ambiental y de Emisión, el Director Ejecutivo de la Comisión Nacional del Medio Ambiente, previa aprobación del Consejo Directivo, podrá crear Comités Operativos formados por representantes de los ministerios, servicios y demás organismos públicos competentes, que intervengan en la dictación de una norma determinada.

Que de conformidad a las disposiciones señaladas en el considerando anterior, el Director Ejecutivo ha designado las instituciones que tendrán representación en el Comité Operativo creado para la revisión de las normas primarias de calidad de aire referenciadas.

ACUERDO Nº 142/2000

Aprobar la integración del Comité Operativo propuesto por el Director Ejecutivo de la Comisión Nacional del Medio Ambiente, que intervendrá en la revisión de las normas primarias de calidad de aire antes referenciadas, cuyos integrantes serán representantes nombrados por los siguientes organismos:

- Ministerio de Transportes y Telecomunicaciones.
- Ministerio de Salud .
- Ministerio de Economía, Fomento y Reconstrucción.
- Ministerio de Obras Públicas.
- Ministerio de Minería.
- Comisión Chilena del Cobre (COCHILCO).
- Comisión Nacional de Energía.
- Servicio de Salud Metropolitano del Ambiente.
- Servicio de Salud de Antofagasta.
- Servicio de Salud Viña del Mar - Quillota.
- Servicio de Salud Valparaiso-San Antonio
- Servicio de Salud O' Higgins
- Servicio de Salud de Talcahuano.
- Servicio de Salud de Concepción.
- Servicio de Salud Araucanía Sur.

CARLOS CARMONA SANTANDER
Ministro Secretario General de la Presidencia (S)
Presidente Consejo Directivo
Comisión Nacional del Medio Ambiente

RODRIGO EGAÑA BARONA
Director Ejecutivo
Secretario Consejo Directivo
Comisión Nacional del Medio Ambiente

RLCH/LVD
Distribución
- Integrantes Consejo Directivo (13)
- Director Ejecutivo de CONAMA
- Departamento Jurídico
- Departamento de Descontaminación, Planes y Normas
- Archivo

ORGANIZACION PANAMERICANA DE LA SALUD

Oficina Sanitaria Panamericana, Oficina Regional de la

ORGANIZACION MUNDIAL DE LA SALUD

REFERENCIA:

CHI-ERA-010/0125

Santiago, 25 de Enero de 2000

OFICINA DE PARTES Y ARCHIVO
Nº INGRESO: 907 / 550
FECHA: 27 ENE 2000
16-2
D. Ejecutivo

Señor
Alvaro Sapag Rajevic
Director Ejecutivo (S)
Comisión Nacional del Medio Ambiente
Obispo Donoso 6
Providencia
Santiago

De mi consideración:

Tengo el agrado de acusar recibo de su atenta carta fechada el 14 de Enero del 2000, relacionada con la iniciación de la revisión de las normas primarias de calidad de aire para anhídrido sulfuroso (SO2); partículas totales en suspensión (PTS; monóxido de carbono (CO); ozono (O3) y dióxido de nitrógeno (NO2) y la formación de un Comité Ampliado que intervenga en la elaboración de la norma.

En relación a lo anterior, tengo el agrado de comunicar a Ud. que el Ing. Rodrigo Cerda, Consultor en Salud Ambiental, ha sido nominado para participar en dicho Comité.

Saluda atentamente a Ud.,

Dra. Ana Cristina Nogueira
Representante OPS/OMS en Chile

Providencia 1017, 4º y 5º Piso • Tel: (56-2) 264 9300 • Fax: (56-2) 264 9311 • e-mail:opschi@reuna.cl • Casilla 9459 •Cod. Postal 6640391 • Santiago de Chile.

ASIMET

JD # 16455

COMISION NACIONAL DEL MEDIO AMBIENTE
OFICINA DE PARTES Y ARCHIVO
Nº INGRESO: 948/574
FECHA: 28 ENE 2000
DESPACHADO: 1545
R. EGAÑA

Santiago, 28 de Enero del 2000

Señor:
Rodrigo Egaña B.
Director Ejecutivo de CONAMA
Obispo Donoso 6
Providencia

Referencia: Nominación de representantes Asimet en Comité Ampliado de revisión de normas primarias de calidad del aire.

Estimado señor:

La Comisión de Medio Ambiente de la Asociación de Industrias Metalúrgicas y Metalmecánicas ASIMET AG, designó dos de sus representantes para participar en el Comité Ampliado de revisión de normas primarias de calidad de aire para anhídrido sulfuroso SO2, partículas totales en suspensión PTS, monoxido de carbono CO, ozono O3 y dióxido de nitrógeno NO2.

Para estos efectos, Alfredo Cánepa Monzo es nominado como representante oficial y como substituto, Andrés Muñoz A.

Finalmente quiero agradecer la disposición de CONAMA en desarrollar la participación de actores relevantes en los temas ambientales.

Atentamente,

Andrés Muñoz Ampuero, M.Sc.
Jefe del Departamento de Asistencia Medioambiental
ASIMET

CC. Alvaro Sapag
DD. CMA-Asimet

Andrés Bello 2777 - 48piso Tel:431 6500 Fax: 203 3025 email:asimet@asimet.cl

SESMA
SERVICIO DE SALUD
METROPOLITANO DEL AMBIENTE

ID #16508

COMISION NACIONAL DEL MEDIO AMBIENTE
OFICINA DE PARTES Y ARCHIVO
Nº INGRESO: 998 / 602
FECHA: 31 ENE 2000
DESPACHADO DE: 16

A SAPAG

001036 28.ENE.2000

ORD.:

ANT.: Ord. Nº 171 del 14/01/2000, CONAMA

MAT.: Responde solicitud del Ant.

DE : DIRECTOR
SERVICIO DE SALUD METROPOLITANO DEL AMBIENTE

A : SR. ALVARO SAPAG RAJEVIC
DIRECTOR EJECUTIVO (S)
COMISION NACIONAL DEL MEDIO AMBIENTE

Tengo el agrado de informar a Ud. que el representante oficial del SESMA en el proceso normativo de revisión de las normas primarias de calidad de aire será el señor Juan A. Sánchez Cortez, Ing. M.C. Como reemplazante, actuará el señor Ignacio Olaeta Undabarrena.

Sin otro particular, le saluda atentamente a usted,

SERVICIO DE SALUD DEL AMBIENTE ★ REGION METROPOLITANA ★ DIRECTOR

DR. MAURICIO ILABACA MARILEO
DIRECTOR
SERVICIO DE SALUD
METROPOLITANO DEL AMBIENTE

DISTRIBUCIÓN:
- Señor Director Ejecutivo (s) CONAMA
- Dirección SESMA
- Dpto. Vigilancia Sanitaria SESMA
- Dpto. Técnico SESMA
- Dpto. Administrativo SESMA
- Oficina de Partes
- Archivo

REPUBLICA DE CHILE

MINISTERIO
DE MINERIA

000021

OF.ORD. Nº: 45 /

COMISION NACIONAL DEL MEDIO AMBIENTE
OFICINA DE PARTES Y ARCHIVO
Nº INGRESO: 1075 / 650
FECHA: -2 FEB 2000
DESPACHADO:
16580

ANT : OF. ORD. N° 000171 de CONAMA de fecha 14.01.2000

MAT : Designa representante ante Comité Operativo.

SANTIAGO, 31 de enero de 2000

DE : MINISTRO DE MINERIA (S)

A : SR. DIRECTOR EJECUTIVO (S)
COMISION NACIONAL DEL MEDIO AMBIENTE

En atención a lo solicitado por medio de su oficio citado en ANT., en orden a iniciar el proceso de revisión de las normas primarias de calidad de aire para anhídrido sulfuroso (SO_2), partículas totales en suspensión (PTS), monóxido de carbono (CO), ozono (O_3) y dióxido de nitrógeno (NO_2) y la formación de un comité para estos efectos, me es grato informar a Ud. que este Ministerio ha designado como representante ante dicho comité al señor **Erwin Oyanader Millas**, Coordinador de la Unidad Ambiental de esta Secretaría de Estado.

A su vez, en calidad de alterno se ha designado a la señora **María de la Luz Vásquez Martínez**, Encargada de Normas de la señalada Unidad Ambiental de este Ministerio, para el evento de ausencia o imposibilidad del titular.

Sin otro particular, saluda atentamente a Ud.,

REPUBLICA DE CHILE - MINISTERIO DE MINERIA
- MINISTRO -

CESAR DIAZ-MUÑOZ CORMATCHES
Ministro de Minería (S)

GTA/MVM

Distribución
- Partes y Archivo

ENAMI

000022

VICEPRESIDENCIA EJECUTIVA Nº12

Santiago, enero 28 de 2000.

ENAMI
OFICINA DE PARTES
00141 31.1.00
SANTIAGO

COMISION NACIONAL DEL MEDIO AMBIENTE
OFICINA DE PARTES Y ARCHIVO
Nº INGRESO: 1083 / 658
FECHA:
DESPACHADO: - 2 FEB 2000
OBS.: 3/2/2000
A Sapag 8310
16589 / + Correo.

Señor
Alvaro Sapag Rajevic
Director Ejecutivo (S)
Comisión Nacional del Medio Ambiente
Santiago

Señor Sapag:

Mediante la presente, informo a usted que se ha designado a Don Eduardo Giesen Amtmann, Jefe de Medio Ambiente Corporativo, como representante oficial de nuestra Empresa, en el Comité Ampliado para la revisión de la norma de calidad de aire para SO_2, PTS, CO, O_3 y NO_2.

Como reemplazante se ha nominado a Don Alejandro Diez Valencia, Jefe de Aseguramiento de Calidad.

Sin otro particular, saluda atentamente a usted,

Vice Presidente Ejecutivo

PATRICIO ARTIAGOITIA ALTI
VICEPRESIDENTE EJECUTIVO

GREENPEACE
CHILE

000023

OFICINA DE PARTES Y ARCHIVO
Nº INGRESO: 1086 / 662
FECHA: 2 FEB 2000
DESPACHADO:
OBS.: 3/2/00 p34
D Ejecutivo 7659 / + correo

Santiago, 25 de Enero del 2000

Señores:
CONAMA
Presente

Att.: Alvaro Sapag Rajevic
Director Ejecutivo
Comisión Nacional del Medio Ambiente

Ref: Revisión Normas Primarias de Calidad Del Aire

De nuestra consideración

Por la presente comunico a ustedes haber recibido la carta que se refiere al tema de la **Revisión Normas Primarias de Calidad de Aire.**

Tenemos el agrado de comunicarles que participaré personalmente como representante oficial de nuestra organización en el **" Comité Ampliado "**, y como reemplazante la señora María Teresa Castro.

Sin otro particular, le saluda atentamente a usted,

ROSA MORENO MOORE
DIRECTORA DE CAMPAÑA
GREENPEACE PACIFICO SUR

RMM/jag

Eleodoro Flores # 2424 Ñuñoa. Santiago. Chile. Fonos: 343.77.88 - 343.77.54 Fax: 204.01.62
www.greenpeace.cl - greenpeace@greenpeace.cl

16

000024

SERVICIO DE SALUD O'HIGGINS

MINISTERIO DE SALUD
SERVICIO DE SALUD O'HIGGINS
DEPARTAMENTO DE PROGRAMAS
SOBRE EL AMBIENTE
N°147/00

ORDINARIO N°: 565

ANT : ORD.OF.N°00017

MAT. : Revisión Normas Primarias de Calidad de Aire.

RANCAGUA, 4 FEB 2000

DE : DRA. MARIA ANGELICA MORENO MUÑOZ
DIRECTOR (S) SERVICIO DE SALUD O'HIGGINS

A : SR. ALVARO SAPAG RAJEVIC
DIRECTOR EJECUTIVO (S)
COMISION NACIONAL DEL MEDIO AMBIENTE

En atención al ORD.OF. del antecedente comunico a Ud. que se ha designado como representante oficial para conformar el Comité Operativo para la Revisión de Normas Primarias de Calidad del Aire al Dr. Guillermo Carrasco Suazo, Jefe del Departamento de Programas Sobre el Ambiente y como reemplazante a la Srta. Cecilia Godoy González Asesora de la Unidad de Contaminación Atmosférica.

Sin otro particular, saluda atentamente a Ud.

DRA. MARIA ANGELICA MORENO MUÑOZ
DIRECTORA (S)
SERVICIO DE SALUD O'HIGGINS

DRA.MAMM/DR.GCS/ING.CGG

DISTRIBUCION
INDICADA
DIRECCION SERVICIO SALUD
DEPTO. PROGRAMAS SOBRE EL AMBIENTE
OFICINA DE PARTES

C - 6257
11 FEB 2000

000025

REPUBLICA DE CHILE
MINISTERIO DE SALUD
SERVICIO SALUD VIÑA DEL MAR-QUILLOTA
SUBDIRECCIÓN AMBIENTAL
DEPTO. PROGRAMAS SOBRE EL AMBIENTE /
Nº 090 26.01.00
F.: 65 L.: 06

0134

ORDINARIO Nº ________________/

ANT.: Ordinario Oficio Nº 171/14.01.00.

MAT.: Informa.

VIÑA DEL MAR, 02 FEB. 2000

COMISION NACIONAL DEL MEDIO AMBIENTE
OFICINA DE PARTES Y ARCHIVO
Nº INGRESO: 1263 / 770
FECHA: 8 FEB 2000
DESPACHADO:

DE : DIRECTOR
SERVICIO SALUD VIÑA DEL MAR-QUILLOTA

A : D. ALVARO SAPAG RAJEVIC
DIRECTOR EJECUTIVO (S)
COMISION NACIONAL DEL MEDIO AMBIENTE

En respuesta a su oficio del antecedente, los profesionales que a continuación se nominan, representarán a nuestro Servicio de Salud en el Comité Operativo que estudiará las Normas de Calidad Ambiental y de Emisión.

- ING. QUIMICO MARICEL LAVIN ZUMAETA (TITULAR)
- ING. QUIMICO HERNAN CONTRERAS CORTES (PRIMER REEMPLAZANTE)
- ING. CONST. EDGARDO BENAVIDES ASTORGA (SEGUNDO REEMPLAZANTE)

Saluda atentamente a Ud.,

SERVICIO DE SALUD * VIÑA DEL MAR-QUILLOTA *
DIRECCION

DR. FRANCISCO ACEVEDO TORO
DIRECTOR
SERVICIO SALUD VIÑA DEL MAR-QUILLOTA

DR.FSG/DR.CGG/xdg.
DISTRIBUCION:
- Destinatario
- Oficina Partes S.S.V.Q.
- Subdirección Ambiental
- Interesados (03)
- Oficina D.P.A.

REPUBLICA DE CHILE
MINISTERIO DE SALUD
DIVISION DE SALUD AMBIENTAL
DEPTO. PROGRAMAS SOBRE AMBIENTE
75

000026

ORD.: N° 9B/ 715 /

ANT.: Su Ordinario N° 171, del 14 de enero del 2000

MAT.: Informa sobre nominación que indica.

SANTIAGO, 14 FEB 2000

DE: MINISTRO DE SALUD

A: DIRECTOR EJECUTIVO
COMISION NACIONAL DEL MEDIO AMBIENTE

En relación con su oficio de antecedente me permito informar a usted, que este Ministerio de Salud ha nominado al Ing. Julio Monreal Urrutia, Jefe del Departamento de Programas sobre Ambiente, como representante de esta Secretaría de Estado ante el Comité Operativo que elaborará las normas de calidad de aire contenidas en la Resolución N° 1215/78, del Ministerio de Salud. Por otro lado, informo a usted, que se ha nominado al Sr. Walter Folch, encargado del Programa de Contaminación Atmosférica, como reemplazante del Ing. Monreal.

Saluda atentamente a usted.

DR. ALVARO ERAZO LATORRE
MINISTRO DE SALUD (S)

Ing.JMU/Ing.JMU/Lic.WFA

DISTRIBUCION
- DIRECTOR EJECUTIVO COMISION NACIONAL DEL MEDIO AMBIENTE
- GABINETE SR. MINISTRO DE SALUD
- DISAM
- DPA
- Of. Partes

COMISION NACIONAL DEL MEDIO AMBIENTE
OFICINA DE PARTES Y ARCHIVO
Nº INGRESO: 1467/907
FECHA: 14 FEB 2000
DESPACHADO:
OBS.: 15/02/2000 + Castillo.

Id#16883

000027

SERVICIO SALUD ARAUCANIA SUR
SUBDIRECCION MEDICA
DEPTO. PROG. SOBRE EL AMBIENTE
DR.PEG
Nº 62

ORD : Nº 210

ANT : ORD. Nº 000171/ 14.01.2000

MAT: Designación de representantes.

TEMUCO, 25 ENE. 2000

DE : DIRECTORA SERVICIO SALUD ARAUCANIA SUR

A : DIRECTOR EJECUTIVO (S)
COMISION NACIONAL DEL MEDIO AMBIENTE.
SR. ALVARO SAPAG RAJEVIC

SANTIAGO

En relación a su oficio citado en "ant", me permito comunicar a usted que los representantes designados por esta Dirección en la formación del Comité Operativo con intervención en la elaboración de la norma aludida en documento anterior son:

representante oficial : Sr. Pedro Díaz Gajardo.
representante reemplazante: Sra. Ana María Prado.

Saluda atentamente a Ud.

SERVICIO SALUD ARAUCANIA SUR
DIRECCION
IX REGION

DRA. WILMA BERG KROLL
DIRECTORA
SERVICIO SALUD ARAUCANIA SUR

pp

DR. HORACIO GIL MUJICA
JEFE DPTO. SALUD AMBIENTAL

DR.HGM/ ING.PDG/pdg
Distribución
- Conama
- Sub- Dirección Médica
- Unidad de Salud Ocupacional (SEIA)
- Oficina de Partes

CONSEJO MINERO a.g.

Hendaya 60 - Piso 9
Las Condes, Santiago - Chile
Fono: (56-2) 331 9026
Fax: (56-2) 331 5381

ID #17307.—

COMISION NACIONAL DEL MEDIO AMBIENTE
OFICINA DE PARTES Y ARCHIVO
Nº INGRESO: 1883 / 1208
FECHA: 1 MAR 2000
DESPACHADO:
OBS.:
R. Egaña

Santiago, 29 de febrero de 2000
CM – 033/2000

Señor
Rodrigo Egaña
Director Ejecutivo
Comisión Nacional del Medio Ambiente
Presente

Estimado señor Director:

De acuerdo a lo solicitado en el oficio ORD. N° 172 del 14 de enero de 2000, de esa Comisión, comunico a usted que el Consejo Minero ha designado a los siguientes señores en representación de esta asociación gremial para los efectos de participar en el Comité Ampliado relativo a la elaboración de las normas primarias de calidad de aire para anhídrido sulfuroso (SO2), partículas totales en suspensión (PTS), monóxido de carbono (CO), ozono (O3) y dióxido de nitrógeno (NO2):

Representante oficial:
Señor Fernando Valenzuela
Tel.: 230-6295
Fax: 230-6255
E-mail: lfvalenzuela@manquehue.net

Reemplazante:
Señor Elliot Cohen
Tel.: (55) 63.01.05
Fax: (55) 63.01.43
E-mail: cohene@altonorte.noranda.cl

Agradecido de la invitación cursada al Consejo Minero saluda atentamente a usted,

Mauro Valdés R.
Gerente General

H:\Correlativo\CARTAS\2000\033.doc

JD # 17459.

UNIVERSIDAD DE CONCEPCION
FACULTAD DE FARMACIA
Fax 56-41-231903 - Casilla 237 - Concepción - CHILE

000029

F.N° 410/2000

Concepción, 25 de febrero de 2000.

DP y N.

COMISION NACIONAL DEL MEDIO AMBIENTE
OFICINA DE PARTES Y ARCHIVO
Nº INGRESO: 2000 / 1315
FECHA: - 6 MAR 2000
DESPACHADO: 07/03/00
OBS.:

+ correo

Señor
Rodrigo Egaña B.
Director Ejecutivo
Comisión Nacional del Medio Ambiente
Obispo Donoso 6 – Providencia
Presente

Señor Director Ejecutivo:

En respuesta a su Ord. N° 0275, recibido el 22 del presente al regreso de vacaciones de la Universidad de Concepción, y de acuerdo a lo solicitado por usted, se designa como representantes oficial y reemplazante para el Comité Ampliado para la Revisión de las Normas Primarias de Calidad de Aire, a los Profesores Doctores Dietrich von Baer y Alex Berg, respectivamente.

Sin otro particular, saluda atentamente a Ud.,

DR. CARLOS CALVO M.
DECANO

c.c. –Dr. Dietrich von Baer

CCM/eat

Ministerio de Obras Públicas
Gabinete del Subsecretario
Chile

3D # 17551

COMISION NACIONAL DEL MEDIO AMBIENTE
OFICINA DE PARTES Y ARCHIVO
Nº INGRESO: 2167 / 1375
FECHA: 8 MAR 2000
DESPACHADO:
OBS.:

RD. Nº 648 /

ANT.: **ORD.OF.Nº 0000171 CONAMA de fecha 14.01.2000**

MAT.: **Nómina Representante MOP Comité Operativo Revisión Normas Primarias Calidad del Aire.**

SANTIAGO, 7 MAR. 2000

DE : GONZALO CASTILLO NAVASAL
JEFE DE GABINETE SS.OO.PP.

A : SEÑOR ALVARO SABAG RAJEVIC
DIRECTOR EJECUTIVO (S)
COMISIÓN NACIONAL DE MEDIO AMBIENTE

De acuerdo a lo solicitado en el antecedente, en relación al proceso de revisión de las Normas Primarias de Calidad de Aire, correspondiente al Reglamento para la Dictación de Normas de Calidad Ambiental y de Emisión, para lo cual se formará un Comité Operativo, me es grato informar a usted, por instrucciones del Sr. Subsecretario de Obras Públicas, se ha nominado como representante oficial al Sr. Carlos Saavedra Pulgar y al Sr. Manuel Alvarez Cabello, como su reemplazante .

Sin otro particular, saluda atentamente a Ud.,

GONZALO CASTILLO NAVASAL
Jefe de Gabinete
Subsecretario de Obras Públicas

GCN/LHR/lemv.
DISTRIBUCION:
- **Sr. Alvaro Sabag R.**
- **Gabinete Sr.Ministro Obras Públicas**
- **U.T. Medio Ambiente**
- **Ases.Técnica SS.OO.PP.**
- Of.de Partes SS.OO.PP.

CNE
COMISION NACIONAL DE ENERGIA

ORDEN OF. CNE N°: 198/2000

COMISION NACIONAL DEL MEDIO AMBIENTE
OFICINA DE PARTES Y ARCHIVO
Nº INGRESO: 2392 / 1531
FECHA: 15 MAR 2000
DESPACHADO:
ORG.
D. Ejecutivo
17592 / + Correo

ANT: Of. N° 171 del 14 de enero de 2000 de la Comisión Nacional de Medio Ambiente.

REF.: Representantes de la Comisión Nacional de Energía en el Comité de revisión de normas primarias de calidad de aire.

SANTIAGO, 08 MAR 2000

A: SR. RODRIGO EGAÑA
DIRECTOR EJECUTIVO
COMISION NACIONAL DEL MEDIO AMBIENTE

DE: SR OSCAR LANDERRETCHE
MINISTRO PRESIDENTE
COMISIÓN NACIONAL DE ENERGÍA

En relación a su oficio, en el cual solicita nombrar un representante para la participación en el Comité antes mencionado, le informamos a usted que el profesional delegado será Jaime Bravo O.. Jefe Area Medio Ambiente de esta institución, el cual será representado en las reuniones por Andrea Varas C., ingeniero de esta área.

Sin otro particular se despide atentamente,

REPUBLICA DE CHILE
MINISTRO PRESIDENTE
COMISION NACIONAL DE ENERGIA

OSCAR LANDERRETCHE
MINISTRO PRESIDENTE
COMISIÓN NACIONAL DE ENERGÍA

OLG/JBO/AVC/mgb/Comité Norma Calidad aire.doc

Teatinos 120 • Piso 7 • Fono: (56-2) 365 6800 • Fax: (56-2) 695 6404 - 365 6888
E-mail: energia@cne.cl • Web:http//www.cne.cl • Santiago - Chile

GASATACAMA

Santiago, Marzo 08, 2000
GAGG-073/2000

Señor
Rodrigo Egaña Barahona
Director Ejecutivo
COMISIÓN NACIONAL DE MEDIO AMBIENTE
Presente

Estimado Sr. Director Ejecutivo:

En el marco del procedimiento de revisión de normas primarias de calidad del aire para anhídrido sulfuroso, partículas totales en suspensión, monóxido de carbono, ozono y dióxido de nitrógeno, me es muy grato adjuntarle antecedentes científico - técnicos sobre esta materia para ser incorporados al expediente del proceso de elaboración de dicha norma.

Nor Oeste Pacífico Generación de Energía Ltda. (NOPEL) mantiene en operación en Bahía de Mejillones, II Región de Antofagasta, su Central Termoeléctrica Atacama. Esta Central fue evaluada y aprobada ambientalmente por Resolución de Calificación Ambiental 042/98, la que estableció un Programa de Vigilancia Ambiental de Calidad del Aire en Mejillones por dos años. NOPEL inició dicho Programa tres meses antes de la entrada en operación de la Central. En este sentido, le adjuntamos una tabla resumen de los datos medidos por la estación de monitoreo ubicada en la ciudad de Mejillones. Dichos datos corresponden a PM10, óxidos de nitrógeno, monóxido de carbono y ozono. Además de estos antecedentes, nuestra empresa cuenta con información detallada sobre la materia, la cual ponemos a su disposición.

Finalmente, quisiéramos llamar su atención sobre la importancia de esta información, puesto que corresponde a datos recientes y representativos de una estación de monitoreo de calidad del aire en Mejillones. Así, estimamos que nuestras mediciones son de gran relevancia, y esperamos que sean un aporte para el proceso de revisión de normas primarias de calidad del aire.

Atentamente

Rudolf Araneda Kauert
Gerente General
Nor Oeste Pacífico Generación de Energía Ltda.

GASODUCTO ATACAMA (CHILE): Gasoducto Atacama Cia. Ltda. Oficina Central, Santiago: Isidora Goyenechea 3365, Piso 8, Tel: (56-2) 366 3800 - Fax: 366 3801 - 02 - Las Condes
Oficina Calama: Parque Industrial APIAC Klm.2, Camino Antofagasta, Tel: (55) 34 9300 - Fax: (55) 34 9311
GASODUCTO (ARGENTINA): Gasoducto Cuenca Noroeste Ltda., Filial Argentina: Ruta Provincial Nº 1, Km 5 1/2, El Arenal, San Salvador de Jujuy, Tel:(54-3884-22 2141) Fax: (54-3884 - 23 7133) Código Postal: 4.600
GENERACION ELECTRICA: Noroeste Pacífico Generación de Energía Ltda. (NOPEL) Oficina Central Stgo: Isidora Goyenechea 3365, Piso 8, Tel: (56 2) 366 3800 - Fax: 366 3884 - 366 3802
Oficina Mejillones: Costanera Oriente s/n Barrio Industrial; Construcción: Tel: (55) 62 1780 Fax: (55) 62 1782 - Operaciones: Tel: (55) 62 3160 Fax: (55) 62 3170

Tabla 1. Resumen de Resultados mediciones de Contaminantes Gaseosos
Estación Mejillones. Período del 01 de junio al 31 de enero del 2000

Contaminante (ug/m^3)	Valor Medio Mes				Valor Máximo Diario				Valor Máximo Horario				Valor Mínimo Diario				Valor Mínimo Horario				Limite Máximo Permisible	
	Jun	Jul	Ago	Sep	Jun	Jul	Ago	Sep	Jun	Jul	Ago	Sep	Jun	Jul	Ago	Sep	Jun	Jul	Ago	Sep	Diario	Horario
Ozono	12	3	5	4	21	13	13	12	49	37	61	27	4	0	0	1	0	0	0	0	-	160
Oxidos de Nitrógeno	8	4	11	8	10	9	16	11	48	49	126	29	3	1	5	4	0	0	2	0	-	-
Oxido Nítrico (NO)	4	3	4	4	7	9	8	6	39	49	117	25	1	1	1	2	0	0	0	0	-	-
Dioxido de Nitrógeno	1	1	7	4	3	5	10	6	6	11	13	13	0	0	5	2	0	0	0	0	80 (*)	-
Monoxido de Carbono	200	200	200	0	300	300	400	200	1,400	800	2,400	1,000	100	0	100	0	0	0	0	0	10.000 (+)	40,000

Contaminante (ug/m^3)	Valor Medio Mes				Valor Máximo Diario				Valor Máximo Horario				Valor Mínimo Diario				Valor Mínimo Horario				Limite Máximo Permisible	
	Oct	Nov	Dic	Ene	Jun	Jul	Ago	Sep	Jun	Jul	Ago	Sep	Jun	Jul	Ago	Sep	Jun	Jul	Ago	Sep	Diario	Horario
Ozono	4	4	8	6	8	9	16	12	25	27	33	37	1	2	1	2	0	0	0	0	-	160
Oxidos de Nitrógeno	5	2	8	6	7	4	13	9	31	10	35	22	3	0	5	3	0	0	0	0	-	-
Oxido Nítrico (NO)	1	0	3	5	2	2	5	8	16	5	12	16	0	0	2	1	0	0	0	0	-	-
Dioxido de Nitrógeno	4	2	3	2	6	3	4	3	26	9	13	9	1	1	1	1	0	0	0	0	80 (*)	-
Monoxido de Carbono	100	100	100	100	200	300	300	100	1,500	2,700	2,200	1,500	0	0	0	0	0	0	0	0	10.000 (+)	40,000

(+): Concentración media máxima intervalo de 8 horas

(*): Promedio diario máximo, según normas Confederación Suiza.

Tabla 2. Resumen resultados de concentración de PM10
Estación Mejillones. Período del 01 de junio al 31 de enero del 2000

Fecha de Muestreo	PM10 ug/m³N
31-May-99	33
3-Jun-99	24
6-Jun-99	26
9-Jun-99	20
12-Jun-99	28
15-Jun-99	40
18-Jun-99	13
21-Jun-99	41
24-Jun-99	28
27-Jun-99	30
30-Jun-99	25
3-Jul-99	8
6-Jul-99	25
9-Jul-99	38
12-Jul-99	21
15-Jul-99	36
18-Jul-99	16
21-Jul-99	25
24-Jul-99	34
27-Jul-99	32
30-Jul-99	25
2-Ago-99	32
5-Ago-99	32
8-Ago-99	37
11-Ago-99	35
14-Ago-99	(*)
17-Ago-99	25
20-Ago-99	22
23-Ago-99	24
26-Ago-99	44
29-Ago-99	28
1-Sep-99	19
4-Sep-99	21
7-Sep-99	17
10-Sep-99	28
13-Sep-99	23
16-Sep-99	38
19-Sep-99	34
22-Sep-99	21
25-Sep-99	23
28-Sep-99	(*)

Fecha de Muestreo	PM10 ug/m³N
2-Oct-99	20
5-Oct-99	17
8-Oct-99	19
11-Oct-99	20
14-Oct-99	33
17-Oct-99	36
20-Oct-99	23
23-Oct-99	20
26-Oct-99	17
29-Oct-99	21
31-Oct-99	19
1-Nov-99	21
4-Nov-99	19
7-Nov-99	18
10-Nov-99	20
13-Nov-99	20
16-Nov-99	23
19-Nov-99	27
22-Nov-99	22
25-Nov-99	21
28-Nov-99	12
1-Dic-99	16
4-Dic-99	23
7-Dic-99	30
10-Dic-99	27
13-Dic-99	22
16-Dic-99	22
19-Dic-99	21
22-Dic-99	22
25-Dic-99	15
28-Dic-99	12
31-Dic-99	20
1-Ene-00	24
4-Ene-00	17
7-Ene-00	19
10-Ene-00	17
13-Ene-00	23
16-Ene-00	22
19-Ene-99	25
22-Ene-99	21
25-Ene-99	24
28-01-99	19
31-01-99	11
PROMEDIO	**23**

10/03/00

Identificador Interno **17.592** 000035

Número asignado en el Libro **225/FAX** Fecha Ingreso **10/03/00**

Origen **CNE, OSCAR LANDERRETCHE**

Tipo Documento : **ORDEN OF.CNE N°198/2000, 08.03.00** Prioridad **NORMAL**

Con Copias .

Destino : **EGAÑA BARAONA RODRIGO** Dpto./Unidad **DIRECCION EJECUTIVA**

Descripción : DA RESPUESTA A OF. N°171 E INFORMA QUE PARTICIPARA EN EL COMITE DE REVISION DE NORMAS PRIMARIAS DE CALIDAD DE AIRE JAIME BRAVO O., REPRESENTADO POR ANDREA VARAS C.-

Primera Derivación P. Matus

ENVIADO A JEFE DE		PARA		TIPO DE DOCUMENTO		PLAZO PARA GENERAR ACCION PEDIDA
Dirección Ejecutiva	☐	Conocimiento	☒	Secreto	☐	
Fiscalía	☐	Informar al Respecto	☐	Confidencial	☐	
Administración, Finanzas y Person	☐	Dar curso/Tramites	☐	Reservado	☐	
Evaluación de Impacto Ambiental	☐	Resolver	☒	Ordinario	☐	
Descontaminación, Planes y Norma	☐	Preparar Respuesta	☐			
Gestión SINIA y S. de informació	☐	Responder Directamente	☐	Observaciones :	ei / cc Directora.	
Recursos Naturales	☐	Acuse Recibo	☐			
[redacted]articipación Ciudadana	☐	Biblioteca	☐			
Economía Ambiental	☐	Su Opinión	☐			
Unidad de Proyectos	☐	Dar Audiencia	☐			
Asesor Técnico	☐	Dar Difusión	☐			
Relaciones Internacionales	☐	Reclasificar	☐			
Política	☐	Otro				
Regiones	☐					
Comunicaciones	☐					
Cooperación Internacional	☐					
Adquisiciones	☐					
Capacitación	☐					
Dirección Regional Conama	☐					
N° Región						

Segunda Derivación

ENVIADO A :

1.- Rodrigo

[redacted]-

3.-

Observaciones

PARA	1	2	3	UNA VEZ HECHO	1	2	3
Conocimiento	☑	☐	☐	Devolverme Dcto.	☐	☐	☐
Resolver	☑	☐	☐	Reportar Avance	☐	☐	☐
Preparar Respuesta	☐	☐	☐	Archivar	☐	☐	☐
Adjuntar Antecedentes	☐	☐	☐	Otro	☐	☐	☐
Acusar Recibo	☐	☐	☐				
Dar Difusión	☐	☐	☐	Plazo			
Visto Bueno	☐	☐	☐				

Tercera Derivación

ENVIADO A :	PARA		UNA VEZ HECHO		OBSERVACIONES
	Conocimiento	☐	Devolverme Dcto.	☐	
	Resolver	☐	Reportar Avance	☐	
	Preparar Respuesta	☐	Archivar	☐	
	Adjuntar Antecedentes	☐	Otro	☐	
	Acusar Recibo	☐			
	Dar Difusión	☐			
	Visto Bueno	☐			

Referencia a : Archivado en :

Firma responsable 13-03-2000

DF Partes #2251 - Ingresar

FROM : COMISION NACIONAL DE ENERGIA PHONE NO. : 56 2 Mar. 08 2000 01:03PM P1

Fol - 17592

COMISION NACIONAL DE ENERGIA

000036

ORDEN OF. CNE Nº: 198/2000

ANT: Of. Nº 171 del 14 de enero de 2000 de la Comisión Nacional de Medio Ambiente.

REF.: Representantes de la Comisión Nacional de Energía en el Comité de revisión de normas primarias de calidad de aire.

SANTIAGO, 08 MAR 2000

A: SR. RODRIGO EGAÑA
DIRECTOR EJECUTIVO
COMISION NACIONAL DEL MEDIO AMBIENTE

DE: SR OSCAR LANDERRETCHE
MINISTRO PRESIDENTE
COMISIÓN NACIONAL DE ENERGÍA

En relación a su oficio, en el cual solicita nombrar un representante para la participación en el Comité antes mencionado, le informamos a usted que el profesional delegado será Jaime Bravo O., Jefe Area Medio Ambiente de esta institución, el cual será representado en las reuniones por Andrea Varas C., ingeniero de esta área.

Sin otro particular se despide atentamente,

REPUBLICA DE CHILE
MINISTRO PRESIDENTE
COMISION NACIONAL DE ENERGIA

OSCAR LANDERRETCHE
MINISTRO PRESIDENTE
COMISIÓN NACIONAL DE ENERGÍA

OLG/JBO/AVC/mgb/Comité Norma Calidad aire.doc

Comisión Regional del Medio Ambiente
Región del Bio Bio

COMISION NACIONAL DEL MEDIO AMBIENTE
OFICINA DE PARTES Y ARCHIVO
Nº INGRESO: 2229 / 1414
FECHA: 10 MAR 2000
DESPACHADO:
OBS.:

1.7641

000037

ORD. Nº 00160 /2000

ANT.: Ord.Nº791 de 06/03/2000

MAT: Designa profesional, proceso revisión Normas Primarias de Calidad de Aire.

CONAMA
COMISION NACIONAL DEL MEDIO AMBIENTE

Concepción, 08 de marzo del 2000

A: SRA. PATRICIA MATUS C.
JEFE DPTO. DESCONTAMINACION, PLANES Y NORMAS

DE: DIRECCION REGIONAL CONAMA BIO BIO

Mediante la presente informó a Ud. que hemos designado al Ing. Germán Oyola Fuentes, representan de esta Dirección Regional para participar en el proceso de revisión de las normas referenciadas, esto es, Comité Operativo y como coordinador Regional del proceso.

Sin otro particular, le saluda atentamente,

COMISION NACIONAL DEL MEDIO AMBIENTE
DIRECTOR REGIONAL
REGION DEL BIO BIO

BOLIVAR RUIZ ADAROS
DIRECTOR REGIONAL CONAMA
REGION DEL BIO BIO

cc.
- Archivo CONAMA
- Calidad de Aire

BRA/GOF\gof
Aire206.doc

000038

CONAMA
COMISION NACIONAL DEL MEDIO AMBIENTE

OF. ORD. N° 000926

ANT.:. Oficios 171 y 172 de fecha 14 de enero de 2000, Oficio 791 de fecha 6 de marzo de 2000, solicitando representante Comité Operativo y Comité Ampliado.

MAT.: Invita a reunión Revisión Normas de Calidad de Aire.

SANTIAGO 14 MAR 2000

DE : PATRICIA MATUS C.
JEFE DEPTO. DESCONTAMINACIÓN, PLANES Y NORMAS
COMISIÓN NACIONAL DEL MEDIO AMBIENTE

A : MIEMBROS DEL COMITÉ OPERATIVO Y AMPLIADO

Por medio del presente y en relación a la revisión de las normas de calidad de aire para SO2, PTS, CO, O3 y NO2 (Resolución Exenta N°1514 de la Dirección Ejecutiva de CONAMA), le invito a usted a una reunión de Comité Operativo y Ampliado para dar inicio al proceso de revisión de las mismas.

La reunión tiene por objeto, en primer lugar: dar a conocer aspectos generales del procedimiento mediante el cual se revisarán las normas y proponer la metodología de trabajo a seguir y en segundo lugar: dar a conocer los antecedentes disponibles a la fecha para la revisión de las normas.

La reunión se efectuará el día lunes 27 del presente en oficinas de CONAMA, piso 7, y se dará inicio a las 10:00 horas de acuerdo al siguiente programa:

1. 10:00 – 12:00 horas: Procedimiento elaboración de normas de calidad ambiental. Metodología de trabajo.

2. 15:00 – 17:00 horas: Presentación del Estudio, Antecedentes para la Revisión de las Normas Contenidas en la Resolución 1215, a cargo del Sr. Jaime Solari, SGA-IBERSIS.

Durante el proceso de revisión de las normas se formarán grupos de trabajo por contaminante.

Solicito a usted confirmar su asistencia e indicar el grupo de trabajo en el cual podrá participar, a más tardar el día miércoles 22 del presente (Fono 2405729, Fax 244 3436, E-mail: eavila@conama.cl).

Sin otro particular, le saluda atentamente a usted,

PATRICIA MATUS C.
Jefe Depto. Descontaminación, Planes y Normas
Comisión Nacional del Medio Ambiente

RLCH/eab

Distribución:

Comité Operativo

Julio Monreal, División de Medio Ambiente, Ministerio de Salud	639 7110
Erwin Oyanader, Unidad de Medio Ambiente, Ministerio de Minería	673 1130
Andrés Portales, Ministerio de Transporte y Telecomunicaciones	695 4344
Rafael Lorenzini, Secretario Ejecutivo, Producción Limpia	664 4318
Carlos Saavedra, Ministerio de Obras Públicas	361 2749
Pedro Santic, Comisión Chilena del Cobre	382 8300
Jaime Bravo, Comisión Nacional de Energía	365 6888
Juan Sánchez, Servicio de Salud Metropolitano del Ambiente, SESMA	671 3542
Manuel Zamorano, Servicio de Salud Antofagasta	55-221 972
Maricel Lavín, Servicio de Salud Viña del Mar - Quillota	32-680 428
Guillermo Carrasco, Servicio de Salud O'Higgins	72-226 902
Sergio Castro, Director Servicio de Salud Concepción	41-227 733
Roberto Fuentes, Director, Servicio de Salud Valparaíso - San Antonio	32-212160
Alex Caniulao, Servicio de Salud Talcahuano	41-409 183
Pedro Díaz, Servicio de Salud Araucanía Sur	45-407 138
María Angélica Ruiz-Tagle, CONAMA II Región	55-268 200
Gerardo Guzmán, CONAMA V Región	32-232 776
Sergio Alcayaga, CONAMA VI Región	72-239 106
Germán Oyola, CONAMA VIII Región	41-242 849
Rocío Toro, CONAMA IX Región	45-238 211
Patricio Vallespín, CONAMA Región Metropolitana	671 7710

Comité Ampliado

Marcos Lima, Corporación Nacional del Cobre, CODELCO	690 3059
Eduardo Giesen, Empresa Nacional de Minería, ENAMI	637 5452
Carlos Salvo, Sociedad Nacional de Minería, SONAMI	334 9700
Fernando Valenzuela, Sociedad Nacional de Minería, SONAMI	334 9700
Enrique Accorsi, Presidente Colegio Médico	633 0940
Mauricio Ilabaca, Sociedad Chilena de Epidemiología	236 2450
Rodrigo Cerda, Representante OPS/OMS	264 9311
Flavia Liberona, RENACE	225 8909
Ximena Abogabir, Casa de la Paz	777 5065
Anibal Mege, Sociedad de Fomento Fabril, SOFOFA	391 3200
Alfredo Cánepa, Asociación de Industrias Metalúrgicas y Metalmecánicas	264 9311
Fernando Muñoz, Consultora Claiss	664 3624
Jaime Solari, SGA Ibersis	232 5070
Leonel Gil, Depto. Bioquímica, Universidad de Chile	777 4216
Paulina Pino, Escuela de Salud Pública, Universidad de Chile	204 7848
Luis Cifuentes, Depto. Ingeniería Industrial, P. Universidad Católica de Chile	552 1608
Jeannette Vega, Depto. de Salud Pública, P. Universidad Católica de Chile	633 1840
Dietrich von Baer, Facultad de Farmacia, Universidad de Concepción	41-231 903
Máximo Honorato, Colegio de Ingenieros de Chile	777 8681
Roberto Abeliuk, Instituto de Ingenieros de Chile	697 1136
Rosa Moreno, Greenpeace Pacífico Sur	204 0162
Hernán Sandoval, Chile Ambiente	341 5322
Fernando Valenzuela, Consejo Minero	230 6255
Demetrio Marinakis, Asociación Metropolitana de Transporte	369 6695
Manuel Oyarzún, CIMAB, Facultad de Medicina, Universidad de Chile	274 1628
Giorgio Solimano, Escuela de Salud Pública, Universidad de Chile	735 5582

COMISION NACIONAL DEL MEDIO AMBIENTE
OFICINA DE PARTES Y ARCHIVO
Nº INGRESO: 2533 / 1624.
FECHA: 17 MAR 2000
DESPACHADO:
OBS.: 13
P. Matus
1890 + correo

000040

CONAMA
COMISION NACIONAL DEL MEDIO AMBIENTE

ORD.: ________________/2000
ANT.: Of. ORD Nº 000791 del 06.03.2000
MAT.: Revisión Normas Primarias de Calidad de Aire

Fecha: Temuco, marzo 10 de 2000

De: **Director CONAMA IX Región**
Sr. Víctor Durán R.

A: **Jefa Depto. Descontaminación, Planes y Normas**
Dra. Patricia Matus C.

En respuesta a vuestra correspondencia del ANT., comunico a usted que se ha nominado a la profesional RocíoToro R. de esta Dirección Regional, para participar en el proceso de revisión de las Normas Primarias de Calidad de Aire (PTS, CO, O3, SO2 y NO2).

Sin otro particular, le saluda atentamente,

COMISION NACIONAL DEL MEDIO AMBIENTE
DIRECTOR REGIONAL

Víctor Durán Rivera
Director Regional CONAMA
Región de La Araucanía

VDR/RTR
Distribución: Indicada
Archivo

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COMISIÓN NACIONAL DEL MEDIO AMBIENTE (CONAMA)
DIRECCIÓN REGIONAL – SEXTA REGIÓN
DEL LIBERTADOR GENERAL BERNARDO O'HIGGINS
SAH/XUA/jog.

COMISION NACIONAL DEL MEDIO AMBIENTE
OFICINA DE PARTES Y ARCHIVO
Nº INGRESO: 2667/1719
FECHA: 21 MAR 2000
DESPACHADO:
OBS.: P. Matus 12/30
13020

MEMORANDUM Nº 028 /

RANCAGUA 20 MAR 2000

A: DRA. PATRICIA MATUS C., JEFA DEPARTAMENTO DESCONTAMINACIÓN PLANES Y NORMAS, CONAMA
DE: SR. SERGIO ALCAYAGA H., DIRECTOR CONAMA SEXTA REGION
MATERIA: ENVÍA NOMBRE DEL REPRESENTANTE DE ESTA OFICINA REGIONAL EN EL COMITÉ OPERATIVO DE LAS NORMAS PRIMARIAS DE CALIDAD DE AIRE..

En virtud de lo solicitado en su Ord. Of. Nº 000791 del 6 de marzo, del Departamento Descontaminación , Planes y Normas, informo a usted que la Sra. Ximena Ubilla Alvarez será el representante de esta Dirección Regional en el Comité Operativo de las normas primarias de calidad de aire para SO2, PTS, CO, O3 y NO2.

Sin otro particular. Saluda cordialmente a usted,

COMISION NACIONAL DEL MEDIO AMBIENTE
DIRECTOR REGIONAL
VI REGION

Sergio Alcayaga Herrera
Director
Comisión Nacional de Medio Ambiente
Sexta Región

Cc.: Archivo

COMISIÓN NACIONAL DEL MEDIO AMBIENTE
REGIÓN DE ANTOFAGASTA

18152

CONAMA
COMISION NACIONAL DEL MEDIO AMBIENTE

ORD. Nº : 0129 / 2000

MAT. : Da respuesta al Oficio Nº 721 del 06 de marzo del 2000; y al Oficio Nº 000926 del 14 de marzo del 2000.-

Antofagasta, 22 de Marzo del 2000.

A : Patricia Matus C.
Depto. de Descontaminación, Planes y Normas
Comisión Nacional del Medio Ambiente

DE : Director Regional (s)
CONAMA II Región

De mi consideración:

Por intermedio del presente se da respuesta a los siguientes documentos remitidos por usted, detallados a continuación:

- En respuesta al Oficio Nº 791 del 06 de marzo del 2000; se ha nombrado como representante de Conama II Región para el Comité Operativo a la Sra. María Angélica Ruiz-Tagle.
- En respuesta al Oficio Nº 000926 del 14 de marzo del 2000; indicamos nuestra intención de participar en el grupo de trabajo de SO2.

Sin otro particular, le saluda cordialmente a usted,

COMISION NACIONAL DEL MEDIO AMBIENTE II REGION DIRECTOR REGIONAL

María Angélica Ruiz-Tagle Borquéz
Director Regional (s)
Conama Región de Antofagasta

COPIA FIEL DE ORIGINAL

MRT/VHV/MOR/scc
c.c.: - Archivo CONAMA II Región.

COMISION NACIONAL DEL MEDIO AMBIENTE
OFICINA DE PARTES Y ARCHIVO
Nº INGRESO: 2921 / 1903
FECHA: 27 MAR 2000
DESPACHADO:
OBS.:

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MINISTERIO DE SALUD
SISTEMA NAC. DE SERVICIOS DE SALUD
SERVICIO DE SALUD TALCAHUANO
SUBDIRECCION DEL AMBIENTE
UNIDAD DE CONTROL INDUSTRIAL

ORD. : 117
ANT. : Ord. 171/00 CONAMA, Santiago.
MAT. : Revisión Normas Primarias de Calidad de Aire.

TALCAHUANO 09 MAR. 2000

DE: SR. JORGE RAMOS VARGAS
SUBDIRECTOR DEL AMBIENTE
SERVICIO DE SALUD TALCAHUANO

A : SRA. PATRICIA MATUS
JEFA DEPTO. DESCONTAMINACION PLANES Y NORMAS
COMISION NACIONAL DEL MEDIO AMBIENTE, SANTIAGO

En atención a la solicitud de la designación de un representante en el Comité Operativo de la Revisión de Normas Primarias de Calidad de Aire, por parte de nuestro Servicio de Salud podemos informar lo siguiente:

- Representante Oficial: Sr. Alex Caniulao Castro Ingeniero Civil Químico, encargado del Programa de Contaminación Atmosférica y de la Unidad del Sistema de Evaluación Impacto Ambiental.
- Reemplazante: Sr. Hugo Rojas Bousoño Ingeniero (E) Prevención de Riesgos, Jefe Departamento de Unidades Técnicas, Subdirección del Ambiente.

Correo electrónico: sdamb@ssthno.cl
Fono: (41)-409180
Fax: (41)-409183

Saluda atentamente a Usted.

Por orden del Señor Director del Servicio

SERVICIO DE SALUD
SUBDIRECTOR DEL AMBIENTE
TALCAHUANO

DR. JORGE RAMOS VARGAS
SUBDIRECTOR DEL AMBIENTE
SERVICIO DE SALUD TALCAHUANO

JRV/ING(E)HRB/ING(CQ)SFG/ING(CQ)ACC/acc.
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- La indicada
- Subdirección del Ambiente.
- U.C.I.N.
- Of. Partes.
- cc. SEREMI SALUD VIII Reg.

COMISIÓN NACIONAL DEL MEDIO AMBIENTE
DEPARTAMENTO DE DESCONTAMINACIÓN, PLANES Y NORMAS

Revisión Norma de Calidad Primaria contenidas en la Resolución Nº 1215/78

ACTA DE REUNION DE COMITÉ OPERATIVO Y AMPLIADO

FECHA REUNION : 27 de marzo de 2000
LUGAR : CONAMA. Obispo Donoso 6. Santiago
ASISTENCIA : Se adjunta hoja de asistencia

Tabla :

1. Presentación de disposiciones generales (Rodrigo Lucero, Depto. Descontaminación, Planes y Normas)

Discusión :

- **D.VanBaer** (*UdeConcepción*) consulta si la metodología de trabajo en grupos considera también ralizar reuniones plenarias para informar sobre el avance de todos los grupos. **R.Lucero** (*CONAMA*) afirma que están contempladas reuniones plenarias e informa que el avance del proceso se podrá encontrar también en Internet.

- **A.Mege** *(SOFOFA)* consulta si se cuenta con datos actualizados, posteriores a 1997, considerando por ejemplo el uso del gas natural en fuentes fijas en la RM. **R.Lucero** (*CONAMA*) señala que se cuenta con datos actualizados de la RM y otras regiones, aunque a nivel regional es más complicado.

- **C.Salvo (SONAMI)** indica que no debiera ser necesario mantener el PTS normado. **R.Lucero** (*CONAMA*) señala que será parte del proceso definir eso.

Rodrigo Lucero Ch.
Depto. Descontaminación, Planes y Normas
CONAMA

COMISION NACIONAL DEL MEDIO AMBIENTE
DEPTO. DESCONTAMINACION, PLANES Y NORMAS

Reunión "Revisión Normas Primarias de Calidad de Aire para SO2, PTS, CO, NO2 Y O3"
Santiago, marzo 27 de 2000

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9.	Teresa Figueroa	RENACE	2234483	" "	RENACE@rdc.cl
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11.	Alex Caviolao C	S.S. TALCAHUANO	409180	409183	sdamb@ssthno.cl
12.	Mª DE LA LUZ VASQUEZ	MIN. MINERIA	6723566	6731130	[illegible]@[illegible].cl
13.	RODRIGO CERDA CANDIA	OPS/OMS	2649300	2649311	CERDAR@CHI.OPS-OMS.ORG
14.	JEANETTE VEGA	U. CATOLICA	6863038	6331840	jvega@med.puc.cl
15.	Mª Angélica Ruiz-Tagle	CONAMA II REGION	268200	268200	
16.					
17.					

jeanvega@reuna.cl

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N°	NOMBRE	INSTITUCION	FONO	FAX	E-MAIL
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48.	Roberto Abeliuk	Inst. Ingenieros CH2M Hill	2319205	2334046	r_abeliuk@yahoo.com
49.	Aníbal Mege	SOFOFA	3913130	3913210	amege@sfF.cl
50.	Andrés Muñoz	ASIMET	2216513	2033025	andres.munoz@asimet.cl
51.	ALFREDO CANEPA	ASIMET	2468619	2468657	acan@cristalchile.cl
52.	Andrea Varas C	C.N.E.	3656800	3656888	avaras@CNE.CL
53.	Aldo Bouyer G.	Servicio Salud Valpo.	239209	239209	abouyer@tutopia.com
54.	CARLOS SARZO	SONAMI	2308686	2308666	—
55.	Richard Vargas	Serv. Sal. Concep.	201591	201595	rvargas@ssconcepcion.cl
56.	Pedro Díaz G.	S.S. Araucanía Sur	45-407136	45-407138	asurdpa@telsur.cl
57.	Eduardo Fisen	ENAMI	6375477	6375452	efiesen@enami.cl
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N°	NOMBRE	INSTITUCION	FONO	FAX	E-MAIL
18.	Dr. Andrei N. Tchernitchin	Colegio Médico de Chile	6786222		atcherni@machi.med.uchile.cl
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20.	Andrés Portales M.	MINTRATEL	4213407	6954344	aportale@mtt.cl
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22.	Patricia Vargas A.	Casa de la Paz / ACPEM	2349060	3343830	emical@chilesat.net
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24.	Guillermo Carrasco Suazo.	Servicio de Salud O'Higgins	72-227040	72-226902	✓ ✓
25.	Santiago Sanhueza	RENACE.	223.4483		
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27.	Fernando Valenzuela	Consejo Minero	2306301	2306255	fvalenzuela@exxon.com
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Revisión Normas Primarias de Calidad de Aire para SO2, PTS, CO, NO2 Y O3

Grupo de Trabajo para NO2

Nombre	Institución	Email
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ANDREA VARAS	CNE	AVARAS@CNE.CL
Ximena Ubilla	CONAMA VI	xubilla.6@conama.cl
Cecilia Godoy González.	Servicio de Salud O'Higgins.	S/E-MAIL. FAX 72 226 802.

Revisión Normas Primarias de Calidad de Aire para SO2, PTS, CO, NO2 Y O3

Grupo de Trabajo para O3

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CLAUDIO CORVALAN R.	CONAMA V REGION	CCORVALAN.5@CONAMA.CL.
Aldo Bouyer G.	servicio salud Valpo.	abouyer@tutopia.com

Revisión Normas Primarias de Calidad de Aire para SO2, PTS, CO, NO2 Y O3

Grupo de Trabajo para CO

Nombre	Institución	Email
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Cortes		
Jeanette Jugo	U Católica	jjugo@med.puc.cl

Revisión Normas Primarias de Calidad de Aire para SO2, PTS, CO, NO2 Y O3

Grupo de Trabajo para SO2

Nombre	Institución	Email
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Manuel Quesada	"	"
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Alex Caniulao C	S.S. TALCAHUANO	sdamb@ssthno.cl
Mª TERESA CASTRO B.	GREENPEACE	
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Andrea Varas C.	C.N.E.	avaras@cne.cl
Cecilia Godoy González	Servicio de Salud O'Higgins	—
Guillermo Jamasao Suazo	Servicio de Salud O'Higgins	—
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REVISION NORMAS PRIMARIAS DE CALIDAD DE AIRE PARA SO2, NO2,O3,CO Y PTS

Comisión Nacional del Medio Ambiente
Depto. Descontaminación, Planes
y Normas

PROGRAMA DE LA REUNION

10:00.
- Procedimiento Dictación Normas Ambientales
- Proceso de Revisión Normas

11:00
- Café

11:15
- Inscripción Grupos de Trabajo

15:00
- Presentación estudio realizado por SGA, Sr. Jaime Solari

ANTECEDENTES GENERALES

Normas ambientales:

- Normas de calidad ambiental
  - Primarias: Protege la salud de la población.
  - Secundaria: Protege los recursos naturales y el patrimonio ambiental.
- Normas de emisión

ANTECEDENTES GENERALES

Normas de Calidad Ambiental:

- Las normas de calidad ambiental fijan estándares ambientales, a cuyo cumplimiento deben orientarse el diseño de políticas públicas y la actividad productiva

PROCEDIMIENTO DICTACION NORMAS DE CALIDAD AMBIENTAL

- Según el Art. N°32 y 40 de la Ley N° 19300:

  Un reglamento establecerá el procedimiento para la dictación de normas de calidad ambiental y de emisión

- El Reglamento D.S Nº 93/95 del Ministerio Secretaría General de la Presidencia establece el procedimiento para la dictación de normas de calidad ambiental y de emisión

REGLAMENTO DICTACION NORMAS DE CALIDAD AMBIENTAL

Disposiciones Generales:

- El reglamento contempla procesos de coordinación interna de los organismos públicos competentes y la participación del sector productivo y organizaciones sociales

- Las normas primarias de calidad ambiental tienen aplicación en todo el territorio de la república

- Las normas primarias de calidad ambiental se dictan mediante D.S del Ministerio Secretaría General de la Presidencia y del Ministerio de Salud

REGLAMENTO DICTACION NORMAS DE CALIDAD AMBIENTAL

Disposiciones Generales:

- La coordinación del proceso de generación de normas corresponde a CONAMA
- El Director ejecutivo de CONAMA podrá previa aprobación del Consejo Directivo de CONAMA crear Comités Operativos que intervengan en la dictación de una norma
- La tramitación del proceso dará origen a un expediente público de la norma y a una tabla pública

REGLAMENTO DICTACION NORMAS DE CALIDAD AMBIENTAL

Disposiciones Generales:

- En marzo de cada año la Dirección Ejecutiva de CONAMA propone al Consejo Directivo un Programa Priorizado de dictación de normas de calidad ambiental y de emisión

PROCEDIMIENTO Y CRITERIOS PARA LA REVISION DE NORMAS VIGENTES

- Toda norma de calidad ambiental y de emisión será revisada a lo menos cada cinco años
- La revisión de las normas deberá sujetarse a criterios de eficacia de la norma y de eficiencia en su aplicación

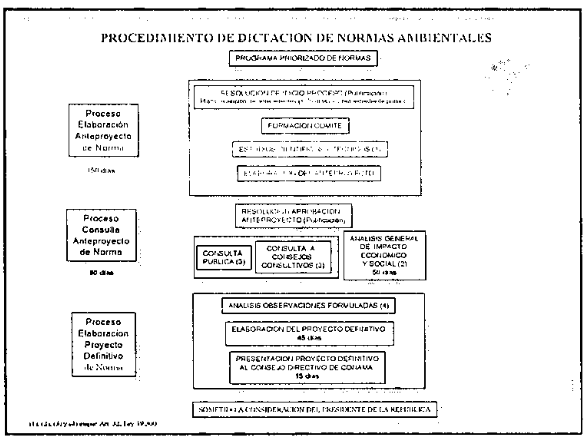
PROCEDIMIENTO Y CRITERIOS PARA LA REVISION DE NORMAS VIGENTES

Los criterios para su revisión se ponderarán según:

- Antecedentes considerados para la determinación de la norma
- Nivel de cumplimiento y vigencia actual de los objetivos al momento de su dictación
- Cambios en las condiciones ambientales
- Resultados de investigaciones científicas que aporten nuevos antecedentes

PRINCIPALES ETAPAS PARA LA DICTACION O REVISION DE NORMAS DE CALIDAD AMBIENTAL

- Elaboración del anteproyecto de norma
- Evaluación del impacto económico y social del Anteproyecto
- Consulta a organismos competentes públicos y privados del anteproyecto de norma
- Análisis de observaciones formuladas al anteproyecto y elaboración del proyecto definitivo norma.
- Aprobación del proyecto definitivo de norma por el Consejo Directivo y sometimiento a consideración del Presidente de la República



EXPEDIENTE PUBLICO

Contenido:

- Resoluciones que se dicten
- Consultas evacuadas
- Observaciones que se formulen
- Todos los datos y documentos relativos a la dictación o revisión de la norma

ANTEPROYECTODE NORMA

Contenidos:

- Fundamentos, objetivo y definiciones.
- Valores de la norma.
- Valores que definen situaciones de emergencia.
- Metodologías de medición y control de la norma.
- Organismos encargados de la fiscalización.
- Plazos de entrada en vigencia de la norma.

CONSULTA DEL ANTEPROYECTO

- Cualquier persona, natural o jurídica, podrá formular observaciones al anteproyecto, dentro de los plazos establecidos
- Las observaciones deberán ser fundadas y entregarse por escrito a CONAMA

ANALISIS DEL IMPACTO ECONOMICO Y SOCIAL DEL ANTEPROYECTO

Análisis del impacto económico y social de la norma evalúa la aplicación de la norma en términos de costos y beneficios para:

- La población, ecosistemas, especies directamente afectadas o protegidas
- Emisores que deberán cumplir la norma
- Estado como responsable de su fiscalización

PARTICIPACION CIUDADANA

- Publicación programa priorizado de normas
- Publicación de resolución de inicio
- Expediente público.
- Tabla pública
- Publicación de extracto de anteproyecto
- Etapa consulta pública
- Publicación en el Diario Oficial de la norma
- Mecanismo de reclamo

PROCESO DE REVISION DE LAS NORMAS DE CALIDAD DE AIRE PARA SO_2, CO, NO_2, O_3 Y PTS

- En el tercer Programa Priorizado de Normas (1998/1999) se estableció la revisión de las normas de calidad de aire para los contaminantes SO_2, NO_2, O_3, CO y PTS.

COMITE OPERATIVO

- Ministerio de Salud
- Ministerio de Minería
- Ministerio Transporte y Telecomunicaciones
- Ministerio de Obras Públicas
- Ministerio de Economía
- COCHILCO
- Comisión Nacional de Energía
- Servicio de Salud Metropolitano del Ambiente

COMITE OPERATIVO:

- Servicio de Salud de Antofagasta
- Servicio de Salud Viña del Mar-Quillota
- Servicio de Salud de Valparaíso - San Antonio
- Servicio de Salud O'Higgins
- Servicio de Salud de Concepción
- Servicio de Salud de Talcahuano
- Servicio de Salud de Araucanía Sur

COMITE AMPLIADO:

Funciones:

- Proponer y entregar antecedentes para la toma de decisiones
- Emitir observaciones y opiniones a las decisiones que sean tomadas por el Comité Operativo

COMITE AMPLIADO:

- Colegio Médico
- Sociedad Chilena de Epidemiología
- OPS/OMS
- Renace
- Casa de la Paz
- Consejo Minero
- CODELCO - Chile
- ENAMI
- SONAMI
- SOFOFA
- ASIMET

COMITE AMPLIADO

- Greenpeace
- Universidad de Chile
- Pontificia Universidad Católica de Chile
- Universidad de Concepción
- Colegio Ingenieros de Chile
- Instituto Ingenieros de Chile
- Chile Ambiente
- Asociación Metropolitana de Transportes

CRONOGRAMA

Actividades	Plazo	2 0 0 0											
		ene	feb	mar	abr	may	jun	jul	ago	sep	oct	nov	dic
Resolución inicio	05-Ene												
Recepción antecedentes	15-Mar												
Anteproyecto Norma	03-Jun												
Evaluación económica	25-Jul												
Consulta pública	02-Ago												
Análisis Observaciones	16-Sep												
Proyecto definitivo	16-Sep												
Aprobación Consejo Directivo													

ACTIVIDADES REALIZADAS
A LA FECHA

- Estudio "Generación de antecedentes para la revisión de las normas contenidas en la Res. N°1215.
- Reuniones con diferentes Ministerios
- Recopilación Antecedentes

ANTECEDENTES DISPONIBLES

Información:

- Estudio "Generación de Información para la Revisión de los Contaminantes contenidos en la Res. N°1215 (SGA):
  - Efectos del contaminante en la salud (nacional e internacional)
  - Niveles de calidad de aire en Chile
  - Comparación con normas internacionales
  - Metodologías de medición
  - Criterios considerados para fijar norma
  - Criterio para manejo de excedencias
  - Normas para situaciones de emergencia
  - Fiscalización y cumplimiento de la Res. 1215
  - Evaluación técnico - económica

ANTECEDENTES DISPONIBLES

Información:

- Resultados Estudio SGA:
  - Propuesta inicial de normas
  - Evalución técnico - económica de la aplicación de la propuesta inicial.
  - Propuesta de norma definitiva.

ANTECEDENTES DISPONIBLES

Información:

- Documentos de base utilizados para el establecimiento de la normativa vigente en la CE (1999/30/CE) (SO2, NOX)
  - Efectos en salud
  - Evaluación del riesgo en salud
  - Evaluación niveles de concentración
  - Evaluación de costos
- Estudio de Calidad de Aire en Regiones Urbanos - Industriales de Chile, Proyecto COSUDE.

ANTECEDENTES DISPONIBLES

Información:

- Resultados de monitoreo de calidad de aire y emisiones asociado Planes de Descontaminación vigentes
- Resultados de monitoreo de monitoreo de calidad de aire asociado a centros urbanos y generada por estudios de impacto ambiental, solicitada a CONAMAs Regionales

ANTECEDENTES DISPONIBLES

Modelos:

- Modelación a escala Regional para macrozonas
  - VI Región
  - V Región
  - Región Metropolitana

OTROS ANTECEDENTES

Expertos Internacionales :

- Expertos Escuela de Salud Pública, Universidad de Harvard.
  - Fecha probable: Mayo-Junio
- Expertos de la Agencia Ambiental Suiza: División Control Atmosférico.
  - Fecha probable: Mayo y Agosto

ORGANIZACION DEL TRABAJO

- Se trabajará en grupos por contaminantes.
- Existirá un coordinador general del proceso (Rodrigo Lucero)
- Existirán tres coordinadores según contaminantes:
  - Para CO y PTS: Andrea Muñoz
  - Para NO2 y O3: Fernando Farías
  - Para SO2: Rodrigo Lucero

ORGANIZACION DEL TRABAJO

- Evaluación Económica y Social del Anteproyecto:
  - Juan Ladrón de Guevara, Unidad de Economía Ambiental de CONAMA
- Participación Ciudadana:
  - Rodrigo Calderón, Unidad de Participación Ciudadana de CONAMA

ORGANIZACION DEL TRABAJO

Se estima la siguiente programación para las reuniones de Comité Operativo y/o Comité Ampliado:

- Días de reunión:
  - Lunes y Martes según contaminante
- Frecuencia de reuniones por contaminante:
  - SO_2 y O_3 : Dos veces por mes
  - CO y NO_2 : 1 vez cada tres semanas
  - PTS : Una vez por mes

ORGANIZACION DEL TRABAJO

Próxima reunión:

- Grupo PTS, SO_2 y O_3: Lunes 17 Abril
- Grupo CO y NO_2 : Martes 18 Abril
  - Presentación antecedentes específicos por contaminante:
    - Antecedentes en salud
    - Normativa Internacional
    - Nivel de cumplimiento de las normas en Chile
    - Fuentes emisoras y niveles de emisión
  - Requerimiento de nuevos antecedentes

ORGANIZACION DEL TRABAJO

Principales vías de distribución de información:

- E-MAIL
- Página WEB CONAMA

GOBIERNO DE CHILE
COMISION NACIONAL
DEL MEDIO AMBIENTE

Con fecha 30 de marzo de 2000 se archivaron bajo los números que a continuación se indican los siguientes antecedentes para la Revisión de las Normas Primarias de Calidad de Aire para CO, O3, NO2, SO2 y PTS:

1-NOR-1/00 Estudio Antecedentes para la Revisión de las Normas de Calidad de Aire contenidas en la Resolución N°1215, del Ministerio de Salud, SGA Ibersis.

2-NOR-1/00 Estudio de Calidad de Aire en regiones urbano-industriales de Chile, COSUDE.

3-NOR-1/00 Council Directive, on ambient air quality assessment and management, European Communities.

RODRIGO LUCERO CH.
Depto. Descontaminación, Planes y Normas
Comisión Nacional del Medio Ambiente

GOBIERNO DE CHILE
COMISION NACIONAL
DEL MEDIO AMBIENTE

Con fecha 30 de marzo de 2000 se archivaron los documentos que a continuación se indican sobre antecedentes para la Revisión de las Normas Primarias de Calidad de Aire para CO, O3, NO2, SO2 y PTS:

1. Anhídrido Sulfuroso y Material Particulado.
2. Información Monitoreo de polvo sedimentable, Dirección Regional XII Región, Aysén.
3. Información Monitoreo Calidad de Aire de CO, NOx O3, PTS y SO2, Dirección Regional II Región.
4. Información Monitoreo Calidad de Aire SO2, NO2, Huasco, Dirección Regional III Región.
5. Resolución N°1215, del Ministerio de Salud.
6. Documento Contraloría General de la República, Resolución N°1215.
7. Análisis de antecedentes para la revisión de normas de calidad contenidas en la Resolución N°1215, Claiss.
8. Guidelines for Equality, WHO Geneva, 1999.
9. Directiva 1999, Comunidad Europea (CE) del Consejo, relativa a los valores límite de dióxido de azufre, dióxido de nitrógeno y óxidos de nitrógeno, partículas y plomo en el aire ambiente.

RODRIGO LUCERO CH.
Depto. Descontaminación, Planes y Normas
Comisión Nacional del Medio Ambiente

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Sulfur dioxide and particulate matter

General Description

Sulfur dioxide (SO_2) and particles derived from the combustion of fossil fuels are major air pollutants in urban areas of the world. Sulfur oxides (SO_x) and particulate matter are parts of a complex pollutant mixture. For guideline purposes, a division into three categories is appropriate:

(*a*) sulfur dioxide,

(*b*) the acid aerosols that may result from the oxidation of sulfur dioxide in the atmosphere, and

(*c*) sulfur dioxide plus particles.

Sulfur dioxide. Sulfur dioxide is a colourless gas that reacts on the surface of a variety of airborne solid particles. It is readily soluble in water and can be oxidized within airborne water droplets.

Sulfur dioxide results from the combustion of sulfur-containing fossil fuels, the smelting of sulfur-containing ores, and other industrial processes. Domestic fires can also produce emissions containing sulfur dioxide.

Acid aerosol. Sulfuric acid (H_2SO_4) is a strong acid that is formed from the reaction of sulfur trioxide gas (SO_3) with water. Sulfuric acid is strongly hygroscopic. As a pure material, it is a clear colourless liquid with a boiling-point of 330 °C. Ammonium bisulfate (NH_4HSO_4), which is less acidic than sulfuric acid as a pure material, is a crystalline solid, with a melting-point of 147 °C.

Particulate matter. Airborne particulate matter represents a complex mixture of organic and inorganic substances. Mass and composition tend to divide into two principal groups: coarse particles larger than 2.5 μm in aerodynamic diameter, and fine particles smaller than 2.5 μm in aerodynamic diameter. The smaller particles contain the secondarily formed aerosols (gas to particle conversion), combustion particles and recondensed organic and metal vapours. The larger particles usually contain earth crustal materials and fugitive dust from roads and industries. The acid component of particulate matter, and most of its mutagenic activity, is generally contained in the fine fraction, although in fog some coarse acid droplets are also present.

Because of the complexity of particulate matter and the importance of particle size in determining exposure, multiple terms are used to describe particulate matter. Some terms are derived from and defined by sampling methods, e.g. suspended particulate matter, total suspended particulates, black smoke. Other terms refer more to the site of deposition in the respiratory tract, e.g. inhalable, thoracic particles that deposit primarily in the lower respiratory tract below the larynx. Other terms, such as PM_{10} (particulate matter with an aerodynamic diameter of $10 \mu m$), have both physiological and sampling components.

Methods for sampling and analysing suspended particulate matter were discussed by WHO *(1)* and the US Environmental Protection Agency (EPA) *(2)*. These methods included "smoke" measurements, which may represent the darkness of stain obtained on a white filter-paper through which air has been passed (according to the British smoke method, sometimes referred to as the black smoke method), and also total suspended particulate measurements (gravimetric measurement of particulates of all sizes collected on a glass fibre filter by a high volume sampler according to the method of the US Department of Health, Education, and Welfare *(3)*, as well as by several other methods).

Respirable particles *(1)*, typically with a $4.5 \mu m$ aerodynamic diameter (50% cut-off point), are collected by the black smoke method and its variations; some particles up to $7–9 \mu m$ are also collected.

Methods to measure total suspended particulates (by high volume sampler) have been used extensively in the USA. There are problems with this method, however, in that the size range of particles sampled extends well beyond those particles that are able to penetrate the upper respiratory tract, and in arid regions the method is liable to sample wind-entrained dust of noncombustive origin. This problem has been recognized by US EPA who recommended that particulate matter of less than $10 \mu m$ aerodynamic diameter (PM_{10}) be measured, as a better indicator of health-related particles.

Recommendations have been made by the International Organization for Standardization (ISO) regarding the aerodynamic particle size range corresponding with thoracic penetration *(4)*, and samplers that have acceptance characteristics that approximate that curve are being increasingly used. Such thoracic particle measurements according to the ISO standard (ISO-TP) are roughly equivalent to the sampling characteristics for particulate matter with a 50% cut-off point at $10 \mu m$ diameter.

Sources

Sulfur dioxide

While there are some natural sources of sulfur dioxide (such as volcanoes) that contribute to environmental levels in the European Region, man-made contributions from the combustion of fossil fuels are of prime concern in relation to human exposures. Over the past 10–20 years there has been a tendency towards declining emissions in much of the Region, due to changes in the types or amounts of fuel used. More importantly, however, the types of sources have changed even more, away from small multiple sources (domestic, commercial or industrial) towards large single sources such as power stations, which disperse pollutants at higher altitudes. The net result has been a marked reduction in concentrations of sulfur dioxide in many large cities that were at one time highly polluted. A more widespread distribution, by long-distance transport within the Region, is now the dominant pattern.

Acid aerosol

The major proportion of sulfur emissions from combustion sources is emitted as sulfur dioxide, which is further oxidized to sulfur trioxide in the atmosphere at a rate of 0.5–10% per hour. As a result of the presence of moisture, sulfuric acid is formed; this is present as an aerosol, often associated with other pollutants in droplets or solid particles extending over a wide range of sizes. Most of the sulfuric acid in ambient air results from sulfur dioxide emitted by combustion. Other direct or primary point sources of sulfuric acid include acid manufacturing plants and consuming industries, such as fertilizer and pigment factories.

Sulfuric acid and its partial atmospheric neutralization product, ammonium bisulfate, represent almost all of the strong acid content in the ambient aerosol. The ultimate neutralization product, ammonium sulfate ($(NH_4)_2SO_4$), is only weakly acidic. Other strong acids in the ambient air, e.g. nitric acid (HNO_3) and hydrochloric acid (HCl), will be present as vapours, except when incorporated into fog droplets.

Because of its hygroscopic property, sulfuric acid in ambient air will always be present as a solution droplet whose H^+ concentration varies with ambient humidity. Pure ammonium bisulfate can be present as a salt crystal at humidities up to 80%. However, once it is dissolved into droplet form it will not become a crystal again until the humidity falls below 69%. Once inhaled into the moist respiratory tract, it will take up water vapour and deposit as dilute droplets.

Particulate matter

Suspended particulate matter is a term used to cover a range of finely divided solids or liquids that originate from a number of natural or man-made sources.

Particulate matter of respirable size may be emitted from a number of sources, some of them natural (e.g. volcanoes and dust storms) and many others that are more widespread and more important (e.g. power plants and industrial processes, vehicular traffic, domestic coal burning, industrial incinerators). The majority of these non-natural sources are concentrated in limited portions of the territory, i.e. the urbanized areas, where populations are also concentrated *(1,5)*.

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Occurrence in air

Sulfur dioxide

As a result of the changes in sources, annual mean levels of sulfur dioxide in major cities of Europe, stated earlier by WHO *(1)* to be within the range 100–200μg/m^3, are now largely below 100μg/m^3. Similarly, there has been a decline in maximum daily mean values, which are now mainly in the range 250–500μg/m^3. Peaks over shorter averaging periods, such as 1 hour, extend to 1000–2000μg/m^3 and in some situations higher transient peaks may also occur. Indoor concentrations of sulfur dioxide are generally lower than outdoor concentrations, since absorption of sulfur dioxide occurs on walls, furniture, clothes and in ventilation systems. An exception is occupational exposure, where concentrations of several thousand micrograms may occur regularly *(1)*.

Data on European concentrations of sulfur dioxide and deposition of other sulfur compounds are based either on national monitoring networks, which are largely concentrated in urban areas, or on cooperative programmes for the study of the long-range transport of pollutants *(6,7)*. Natural concentrations of sulfur dioxide are normally below 5μg/m^3. The annual mean sulfur dioxide concentrations in most rural areas of Europe are between 5μg/m^3 and 25μg/m^3. However, as a result of the common practice of using high chimneys to disperse emissions, there are also large rural areas in Europe where average concentrations now exceed 25μg/m^3. Sulfur dioxide is often accompanied by elevated levels of nitrogen oxides (NO_x) *(8)*.

Acid aerosol

Current average acid aerosol levels in Europe and North America are not known. The highest current levels reported in recent years have been summarized by Lioy & Lippmann *(9)*. They are in the range of 20–30μg sulfuric acid per m^3 (6–12 hours average) in various parts of North America, and 28μg sulfuric acid per m^3 in Europe (Berlin (West)). The highest reported level in the United Kingdom was 680μg sulfuric acid per m^3 (1-hour average) in London in 1962. Higher levels were almost certainly present in London in earlier years. Maximum ambient concentrations are likely to occur in urban fogs or downwind of coal- and oil-fired power plants and industrial sources. The distribution of secondary acidic aerosol is much more general, ambient levels depending on the rates of sulfur dioxide oxidation and the subsequent neutralization of sulfuric acid in the ambient air by ammonia (NH_3). Rates of sulfur dioxide oxidation depend on ambient temperature, humidity, and concentrations of oxidants and catalytic components of particles in the atmosphere and cloud droplets. Rates of ammonia neutralization depend on the strength of ammonia sources and atmospheric mixing. Ammonia emissions are lowest over water and afforested regions, and higher over urban and agricultural regions. Indoor sources of sulfuric acid are generally not significant except in some occupational environments.

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Particulate matter
In rural areas within Europe, black smoke values range from near zero to about $10 \mu g/m^3$. In the larger cities, annual mean concentrations of smoke range from 10 to $40 \mu g/m^3$. Where gravimetric measurements of particulates are made, the annual values lie between about 50 and $150 \mu g/m^3$. Corresponding maxima are $100–250 \mu g/m^3$ (black smoke) and $200–400 \mu g/m^3$ (suspended particulate matter gravimetric).

Conversion factors

Sulfur dioxide

$$1\,\text{ppm} = 2860 \mu g/m^3$$
$$1\,mg/m^3 = 0.35\,\text{ppm}$$

Acid aerosol
Acidic aerosol concentrations can be expressed as μmols of H^+/m^3 or as sulfuric acid equivalent in $\mu g/m^3$. There are $98 \mu g$ per μmol.

Particulate matter
As indicated, no generally applicable conversion factors can be set between black smoke values and various gravimetric particulate matter values (e.g. total suspended particulates or ISO-TP).

Routes of Exposure

Inhalation is the only route of exposure that is of interest in relation to the effects of sulfur dioxide, acidic aerosol and suspended particulate matter on human health. For some special substances, which are constituents such as lead and some highly toxic organic compounds, other routes of uptake such as the alimentary tract may also be of interest. In this context, however, only health effects on the respiratory tract will be considered.

Kinetics and Metabolism

Sulfur dioxide
Absorption of sulfur dioxide in the mucous membranes of the nose and upper respiratory tract occurs as a result of its solubility in aqueous media. The absorption is concentration-dependent, with 85% absorption in the nose at $4–6\,mg/m^3$ and about 99% at $46\,mg/m^3$. Only minimal amounts reach the lower respiratory tract *(2,10,11)*. From the respiratory tract, sulfur dioxide enters the blood. Elimination occurs (after biotransformation to sulfate in the liver), mainly by the urinary route.

Acid aerosol
The deposition pattern within the respiratory tract is dependent on the size distribution of the ambient droplets and humidity. Acidic ambient aerosol typically has a mass median aerodynamic diameter of $0.3–0.6 \mu m$. Thus,

even with hygroscopic growth in diameter in the respiratory airways by a factor of between 2 and 4, particles remain within the fine-particle range and deposit preferentially in the distal lung airways and airspaces. Some neutralization of the droplets can occur before deposition, due to the normal excretion of endogenous ammonia into the airways. Deposited free H^+ reacts with components of the mucus of the respiratory tract, changing its viscosity *(12)*. The unreacted part of H^+ diffuses into surrounding tissues. The capacity of the mucus to react with H^+ is dependent on the H^+ absorption capacity, which is reduced in acidic saturated mucus as found, for example, in asthmatics.

Under fog conditions the ambient acid is incorporated into droplets, with average droplet sizes in the range of 10–15μm. Such droplets can also contain dissolved nitric acid and other acidic vapours. Inhaled fog droplets will deposit primarily in the upper respiratory tract; very little will penetrate to the deeper lung airways, where most of the fine acidic aerosol will deposit.

Particulate matter

As discussed elsewhere *(1,11,13,14)*, a portion of the inhaled aerosol is deposited by contact with airway surfaces and the remainder is exhaled. In inhalation toxicology, the term "deposition" refers to removal from inspired air of inhaled particles. "Clearance" refers to the subsequent removal of deposited material from the respiratory tract. Within a species, deposition of inhaled particles in the respiratory tract depends mainly on breathing pattern and particle size (aerodynamic diameter). Larger particles (10μm and above) are mainly deposited in the extrathoracic part of the respiratory tract (above the epiglottis) and the main proportion of particles 5–10μm in size are deposited in proximity to the fine airways (respiratory bronchioles) with normal nasal breathing. With mouth breathing, the regional deposition pattern changes markedly, extrathoracic deposition being reduced and tracheobronchial and pulmonary deposition enhanced. The proportion of mouth breathing to nose breathing increases with exercise and conversation *(15)*.

During mouth breathing, fine particles ($<$2.5μm aerodynamic equivalent diameter (D_{ae})) deposit primarily in the pulmonary region; between about 3 and 5μm D_{ae} significant deposition in both the pulmonary and the tracheobronchial regions occurs; at larger sizes (about 7–15μm D_{ae}), deposition is predominantly in the tracheobronchial region as opposed to the pulmonary region *(16)*.

Health Effects

Sulfur dioxide

Acute effects

High concentrations of sulfur dioxide can give rise to severe effects in the form of bronchoconstriction and chemical bronchitis and tracheitis, as seen in animal experiments *(1)* and in occupational exposures to more than 10 000 $\mu g/m^3$. Concentrations of sulfur dioxide in the range 2600–2700 $\mu g/m^3$ give rise to frank effects with bronchospasm in asthmatics *(17)*.

The effects of concern in relation to short-term exposures are those on the respiratory tract. There is an extremely large variability of sensitivity to sulfur dioxide exposure among individuals. This is true for normal persons, but especially so if asthmatics are included *(12)*. Asthmatics have very labile airways and resistance is likely to change in response to many other stimuli, including pollens *(1,2,11)*. Effects observed in asthmatics at relatively low concentrations of sulfur dioxide under laboratory exposure situations are listed in Table 1.

Effects of repeated and/or long-term exposures

Repeated short-term occupational exposure to high concentrations of sulfur dioxide combined with long-term exposure to lower concentrations can give rise to an increased prevalence of chronic bronchitis, especially in cigarette smokers. A possible contribution of simultaneously occurring sulfuric acid aerosol has, however, not been examined in these studies *(24)*. Several epidemiological studies have associated the occurrence of pulmonary effects in communities with combined exposure to sulfur dioxide and particulates.

A continuum of response to sulfur dioxide exposures at relatively low concentrations has been observed in laboratory investigations of human volunteers. The magnitude of the effects was much enhanced when subjects increased their breathing rates through exercise. The findings in a wide range of studies among asthmatics (Table 1) are consistent with a linear relationship *(25)* between magnitude of effect (in terms of proportionate increase in airway resistance) and dose of sulfur dioxide delivered to the airways (after allowing for removal of a substantial proportion in the nose or mouth). Thus, in a strict sense it would be difficult to define a lowest-adverse-effect level since the effect appears to be a function of the sensitivity of the subject, concentration, duration of exposure (10 minutes being the most usual duration of test exposure), level of activity and mucus rheological properties. It was, nevertheless, considered that effects of concern to the health of exercising asthmatic subjects were demonstrable down to sulfur dioxide levels of about 1000 $\mu g/m^3$, with discernible effects of less certain consequence below that level.

Another aspect, of greater importance to public health, is the proportion of the population liable to be affected. Detailed information regarding the proportion of asthmatic or otherwise sensitive people in the community is not available, although estimates of around 5% have been suggested.

Sensory effects

At concentrations of 10 000 $\mu g/m^3$, sulfur dioxide has a pungent, irritating odour. Since the odour threshold of sulfur dioxide is several thousand $\mu g/m^3$, this criterion is not critical in relation to public health.

Acid aerosol: effects on experimental animals

Acute exposures

Respiratory mechanical function. Alterations of pulmonary function, particularly increases in pulmonary flow resistance, occur after acute exposure. Reports of the irritant potency of various sulfate species are variable *(2,11)*, owing in part to differences in animal species and strains, and also to differences in particle size, pH, composition and solubility. Sulfuric acid is more potent than any of the sulfate salts in terms of increased airway irritancy. For short-term (1-hour) exposures, the lowest concentration of sulfuric acid reported to increase airway resistance was $100 \mu g/m^3$ (in guinea pigs). The irritant potency of sulfuric acid depends in part on particle size, with smaller particles having more effect.

Particle clearance function. Donkeys exposed by inhalation for 1 hour to $0.3–0.6 \mu m$ sulfuric acid at concentrations ranging from 100 to $1000 \mu g/m^3$ exhibited slowed bronchial mucociliary clearance function at concentrations of $\geqq 200 \mu g/m^3$, while rabbits undergoing similar exposures showed an acceleration of clearance at concentrations between 100 and $300 \mu g/m^3$, and a progressive slowing of clearance at concentrations of $\geqq 500 \mu g/m^3$ *(26)*.

Subchronic exposures

Particle clearance function. Donkeys exposed for 1 hour per day, 5 days per week, for 6 months to an aerosol ($0.3–0.6 \mu m$) of sulfuric acid at a concentration of $100 \mu g/m^3$ developed highly variable clearance rates, and a persistent shift from baseline rate of bronchial mucociliary clearance during the exposures and for 3 months after the final exposure. During the 3 months of follow-up, 2 animals had much slower clearance than the baseline rate, while 2 had rates faster than the baseline *(26)*. Rabbits exposed for 1 hour per day, 5 days per week for 20 days to $0.3 \mu m$ sulfuric acid at $250 \mu g/m^3$ developed variable mucociliary clearance rates during the exposure period, and their clearance during a 2-week period following the exposure was substantially faster than their baseline rates *(26)*.

Histology. In the study cited above, in which rabbits were exposed to $250 \mu g/m^3$ for 4 weeks and sacrificed 2 weeks later, histological examinations of the airways showed increased numbers of secretory cells in distal airways, and thickened epithelial cell layers in airways extending from medium-sized airways to terminal bronchioles. There were no corresponding changes in the trachea or other large airways *(26)*. In a study in which dogs were exposed daily for 5 years to $1100 \mu g$ sulfur dioxide per m^3 plus $90 \mu g$ sulfuric acid per m^3 and were then allowed to remain in unpolluted air for 2 years, there were small changes in pulmonary functions during the exposure, which continued following the termination of exposure. Morphometric lung measurements made at the end of the two-year post-exposure period showed changes analogous to an incipient stage of human centrilobular emphysema *(14)*.

Table 1. Effects observed in asthmatic subjects during laboratory conditions of exposure to sulfur dioxide

Sulfur dioxide concentration[a] (ppm)	Duration of exposure (min)	Number and type of subject	Type of exposure	Type of activity	Effects[b]	Reference
1, 3, 5	10	7, normal 7, atopic 7, asthmatic	Mouthpiece	Rest	*SRaw* increased significantly at all concentrations for asthmatic subjects, only at 5 ppm for normal and atopic subjects. Some asthmatics exhibited marked dyspnoea requiring bronchodilation therapy	*(18)*
1.0 0.1, 0.25, 0.5	5 10	6, asthmatic 7, asthmatic	Mouthpiece	Exercise	*SRaw* significantly increased in the asthmatic group at 0.5 and 0.25 ppm of sulfur dioxide and at 0.1 ppm in the two most responsive subjects. At 0.5 ppm three asthmatic subjects developed wheezing and shortness of breath	*(19,20)*
0.50	180	40, asthmatic	Oral chamber Nose clips	Rest	*MMFR* significantly decreased 2.7%; recovery within 30 minutes	*(21)*
0.5	10	5, asthmatic	Mouthpiece	Exercise	*SRaw* increases were observed over exercise baseline rates for 80% of the subjects	*(22)*
0.25, 0.5	60	24, asthmatic	Chamber	Exercise	No statistically significant changes in *FVC* or *SRaw*	*(22)*

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0.5	10	5, asthmatic	Mouthpiece	Exercise	*SRaw* increases were observed over exercise baseline rates for 80% of the subjects	*(22)*
0.25, 0.5	60	24, asthmatic	Chamber	Exercise	No statistically significant changes in *FVC* or *SRaw*	*(22)*
0.30	120	19, asthmatic	Chamber	Exercise	No pulmonary effects seen with 0.3 ppm of sulfur dioxide and 0.5 ppm of nitrogen dioxide exposure compared to exercise baseline	(23)

[a] 0.1 ppm of sulfur dioxide ≅ 262 μg/m³; 0.5 ppm ≅ 1310 μg/m³; 1.0 ppm ≅ 2620 μg/m³; 5.0 ppm ≅ 13 100 μg/m³; 10 ppm ≅ 26 200 μg/m³; 50 ppm ≅ 131 000 μg/m³.

[b] Significant increase or decrease noted here refers to "statistically significant" effects, independent of whether the observed effects are "medically significant" or not. Abbreviations are as follows: *SRaw*, specific airway resistance; *MMFR*, maximum mid-expiratory flow rate; *FVC*, forced vital capacity.

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Acid aerosol: effects on humans

Acute effects

Respiratory mechanical function. Sulfuric acid and other sulfates have been found to affect both the sensory and the respiratory function in humans.

Respiratory effects from exposure to sulfuric acid (350–500$\mu g/m^3$) have been reported to include increased respiratory rate and decreased maximal inspiratory and expiratory flow rates and tidal volume *(2,11)*. However, other studies of pulmonary function in nonsensitive healthy adult subjects indicated that pulmonary mechanical function was little affected when subjects were exposed to 100–1000μg sulfuric acid per m^3 for 10–120 minutes. In one study, the bronchoconstrictive action of carbachol was potentiated by sulfuric acid and other sulfate aerosols, more or less in relation to their acidity. Asthmatics are substantially more sensitive in terms of changes in pulmonary mechanics than healthy people, and vigorous exercise potentiates the effects at a given concentration. The lowest-demonstrated-effect level for sulfuric acid was 100$\mu g/m^3$ via mouthpiece inhalation in exercising adolescent asthmatics. The effects were relatively small and disappeared within about 15 minutes. In adult asthmatics undergoing similar protocols, the lowest-observed-effect level was 350$\mu g/m^3$ *(11,27)*.

Particle clearance function. In healthy nonsmoking adult volunteers exposed to 0.5μm sulfuric acid at rest at 100$\mu g/m^3$ for 1 hour, there was an acceleration of bronchial mucociliary clearance of particles which deposited primarily in large thoracic airways, and a slowing of clearance when the exposure was raised to 1000$\mu g/m^3$. For particles that deposited primarily in medium-sized and small airways, there was a small but significant slowing of clearance at 100$\mu g/m^3$ and a greater slowing at 1000$\mu g/m^3$. These changes are consistent with the greater deposition of acid in medium-sized to smaller airways. Exposures to 100$\mu g/m^3$ for 2 hours produced slower clearance than the same exposure for 1 hour, indicating a cumulative relationship to dose *(26)*.

Effects of longer-term exposure

Kitagawa *(28)* identified sulfuric acid as the probable causal agent for approximately 600 cases of respiratory disease in the Yokkaichi area of central Japan between 1960 and 1969. The patients' homes were concentrated within 5 km of a titanium dioxide plant with a 14 m stack that emitted from 100 000 to 300 000 kg sulfuric acid per month in the period 1961–1967. The average concentration of sulfur trioxide in February 1965 in Isozu, a village 1–2 km from the plant, was 130$\mu g/m^3$, equivalent to a sulfuric acid concentration of 159$\mu g/m^3$. Kitagawa estimated that peak concentrations might be up to 100 times as high when a north wind was blowing. Electrostatic precipitators were installed to control aerosol emissions in 1967, and after 1968 the number of newly found patients with "allergic asthmatic bronchitis" or "Yokkaichi asthma" gradually decreased. Kitagawa's quantitative estimates of exposure to sulfuric acid and the criteria used to describe cases of respiratory disease may differ from current methods. The unique aspect of this report is the identification of sulfuric acid as the likely causal agent for excess morbidity.

Other evidence of links between high concentrations of ambient sulfuric acid and effects on human health is more circumstantial. Sulfuric acid concentrations in the ambient air were certainly much higher than current levels during the classic episodes in London, the Meuse valley, and Donora, but so were concentrations of many other pollutants. Similarly, the decline in the prevalence of chronic bronchitis in the United Kingdom over the past three decades could have been due to the decline in emissions of any of several pollutants. However, on mechanistic grounds and in view of known exposure–response relationships, sulfuric acid is a more plausible candidate than sulfur dioxide, carbonaceous particles and other known constituents *(29)*.

In an analysis of 1980 cross-sectional mortality for the USA *(30)*, predictors of mortality due to air pollution were expressed in terms of four aerosol pollutant surrogates, i.e. total suspended particulates, inhalable particles $< 15 \mu m$, fine particles $< 2.5 \mu m$, and sulfate (SO_4^{2-}). Among these, only fine particles and sulfate had statistical significance as predictors of response, but these two surrogates' P values were typically < 0.01.

The measured sulfate includes strong acids (sulfuric acid), the less acidic salt (ammonium bisulfate) and the fully neutralized salt (ammonium sulfate). Since the H^+/SO_4^{2-} ratio is highly variable in time and location and is often close to zero, sulfate is a relatively poor surrogate for acid aerosol concentration. The conclusion that sulfate is a better surrogate for the active component of fine particles than the other three surrogates does not necessarily make it a good one *(29)*. It does, however, lend support to the hypothesis that H^+ is the active agent *(12)*. Unfortunately, epidemiological studies are not available by which mortality and/or morbidity can be related to the acidity (i.e. H^+ ion concentration) of respirable particles *(29)*. This would be expected to constitute a more appropriate measurement *(12)*.

Sensory effects

The odour threshold for sulfuric acid has been estimated to be $750 \mu g/m^3$ on the basis of one study and $3000 \mu g/m^3$ on the basis of another *(2)*.

Sulfur dioxide and particulate matter

Short-term health effects related to 24-hour average values of sulfur dioxide and particulate matter

Variations in 24-hour average concentrations of sulfur dioxide, black smoke and total suspended particulates have been associated with increased mortality, morbidity and deficits in pulmonary function tests *(1,2,11)*. Regression analysis of daily pollution variables in relation to urban death rates results in significant coefficients, even after accounting for temperature and other associations. These relationships cannot clearly establish a threshold effect. However, on the basis of the London studies *(31)* in which 24-hour concentrations of sulfur dioxide and black smoke were above $500 \mu g/m^3$, the daily mortality increased significantly above baseline rates. This does not

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preclude the possibility that mortality effects occur below these concentrations. In fact, recent time-series analyses of New York City mortality data over 15 years *(32)* suggest that variations in fine particle measures can explain approximately 5% of the fluctuation in mortality, regardless of weather effects. Concentrations in a range below 500 μg black smoke per m^3 were reported in the London analysis, but a different measurement method was used in the report from the USA. Short-term effects of air pollution have been investigated in several studies involving responses in "sensitive" populations. Panel studies of asthmatic individuals have been the most frequently used design *(11)*. Some of the earlier studies, using the responses of asthmatics to varying daily pollution levels, have not been relied upon, primarily because of their small sample size and inadequate exposure measurements. In addition, incidences of illness within a population of bronchitic patients have been studied with respect to daily air pollution concentrations. Significant changes in patients' conditions were observed when black smoke exceeded 250 μg/m^3 and sulfur dioxide exceeded 500 μg/m^3 *(33)*. Taking into account indications from some other studies, as in the earlier WHO report *(1)*, the minimum level of smoke and sulfur dioxide needed to produce effects was taken as 250 μg/m^3.

In some studies, deviations in pulmonary function measures have been observed in children and adults that are associated with short-term fluctuations in particulate concentrations *(1,2,11,34,35)*. In another study of approximately 200 children living in an industrialized community, a statistically significant negative mean slope of forced vital capacity (FVC) and forced expiratory volume (FEV) was found for total suspended particulates (11–272 μg/m^3) and sulfur dioxide (0–281 μg/m^3), with a correlation coefficient $r = 0.75$ *(36)*. In this study total suspended particulate measurements were complemented by parallel inhalable particle measurements *(37,38)*. Since inhalable particle values are generally similar to thoracic particle values, it was possible to estimate total suspended particulates/ISO-TP ratios. From the data collected by Dockery et al. *(36)* it can be calculated that in those 25% of children who were most sensitive, there was at least a four times greater deficit in pulmonary function compared with those of average sensitivity (for this subgroup a decrease in FEV of 0.39 ml/μg per m^3 was observed). Those effects are associated with concentrations of total suspended particulates in the range of 150–200 μg/m^3 (in the presence of sulfur dioxide), although total suspended particulate concentrations have frequently exceeded 260 μg/m^3. Minimum levels for effects were judged to be 180 μg/m^3 in the presence of sulfur dioxide. Relating total suspended particulates to ISO-TP would result in the same deficit in pulmonary function at concentrations of thoracic particles above 110 μg/m^3 in the presence of sulfur dioxide. These values are estimated using specific total suspended particulates/ISO-TP ratios *(37)*.

Although these changes are of health concern, the physiological significance of such apparently reversible effects on the immediate or long-term health of the individual is unknown.

In Table 2 the evidence on short-term health effects is summarized in terms of the lowest-observed-effect levels of air pollutants on health.

Table 2. Summary of effects on human health of lowest-observed-effect levels of sulfur dioxide and particulate matter (short-term exposure)

Effect	24-hour mean exposure to:			
	SO_2 ($\mu g/m^3$)	smoke ($\mu g/m^3$)	total suspended particulates ($\mu g/m^3$)	thoracic particles ($\mu g/m^3$)
Excess mortality	500	500		
Increased acute respiratory morbidity (adults)	250	250		
Decrements in lung function (children)			180	110

Long-term health effects related to annual means of sulfur dioxide and particulate matter

Mortality. Variations in mortality (all causes) and, more specifically, in mortality from cardiorespiratory diseases have been found during comparison of the findings from different cities in several countries *(1)*. Multiple-regression analyses, using various indices of pollution (as long-term means), together with socioeconomic factors, indicate associations with pollutants (particulates and sulfate being the ones generally incorporated in analyses in the USA) that account for a small proportion (about 4%) of the variation in death rates between cities *(30,39–41)*. Thus, it could be said that there are discernible effects of long-term exposure to the pollution complex of the particulate matter/sulfur dioxide type at relatively low annual mean levels, but it is considered that no firm guidance on lowest-observed-effect levels can be given on the basis of relationships of this type.

Morbidity. Further epidemiological studies on differences in the prevalence of respiratory symptoms (adults and children) and the frequency of respiratory illness (children) between communities with differing levels of pollution have provided results that are consistent with the conclusions reached earlier by WHO *(1)*, indicating detectable increases where annual mean concentrations of both black smoke and sulfur dioxide exceed $100 \mu g/m^3$ *(42,43)*. Other pollutants, such as sulfates (or acid sulfates) may be relevant, but no measurements were available in the studies in question. The more recent studies have mainly been analysed using multiple-regression models, taking confounding variables into account as far as possible *(44,45)*. In this way, the relative importance of different factors

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Table 4. Guideline values for combined exposure to sulfur dioxide and particulate matter[a]

	Averaging time	Sulfur dioxide ($\mu g/m^3$)	Reflectance assessment: black smoke[b] ($\mu g/m^3$)	Gravimetric assessment: Total suspended particulates (TSP)[c] ($\mu g/m^3$)	Gravimetric assessment: Thoracic particles (TP)[d] ($\mu g/m^3$)
Short term	24 hours	125	125	120[e]	70[e]
Long term	1 year	50	50	—	—

[a] No direct comparisons can be made between values for particulate matter in the right- and left-hand sections of this table, since both the health indicators and the measurement methods differ. While numerically TSP/TP values are generally greater than those of black smoke, there is no consistent relationship between them, the ratio of one to the other varying widely from time to time and place to place, depending on the nature of the sources.

[b] Nominal $\mu g/m^3$ units, assessed by reflectance. Application of the black smoke value is recommended only in areas where coal smoke from domestic fires is the dominant component of the particulates. It does not necessarily apply where diesel smoke is an important contributor.

[c] TSP: measurement by high volume sampler, without any size selection.

[d] TP: equivalent values as for a sampler with ISO-TP characteristics (having 50% cut-off point at $10 \mu m$): estimated from TSP values using site-specific TSP/ISO-TP ratios.

[e] Values to be regarded as tentative at this stage, being based on a single study (involving sulfur dioxide exposure also).

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has been shown more clearly and relationships are taken to be continuous, indicating that effects may well extend below the pollution levels quoted.

Community-based health studies are useful in attributing excess illness rates or differences in pulmonary performance to air pollution. Communities differ for a variety of cultural, social, economic and other factors that can result in different frequencies of illness. While air pollution may contribute to elevated illness rates, it is difficult to describe with certainty a level, an averaging time or even a specific contaminant that is unequivocally associated with a threshold effect level. Increased age-adjusted illness rates are associated with indices for sulfur dioxide, black smoke, total suspended particulates, and fine particles in several studies *(1,2,11)*. Community differences in illness rates can be discerned in several more contemporary studies conducted in the late 1970s and early 1980s. It is of interest to note that the annual sulfur dioxide and total suspended particulate concentrations are lower than the concentrations associated with effects in earlier studies. For instance, in the USA *(46)* differences in community illness rates have been associated with annualized total suspended particulate concentrations ranging from 30 to 100 $\mu g/m^3$ (20–55 $\mu g/m^3$ when the particles measure less than 10 μm in diameter). The two communities with the highest illness rates had particle concentrations (for particles less than 10 μm in diameter) of 35 and 55 $\mu g/m^3$ (annual means).

In the Netherlands, a decreasing difference in respiratory symptom rates between a polluted and a cleaner area was observed *(47)*. Initially, annual average sulfur dioxide concentrations above 200 $\mu g/m^3$ were observed in the polluted area, but after the mid-1970s sulfur dioxide levels were between 45 and 80 $\mu g/m^3$, while black smoke decreased from 34–45 to 25–35 $\mu g/m^3$. In the cleaner area sulfur dioxide values, measured after 1975, were 10–25 $\mu g/m^3$, and black smoke levels, measured after 1982, were 10–15 $\mu g/m^3$. In France *(48)* differences in symptom rates are associated with annual averages of sulfur dioxide over a range of 13–127 $\mu g/m^3$, measured by acidimetry, or a range of 22–85 $\mu g/m^3$, as measured by a specific technique.

Decrements in lung function. Measurements of respiratory physiology were included in several of the studies referred to above. Several of these observations have been reviewed by WHO *(1)*, EPA *(2)* and Ericsson & Camner *(11)*. Studies that have been conducted in the same communities over a period of years show associations between the magnitude of lung function changes and the levels of pollution. One series of such studies, carried out in the USA *(49–51)*, indicated effects associated with particulates (measured as total suspended particulates) at an annual mean of 180 $\mu g/m^3$, though documentation of pollution levels in the series as a whole was incomplete and other pollutants could have been involved. From a more extensive series carried out in the Netherlands *(47)* it has been concluded that consistently lower lung function values in an urban, as compared with a rural, area might point to long-term effects of pollution. While much current information on a wide range of pollutants was available, it was considered that the effect could have related to earlier higher levels, and no firm guidance can be given at this stage in relation to lowest-observed-adverse-effect levels.

Sensory effects
Community exposure to urban air pollutants, including sulfur oxides, nitrogen oxides and particulate matter, may give rise to feelings of discomfort, which can only be assessed subjectively by those persons who are affected *(1,52)*. Annoyance reactions to urban air pollutants are common phenomena. In a Swedish study *(52)* of population groups in central Stockholm, 60% of the population reported annoyance of this kind. One quarter of those were classed as being very annoyed. Comparative studies in suburban areas and smaller Swedish towns disclosed lower prevalence figures for annoyance. Surveys of annoyance are fraught with many problems *(1)*. Since annoyance reactions have a large sociocultural component, prevalence figures in relation to air pollution levels may vary from place to place and should be determined for each locality.

Evaluation of Human Health Risks

Sulfur dioxide
When using the evidence from human experimental studies of sulfur dioxide to draw up recommendations for guideline values aimed at protecting people from the risk of adverse effects, the need to avoid brief exposures to peak values is implied. Some protection (safety) factor may have to be incorporated when using information on the lowest-observed-effect level in order to protect especially sensitive asthmatic patients (who have not been subject to testing), though they would be less likely to be involved in exercise at the levels used in the experimental exposures. In relation to a lowest-observed-effect level of concern to health of $1000 \mu g/m^3$ (10 minutes), it appears reasonable to apply a protection (safety) factor of 2 for the protection of public health; this would give a concentration of $500 \mu g/m^3$ (10 minutes). The occurrence of such concentrations can often be predicted from the frequency distribution of locally measured concentrations, by using some existing models for averaging values over different time periods in the case of diffuse or multiple sources *(53)*.

Predictions for point sources can also be made if the characteristics of the source and the local diffusion conditions are known *(54)*. Frequency distribution characteristics can also help in guiding authorities towards solutions. These frequency distributions are known for a large number of towns in Europe *(55)* and the USA *(56)*. As an example, if the aim were to ensure that the 10-minute mean value of $500 \mu g/m^3$ was not exceeded, then on the basis of calculations of multiple-source situations in the Netherlands *(55)*, the corresponding 1-hour value that should not be exceeded would be $350 \mu g/m^3$.

Acid aerosol
While the data currently available are insufficient to establish a numerical guideline, they do raise serious concern that acidic aerosol could account

for past associations between particulate air pollution and the exacerbation and development of chronic bronchitis.

Recent 1-hour acute experimental inhalation exposure data on humans and two animal species (donkeys and rabbits) show similar exposure–response relationships in terms of transient and reversible changes in the rate of tracheobronchial mucociliary clearance. Comparable exposures, when repeated on a daily basis in the two animal species, produced persistent changes in clearance rates, and in the one species in which histological examinations were made, changes in the airways after only 20 days of exposure were of a similar character to those seen in young human smokers examined at autopsy. The analogy with cigarette smoke, which is a known causal factor in chronic bronchitis, has been pointed out by Lippmann *(29)*.

The association shown in Japan (Yokkaichi) between sulfuric acid aerosols and respiratory morbidity gives support to the hypothesis that acid aerosol is an important component of urban air pollution. This hypothesis is also consistent with the results of cross-sectional studies of daily mortality in major cities in the USA, which indicate that sulfate is a better predictor for mortality than any of the nonspecific gravimetric indices that have been used.

More data on human exposures are clearly needed to test the hypothesis of causality. Situations that would be of concern for monitoring purposes would be those where humans were exposed repeatedly to concentrations at or above $10 \mu g/m^3$ (sulfuric acid or equivalent acidity of aerosol).

Sulfur dioxide and particulate matter

The lowest-observed-effect levels for short-term and long-term (annual mean) average air pollution measurements are summarized in Tables 2 and 3. Evaluation of the measured components of air pollution in relation to public health is, however, difficult for a number of reasons noted in the

Table 3. Summary of effects on human health of lowest-observed-effect levels of sulfur dioxide and particulate matter (long-term exposure)

Effect	Annual mean exposure to:		
	SO_2 ($\mu g/m^3$)	smoke ($\mu g/m^3$)	total suspended particulates ($\mu g/m^3$)
Increased respiratory symptoms or illness	100	100	
Decrements in lung function			180

WHO publication *(1)*. A number of these points still remain largely unresolved. For example, it is not clear whether long-term effects can be related simply to annual mean values or to repeated exposures to peak values. Similarly, it remains uncertain which components of the sulfur dioxide/particulates complex are involved in the adverse effects, though increasingly attention is being given to the role of secondary products such as acid sulfates. Arbitrary protection (safety) factors of 2 in relation to the morbidity and mortality data, and 1.5 for decrements in lung functions (considered to represent a less severe effect), seem to be appropriate according to the present state of knowledge.

Measurements of black smoke can no longer be interpreted in terms of $\mu g/m^3$ in many localities, and decisions have already been made (by ISO) to abandon any attempt at mass equivalence. The method is still of value as an index of soiling capacity and of the type of pollution (coal smoke) that has been associated in the past with adverse health effects, and to provide continuity with any further epidemiological studies. Therefore, observations should be continued.

Various direct gravimetric measurements have been used in recent decades, notably the total suspended particulate measurements (by high volume sampler) in the USA. There are problems, however, with the wide size range of particles sampled and the influence of wind-entrained dust. Although a large body of data on such measurements exists, it is now considered misleading to attempt to specify guidelines in terms of total suspended particulates.

Total suspended particulate measurements may, nevertheless, be used for comparison with newer indices of pollution, and they may be of value as a supplement to gravimetric ISO-TP measurements, especially in areas where there is special concern about larger particles.

Efforts should now be made to establish a method of gravimetric measurement representing more realistically the size range of particles that can be inhaled into the thoracic region, even though uncertainties must remain about the component or components most relevant to health. Recommendations have already been made by ISO regarding the (aerodynamic) particle size range corresponding with thoracic penetration, and it is proposed that samplers should have acceptance characteristics that approximate to that curve.

The inclusion of the somewhat wider size range of particles than those sampled by the black smoke method would mean that, even in areas where coal smoke still forms a dominant part of the suspended particulates, results from these gravimetric instruments would be somewhat higher than might be obtained from co-located smoke samplers. Thus, in those circumstances the corresponding guidelines would be a little higher in true gravimetric terms (possibly by about 10%). Now that the characteristics of present-day pollution differ from those of coal smoke pollution, the old data cannot be used with any confidence as a basis for guidelines.

In view of the considerable uncertainties involved in formulating guidelines for particulate matter, there is a need for further epidemiological studies, particularly in those areas where high concentrations will occur,

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using well defined methods for particulate measurement and epidemiological assessment, including the control of possible confounding factors such as smoking.

Guidelines

Sulfur dioxide
It appears reasonable to apply a protection factor of 2 for the protection of public health; a guideline value of 500$\mu g/m^3$ (10 minutes, not to be exceeded) is recommended. A 1-hour maximum value that conforms with this guideline can be calculated as approximately 350$\mu g/m^3$.

Acid aerosol
Recommendations for air quality guideline values for the strong acid content of ambient aerosol cannot now be made owing to the sparsity of current data on effects and ambient exposure levels. However, monitoring is warranted when levels (sulfuric acid or equivalent acidity of aerosol) exceed 10$\mu g/m^3$. Therefore, ambient air should be regularly monitored for the H^+ ion concentration of the aerosol (which should be sampled in a size-fractionating particulate sampler) when levels of this magnitude are likely to occur.

Combined effects
In proposing guidelines based on the present knowledge of exposure to both sulfur dioxide and particulate matter, an arbitrary protection (safety) factor of 2 has been used in relation to morbidity and mortality, and a factor of 1.5 has been used for the decrement in lung function, which is considered to be a less severe effect. The recommended guideline values are shown in Table 4.

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Table 4. Guideline values for combined exposure to sulfur dioxide and particulate matter[a]

COMISION NACIONAL DEL MEDIO AMBIENTE
XI REGIÓN AYSEN

COMISION NACIONAL DEL MEDIO AMBIENTE
OFICINA DE PARTES Y ARCHIVO
Nº INGRESO: 1448/10612
FECHA: 17 DIC 1999
DESPACHADO:
OBS.: 13.992
D. DATOS

ORD.: 990723 14991.

ANT.: Su Ord. Nº 993613

MAT.: Envía información solicitada.

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Coyhaique, 15 DIC 1999

DE SRA.: MILLARAY HERNÁNDEZ ERAZO - DIRECTORA REGIONAL CONAMA XI REGIÓN AYSEN.

A SRA.: PATRICIA MATUS C. - JEFE DEPARTAMENTO DE DESCONTAMINACIÓN, PLANES Y NORMAS

1. Adjunto remito a Ud. información sobre monitoreo de polvo sedimentable correspondiente al proyecto Fachinal, aprobado por el SEIA.

2. Con respecto a datos de otros contaminantes (CO, NO2, SO2 y O3), comunico a Ud. que no existen programas de monitoreo que los incluyan.

3. Sin otro particular, saluda atentamente a Ud.,

COMISION NACIONAL DEL MEDIO AMBIENTE
DIRECCION XI REGION

MILLARAY HERNÁNDEZ ERAZO
Directora Regional
CONAMA XI Región Aysén

MHE/PMV
Distribución:
- La indicada
- Archivo tipo-ofi2.doc

Nombre de la actividad industrial encargada del monitoreo:

El monitoreo lo realiza la empresa Servicios y Proyectos Ambientales S.A., para el proyecto Fachinal de Compañía Minera CDE Fachinal Ltda.

Ubicación de las estaciones de la red de monitoreo:
E1: ciudad de Chile Chico.
E2: Bahía Jara
E3: Pampa La Perra
E4: Laguna Verde
E5: Antes del proyecto

Las estaciones E2, E3, E4, y E5 pueden observarse en el plano adjunto.

Metodología de medición utilizada para medir el contaminante:

Colectores de agua destilada son expuestos al aire ambiente durante 30 días y luego son enviados al laboratorio químico para ser analizados.

Certificación de mediciones por parte del Servicio de Salud correspondiente:

Los informes de resultados remitidos por la empresa son enviados al Departamento Programas sobre el Ambiente/Servicio de Salud Aysén, a modo de información. No existe certificación de las mediciones.

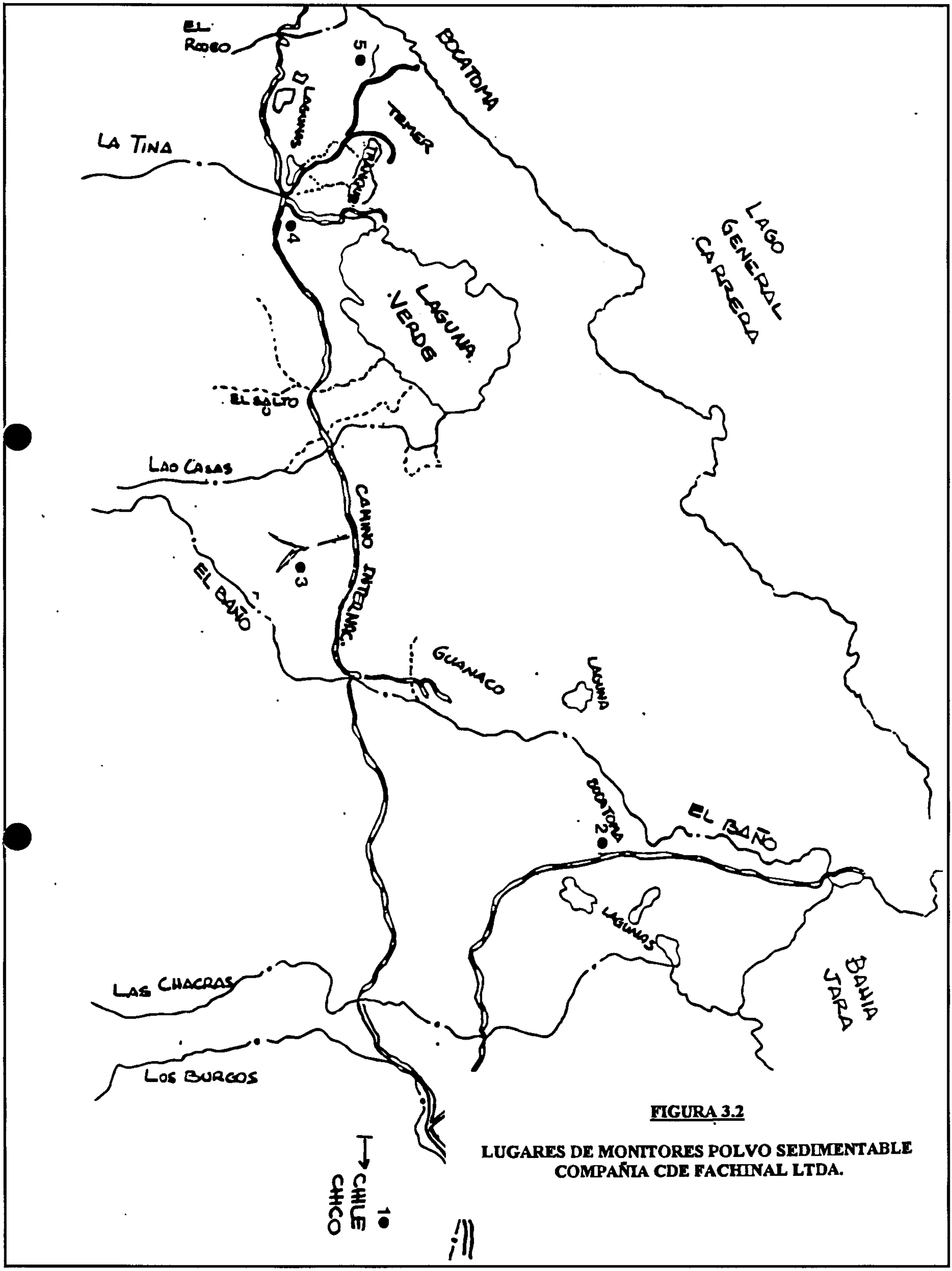

FIGURA 3.2

LUGARES DE MONITORES POLVO SEDIMENTABLE
COMPAÑIA CDE FACHINAL LTDA.

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Enero 1997

Número muestra	Lugar de muestreo	Polvo sedimentable	Composición química (%)	
		mg/cm^2/30 días	Fe	SiO_2
E1	Chile Chico	1,2086	2,73	44,20
E2	Bahía Jara	0,6978	2,06	7,51
E3	Pampa La Perra	0,2590	2,52	6,00
E4	Laguna Verde	0,1151	2,75	13,50
E5	Antes del proyecto	0,0180	1,89	3,45

Febrero 1997

Número muestra	Lugar de muestreo	Polvo sedimentable	Composición química (%)	
		mg/cm^2/30 días	Fe	SiO_2
E1	Chile Chico	------	------	------
E2	Bahía Jara	------	------	------
E3	Pampa La Perra	------	------	------
E4	Laguna Verde	------	------	------
E5	Antes del proyecto	------	------	------

Marzo 1997

Número muestra	Lugar de muestreo	Polvo sedimentable	Composición química (%)	
		mg/cm^2/30 días	Fe	SiO_2
E1	Chile Chico	------	------	------
E2	Bahía Jara	------	------	------
E3	Pampa La Perra	------	------	------
E4	Laguna Verde	------	------	------
E5	Antes del proyecto	------	------	------

Abril 1997

Número muestra	Lugar de muestreo	Polvo sedimentable	Composición química (%)	
		mg/cm^2/30 días	Fe	SiO_2
E1	Chile Chico	------	------	------
E2	Bahía Jara	------	------	------
E3	Pampa La Perra	------	------	------
E4	Laguna Verde	------	------	------
E5	Antes del proyecto	------	------	------

Mayo 1997

Número muestra	Lugar de muestreo	Polvo sedimentable	Composición química (%)	
		mg/cm^2/30 días	Fe	SiO_2
E1	Chile Chico	------	------	------
E2	Bahía Jara	------	------	------
E3	Pampa La Perra	------	------	------
E4	Laguna Verde	------	------	------
E5	Antes del proyecto	------	------	------

Junio 1997

Número muestra	Lugar de muestreo	Polvo sedimentable	Composición química (%)	
		mg/cm^2/30 días	Fe	SiO_2
E1	Chile Chico	0,1835	2,75	7,20
E2	Bahía Jara	0,0540	1,97	3,23
E3	Pampa La Perra	0,1007	2,05	6,75
E4	Laguna Verde	0,1079	2,47	6,54
E5	Antes del proyecto	0,0863	2,54	2,01

Julio 1997

			Composición química (%)	
Número muestra	Lugar de muestreo	Polvo sedimentable mg/cm^2/30 días	Fe	SiO_2
E1	Chile Chico	0,1547	2,78	6,03
E2	Bahía Jara	0,0612	3,02	2,20
E3	Pampa La Perra	0,0360	4,19	<1
E4	Laguna Verde	0,0612	3,58	7,21
E5	Antes del proyecto	0,0360	3,20	<1

Agosto 1997

			Composición química (%)	
Número muestra	Lugar de muestreo	Polvo sedimentable mg/cm^2/30 días	Fe	SiO_2
E1	Chile Chico	0,7206	3,05	7,93
E2	Bahía Jara	0,1427	2,27	3,41
E3	Pampa La Perra	0,1114	2,84	1,85
E4	Laguna Verde	0,2576	3,45	6,54
E5	Antes del proyecto	0,1218	1,93	1,03

Septiembre 1997

			Composición química (%)	
Número muestra	Lugar de muestreo	Polvo sedimentable mg/cm^2/30 días	Fe	SiO_2
E1	Chile Chico	0,5360	2,87	9,81
E2	Bahía Jara	0,3813	2,78	7,51
E3	Pampa La Perra	0,6475	1,59	6,10
E4	Laguna Verde	0,5612	3,29	6,05
E5	Antes del proyecto	0,1835	1,61	5,31

Octubre 1997

			Composición química (%)	
Número muestra	Lugar de muestreo	Polvo sedimentable mg/cm^2/30 días	Fe	SiO_2
E1	Chile Chico	0,9568	2,59	5,40
E2	Bahía Jara	0,3165	2,23	2,10
E3	Pampa La Perra	Muestra perdida		
E4	Laguna Verde	0,5216	3,32	3,30
E5	Antes del proyecto	0,1834	1,52	3,40

Noviembre 1997

			Composición química (%)	
Número muestra	Lugar de muestreo	Polvo sedimentable mg/cm^2/30 días	Fe	SiO_2
E1	Chile Chico	2,8023	2,57	4,30
E2	Bahía Jara	0,2123	2,41	1,80
E3	Pampa La Perra	Muestra perdida		
E4	Laguna Verde	0,8703	3,30	2,90
E5	Antes del proyecto	0,0627	2,51	2,60

Diciembre 1997

			Composición química (%)	
Número muestra	Lugar de muestreo	Polvo sedimentable mg/cm^2/30 días	Fe	SiO_2
E1	Chile Chico	2,4496	0,90	3,90
E2	Bahía Jara	0,3813	0,75	1,30
E3	Pampa La Perra	0,1295	1,99	0,90
E4	Laguna Verde	0,6151	2,98	1,90
E5	Antes del proyecto	0,0971	2,03	1,90

000091

Enero 1998

Número muestra	Lugar de muestreo	Polvo sedimentable mg/cm^2/30 días	Composición química (%) Fe	SiO_2
E1	Chile Chico	3,8988	0,82	3,20
E2	Bahía Jara	0,7345	0,51	1,04
E3	Pampa La Perra	0,0800	0,94	1,91
E4	Laguna Verde	0,6092	1,41	1,95
E5	Antes del proyecto	0,1392	0,83	1,35

Febrero 1998

Número muestra	Lugar de muestreo	Polvo sedimentable mg/cm^2/30 días	Composición química (%) Fe	SiO_2
E1	Chile Chico	1,8183	0,97	2,80
E2	Bahía Jara	0,8935	0,55	1,90
E3	Pampa La Perra	0,1739	1,25	1,30
E4	Laguna Verde	0,5257	1,72	2,40
E5	Antes del proyecto	0,2569	1,15	2,60

Marzo 1998

Número muestra	Lugar de muestreo	Polvo sedimentable mg/cm^2/30 días	Composición química (%) Fe	SiO_2
E1	Chile Chico	1,5421	2,10	2,70
E2	Bahía Jara	0,2785	0,80	2,00
E3	Pampa La Perra	0,1059	2,80	2,30
E4	Laguna Verde	0,5117	3,12	2,20
E5	Antes del proyecto	0,0974	1,48	1,70

Abril 1998

Número muestra	Lugar de muestreo	Polvo sedimentable mg/cm^2/30 días	Composición química (%) Fe	SiO_2
E1	Chile Chico	0,5711	1,45	1,44
E2	Bahía Jara	0,2060	0,72	1,86
E3	Pampa La Perra	0,0997	1,46	2,57
E4	Laguna Verde	0,2619	1,78	1,27
E5	Antes del proyecto	0,0835	1,21	1,16

Mayo 1998

Número muestra	Lugar de muestreo	Polvo sedimentable mg/cm^2/30 días	Composición química (%) Fe	SiO_2
E1	Chile Chico	0,1224	1,20	1,21
E2	Bahía Jara	0,0705	1,02	1,81
E3	Pampa La Perra	0,0445	1,18	1,70
E4	Laguna Verde	0,1414	1,53	1,80
E5	Antes del proyecto	0,0447	1,12	0,80

Junio 1998

Número muestra	Lugar de muestreo	Polvo sedimentable mg/cm^2/30 días	Composición química (%) Fe	SiO_2
E1	Chile Chico	0,1804	1,45	0,96
E2	Bahía Jara	0,0442	0,90	1,31
E3	Pampa La Perra	0,0340	0,88	1,92
E4	Laguna Verde	0,1055	1,53	1,90
E5	Antes del proyecto	0,0443	67,00	0,98

Julio 1998				
			Composición química (%)	
Número muestra	Lugar de muestreo	Polvo sedimentable mg/cm^2/30 días	Fe	SiO_2
E1	Chile Chico	0,3203	1,38	1,53
E2	Bahía Jara	0,0975	0,92	2,23
E3	Pampa La Perra	0,0348	1,89	1,76
E4	Laguna Verde	0,3028	1,44	1,60
E5	Antes del proyecto	0,1009	0,76	1,41

Agosto 1998				
			Composición química (%)	
Número muestra	Lugar de muestreo	Polvo sedimentable mg/cm^2/30 días	Fe	SiO_2
E1	Chile Chico	0,3701	1,22	1,74
E2	Bahía Jara	0,2663	1,05	1,29
E3	Pampa La Perra	0,0934	1,40	1,51
E4	Laguna Verde	0,3182	1,45	1,90
E5	Antes del proyecto	0,1141	0,72	1,30

Septiembre 1998				
			Composición química (%)	
Número muestra	Lugar de muestreo	Polvo sedimentable mg/cm^2/30 días	Fe	SiO_2
E1	Chile Chico	0,3717	1,41	1,60
E2	Bahía Jara	0,7832	1,10	0,88
E3	Pampa La Perra	0,1985	1,50	2,28
E4	Laguna Verde	0,7025	1,51	1,30
E5	Antes del proyecto	0,5051	0,78	0,75

Octubre 1998				
			Composición química (%)	
Número muestra	Lugar de muestreo	Polvo sedimentable mg/cm^2/30 días	Fe	SiO_2
E1	Chile Chico	1,6963	0,44	1,52
E2	Bahía Jara	1,6115	0,91	1,54
E3	Pampa La Perra	0,1906	0,79	1,72
E4	Laguna Verde	0,5055	1,31	2,21
E5	Antes del proyecto	0,3155	0,45	1,30

Noviembre 1998				
			Composición química (%)	
Número muestra	Lugar de muestreo	Polvo sedimentable mg/cm^2/30 días	Fe	SiO_2
E1	Chile Chico	0,9343	3,34	1,80
E2	Bahía Jara	0,7782	3,12	1,23
E3	Pampa La Perra	0,1601	1,25	1,03
E4	Laguna Verde	0,2619	2,16	1,52
E5	Antes del proyecto	0,1814	19,00	1,01

Diciembre 1998				
			Composición química (%)	
Número muestra	Lugar de muestreo	Polvo sedimentable mg/cm^2/30 días	Fe	SiO_2
E1	Chile Chico	0,8999	0,92	1,08
E2	Bahía Jara	0,5554	0,99	0,99
E3	Pampa La Perra	0,1566	0,86	0,98
E4	Laguna Verde	0,4247	0,92	0,55
E5	Antes del proyecto	0,1515	0,83	0,95

000093

Enero 1999				
			Composición química (%)	
Número muestra	Lugar de muestreo	Polvo sedimentable mg/cm^2/30 días	Fe	SiO_2
E1	Chile Chico	0,7133	0,20	0,89
E2	Bahía Jara	0,3733	0,78	1,04
E3	Pampa La Perra	0,1446	0,53	1,78
E4	Laguna Verde	0,1842	0,96	1,02
E5	Antes del proyecto	0,0739	0,67	1,13

Febrero 1999				
			Composición química (%)	
Número muestra	Lugar de muestreo	Polvo sedimentable mg/cm^2/30 días	Fe	SiO_2
E1	Chile Chico	0,8242	0,79	1,60
E2	Bahía Jara	1,0301	1,19	1,10
E3	Pampa La Perra	0,2026	0,73	1,60
E4	Laguna Verde	0,3258	0,89	2,20
E5	Antes del proyecto	0,3480	0,50	1,10

Marzo 1999				
			Composición química (%)	
Número muestra	Lugar de muestreo	Polvo sedimentable mg/cm^2/30 días	Fe	SiO_2
E1	Chile Chico	0,3358	1,26	1,20
E2	Bahía Jara	0,0500	0,32	2,00
E3	Pampa La Perra	0,0750	1,53	1,80
E4	Laguna Verde	0,2037	1,63	2,20
E5	Antes del proyecto	0,0929	0,52	1,80

Abril 1999				
			Composición química (%)	
Número muestra	Lugar de muestreo	Polvo sedimentable mg/cm^2/30 días	Fe	SiO_2
E1	Chile Chico	0,0652	1,41	1,30
E2	Bahía Jara	0,4764	0,68	1,40
E3	Pampa La Perra	0,0686	1,38	1,50
E4	Laguna Verde	0,4454	1,51	1,90
E5	Antes del proyecto	0,1408	0,66	2,10

Mayo 1999				
			Composición química (%)	
Número muestra	Lugar de muestreo	Polvo sedimentable mg/cm^2/30 días	Fe	SiO_2
E1	Chile Chico	1,1312	1,10	1,10
E2	Bahía Jara	0,3147	0,85	1,20
E3	Pampa La Perra	0,1180	0,96	2,00
E4	Laguna Verde	0,4650	1,33	1,10
E5	Antes del proyecto	0,1591	1,00	2,10

Junio 1999				
			Composición química (%)	
Número muestra	Lugar de muestreo	Polvo sedimentable mg/cm^2/30 días	Fe	SiO_2
E1	Chile Chico	0,1990	1,29	1,20
E2	Bahía Jara	0,1327	1,25	1,20
E3	Pampa La Perra	0,1093	1,81	1,60
E4	Laguna Verde	0,1490	1,58	0,70
E5	Antes del proyecto	0,0546	1,00	1,10

COMISIÓN NACIONAL DEL MEDIO AMBIENTE
REGIÓN DE ANTOFAGASTA

000094

CONAMA
COMISION NACIONAL DEL MEDIO AMBIENTE

COMISION NACIONAL DEL MEDIO AMBIENTE
OFICINA DE PARTES Y ARCHIVO
INGRESO: 14582 / 10678
FECHA: 20 DIC 1999
DESPACHADO:
P. Datos 230 / 3
13773 x correo

ORD. Nº : 0523 / 99

ANT. : No Hay

MAT. : Remite resultados solicitados de monitoreos, según ORD.Nº 995613 de fecha 10 de Noviembre de 1999.

Antofagasta, 15 de Diciembre de 1999

A : SRA. PATRICIA MATUS CORREA
JEFE DEPTO. DESCONTAMINACIÓN, PLANES Y NORMAS
CONAMA

DE : SR. ALBERTO ACUÑA CERDA
DIRECTOR REGIONAL (S)
CONAMA II REGIÓN

En respuesta a la solicitud de resultados de monitoreo de CO, NOx, O3, PTS y SO2 a nivel urbano y aquellos realizados como consecuencia de los compromisos asumidos por proyectos que fueron aprobados por el S.E.I.A., se adjunta información enviada por el Servicio de Salud de Antofagasta.

Sin otro particular, saluda atentamente a usted,

COMISION NACIONAL DEL MEDIO AMBIENTE II REGION
DIRECTOR REGIONAL

ALBERTO ACUÑA CERDA
DIRECTOR REGIONAL (S)
CONAMA REGIÓN DE ANTOFAGASTA

AAC/MRT/mem
c.c.: Archivo CONAMA II Región.

COPIA FIEL DE ORIGINAL

EMPRESA : REFIMET
CONTAMINANTE : ANHIDRIDO SULFUROSO(SO2) Y MATERIAL PARTICULADO (PM-10)
NORMA : CONCENTRACIÓN MEDIA DIARIA SO_2=365 μg/m^3
: CONCENTRACIÓN MEDIA DIARIA PM-10=150 μg/m^3

	AÑO 1998								
Mes	**Ubicación Estación**	**N°Mediciones**		**N°Mediciones sobre Norma**		**Promedio μg/m^3**		**Conc. Máxima Diaria μg/m^3**	
		SO_2	**PM-10**	**SO_2**	**PM-10**	**SO_2**	**PM-10**	**SO_2**	**PM-10**
Enero	Coviefi	30	14	-	-	2	35	18	39
	Sur	31	14	1	-	134	36	384	76
	Negra	31	12	-	-	23	32	103	48
Febrero	Coviefi	28	12	-	-	3	30	30	41
	Sur	28	11	1	-	150	52	506	90
	Negra	26	12	-	-	39	37	222	57
Marzo	Coviefi	28	11	-	-	5	49	27	128
	Sur	22	13	3	-	207	58	452	102
	Negra	29	12	-	-	36	56	184	128
Abril	Coviefi	29	12	-	-	9	38	64	50
	Sur	27	11	5	-	280	52	764	93
	Negra	30	12	-	-	52	61	196	114
Mayo	Coviefi	30	13	-	-	7	41	49	55
	Sur	30	12	9	-	235	49	681	79
	Negra	31	12	-	-	49	45	231	81
Junio	Coviefi	24	12	-	-	5	39	26	59
	Sur	30	12	9	-	276	45	762	57
	Norte	30	12	-	-	69	48	203	79
Julio	Coviefi	31	13	-	-	14	38	145	50
	Sur	30	13	14	-	366	50	861	77
	Norte	31	10	-	-	115	50	314	72
Agosto	Coviefi	31	13	-	-	4	39	22	52
	Sur	30	12	26	-	689	50	1459	75
	Norte	30	10	-	-	102	54	239	72
Septiembre	Coviefi	30	11	-	-	4	33	30	52
	Sur	30	13	16	-	602	54	1492	136
	Negra	30	12	1	-	76	50	416	71
Octubre	Coviefi	31	12	-	-	0	24	2	38
	Sur	31	14	11	-	328	44	983	67
	Norte	31	13	-	-	22	41	106	69
Noviembre	Coviefi	27	11	-	-	3	25	23	36
	Sur	30	11	8	-	324	45	844	67
	Norte	29	12	-	-	28	41	281	65
Diciembre	Coviefi	29	6	-	-	2	28	19	34
	Sur	31	14	2	-	160	35	473	88
	Norte	29	13	-	-	18	37	107	50
TOTAL	Coviefi	348	140	0	0	5	35	145	128
	Sur	350	150	105	0	313	48	1492	136
	Norte	357	142	1	0	52	46	416	128

EMPRESA : REFIMET
CONTAMINANTE : ANHIDRIDO SULFUROSO(SO2) Y MATERIAL PARTICULADO (PM-10)
NORMA : CONCENTRACIÓN MEDIA DIARIA SO_2=365 μg/m^3
: CONCENTRACIÓN MEDIA DIARIA PM-10=150 μg/m^3

		AÑO 1999							
Mes	**Ubicación Estación**	**N°Mediciones**		**N°Mediciones sobre Norma**		**Promedio μg/m^3**		**Conc. Máxima Diaria μg/m^3**	
		SO_2	**PM-10**	**SO_2**	**PM-10**	**SO_2**	**PM-10**	**SO_2**	**PM-10**
Enero	Coviefi	27	10	-	-	4	34	46	93
	Sur	28	12	1	-	200	42	428	62
	Negra	31	13	-	-	12	41	58	108
Febrero	Coviefi	28	12	-	-	0	25	4	33
	Sur	28	12	1	-	206	45	552	77
	Negra	28	12	-	-	18	54	96	88
Marzo	Coviefi	31	12	-	-	1	31	15	41
	Sur	31	12	3	-	205	46	430	68
	Negra	31	13	-	-	15	53	58	70
Abril	Coviefi	26	12	-	-	1	36	15	43
	Sur	25	10	-	-	69	61	247	116
	Negra	27	12	-	-	4	52	29	75
Mayo	Coviefi	31	12	-	-	3	32	14	44
	Sur	31	11	-	-	109	57	261	88
	Negra	30	11	-	-	18	61	86	130
Junio	Coviefi	28	11	-	-	3	42	18	60
	Sur	30	11	-	-	109	56	309	114
	Negra	30	11	-	-	29	71	102	103
Julio	Coviefi	29	14	-	-	3	36	19	54
	Sur	14	14	-	-	139	51	272	136
	Negra	30	13	-	-	22	58	125	126
Agosto	Coviefi	23	13	-	-	5	36	44	57
	Sur	11	13	-	-	180	58	307	93
	Negra	30	13	-	-	22	56	137	84
Septiembre	Coviefi	25	12	-	-	1	30	11	66
	Sur	28	12	1	-	188	48	383	92
	Negra	30	12	-	-	44	41	152	71
Octubre	Coviefi	29	17	-	-	1	32	9	58
	Sur	31	10	1	-	161	40	639	58
	Negra	30	13	-	-	34	50	115	107
Noviembre	Coviefi								
	Sur								
	Negra								
Diciembre	Coviefi								
	Sur								
	Negra								
TOTAL	Coviefi	277	125	0	0	2	33	46	93
	Sur	257	117	7	0	157	50	639	136
	Negra	297	123	0	0	22	54	152	130

EMPRESA : REFIMET
CONTAMINANTE : ANHIDRIDO SULFUROSO(SO2) Y MATERIAL PARTICULADO (PM-10)
NORMA : CONCENTRACIÓN MEDIA DIARIA SO_2=365 $\mu g/m^3$
: CONCENTRACIÓN MEDIA DIARIA PM-10=150 $\mu g/m^3$

	AÑO 1997								
Mes	**Ubicación Estación**	**N°Mediciones**		**N°Mediciones sobre Norma**		**Promedio $\mu g/m^3$**		**Concentración Máxima Diaria µg/m3**	
		SO_2	**PM-10**	**SO_2**	**PM-10**	**SO_2**	**PM-10**	**SO_2**	**PM-10**
Enero	J. Sur	31	10	-	-	3	27	60	33
	Sur	31	11	-	-	163	43	316	51
	Negra	31	10	-	-	35	35	124	50
Febrero	J. Sur	26	12	-	-	2	27	19	40
	Sur	28	12	3	-	220	48	465	79
	Negra	24	11	-	-	32	40	69	49
Marzo	J. Sur	31	12	-	-	5	23	26	57
	Sur	31	12	20	-	463	50	1103	68
	Negra	31	12	-	-	60	40	234	60
Abril	J. Sur	30	13	-	-	17	35	94	47
	Sur	30	13	23	-	618	66	1213	87
	Negra	30	13	-	-	76	57	286	94
Mayo	J. Sur	30	13	-	-	22	28	114	33
	Sur	30	12	28	-	735	79	1350	138
	Negra	31	13	2	-	148	59	461	114
Junio	J. Sur	30	11	-	-	9	24	29	41
	Sur	30	12	25	-	675	59	1431	84
	Negra	30	12	1	-	108	55	383	81
Julio	J. Sur	31	12	-	-	7	31	36	52
	Sur	27	14	24	-	933	82	1969	133
	Negra	25	13	2	-	147	61	415	90
Agosto(1)	J. Sur	12	3	-	-	4	41	11	48
	Sur	29	12	2	-	195	63	431	144
	Negra	29	12	21	-	635	76	1257	136
Septiembre(2)	-	-	-	-	-	-	-	-	-
	Sur	22	12	14	-	527	65	1018	93
	Negra	30	12	1	-	137	38	405	56
Octubre	Coviefi	22	8	-	-	1	26	8	28
	Sur	31	13	15	-	422	55	1741	129
	Negra	31	13	1	-	83	37	404	66
Noviembre	Coviefi	30	12	-	-	10	27	88	31
	Sur	30	13	8	-	266	53	668	113
	Negra	28	11	-	-	94	39	332	50
Diciembre	Coviefi	31	10	-	-	2	23	15	38
	Sur	13	11	3	-	265	37	737	54
	Negra	29	9	-	-	36	32	134	50
TOTAL	Coviefi	304	116	0	0	7	28	114	57
	Sur	332	147	165	0	457	58	1969	144
	Negra	349	141	28	0	133	47	1257	136

Nota: (1) Estacón sufre atentado vandálico.
(2) Fuera de servicio estación J. Sur.

EMPRESA : MINERA ESCONDIDA
CONTAMINANTE : MATERIAL PARTICULADO (PM-10) y SÓLIDOS TOTALES EN SUSPENSIÓN (PTS)
NORMA : CONCENTRACIÓN MEDIA DIARIA PM-10=150 $\mu g/m^3$
CONCENTRACIÓN MEDIA DIARIA PTS=260 $\mu g/m^3$

	AÑO 1997							
Mes	N°Mediciones		N°Mediciones sobre Norma		Promedio $\mu g/m^3$		Concentración Máxima Diaria µg/m3	
	PM-10	PTS	PM-10	PTS	PM-10	PTS	PM-10	PTS
Julio	8	1	-	-	80	112	114	112
Agosto	9	5	-	-	81	136	111	174
Septiembre	11	6	-	-	64	134	85	183
Octubre	11	5	-	-	71	128	107	176
Noviembre	7	5	-	-	80	106	140	144
Diciembre(1)(2)	3	0	-	-	51	-	63	-
TOTAL	49	22	0	0	71	123	140	183

	AÑO 1998							
Mes	N°Mediciones		N°Mediciones sobre Norma		Promedio $\mu g/m^3$		Concentración Máxima Diaria µg/m3	
	PM-10	PTS	PM-10	PTS	PM-10	PTS	PM-10	PTS
Enero(2)	0	0	-	-	-	-	-	-
Febrero	5	1	-	-	87	194	119	194
Marzo	9	4	-	-	69	128	99	144
Abril	10	5	-	-	82	120	91	148
Mayo	11	5	-	-	73	92	147	134
Junio	10	5	-	-	70	98	96	137
Julio	10	6	-	-	76	87	106	129
Agosto	10	5	1	-	81	109	154	129
Septiembre	10	5	-	-	52	74	80	85
Octubre	9	4	-	-	48	200	61	197
Noviembre	3	2	-	-	50	59	57	64
Diciembre	9	4	-	-	42	90	62	136
TOTAL	96	46	1	0	66	114	154	197

Notas Todas las mediciones estan referidas a la estación Playa Amarilla.
1. Falla en equipo muestreador.
2. Estación fuera de servicio por traslado a nueva ubicación.

	AÑO 1999							
Mes	N°Mediciones		N°Mediciones sobre Norma		Promedio $\mu g/m^3$		Concentración Máxima Diaria µg/m3	
	PM-10	PTS	PM-10	PTS	PM-10	PTS	PM-10	PTS
Enero	10	*	-	*	43	*	63	*
Febrero	9	*	-	*	54	*	87	*
Marzo	11	*	-	*	53	*	65	*
Abril	10	*	-	*	44	*	57	*
Mayo	10	*	-	*	44	*	60	*
Junio	10	*	-	*	43	*	86	*
Julio	10	*	-	*	36	*	48	*
Agosto	10	5	1	-	81	109	154	129
Septiembre	9	-	-	*	39	*	56	*
Oçtubre								
Noviembre								
Diciembre								
TOTAL	89	5	1	0	49	109	154	129

Notas 1. La empresa informa sobre la modificación de parámetros a medir, eliminado PTS

000099

EMPRESA : NOPEL

CONTAMINANTE : DIÓXIDO DE NITRÓGENO(NO_2), OZONO (O3), MONÓXIDO DE CRABONO (CO) Y MATERIAL PARTICULADO (PM-10)

NORMA : CONCENTRACIÓN MEDIA DIARIA NO_2=80 μg/m^3 (SUIZA)

: CONCENTRACIÓN MEDIA HORARIA O_3=160 μg/m^3

: CONCENTRACIÓN MEDIA HORARIA CO= 40.000 μg/m^3

: CONCENTRACIÓN MEDIA DIARIA PM-10=150 μg/m^3

	AÑO 1999																			
Mes	N°Mediciones				N°Mediciones sobre norma				N°Mediciones sobre 80% norma				Promedio Mensual μg/m3				Conc. Máxima μg/m3			
	NO_2	O_3	CO	PM-10	NO_2	O_3	CO	PM-10	NO_2	O_3	CO	PM-10	NO_2	O_3	CO	PM-10	NO_2	O_3	CO	PM-10
Junio	30	30	30	11	-	-	-	-	-	-	-	-	1	12	200	28	3	49	1400	41
Julio	31	31	31	10	-	-	-	-	-	-	-	-	1	3	200	26	2	37	800	38
Agosto	31	31	31	9	-	-	-	-	-	-	-	-	7	5	200	31	10	61	2400	44
Septiembre																				
Octubre																				
Noviembre																				
Diciembre																				
TOTAL	92	30	0	0	0	0	0	0	0	0	9	20	3	7	200	28	10	61	2400	44

EMPRESA : EDELNOR
CONTAMINANTE : MATERIAL PARTICULADO PM-10
NORMA : CONCENTRACIÓN MEDIA DIARIA PM-10=150 $\mu g/m^3$

	AÑO 1998			
Mes	**N°Mediciones**	**N°Mediciones sobre Norma**	**Promedio $\mu g/m^3$**	**Concentración Máxima Diaria $\mu g/m3$**
Enero	9	-	18	26
Febrero	9	-	17	31
Marzo	11	-	21	38
Abril	15	-	21	46
Mayo	16	-	25	58
Junio				
Julio	12	-	30	51
Agosto	16	-	33	71
Septiembre	15	-	26	49
Octubre	15	-	17	26
Noviembre	14	-	19	24
Diciembre	16	-	21	29
TOTAL	148	0	22	71

	AÑO 1999			
Mes	**N°Mediciones**	**N°Mediciones sobre Norma**	**Promedio $\mu g/m^3$**	**Concentración Máxima Diaria $\mu g/m3$**
Enero	11	-	14	20
Febrero	13	-	20	45
Marzo	15	-	15	26
Abril	14	-	22	30
Mayo	16	-	23	35
Junio	15	-	27	70
Julio	14	-	26	39
Agosto	16	-	22	29
Septiembre	14	-	21	31
Octubre	14		20	33
Noviembre				
Diciembre				
TOTAL	142	0	21	70

EMPRESA : ENAEX
CONTAMINANTE : DIÓXIDO DE NITRÓGENO NO2
NORMA : CONCENTRACIÓN ANUAL NO_2=100μg/m^3
: CONCENTRACIÓN MEDIA DIARIA NO_2=80 μg/m

	AÑO 1999			
Mes	**N°Mediciones**	**N°Mediciones sobre Norma**	**Promedio μg/m^3**	**Concentración Máxima Diaria μg/m3**
Enero	31	-	2,35	3,76
Febrero	14	-	9,41	10,20
Marzo	27	-	5,63	14,16
Abril	30	-	6,32	12,18
Mayo	30	-	5,36	11,51
Junio	30	-	5,44	10,12
Julio				
Agosto				
Septiembre				
Octubre				
Noviembre				
Diciembre				
TOTAL	162	0	5,75	14,16

NOTA
En el mes de febrero se cambia equipo de muestreo a Jardín Infantil ubicado er andalican N°920.

EMPRESA : ENAEX
CONTAMINANTE : DIÓXIDO DE NITRÓGENO NO2
NORMA : CONCENTRACIÓN ANUAL NO_2=100μg/m^3
: CONCENTRACIÓN MEDIA DIARIA NO_2=80 μg/m^3(SUIZA)

	AÑO 1993			
Mes	**N°Mediciones**	**N°Mediciones sobre Norma**	**Promedio μg/m^3**	**Concentración Máxima Diaria μg/m3**
Agosto	15		1,75	3,76
TOTAL	15	0	1,75	3,76

	AÑO 1996			
Mes	**N°Mediciones**	**N°Mediciones sobre Norma**	**Promedio μg/m^3**	**Concentración Máxima Diaria μg/m3**
Abril	18	-	6,26	22,18
Mayo	13	-	5,83	10,85
Junio	31	-	7,14	29,10
TOTAL	62	0	6,41	29,10

	AÑO 1997			
Mes	**N°Mediciones**	**N°Mediciones sobre Norma**	**Promedio μg/m^3**	**Concentración Máxima Diaria μg/m3**
Agosto	12	-	2,44	5,13
Septiembre	30	-	1,7	4,49
Octubre	31	-	1,43	3,41
Noviembre	30	-	0,94	2,75
TOTAL	103	0	1,63	5,13

	AÑO 1998			
Mes	**N°Mediciones**	**N°Mediciones sobre Norma**	**Promedio μg/m^3**	**Concentración Máxima Diaria μg/m3**
Enero	30	-	4,14	40,89
Febrero	28	6	45,66	254,10
Marzo	31	1	8,45	196,86
Abril	26	-	2,70	6,74
Mayo	23	-	3,34	6,44
Junio	27	-	5,13	10,02
Julio	31	-	4,07	8,62
Agosto	31	-	4,03	6,72
Septiembre	30	-	3,31	6,87
Octubre	31	-	3,24	4,53
Noviembre	30	-	2,77	10,19
Diciembre	28	-	2,83	4,68
TOTAL	346	7	7,47	254,10

Nota
La norma anual chilena no se sobrepasó, pero la referecia suiza diaria en 7 oportunidades.

EMPRESA : ELECTROANDINA
CONTAMINANTE : ANHIDRIDO SULFUROSO(SO2) Y MATERIAL PARTICULADO (PM-10)
NORMA : CONCENTRACIÓN MEDIA DIARIA SO_2=365 µg/m^3
CONCENTRACIÓN MEDIA DIARIA PM-10=150 µg/m^3
CONCENTRACIÓN MEDIA DIARIA NO_2= 80 µg/m^3(SUIZA)

	AÑO 1996														
Mes	**N°Mediciones**			**N°Mediciones sobre Norma**			**N°Mediciones sobre 80%Norma**			**Promedio µg/m^3**			**Conc, Máxima Diaria µg/m3**		
	SO_2	**NO_2**	**PM-10**	**SO_2**	**NO_2**	**PM-10**	**SO_2**	**NO_2**	**PM-10**	**SO_2**	**NO_2**	**PM-10**	**SO_2**	**NO_2**	**PM-10**
Enero	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Febrero	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Marzo	24	24	12	-	-	-	-	-	1	64	7,1	87	177	9,6	121
Abril	11	29	12	-	-	-	-	-	-	112	7,4	82	203	11,4	114
Mayo	*	31	12	*	-	-	*	-	-	*	6,6	82	*	10,4	93
Junio	*	30	11	*	-	-	*	-	-	*	6,3	77	*	10,8	106
Julio	5	31	13	-	-	-	-	-	-	36	6,3	67	57	9,5	91
Agosto	27	26	12	-	-	-	-	-	-	22	5,2	67	127	11,0	84
Septiembre	19	17	11	-	-	-	-	-	-	27	2,2	78	114	6,9	102
Octubre	24	22	13	-	-	-	-	-	-	37	3,8	63	99	8,2	91
Noviembre	*	*	12	*	-	-	*	-	1	*	*	74	*	*	148
Diciembre	*	25	12	*	-	-	*	-	-	*	0,18	67	*	0,35	93
TOTAL	110	235	120	0	0	0	0	0	2	50	5,0	74	203	11,4	148

	AÑO 1997									
Mes	**N°Mediciones**		**N°Mediciones sobre Norma**		**N°Mediciones sobre 80% Norma**		**Promedio µg/m^3**		**Conc.Máx. Diaria µg/m3**	
	SO_2	**PM-10**	**SO_2**	**PM-10**	**SO_2**	**PM-10**	**SO_2**	**PM-10**	**SO_2**	**PM-10**
Enero	22	12	-	-	-	-	51	75	78	103
Febrero	28	12	-	-	-	-	67	79	164	119
Marzo	25	12	-	-	-	1	90	98	146	128
Abril	30	12	-	-	-	3	53	98	174	128
Mayo	31	12	-	-	-	-	22	74	92	110
Junio	30	13	-	-	-	-	13	72	54	116
Julio	12	13	-	-	-	-	7	64	21	98
Agosto	*	12	*	-	*	-	*	72	*	94
Septiembre	*	12	*	-	*	-	*	63	*	89
Octubre	*	12	*	-	*	-	*	70	*	83
Noviembre	*	12	*	-	*	-	*	64	*	96
Diciembre	*	12	*	-	*	-	*	50	*	66
TOTAL	178	146	0	0	0	4	43	73	174	128

NOTA 1. En año 1997 no se mide NO_2 por desperfectos en instrumentos.

EMPRESA : ELECTROANDINA
CONTAMINANTE : ANHIDRIDO SULFUROSO(SO2) Y MATERIAL PARTICULADO (PM-10)
NORMA : CONCENTRACIÓN MEDIA DIARIA SO_2=365 $\mu g/m^3$
CONCENTRACIÓN MEDIA DIARIA PM-10=150 $\mu g/m^3$
CONCENTRACIÓN MEDIA DIARIA NO_2= 80 $\mu g/m^3$(SUIZA)

Mes	AÑO 1999														
	N°Mediciones			N°Mediciones sobre Norma			N°Mediciones sobre 80% Norma			Promedio $\mu g/m^3$			Conc, Máxima Diaria µg/m3		
	SO_2	NO_2	PM-10	SO_2	NO_2	PM-10	SO_2	NO_2	PM-10	SO_2	NO_2	PM-10	SO_2	NO_2	PM-10
Enero	*	14	19	*	-	-	*	-	-	*	13	62	*	16	85
Febrero	*	28	13	*	-	-	*	-	-	*	10	78	*	13	98
Marzo	28	28	14	-	-	-	-	-	-	70	22	84	70	22	114
Abril	30	30	13	-	-	-	-	-	-	40	28	74	79	36	108
Mayo	31	28	13	-	-	-	-	-	-	34	19	78	95	31	112
Junio	30	30	12	-	-	-	-	-	1	17	27	73	78	49	129
Julio	23	23	9	-	-	-	-	-	-	13	26	63	43	38	72
Agosto	20	20	9	-	-	-	-	-	-	19	19	64	58	40	115
Septiembre	23	23	13	-	-	-	-	-	-	22	19	53	77	30	86
Octubre	31	31	12	-	-	-	-	-	-	15	22	73	50	34	107
Noviembre															
Diciembre															
TOTAL	216	255	127	0	0	0	0	0	1	29	20	70	95	49	129

Nota

1. En el mes de Enero problemas en monitor de SO_2
2. En el mes de Febrero continuan problemas con monitor, se arrienda equipo a CIMM quedando en operaciones 04-03-99

EMPRESA : NORGENER
CONTAMINANTE : ANHIDRIDO SULFUROSO(SO_2) Y MATERIAL PARTICULADO (PM-10)
NORMA : CONCENTRACIÓN MEDIA DIARIA SO_2=365 $\mu g/m^3$

Mes	AÑO 1996									
	N°Mediciones		N°Mediciones sobre Norma		N°Mediciones sobre 80% Norma		Promedio $\mu g/m^3$		Conc. Máxima Diaria µg/m3	
	SO_2	PM-10	SO_2	PM-10	SO_2	PM-10	SO_2	PM-10	SO_2	PM-10
Enero	-	-	-	-	-	-	-	-	-	-
Febrero	-	-	-	-	-	-	-	-	-	-
Marzo	5	-	-	-	-	-	59	-	107	-
Abril	30	11	-	-	-	-	31	64	61	92
Mayo	31	10	-	-	-	-	22	61	56	86
Junio	-	10	-	-	-	-	-	50	-	69
Julio	22	11	-	-	-	-	18	53	66	71
Agosto	31	10	-	-	-	-	12	43	54	56
Septiembre	30	10	-	-	-	1	15	51	83	144
Octubre	31	10	-	-	-	-	23	43	52	58
Noviembre	30	10	-	-	-	-	20	36	64	45
Diciembre	31	10	-	-	-	-	22	50	67	80
TOTAL	241	92	0	0	0	1	25	50	107	144

Mes	AÑO 1997									
	N°Mediciones		N°Mediciones sobre Norma		N°Mediciones sobre 80% Norma		Promedio $\mu g/m^3$		Conc. Máxima Diaria µg/m3	
	SO_2	PM-10	SO_2	PM-10	SO_2	PM-10	SO_2	PM-10	SO_2	PM-10
Enero	29	10	-	-	-	-	30	71	56	91
Febrero	28	10	-	-	-	1	40	84	90	141
Marzo	31	10	-	-	-	-	37	58	65	95
Abril	-	-	-	-	-	-	-	-	-	-
Mayo	-	-	-	-	-	-	-	-	-	-
Junio	-	-	-	-	-	-	-	-	-	-
Julio	-	-	-	-	-	-	-	-	-	-
Agosto	-	-	-	-	-	-	-	-	-	-
Septiembre	30	7	-	-	-	-	43	47	75	53
Octubre	31	10	-	-	-	-	20	53	54	73
Noviembre	30	10	-	-	-	-	42	39	164	63
Diciembre	31	10	-	-	-	-	42	41	164	59
TOTAL	210	67	0	0	0	1	36	56	164	141

EMPRESA : NORGENER
CONTAMINANTE : ANHIDRIDO SULFUROSO(SO_2) Y MATERIAL PARTICULADO (PM-10)
NORMA : CONCENTRACIÓN MEDIA DIARIA SO_2=365 $\mu g/m^3$
: CONCENTRACIÓN MEDIA DIARIA PM-10=150 $\mu g/m^3$

	AÑO 1999									
Mes	N°Mediciones		N°Mediciones sobre Norma		N°Mediciones sobre 80 %Norma		Promedio $\mu g/m^3$		Conc. Máxima Diaria $\mu g/m^3$	
	SO_2	PM-10	SO_2	PM-10	SO_2	PM-10	SO_2	PM-10	SO_2	PM-10
Enero	23	10	-	-	-	-	13	69	27	89
Febrero	28	9	-	-	-	1	59	79	122	123
Marzo	31	10	-	-	-	5	44	116	122	148
Abril	29	10	-	-	-	-	44	61	23	113
Mayo	31	10	-	-	-	-	17	50	104	59
Junio	30	10	-	-	-	-	4	43	11	68
Julio	31	10	-	-	-	-	5	43	16	58
Agosto	31	9	-	-	-	-	6	40	42	57
Septiembre	30	10	-	-	-	-	34	37	71	63
Octubre										
Noviembre										
Diciembre										
TOTAL	264	88	0	0	0	6	25	60	122	148

	AÑO 1998									
Mes	N°Mediciones		N°Mediciones sobre Norma		N°Mediciones sobre 80 %Norma		Promedio $\mu g/m^3$		Conc. Máxima Diaria $\mu g/m^3$	
	SO_2	PM-10	SO_2	PM-10	SO_2	PM-10	SO_2	PM-10	SO_2	PM-10
Enero	31	11	-	-	-	-	41	59	83	75
Febrero	25	9	-	-	-	2	65	82	177	143
Marzo	31	10	-	-	-	-	55	57	152	85
Abril	30	10	-	-	-	-	56	59	134	83
Mayo	31	10	-	-	-	-	76	62	216	102
Junio	30	10	-	-	-	-	29	56	128	98
Julio	31	11	-	-	-	-	13	56	46	75
Agosto	29	10	-	-	-	-	17	58	74	101
Septiembre	30	10	-	-	1	-	39	52	327	84
Octubre	25	10	-	-	-	-	14	51	46	74
Noviembre	30	8	-	-	-	-	5	43	25	58
Diciembre	31	9	-	-	-	-	15	49	66	92
TOTAL	354	118	0	0	1	2	35	57	327	143

EMPRESA : CODELCO
CONTAMINANTE : ANHIDRIDO SULFUROSO(SO2) Y MATERIAL PARTICULADO (PM-10)
NORMA : CONCENTRACIÓN MEDIA DIARIA SO_2=365 $\mu g/m^3$
: CONCENTRACIÓN MEDIA DIARIA PM-10=150 $\mu g/m^3$

		AÑO 1999							
Mes	Ubicación Estación	N°Mediciones		N°Mediciones sobre Norma		Promedio $\mu g/m^3$		Conc. Máxima Diaria $\mu g/m^3$	
		SO_2	PM-10	SO_2	PM-10	SO_2	PM-10	SO_2	PM-10
Enero	J. BRAD.	23	10	1	-	121	109	366	146
	EANA	30	10	1	-	181	114	369	143
	AUKA	29	10	1	-	85	75	390	88
	V.AYQUIN.	27	10	-	-	0	67	8	101
	V.CASPA.	25	10	-	-	0	52	6	60
Febrero	J. BRAD.	24	9	6	-	240	79	759	107
	EANA	23	9	3	-	143	82	462	107
	AUKA	28	9	2	-	96	62	499	88
	V.AYQUIN.	28	8	-	-	0	64	0	88
	V.CASPA.	28	9	-	-	0	47	4	55
Marzo	J. BRAD.	31	11	5	-	188	82	613	110
	EANA	26	11	3	-	171	82	869	106
	AUKA	29	11	5	-	204	58	991	82
	V.AYQUIN.	31	11	-	-	0	59	8	84
	V.CASPA.	31	11	-	-	0	52	0	62
Abril	J. BRAD.	30	10	3	-	174	98	518	149
	EANA	28	10	2	-	124	98	600	145
	AUKA	*	10	*	-	*	53	*	103
	V.AYQUIN.	30	10	-	-	5	63	73	84
	V.CASPA.	30	10	-	-	3	52	26	67
Mayo	J. BRAD.	27	10	2	2	149	116	509	211
	EANA	31	10	7	2	203	116	757	176
	AUKA	30	10	4	-	198	63	747	106
	V.AYQUIN.	26	10	-	-	11	66	60	91
	V.CASPA.	26	10	-	-	4	60	19	78
Junio	J. BRAD.	30	10	2	-	78	60	616	104
	EANA	30	10	2	-	89	78	705	117
	AUKA	30	10	2	-	109	41	777	61
	V.AYQUIN.	30	9	-	-	5	68	46	90
	V.CASPA.	30	10	-	-	1	58	23	84
Julio	J. BRAD.	29	9	1	-	48	56	424	148
	EANA	26	10	1	-	44	50	395	117
	AUKA	24	9	-	-	56	32	300	83
	V.AYQUIN.	27	10	-	-	1	59	7	79
	V.CASPA.	29	10	-	-	0	52	6	65
Agosto	J. BRAD.	31	11	2	-	101	84	520	111
	EANA	28	11	2	-	160	115	960	143
	AUKA	31	11	2	-	158	52	1003	82
	V.AYQUIN.	31	11	-	-	7	66	63	85
	V.CASPA.	31	11	-	-	4	59	31	83
Septiembre	J. BRAD.	30	10	4	-	209	76	672	122
	EANA	30	10	2	-	184	100	543	138
	AUKA	29	10	6	-	222	51	618	75
	V.AYQUIN.	30	10	-	-	10	65	54	88
	V.CASPA.	30	9	-	-	2	54	20	67
Octubre	J. BRAD.								
	EANA								
	AUKA								
	V.AYQUIN.								
	V.CASPA.								
Noviembre	J. BRAD.								
	EANA								
	AUKA								
	V.AYQUIN.								
	V.CASPA.								
Diciembre	J. BRAD.								
	EANA								
	AUKA								
	V.AYQUIN.								
	V.CASPA.								
TOTAL	J. BRAD.	255	90	26	2	145	84	759	211
	EANA	252	91	23	2	144	93	960	176
	AUKA	230	90	22	0	141	54	1003	106
	V.AYQUIN.	260	89	0	0	4	64	73	101
	V.CASPA.	260	90	0	0	2	54	31	84

EMPRESA : CODELCO
CONTAMINANTE : ANHIDRIDO SULFUROSO(SO2) Y MATERIAL PARTICULADO (PM-10)
NORMA : CONCENTRACIÓN MEDIA DIARIA SO_2=365 $\mu g/m^3$
: CONCENTRACIÓN MEDIA DIARIA PM-10=150 $\mu g/m^3$

	AÑO 1998								
Mes	Ubicación Estación	N°Mediciones		N°Mediciones sobre Norma		Promedio $\mu g/m^3$		Conc. Máxima Diaria $\mu g/m^3$	
		SO_2	PM-10	SO_2	PM-10	SO_2	PM-10	SO_2	PM-10
Enero	J. BRAD.	28	10	5	0	228	90	995	149
	EANA	30	10	1	0	132	87	914	144
	AUKA	30	10	1	0	142	69	890	107
	V.AYQUIN.	30	10	0	0	2	78	24	103
	V.CASPA.	30	10	0	0	0	53	0	67
Febrero	J. BRAD.	22	10	0	0	162	68	359	89
	EANA	27	10	1	0	84	66	474	90
	AUKA	22	9	2	0	118	51	615	69
	V.AYQUIN.	26	10	0	0	0	61	0	86
	V.CASPA.	17	10	0	0	0	48	0	56
Marzo	J. BRAD.	28	10	5	0	272	78	1023	115
	EANA	30	10	4	0	201	79	838	110
	AUKA	29	10	4	0	182	62	788	134
	V.AYQUIN.	31	10	0	0	1	59	16	80
	V.CASPA.	9	10	0	0	2	40	10	56
Abril	J. BRAD.	21	10	1	0	121	50	408	81
	EANA	28	10	1	0	82	56	429	86
	AUKA	29	10	0	0	49	39	186	60
	V.AYQUIN.	30	9	0	0	1	69	13	81
	V.CASPA.	23	10	0	0	1	54	18	100
Mayo	J. BRAD.	29	10	3	0	124	57	882	104
	EANA	31	10	2	0	94	80	667	139
	AUKA	29	10	1	0	66	47	521	82
	V.AYQUIN.	31	10	0	0	1	75	21	105
	V.CASPA.	22	10	0	0	2	67	34	104
Junio	J. BRAD.	30	10	1	0	138	51	529	83
	EANA	30	10	0	0	51	74	196	109
	AUKA	20	10	0	0	26	43	120	72
	V.AYQUIN.	29	10	0	0	1	67	18	89
	V.CASPA.	29	9	0	0	0	62	0	73
Julio	J. BRAD.	31	11	0	0	100	42	330	77
	EANA	31	11	0	0	28	65	167	121
	AUKA	31	11	0	0	21	37	209	84
	V.AYQUIN.	28	11	0	0	1	65	17	97
	V.CASPA.	28	11	0	0	0	66	0	142
Agosto	J. BRAD.	31	10	2	0	104	44	470	100
	EANA	31	10	0	0	73	58	328	110
	AUKA	31	10	0	0	41	37	287	75
	V.AYQUIN.	23	10	0	0	2	74	27	83
	V.CASPA.	20	10	0	0	2	68	10	85
Septiembre	J. BRAD.	30	10	0	0	65	51	289	92
	EANA	26	10	0	0	59	64	293	103
	AUKA	30	10	0	0	66	42	361	66
	V.AYQUIN.	28	10	0	0	0	71	0	106
	V.CASPA.	22	10	0	0	0	59	0	78
Octubre	J. BRAD.	31	10	1	0	49	80	384	117
	EANA	30	10	0	0	45	88	206	120
	AUKA	31	10	0	0	62	54	338	77
	V.AYQUIN.	26	10	0	0	2	80	11	103
	V.CASPA.	17	10	0	0	0	56	5	69
Noviembre	J. BRAD.	30	9	2	0	186	95	1029	130
	EANA	28	9	1	0	156	100	779	131
	AUKA	24	10	1	0	147	44	715	90
	V.AYQUIN.	27	9	0	0	4	72	38	81
	V.CASPA.	10	10	0	0	2	57	25	76
Diciembre	J. BRAD.	31	11	4	0	177	114	680	148
	EANA	26	11	4	0	230	107	720	146
	AUKA	31	11	2	0	157	72	739	103
	V.AYQUIN.	29	11	0	0	2	70	14	86
	V.CASPA.	31	11	0	0	1	55	28	70
TOTAL	J. BRAD.	342	121	24	0	144	68	1029	149
	EANA	348	121	14	0	103	77	914	146
	AUKA	337	121	11	0	90	50	890	134
	V.AYQUIN.	338	120	0	0	1	70	38	106
	V.CASPA.	258	121	0	0	1	57	34	142

Servicio de Salud
ANTOFAGASTA

Depto. Programas
Sobre el Ambiente

ORD : N° 7091

ANT :OF.ORD.N°0487/99 CONAMA. REGIONAL
MAT : REMITE INFORME SOLICITADO.

ANTOFAGASTA,

DE : DIRECTOR SERVICIO DE SALUD ANTOFAGASTA.

A : DIRECTOR REGIONAL(S)
CONAMA REGION ANTOFAGASTA
A.Prat N°461,of.1407
ANTOFAGASTA

En relación a su solicitud de antecedentes sobre monitoreos de calidad de aire en la región,comunico a Ud. lo siguiente:

1.-Monóxido de Carbono(CO) y Ozono(O3):

Actualmente existe solo una estación de monitoreo que mide monoxido de carbono(CO) y ozono(O3) a nivel urbano en la región.Está ubicada en la localidad de Mejillones(Compañía de Bomberos) y funciona desde el mes de Junio del presente año;pertenece a la empresa NOPEL y la opera SERPRAM.La metodología de medición es el **infrarojo no dispersivo con filtro de correlación** para el CO y **espectrofotetría UV para el ozono.**

2.-Dióxido de Nitrógeno(NO):

Este contaminante es medido a nivel urbano en las localidades de Tocopilla y Mejillones.En Mejillones existen tres estaciones que miden este contaminante:Jardín Integra,FCAB y Cia de Bomberos,las cuales pertenecen a las empresas ENAEX, EDELNOR y NOPEL.Los operadores de estas estaciones son ENAEX,CIMM y SERPRAM respectivamente.La metodología de medición es **luminiscencia química** en todos los casos.

3.-Anhídrido sulfuroso(SO2):

A nivel urbano,este contaminante se mide actualmente en las localidades de Tocopilla,Mejillones y en las ciudades de Antofagasta y Calama,empleandose la metodología de **fluorescencia UV** en todos los casos.Las estaciones pertenecen a las empresas ELECTROANDINA y NORGENER en Tocopilla,NOPEL y EDELNOR en Mejillones,FUNDICION ALTONORTE en Antofagasta y CODELCO Chuquicamata en Calama.Las estaciones de Calama son operadas por la misma empresa.

4.-Partículas totales en suspención(PTS):

Actualmente,a nivel urbano no se está midiendo partículas totales en suspención sino solo partículas respirables(MP-10).En la ciudad de Antofagasta el Srvicio de Salud Antofagasta midió con equipos propios PTS durante los años 1997 y 1998 con motivo de la problemática de los acopios de concentrados de minerales bolivianos,empleándose para el efecto dos estaciones:Pasaje Loa y Gobernación Marítima,ubicadas frente a dichos acopios.

Para información más detallada sobre otros aspectos,se adjuntan tablas que incluyen resumenes de los resultados por estación.Si se desean los datos completos,deberán ser copiados directamente en las oficinas del Depto. de Programas sobre el Ambiente de este Servicio,ya que no existen bases de datos computacionales para todos los casos.

Saluda atentamente a Ud.

DR. MANUEL ZAMORANO GODOY
MEDICO CIRUJANO
DIRECTOR

MOC/MCC/JTF/mcc.
DISTRIBUCIÓN: N° 2194

- La indicada
- Dirección SSA
- SDM
- DPA
- Ofipar

"HACIA LA REGION QUE QUEREMOS"

REDES DE MONITOREO DE CALIDAD DEL AIRE II REGIÓN

COMUNA	PROPIETARIO	ESTACIONES N°	ESTACIONES UBICACIÓN	VARIABLES MONITOREADAS	METODOLOGÍA MEDICIÓN	AUTORIZACIÓN
CALAMA	CODELCO DIVISIÓN CHUQUICAMATA	5	3 Chuquicamata: Auka,J. Bradford,San José 2 Calama: V.Ayquina, V. Caspana	SO_2 PM-10 As en PM-10 Meteorología	F.U.V. G A.A	Resolución N°4074 del 22-09-1998
	CODELCO DIVISIÓN RADOMIRO TOMIC	3	Todas ubicadas en terrenos de la Planta	PM-10 PTS Meteorología	G G	✓
	SCM EL ABRA	2	1 Hotel el Abra 1 Sector Conchi	PM-10 PTS	G G	✓
ANTOFAGASTA	FUNDICIÓN ALTONORTE (EX-REFIMET)	3	2 La Negra, Sur 1 Coviefi	SO_2 PM-10 As en PM-10 Meteorología	F.U.V. G A.A	Res. Jurídica N°2084 27-Jul-94
	ESCONDIDA	3	Todas ubicadas en Sector Coloso	PM-10 PTS	G G	Ord N°6445 del 23/11/1998 (sólo Est.Coloso)
		2	1 Sector Campamentos 1 Mina	PM-10 PTS		Ord N°1013 del 24/02/1999
MARÍA ELENA	SQM NITRATOS	2	1 Iglesia 1 Hospital	PM-10 Meteorología	G	Resolución N°4075 del 22-09-1998
TOCOPILLA	ELECTROANDINA	1	Escuela E-10	SO_2, NO_2, NO_x PM-10 Meteorología	F.U.V, L.Q. G	✓
	NORGENER	1	Comisaría Carabineros	SO_2 PM-10 Meteorología	F.U.V. G	✓
MEJILLONES	ENAEX	1	Jardín Infantil Integra	NO_2 NO, NOx	L.Q. L.Q.	✓
	EDELNOR	1	Estación Ferrocarril	SO_2, NO_2 (campaña) PM-10 Meteorología	F.U.V., L.Q. G	✓
	NOPEL	1	Cía. De Bomberos	O_3, NO_2, CO PM-10	E.U.V,L.Q.,I.N.D. G	✖

Simbología

F.U.V.	Fluorescencia UV
G	Gravimetría
LQ	Luminiscencia química
E.U.V.	Espectrofometría U.V
I.N.D.	Infrarrojo no dispersivo con filtro de correlación
A.A.	Absorción Atómica
✓	ha sido inspeccionada
✖	no ha sido inspeccionada

000112

REDES DE MONITOREO DE CALIDAD DEL AIRE II REGIÓN

COMUNA	PROPIETARIO	MANEJO	
		OPERACIÓN	ANÁLIS/MANTENC/CALIB.
CALAMA	CODELCO DIVISIÓN CHUQUICAMATA	PROPIO	PROPIO
	CODELCO DIVISIÓN RADOMIRO TOMIC	CESMEC	CESMEC
	SCM EL ABRA		
ANTOFAGASTA	FUNDICIÓN ALTONORTE (EX-REFIMET)	CIMM	CIMM
	ESCONDIDA	SGS ECOCARE	SGS ECOCARE
		SGS ECOCARE	SGS ECOCARE
MARÍA ELENA	SQM NITRATOS	PROPIO	PROPIO+SK ECOLOGÍA+ SERPRAM (pesaje)
TOCOPILLA	ELECTROANDINA	PROPIO	CIMM PROPIO (pesaje)
	NORGENER	PROPIO	SERPRAM (Mantención,pesaje)
MEJILLONES	ENAEX	ENAEX	SK-ECOLOGÍA
	EDELNOR		CESMEC
	NOPEL		SERPRAM

Simbología

F.U.V.	Fluorescencia UV
G	Gravimetría
LQ	Luminiscencia química
E.U.V.	Espectrofometría U.V
I.N.D.	Infrarrojo no dispersivo con filt
A.A.	Absorción Atómica
✓	h[illegible]do inspeccionada
✖	n[illegible]a sido inspeccionada

DIRECCION REGIONAL
COMISION NACIONAL DEL MEDIO AMBIENTE
REGION DE ATACAMA

COMISION NACIONAL DEL MEDIO AMBIENTE
OFICINA DE PARTES Y ARCHIVO
INGRESO: 14280 / 10506
DESPACHADO: 14 DIC 1999
P. Matus 12
14824

ORD.: N° 01104 /

ANT.: Su Ord. N° 995613 del 10 .11.1999.

MAT.: Remite información.

COPIAPO, 13 DIC 1999

DE: DIRECTOR REGIONAL COMISION NACIONAL DEL MEDIO AMBIENTE REGION DE ATACAMA

A : DRA. PATRICIA MATUS C.
JEFE DEPTO. DESCONTAMINACION PLANES Y NORMAS
COMISION NACIONAL DEL MEDIO AMBIENTE

En atención a lo solicitado mediante documento citado en Antecedentes, adjunto me permito remitir a Ud. información de la red de monitoreo de calidad del aire por los parámetros SO2 y NO2 de la Empresa Eléctrica Guacolda en Huasco correspondiente a los años 1997-1999.

Saluda atentamente a Ud.

Comisión Nacional del Medio Ambiente
DIRECTOR
ATACAMA

JORGE TRONCOSO CONTRERAS
DIRECTOR REGIONAL
COMISION NACIONAL DEL MEDIO AMBIENTE

JTC/RRD/rrd
DISTRIBUCION

- Destinatario
- Archivos

INFORMACION RED DE MONITOREO DE CALIDAD DEL AIRE

ACTIVIDAD INDUSTRIAL PROPIETARIA DE LA RED: EMPRESA ELECTRICA GUACOLDA

ADMINISTRADOR DE LA RED	: CESMEC LTDA.
UBICACIÓN DE LA RED	: CUERPO DE BOMBEROS ZONA URBANA DE HUASCO.
SITUACION LEGAL DE LA RED	: CERTIFICADA POR EL SERVICIO DE SALUD DE ATACAMA
METODOLOGIA MEDICION SO2	: FLUORESCENCIA ULTRAVIOLETA
METOLOGIA DE MEDICION NO2	: QUIMIOLUMINISCENCIA ULTRAVIOLETA

Nota : La red de monitoreo fue establecida como parte del programa de seguimiento del EIA del Proyecto Guacolda y obtiene, además de SO2 Y NO2, datos de concentración de PM10, NO y variables meteorológicas.

MONITOREO DE ANHIDRIDO SULFUROSO

MONITOREO DE CALIDAD DEL AIRE

TABLA 3.

LUGAR : CUERPO DE BOMBEROS

VARIABLE : ANHIDRIDO SULFUROSO (SO_2)

PERIODO : 1 AL 30 DE SEPTIEMBRE DE 1999

UNIDAD : $\mu g/m^3N$

D/H	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	MAXIMA	MINIMA	MEDIA
1-Sep	28.8	26.1	39.2	26.1	47.0	26.1	44.4	26.1	31.4	47.0	31.4	31.4	26.1	44.4	26.1	41.8	26.1	39.2	26.1	36.6	26.1	44.4	26.1	26.1	47.0	26.1	33.1
2-Sep	36.6	26.1	41.8	26.1	44.4	26.1	44.4	26.1	39.2	26.1	26.1	31.4	26.1	44.4	26.1	36.6	26.1	39.2	26.1	44.4	26.1	34.0	26.1	26.1	44.4	26.1	32.3
3-Sep	28.8	26.1	34.0	26.1	44.4	26.1	39.2	26.1	36.6	31.4	57.5	49.7	31.4	26.1	31.4	31.4	26.1	44.4	26.1	39.2	26.1	36.6	26.1	26.1	57.5	26.1	33.2
4-Sep	34.0	26.1	36.6	26.1	39.2	26.1	34.0	26.1	36.6	26.1	36.6	26.1	34.0	26.1	31.4	26.1	36.6	26.1	47.0	26.1	34.0	26.1	26.1	26.1	47.0	26.1	30.8
5-Sep	28.8	26.1	34.0	26.1	44.4	26.1	39.2	26.1	31.4	44.4	36.6	31.4	26.1	31.4	36.6	31.4	26.1	36.6	26.1	39.2	26.1	18.3	54.9	39.2	54.9	18.3	32.8
6-Sep	36.6	26.1	39.2	26.1	36.6	26.1	31.4	26.1	28.8	31.4	26.1	31.4	26.1	31.4	28.8	26.1	34.0	26.1	36.6	26.1	36.6	26.1	28.8	26.1	39.2	26.1	29.9
7-Sep	34.0	26.1	36.6	26.1	28.8	26.1	31.4	26.1	39.2	36.6	36.6	26.1	31.4	26.1	28.8	26.1	26.1	18.3	26.1	47.0	26.1	34.0	26.1	26.1	47.0	18.3	29.8
8-Sep	26.1	26.1	26.1	26.1	26.1	18.3	18.3	26.1	36.6	26.1	34.0	26.1	39.2	26.1	44.4	26.1	36.6	26.1	18.3	#	C	C	47.0	31.4	47.0	18.3	29.1
9-Sep	41.8	39.2	31.4	28.8	34.0	36.6	39.2	31.4	36.6	34.0	57.5	36.6	26.1	31.4	26.1	39.2	26.1	44.4	26.1	34.0	26.1	28.8	26.1	26.1	57.5	26.1	33.7
10-Sep	28.8	26.1	34.0	26.1	44.4	26.1	31.4	26.1	34.0	26.1	36.6	44.4	31.4	26.1	36.6	26.1	44.4	26.1	34.0	26.1	31.4	26.1	28.8	26.1	44.4	26.1	31.1
11-Sep	36.6	26.1	34.0	26.1	36.6	26.1	34.0	26.1	39.2	26.1	28.8	26.1	26.1	44.4	36.6	26.1	34.0	26.1	44.4	26.1	28.8	26.1	31.4	26.1	44.4	26.1	30.9
12-Sep	28.8	26.1	34.0	26.1	31.4	26.1	39.2	26.1	39.2	31.4	31.4	26.1	34.0	26.1	31.4	31.4	26.1	39.2	26.1	34.0	26.1	39.2	26.1	26.1	39.2	26.1	30.5
13-Sep	28.8	26.1	34.0	26.1	39.2	26.1	31.4	26.1	44.4	36.6	26.1	36.6	26.1	34.0	26.1	36.6	26.1	39.2	26.1	44.4	26.1	47.0	26.1	26.1	47.0	26.1	31.9
14-Sep	34.0	26.1	39.2	26.1	44.4	26.1	39.2	26.1	41.8	26.1	31.4	26.1	36.6	26.1	31.4	26.1	34.0	26.1	44.4	26.1	39.2	26.1	26.1	26.1	44.4	26.1	31.5
15-Sep	36.6	26.1	34.0	26.1	39.2	26.1	31.4	26.1	31.4	34.0	26.1	28.8	26.1	31.4	26.1	34.0	26.1	39.2	26.1	31.4	26.1	39.2	26.1	26.1	39.2	26.1	30.2
16-Sep	31.4	26.1	39.2	26.1	36.6	26.1	28.8	26.1	34.0	26.1	34.0	26.1	31.4	26.1	31.4	31.4	26.1	28.8	26.1	34.0	26.1	34.0	26.1	26.1	39.2	26.1	29.5
17-Sep	20.9	26.1	28.8	26.1	39.2	26.1	47.0	26.1	28.8	34.0	26.1	34.0	26.1	36.6	36.6	26.1	31.4	26.1	39.2	26.1	31.4	26.1	28.8	26.1	47.0	20.9	30.2
18-Sep	31.4	26.1	34.0	26.1	39.2	26.1	44.4	26.1	47.0	26.1	34.0	26.1	31.4	26.1	39.2	26.1	36.6	26.1	34.0	26.1	28.8	26.1	31.4	26.1	47.0	26.1	31.0
19-Sep	31.4	26.1	34.0	26.1	36.6	26.1	39.2	26.1	41.8	26.1	34.0	26.1	39.2	26.1	44.4	26.1	36.6	26.1	41.8	26.1	28.8	26.1	31.4	26.1	44.4	26.1	31.4
20-Sep	31.4	26.1	36.6	26.1	34.0	26.1	39.2	26.1	44.4	26.1	28.8	26.1	39.2	26.1	44.4	31.4	31.4	26.1	39.2	26.1	44.4	26.1	28.8	26.1	44.4	26.1	31.7
21-Sep	31.4	26.1	36.6	26.1	34.0	26.1	39.2	26.1	44.4	26.1	34.0	26.1	28.8	26.1	31.4	26.1	36.6	26.1	41.8	26.1	31.4	26.1	44.4	26.1	44.4	26.1	31.1
22-Sep	47.0	26.1	39.2	26.1	44.4	26.1	36.6	26.1	34.0	26.1	28.8	26.1	26.1	18.3	26.1	34.0	26.1	39.2	26.1	47.0	26.1	47.0	26.1	26.1	47.0	18.3	31.5
23-Sep	31.4	26.1	34.0	26.1	44.4	26.1	39.2	26.1	31.4	36.6	26.1	31.4	31.4	36.6	26.1	39.2	26.1	44.4	26.1	41.8	26.1	28.8	26.1	28.8	44.4	26.1	31.7
24-Sep	26.1	34.0	26.1	36.6	26.1	39.2	26.1	31.4	26.1	47.0	26.1	26.1	31.4	26.1	41.8	26.1	44.4	26.1	36.6	26.1	34.0	26.1	39.2	26.1	47.0	26.1	31.5
25-Sep	36.6	26.1	31.4	26.1	47.0	26.1	36.6	26.1	44.4	26.1	31.4	44.4	26.1	36.6	26.1	34.0	26.1	31.4	26.1	47.0	26.1	39.2	26.1	26.1	47.0	26.1	32.2
26-Sep	26.1	36.6	26.1	34.0	26.1	28.8	26.1	44.4	26.1	39.2	31.4	26.1	31.4	26.1	39.2	26.1	34.0	26.1	39.2	26.1	44.4	26.1	36.6	26.1	44.4	26.1	31.4
27-Sep	34.0	26.1	44.4	26.1	39.2	26.1	44.4	26.1	36.6	26.1	57.5	36.6	26.1	36.6	26.1	49.7	26.1	34.0	26.1	44.4	26.1	39.2	26.1	26.1	57.5	26.1	33.7
28-Sep	26.1	31.4	26.1	39.2	26.1	36.6	26.1	44.4	26.1	49.7	26.1	44.4	26.1	36.6	26.1	18.3	18.3	26.1	39.2	26.1	47.0	26.1	26.1	28.8	49.7	18.3	31.1
29-Sep	26.1	39.2	26.1	47.0	26.1	49.7	26.1	52.3	26.1	54.9	26.1	34.0	26.1	62.7	31.4	26.1	39.2	26.1	36.6	26.1	34.0	26.1	31.4	26.1	62.7	26.1	34.4
30-Sep	34.0	26.1	36.6	26.1	39.2	26.1	44.4	26.1	41.8	47.0	26.1	31.4	26.1	34.0	26.1	36.6	18.3	20.9	18.3	26.1	41.8	26.1	44.4	26.1	47.0	18.3	31.2
MAXIMA	47.0	39.2	44.4	47.0	47.0	49.7	47.0	52.3	47.0	54.9	57.5	49.7	39.2	62.7	44.4	49.7	44.4	44.4	47.0	47.0	47.0	47.0	54.9	39.2			
MINIMA	20.9	26.1	26.1	26.1	26.1	18.3	18.3	26.1	26.1	26.1	26.1	26.1	26.1	18.3	26.1	18.3	18.3	18.3	18.3	26.1	26.1	18.3	26.1	26.1			
MEDIA	31.8	27.8	34.2	27.9	37.3	27.9	35.7	28.5	36.0	33.4	33.1	31.4	29.8	31.9	32.1	30.7	30.4	31.0	31.9	33.0	31.1	31.1	30.8	26.9			

Código ausencia de datos por mantención del equipo : #
Código ausencia de datos por calibración del equipo : C
Código ausencia de datos por falta de energía eléctrica temporalmente : +
N° de datos validos : 717
Recuperación de datos : 99.6 %
D : Día de Medición
H : Hora de Medición

Nota importante al reverso

AV. MARATHON 2595, COD. POSTAL 6900502 - MACUL - FONO 56-2-3502100 - FAX 56-2-2384135 - E-mail:cesmec@reuna.cl

MONITOREO DE CALIDAD DEL AIRE

TABLA 3.

LUGAR : CUERPO DE BOMBEROS

PERIODO : 01 DE JULIO AL 31 DE JULIO DE 1999

VARIABLE : ANHIDRIDO SULFUROSO (SO_2)

UNIDAD : $\mu g/m^3N$

D/H	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	MAXIMA	MINIMA	MEDIA
1-Jul	47.0	39.2	31.3	26.1	39.2	31.3	39.2	36.6	26.1	47.0	54.9	36.6	73.1	88.8	73.1	C	C	44.4	47.0	44.4	52.2	57.5	44.4	52.2	88.8	26.1	46.9
2-Jul	44.4	52.2	26.1	73.1	39.2	52.2	54.9	73.1	52.2	57.5	52.2	83.6	57.5	52.2	52.2	44.4	44.4	52.2	47.0	52.2	39.2	52.2	54.9	26.1	83.6	26.1	51.5
3-Jul	47.0	52.2	65.3	52.2	54.9	39.2	52.2	47.0	52.2	36.6	57.5	70.5	57.5	52.2	52.2	44.4	62.7	44.4	52.2	39.2	52.2	31.3	52.2	26.1	70.5	26.1	49.7
4-Jul	39.2	47.0	31.3	52.2	36.6	52.2	44.4	52.2	41.8	52.2	62.7	57.5	31.3	52.2	62.7	52.2	44.4	52.2	39.2	52.2	31.3	52.2	44.4	31.3	62.7	31.3	46.5
5-Jul	47.0	52.2	31.3	52.2	39.2	52.2	57.5	52.2	57.5	47.0	88.8	96.7	114.9	57.5	52.2	57.5	36.6	52.2	26.1	31.3	36.6	41.8	31.3	44.4	114.9	26.1	52.3
6-Jul	41.8	39.2	26.1	31.3	39.2	47.0	52.2	57.5	36.6	31.3	26.1	44.4	26.1	44.4	39.2	57.5	31.3	52.2	73.1	26.1	31.3	39.2	44.4	26.1	73.1	26.1	40.2
7-Jul	31.3	36.6	41.8	26.1	39.2	47.0	52.2	57.5	31.3	52.2	57.5	57.5	62.7	57.5	57.5	31.3	26.1	36.6	39.2	31.3	26.1	39.2	36.6	31.3	62.7	26.1	41.9
8-Jul	36.6	39.2	41.8	31.3	26.1	36.6	47.0	52.2	57.5	62.7	57.5	52.2	47.0	52.2	57.5	52.2	54.9	52.2	47.0	36.6	52.2	47.0	52.2	31.3	62.7	26.1	46.8
9-Jul	26.1	36.6	41.8	44.4	52.2	36.6	41.8	31.3	26.1	31.3	26.1	36.6	49.6	52.2	36.6	99.3	26.1	31.3	36.6	49.6	52.2	62.7	26.1	26.1	99.3	26.1	40.8
10-Jul	47.0	26.1	36.6	31.3	44.4	41.8	57.5	52.2	31.3	36.6	47.0	70.5	114.9	88.8	57.5	52.2	57.5	52.2	70.5	52.2	57.5	47.0	36.6	26.1	114.9	26.1	51.5
11-Jul	36.6	41.8	39.2	44.4	31.3	54.9	44.4	52.2	57.5	52.2	62.7	57.5	52.2	47.0	52.2	57.5	47.0	52.2	57.5	62.7	52.2	47.0	31.3	26.1	62.7	26.1	48.3
12-Jul	36.6	26.1	31.3	39.2	44.4	31.3	36.6	52.2	31.3	26.1	26.1	41.8	62.7	57.5	52.2	57.5	47.0	36.6	26.1	31.3	36.6	41.8	31.3	26.1	62.7	26.1	38.7
13-Jul	31.3	36.6	31.3	26.1	36.6	44.4	31.3	26.1	52.2	57.5	47.0	39.2	62.7	52.2	57.5	52.2	62.7	52.2	67.9	52.2	57.5	52.2	47.0	31.3	67.9	26.1	46.1
14-Jul	36.6	26.1	31.3	36.6	44.4	52.2	57.5	52.2	57.5	70.5	101.9	70.5	57.5	52.2	57.5	52.2	47.0	41.8	57.5	52.2	57.5	62.7	52.2	36.6	101.9	26.1	52.7
15-Jul	31.3	36.6	26.1	44.4	57.5	62.7	57.5	83.6	75.8	62.7	62.7	57.5	62.7	70.5	57.5	52.2	52.2	57.5	57.5	47.0	52.2	41.8	31.3	26.1	83.6	26.1	52.8
16-Jul	31.3	31.3	26.1	36.6	39.2	31.3	26.1	70.5	62.7	73.1	62.7	57.5	70.5	70.5	62.7	75.8	57.5	47.0	39.2	31.3	26.1	31.3	36.6	31.3	75.8	26.1	47.0
17-Jul	26.1	36.6	28.7	39.2	31.3	44.4	28.7	41.8	31.3	47.0	52.2	47.0	36.6	52.2	57.5	60.1	81.0	62.7	73.1	39.2	34.0	26.1	31.3	26.1	81.0	26.1	43.1
18-Jul	31.3	36.6	28.7	39.2	31.3	44.4	31.3	39.2	26.1	54.9	26.1	73.1	57.5	52.2	62.7	52.2	47.0	31.3	36.6	49.6	52.2	47.0	31.3	26.1	73.1	26.1	42.0
19-Jul	31.3	36.6	39.2	31.3	26.1	31.3	36.6	31.3	26.1	36.6	75.8	81.0	70.5	57.5	52.2	47.0	39.2	31.3	44.4	39.2	31.3	36.6	26.1	26.1	81.0	26.1	41.0
20-Jul	31.3	36.6	41.8	26.1	28.7	36.6	31.3	39.2	54.9	62.7	73.1	62.7	57.5	70.5	75.8	57.5	52.2	54.9	47.0	52.2	39.2	26.1	31.3	26.1	75.8	26.1	46.5
21-Jul	31.3	28.7	36.6	31.3	26.1	36.6	39.2	31.3	62.7	57.5	52.2	57.5	31.3	133.2	154.1	57.5	52.2,	47.0	39.2	52.2	36.6	52.2	39.2	26.1	154.1	26.1	50.5
22-Jul	31.3	36.6	31.3	26.1	28.7	36.6	26.1	+	+	+	+	+	+	52.2	57.5	120.2	146.3	52.2	44.4	52.2	54.9	39.2	31.3	26.1	146.3	26.1	49.6
23-Jul	31.3	36.6	39.2	31.3	26.1	36.6	39.2	41.8	54.9	36.6	31.3	36.6	39.2	31.3	26.1	88.8	57.5	52.2	62.7	52.2	73.1	52.2	65.3	52.2	88.8	26.1	45.6
24-Jul	36.6	31.3	26.1	36.6	31.3	39.2	26.1	36.6	34.0	39.2	26.1	31.3	36.6	44.4	41.8	26.1	75.8	83.6	70.5	62.7	83.6	75.8	70.5	62.7	83.6	26.1	47.0
25-Jul	62.7	57.5	52.2	57.5	39.2	57.5	36.6	57.5	52.2	57.5	36.6	52.2	41.8	52.2	47.0	62.7	83.6	62.7	75.8	83.6	83.6	62.7	57.5	26.1	83.6	26.1	56.6
26-Jul	31.3	39.2	36.6	54.9	52.2	47.0	36.6	75.8	57.5	52.2	44.4	49.6	39.2	34.0	70.5	62.7	57.5	52.2	47.0	39.2	36.6	52.2	47.0	47.0	75.8	31.3	48.4
27-Jul	39.2	36.6	47.0	39.2	36.6	26.1	62.7	44.4	70.5	44.4	62.7	57.5	62.7	52.2	62.7	57.5	52.2	75.8	70.5	57.5	52.2	47.0	39.2	26.1	75.8	26.1	50.9
28-Jul	31.3	41.8	31.3	36.6	26.1	31.3	39.2	28.7	41.8	34.0	26.1	39.2	31.3	39.2	31.3	36.6	26.1	41.8	26.1	31.3	41.8	31.3	31.3	26.1	41.8	26.1	33.4
29-Jul	31.3	36.6	26.1	31.3	36.6	31.3	26.1	36.6	31.3	31.3	36.6	57.5	52.2	62.7	26.1	31.3	36.6	57.5	52.2	57.5	52.2	44.4	36.6	26.1	62.7	26.1	39.5
30-Jul	31.3	26.1	31.3	39.2	31.3	26.1	31.3	31.3	36.6	39.2	31.3	109.7	128.0	141.1	141.1	96.7	62.7	52.2	47.0	52.2	41.8	52.2	39.2	31.3	141.1	26.1	56.3
31-Jul	26.1	36.6	31.3	26.1	34.0	28.7	26.1	52.2	31.3	36.6	26.1	31.3	26.1	31.3	26.1	36.6	47.0	39.2	57.5	52.2	36.6	47.0	36.6	26.1	57.5	26.1	35.4
MAXIMA	62.7	57.5	65.3	73.1	57.5	62.7	62.7	83.6	75.8	73.1	101.9	109.7	128.0	141.1	154.1	120.2	146.3	83.6	75.8	83.6	83.6	75.8	70.5	62.7			
MINIMA	26.1	26.1	26.1	26.1	26.1	26.1	26.1	26.1	26.1	26.1	26.1	31.3	26.1	31.3	26.1	26.1	26.1	31.3	26.1	26.1	26.1	26.1	26.1	26.1			
MEDIA	36.0	37.8	35.0	38.5	37.1	40.9	40.9	47.9	45.4	47.5	49.8	57.2	57.1	59.8	58.5	57.7	53.8	50.1	50.9	47.3	47.2	46.4	40.9	31.6			

Código ausencia de datos por mantención del equipo : #
Código ausencia de datos por calibración del equipo : C
Código ausencia de datos por falta de energía eléctrica temporalmente : +
N° de datos validos : 736
Recuperación de datos : 98.9 %
D : Día de Medición
H : Hora de Medición

Nota Importante al reverso

AV. MARATHON 2595, COD. POSTAL 6900502 - MACUL - FONO 56-2-3502100 - FAX 56-2-2384135 - E-mail:cesmec@reuna.cl

MONITOREO DE CALIDAD DEL AIRE

TABLA 3.

LUGAR : CUERPO DE BOMBEROS

VARIABLE : ANHIDRIDO SULFUROSO (SO_2)

PERIODO : 1 AL 30 DE JUNIO DE 1999

UNIDAD : μg/m³N

D/H	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	MAXIMA	MINIMA	MEDIA
1-jun	26.1	31.3	34.0	31.3	39.2	31.3	49.6	52.2	26.1	31.3	28.7	26.1	49.6	#	C	C	C	26.1	28.7	26.1	26.1	47.0	31.3	36.6	52.2	26.1	33.9
2-jun	28.7	26.1	47.0	26.1	49.6	28.7	26.1	47.0	31.3	26.1	31.3	34.0	54.9	62.7	67.9	49.6	26.1	62.7	26.1	75.8	26.1	31.3	26.1	151.5	151.5	26.1	44.3
3-jun	47.0	26.1	67.9	62.7	41.8	62.7	41.8	39.2	31.3	47.0	31.3	26.1	28.7	26.1	31.3	39.2	31.3	49.6	26.1	31.3	44.4	31.3	39.2	44.4	67.9	26.1	39.5
4-jun	31.3	26.1	65.3	31.3	39.2	49.6	31.3	44.4	31.3	47.0	31.3	39.2	31.3	26.1	28.7	26.1	36.6	26.1	28.7	47.0	31.3	26.1	28.7	31.3	65.3	26.1	34.8
5-jun	26.1	39.2	26.1	47.0	26.1	28.7	26.1	47.0	26.1	39.2	75.8	88.8	31.3	26.1	5.2	151.5	122.8	122.8	222.0	47.0	49.6	36.6	41.8	148.9	222.0	5.2	62.6
6-jun	49.6	62.7	109.7	73.1	146.3	36.6	41.8	62.7	41.8	120.2	31.3	47.0	57.5	31.3	26.1	36.6	26.1	62.7	26.1	128.0	26.1	73.1	26.1	47.0	146.3	26.1	57.9
7-jun	28.7	120.2	39.2	36.6	36.6	151.5	122.8	39.2	120.2	65.3	36.6	120.2	36.6	122.8	39.2	31.3	47.0	31.3	26.1	36.6	36.6	26.1	26.1	36.6	151.5	26.1	58.9
8-jun	41.8	47.0	28.7	52.2	54.9	36.6	28.7	26.1	31.3	52.2	54.9	78.4	62.7	36.6	26.1	31.3	28.7	26.1	52.2	26.1	47.0	31.3	39.2	54.9	78.4	26.1	41.5
9-jun	39.2	31.3	26.1	122.8	31.3	36.6	31.3	47.0	31.3	41.8	31.3	52.2	39.2	57.5	62.7	67.9	73.1	52.2	41.8	39.2	31.3	26.1	31.3	26.1	122.8	26.1	44.6
10-jun	36.6	31.3	47.0	31.3	26.1	31.3	28.7	718.4	+	+	741.9	553.8	57.5	83.6	96.7	62.7	31.3	26.1	36.6	31.3	26.1	20.9	26.1	31.3	741.9	20.9	126.2
11-jun	36.6	31.3	26.1	28.7	26.1	31.3	54.9	41.8	31.3	26.1	31.3	26.1	28.7	39.2	47.0	54.9	44.4	41.8	36.6	31.3	28.7	26.1	26.1	36.6	54.9	26.1	34.7
12-jun	41.8	44.4	52.2	54.9	52.2	47.0	39.2	31.3	44.4	39.2	31.3	36.6	26.1	57.5	75.8	44.4	31.3	28.7	26.1	54.9	47.0	41.8	31.3	31.3	75.8	26.1	42.1
13-jun	36.6	41.8	41.8	36.6	31.3	26.1	28.7	26.1	44.4	49.6	44.4	39.2	34.0	31.3	28.7	31.3	36.6	26.1	39.2	26.1	26.1	36.6	31.3	47.0	49.6	26.1	35.0
14-jun	36.6	54.9	47.0	41.8	36.6	28.7	31.3	36.6	39.2	44.4	49.6	39.2	62.7	39.2	47.0	52.2	39.2	31.3	26.1	57.5	88.8	52.2	57.5	57.5	88.8	26.1	45.7
15-jun	52.2	44.4	44.4	39.2	39.2	31.3	47.0	31.3	49.6	31.3	31.3	26.1	26.1	101.9	44.4	31.3	31.3	31.3	52.2	26.1	26.1	39.2	39.2	39.2	101.9	26.1	39.8
16-jun	47.0	31.3	36.6	28.7	31.3	44.4	39.2	31.3	39.2	57.5	57.5	39.2	31.3	52.2	96.7	39.2	39.2	36.6	31.3	28.7	39.2	31.3	36.6	31.3	96.7	28.7	40.7
17-jun	36.6	41.8	39.2	39.2	31.3	36.6	31.3	31.3	41.8	31.3	31.3	44.4	70.5	75.8	44.4	31.3	31.3	26.1	28.7	26.1	47.0	31.3	26.1	28.7	75.8	26.1	37.6
18-jun	36.6	41.8	47.0	49.6	28.7	34.0	36.6	41.8	39.2	57.5	57.5	57.5	39.2	88.8	26.1	36.6	41.8	31.3	49.6	26.1	28.7	31.3	31.3	34.0	88.8	26.1	41.4
19-jun	31.3	28.7	39.2	41.8	39.2	34.0	39.2	44.4	39.2	44.4	101.9	141.1	164.6	52.2	70.5	31.3	26.1	39.2	26.1	31.3	31.3	49.6	31.3	31.3	164.6	26.1	50.4
20-jun	31.3	39.2	44.4	44.4	39.2	44.4	52.2	52.2	154.1	185.5	141.1	62.7	39.2	39.2	52.2	39.2	31.3	36.6	41.8	28.7	26.1	47.0	26.1	26.1	185.5	26.1	55.2
21-jun	31.3	39.2	31.3	31.3	39.2	62.7	39.2	39.2	44.4	44.4	39.2	36.6	34.0	31.3	26.1	52.2	31.3	26.1	47.0	28.7	41.8	49.6	28.7	31.3	62.7	26.1	37.8
22-jun	36.6	41.8	36.6	31.3	36.6	31.3	47.0	31.3	41.8	31.3	26.1	28.7	41.8	128.0	141.1	62.7	31.3	26.1	39.2	31.3	26.1	31.3	31.3	31.3	141.1	26.1	43.4
23-jun	26.1	31.3	36.6	31.3	41.8	31.3	28.7	31.3	34.0	31.3	31.3	26.1	36.6	26.1	44.4	52.2	54.9	31.3	26.1	49.6	31.3	31.3	31.3	26.1	54.9	26.1	34.3
24-jun	31.3	36.6	39.2	36.6	41.8	44.4	47.0	49.6	39.2	62.7	96.7	88.8	31.3	26.1	624.3	96.7	75.8	75.8	62.7	57.5	52.2	57.5	57.5	57.5	624.3	26.1	78.7
25-jun	62.7	62.7	62.7	70.5	70.5	75.8	75.8	83.6	96.7	133.2	57.5	62.7	57.5	52.2	67.9	70.5	57.5	54.9	52.2	67.9	52.2	75.8	52.2	52.2	133.2	52.2	67.8
26-jun	57.5	62.7	57.5	52.2	67.9	52.2	73.1	52.2	54.9	52.2	57.5	62.7	67.9	52.2	54.9	52.2	75.8	52.2	62.7	31.3	52.2	57.5	52.2	62.7	75.8	31.3	57.4
27-jun	67.9	65.3	52.2	54.9	52.2	62.7	67.9	73.1	62.7	54.9	52.2	44.4	44.4	62.7	57.5	44.4	44.4	44.4	44.4	52.2	44.4	44.4	44.4	36.6	73.1	36.6	53.1
28-jun	44.4	49.6	52.2	54.9	44.4	52.2	73.1	60.1	54.9	52.2	75.8	44.4	44.4	41.8	44.4	47.0	44.4	49.6	52.2	62.7	52.2	67.9	52.2	54.9	75.8	41.8	53.0
29-jun	57.5	60.1	73.1	52.2	62.7	67.9	57.5	52.2	54.9	52.2	62.7	120.2	57.5	52.2	52.2	52.2	44.4	52.2	52.2	44.4	52.2	52.2	52.2	52.2	120.2	44.4	57.9
30-jun	44.4	49.6	44.4	52.2	62.7	52.2	57.5	52.2	57.5	57.5	52.2	57.5	83.6	57.5	57.5	52.2	44.4	44.4	52.2	52.2	62.7	57.5	52.2	54.9	83.6	44.4	54.6
MAXIMA	67.9	120.2	109.7	122.8	146.3	151.5	122.8	718.4	154.1	185.5	741.9	553.8	164.6	128.0	624.3	151.5	122.8	122.8	222.0	128.0	88.8	75.8	57.5	151.5			
MINIMA	26.1	26.1	26.1	26.1	26.1	26.1	26.1	26.1	26.1	26.1	26.1	26.1	26.1	26.1	5.2	26.1	26.1	26.1	26.1	26.1	26.1	20.9	26.1	26.1			
MEDIA	40.0	44.7	46.5	46.2	45.5	46.1	46.5	67.2	49.5	55.5	74.1	71.7	49.0	54.5	72.0	50.7	44.1	42.4	45.4	43.4	40.0	42.0	36.9	47.7			

Código ausencia de datos por mantención del equipo : #
Código ausencia de datos por calibración del equipo : C
Código ausencia de datos por falta de energía eléctrica temporalmente : +
N° de datos validos : 714
Recuperación de datos : 99.2 %
D : Dia de Medición
H : Hora de Medición

Nota Importante al reverso

AV. MARATHON 2595, COD. POSTAL 6900502 - MACUL - FONO 56-2-3502100 - FAX 56-2-2384135 - E-mail:cesmec@reuna.cl

MONITOREO DE CALIDAD DEL AIRE

TABLA 3.

LUGAR : CUERPO DE BOMBEROS

PERIODO : 1 AL 31 DE MAYO DE 1999

VARIABLE : ANHIDRIDO SULFUROSO (SO_2)

UNIDAD : $\mu g/m^3N$

D/H	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	MAXIMA	MINIMA	MEDIA
1-may	28.7	26.1	31.3	26.1	44.4	39.2	26.1	26.1	28.7	26.1	26.1	18.3	31.3	44.4	52.2	31.3	18.3	31.3	39.2	26.1	26.1	18.3	31.3	13.1	52.2	13.1	29.6
2-may	26.1	28.7	26.1	18.3	13.1	18.3	23.5	18.3	0.0	18.3	20.9	18.3	39.2	83.6	62.7	26.1	26.1	18.3	20.9	18.3	20.9	18.3	23.5	31.3	83.6	0.0	25.8
3-may	39.2	31.3	26.1	28.7	26.1	31.3	26.1	34.0	31.3	+	+	39.2	141.1	83.6	44.4	26.1	26.1	18.3	26.1	31.3	31.3	26.1	26.1	26.1	141.1	18.3	37.3
4-may	28.7	26.1	31.3	26.1	31.3	26.1	31.3	39.2	70.5	39.2	39.2	0.0	31.3	39.2	15.7	13.1	26.1	18.3	26.1	31.3	39.2	31.3	31.3	26.1	70.5	0.0	29.9
5-may	28.7	26.1	28.7	26.1	31.3	26.1	31.3	26.1	28.7	26.1	39.2	18.3	26.1	28.7	18.3	+	+	31.3	26.1	28.7	26.1	39.2	26.1	26.1	39.2	18.3	27.9
6-may	31.3	26.1	36.6	26.1	41.8	26.1	47.0	26.1	52.2	26.1	146.3	109.7	44.4	31.3	26.1	28.7	26.1	28.7	26.1	39.2	26.1	26.1	26.1	18.3	146.3	18.3	39.3
7-may	20.9	18.3	26.1	18.3	18.3	26.1	18.3	23.5	18.3	26.1	26.1	18.3	18.3	23.5	18.3	26.1	18.3	+	+	26.1	18.3	20.9	18.3	18.3	26.1	18.3	21.1
8-may	23.5	18.3	31.3	18.3	39.2	18.3	26.1	18.3	28.7	18.3	0.0	18.3	23.5	18.3	26.1	18.3	31.3	52.2	18.3	18.3	0.0	18.3	0.0	18.3	52.2	0.0	20.9
9-may	26.1	18.3	28.7	18.3	39.2	18.3	26.1	18.3	26.1	44.4	26.1	39.2	39.2	26.1	18.3	23.5	18.3	18.3	0.0	18.3	26.1	18.3	18.3	18.3	44.4	0.0	23.8
10-may	26.1	18.3	31.3	18.3	23.5	18.3	26.1	26.1	+	+	+	31.3	26.1	18.3	26.1	44.4	83.6	26.1	26.1	18.3	26.1	18.3	18.3	18.3	83.6	18.3	27.1
11-may	26.1	28.7	26.1	39.2	26.1	47.0	31.3	31.3	34.0	26.1	28.7	18.3	20.9	18.3	23.5	18.3	26.1	18.3	28.7	26.1	39.2	26.1	31.3	31.3	47.0	18.3	28.0
12-may	26.1	39.2	31.3	26.1	28.7	26.1	31.3	39.2	44.4	57.5	0.0	0.0	0.0	0.0	0.0	+	+	31.3	C	C	C	C	31.3	31.3	57.5	0.0	24.7
13-may	20.9	31.3	26.1	31.3	26.1	41.8	26.1	31.3	26.1	52.2	26.1	54.9	70.5	26.1	26.1	31.3	26.1	28.7	26.1	39.2	26.1	47.0	26.1	26.1	70.5	20.9	33.1
14-may	39.2	26.1	47.0	26.1	49.6	26.1	31.3	31.3	44.4	39.2	31.3	26.1	26.1	47.0	31.3	26.1	28.7	26.1	26.1	31.3	39.2	31.3	31.3	39.2	49.6	26.1	33.4
15-may	31.3	26.1	47.0	26.1	49.6	26.1	52.2	26.1	47.0	39.2	26.1	49.6	26.1	39.2	31.3	26.1	49.6	31.3	47.0	31.3	39.2	44.4	44.4	39.2	52.2	26.1	37.3
16-may	36.6	39.2	31.3	34.0	31.3	39.2	31.3	49.6	31.3	70.5	101.9	101.9	96.7	31.3	13.1	0.0	26.1	26.1	5.2	26.1	47.0	26.1	26.1	26.1	101.9	0.0	39.5
17-may	20.9	26.1	47.0	26.1	49.6	26.1	52.2	26.1	31.3	31.3	26.1	26.1	177.6	109.7	26.1	31.3	26.1	52.2	31.3	26.1	47.0	26.1	26.1	28.7	177.6	20.9	41.6
18-may	26.1	47.0	26.1	49.6	26.1	39.2	26.1	41.8	26.1	44.4	31.3	39.2	52.2	44.4	39.2	31.3	26.1	31.3	26.1	26.1	31.3	31.3	26.1	26.1	52.2	26.1	33.9
19-may	31.3	28.7	31.3	39.2	31.3	36.6	31.3	39.2	31.3	34.0	31.3	26.1	26.1	44.4	44.4	31.3	26.1	28.7	26.1	26.1	39.2	26.1	49.6	26.1	49.6	26.1	32.7
20-may	31.3	44.4	26.1	31.3	31.3	26.1	26.1	31.3	31.3	39.2	62.7	101.9	109.7	52.2	31.3	31.3	26.1	31.3	52.2	31.3	39.2	47.0	39.2	39.2	109.7	26.1	42.2
21-may	41.8	39.2	44.4	57.5	57.5	62.7	57.5	54.9	52.2	44.4	172.4	300.4	177.6	83.6	185.5	70.5	88.8	88.8	83.6	88.8	159.3	120.2	83.6	88.8	300.4	39.2	96.0
22-may	83.6	75.8	70.5	75.8	70.5	70.5	62.7	52.2	57.5	52.2	39.2	31.3	26.1	31.3	26.1	31.3	31.3	52.2	128.0	83.6	96.7	109.7	62.7	39.2	128.0	26.1	60.8
23-may	62.7	70.5	57.5	44.4	49.6	44.4	52.2	44.4	44.4	52.2	52.2	57.5	75.8	83.6	62.7	39.2	31.3	36.6	31.3	47.0	31.3	57.5	31.3	31.3	83.6	31.3	49.6
24-may	57.5	31.3	52.2	31.3	28.7	31.3	39.2	47.0	39.2	31.3	26.1	31.3	41.8	31.3	31.3	39.2	31.3	26.1	31.3	26.1	31.3	20.9	31.3	31.3	57.5	20.9	34.2
25-may	31.3	31.3	31.3	31.3	31.3	31.3	31.3	31.3	39.2	31.3	26.1	26.1	26.1	39.2	39.2	39.2	31.3	31.3	26.1	26.1	26.1	26.1	26.1	26.1	39.2	26.1	30.7
26-may	31.3	39.2	31.3	39.2	39.2	31.3	49.6	31.3	36.6	31.3	26.1	57.5	57.5	39.2	31.3	26.1	26.1	52.2	26.1	31.3	60.1	31.3	26.1	31.3	60.1	26.1	36.8
27-may	36.6	31.3	41.8	31.3	47.0	31.3	52.2	31.3	39.2	44.4	39.2	39.2	31.3	31.3	26.1	47.0	26.1	28.7	26.1	39.2	26.1	49.6	26.1	26.1	52.2	26.1	35.4
28-may	31.3	26.1	41.8	26.1	73.1	26.1	65.3	26.1	151.5	26.1	52.2	26.1	26.1	31.3	26.1	65.3	26.1	26.1	91.4	26.1	125.4	26.1	169.8	26.1	169.8	26.1	51.6
29-may	31.3	26.1	26.1	31.3	36.6	31.3	31.3	39.2	44.4	39.2	31.3	164.6	96.7	44.4	31.3	39.2	39.2	31.3	26.1	31.3	39.2	31.3	26.1	31.3	164.6	26.1	41.7
30-may	28.7	26.1	31.3	54.9	26.1	47.0	26.1	39.2	26.1	31.3	26.1	28.7	26.1	39.2	26.1	49.6	26.1	52.2	26.1	54.9	26.1	65.3	31.3	39.2	65.3	26.1	35.6
31-may	31.3	31.3	26.1	28.7	26.1	65.3	26.1	73.1	26.1	83.6	26.1	62.7	26.1	128.0	26.1	62.7	26.1	31.3	28.7	26.1	47.0	26.1	39.2	28.7	128.0	26.1	41.8
MAXIMA	83.6	75.8	70.5	75.8	73.1	70.5	65.3	73.1	151.5	83.6	172.4	300.4	177.6	128.0	185.5	70.5	88.8	88.8	128.0	88.8	159.3	120.2	169.8	88.8			
MINIMA	20.9	18.3	26.1	18.3	13.1	18.3	18.3	18.3	0.0	18.3	0.0	0.0	0.0	0.0	0.0	0.0	18.3	18.3	0.0	18.3	0.0	18.3	0.0	13.1			
MEDIA	33.4	32.3	35.2	32.4	36.9	34.0	36.0	34.6	39.6	38.8	41.6	51.0	52.8	44.9	35.0	33.6	31.7	33.5	34.6	33.3	41.9	36.8	35.6	29.9			

Código ausencia de datos por calibración del equipo	:	**C**
Código ausencia de datos por falta de energía eléctrica temporalmente	:	**+**
N° de datos validos	:	**729**
Recuperación de datos	:	**90.7 %**
D	:	**Día de Medición**
H	:	**Hora de Medición**

Nota Importante al reverso

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cesmec

SEB-10240

MONITOREO DE CALIDAD DEL AIRE

TABLA 3.

LUGAR : CUERPO DE BOMBEROS

PERIODO : 1 AL 30 DE ABRIL DE 1999

VARIABLE : ANHIDRIDO SULFUROSO (SO_2)

UNIDAD : µg/m³N

D/H	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	MAXIMA	MINIMA	MEDIA
1-abr	79.7	73.2	117.6	98.0	88.8	145.0	126.7	92.7	103.2	53.6	81.0	94.1	105.8	154.2	168.5	207.7	163.3	116.3	54.9	90.2	57.5	54.9	66.6	57.5	207.7	53.6	102.1
2-abr	111.0	61.4	41.8	62.7	61.4	90.1	104.5	130.6	74.5	37.9	49.7	31.4	26.1	113.7	22.2	51.0	47.0	+	+	+	+	100.6	62.7	9.2	130.6	9.2	64.5
3-abr	47.0	47.0	32.7	28.7	28.7	41.8	9.2	10.5	14.4	83.6	112.4	74.5	96.7	100.6	116.3	128.0	135.8	163.3	116.3	112.3	75.8	20.9	9.2	14.4	163.3	9.2	67.5
4-abr	30.1	32.7	47.0	61.4	81.0	104.5	112.3	87.5	118.9	74.5	94.1	124.1	109.7	116.3	61.4	90.1	160.7	116.3	87.5	61.4	17.0	10.5	5.2	7.9	160.7	5.2	75.5
5-abr	11.8	14.4	32.7	31.4	9.2	17.0	36.6	44.4	39.2	+	+	+	60.1	148.9	103.2	107.1	122.8	99.3	73.2	41.8	34.0	18.3	13.1	18.3	148.9	9.2	51.2
6-abr	35.3	47.0	35.3	49.6	61.4	65.3	70.5	112.3	62.7	62.7	75.8	26.2	32.7	14.4	101.9	129.3	133.3	143.7	121.5	160.7	C	C	22.2	23.6	160.7	14.4	72.1
7-abr	40.5	54.9	69.3	26.2	87.6	74.5	84.9	107.1	109.8	117.6	73.2	87.5	65.3	34.0	15.7	+	+	+	65.3	31.4	7.9	15.7	13.1	19.6	117.6	7.9	57.2
8-abr	24.8	40.5	26.1	35.3	17.0	35.3	73.2	58.8	37.9	61.4	65.3	82.3	126.7	154.2	148.9	113.6	86.2	96.7	62.7	35.3	15.7	5.2	9.2	5.2	154.2	5.2	59.0
9-abr	14.4	17.0	32.7	44.4	36.6	44.4	34.0	60.1	15.7	19.6	7.8	14.4	32.7	34.0	32.7	133.2	128.0	+	+	+	+	19.6	22.2	13.1	133.2	7.8	37.8
10-abr	32.7	48.4	44.4	24.8	9.2	27.5	39.2	44.4	34.0	51.0	81.0	172.5	57.5	34.0	26.2	61.4	13.1	26.1	30.1	9.2	1.3	15.7	6.6	10.5	172.5	1.3	37.5
11-abr	15.7	26.2	66.7	56.2	48.4	27.5	34.0	10.5	15.7	26.1	37.9	26.1	44.4	18.3	35.3	15.7	86.2	58.8	37.9	47.1	56.2	41.8	23.6	11.8	86.2	10.5	36.1
12-abr	17.0	5.3	6.6	1.3	14.4	22.2	35.3	40.5	27.5	+	+	+	13.1	17.0	31.4	41.8	73.2	95.4	135.9	120.2	142.4	116.3	68.0	37.9	142.4	1.3	50.6
13-abr	27.5	11.8	40.5	37.9	26.2	36.6	18.3	19.6	32.7	41.8	88.9	34.0	13.1	37.9	48.3	24.8	35.3	26.1	31.4	10.5	15.7	2.7	1.3	19.6	88.9	1.3	28.4
14-abr	44.5	66.7	99.3	41.8	58.8	35.3	49.7	73.2	142.4	111.0	103.2	54.9	65.3	53.6	32.7	+	+	+	5.3	5.2	10.5	15.7	1.3	15.7	142.4	1.3	51.7
15-abr	26.2	23.6	40.5	69.3	18.3	40.5	58.8	70.6	49.7	30.1	52.3	40.5	99.3	160.7	148.9	151.5	138.5	98.0	84.9	54.9	88.8	56.2	15.7	19.6	160.7	15.7	68.2
16-abr	48.4	54.9	37.9	48.4	137.2	99.3	111.0	126.7	77.1	60.1	87.5	39.2	28.8	18.3	9.2	6.6	5.2	+	+	+	+	10.5	18.3	6.6	137.2	5.2	51.5
17-abr	1.3	13.1	27.5	31.4	41.8	35.3	44.5	56.2	109.8	128.0	113.7	118.9	90.2	40.5	48.4	40.5	23.6	26.1	48.3	62.7	26.1	6.6	11.8	15.7	128.0	1.3	48.4
18-abr	26.2	18.3	14.4	17.0	10.5	7.9	30.1	15.7	11.8	6.6	13.1	19.6	47.0	111.0	147.6	120.2	71.9	19.6	44.4	99.3	73.2	128.0	27.5	73.2	147.6	6.6	48.1
19-abr	141.1	66.6	87.5	116.3	74.5	56.2	39.2	45.7	14.4	+	+	+	90.1	31.4	44.4	36.6	22.2	18.3	91.5	66.7	27.5	15.7	26.2	36.6	141.1	14.4	54.7
20-abr	62.7	57.5	88.9	54.9	99.3	30.1	44.4	75.8	99.3	26.1	41.8	56.2	71.9	27.5	13.1	14.4	2.7	27.5	95.4	34.0	43.1	30.1	11.8	15.7	99.3	2.7	46.8
21-abr	92.8	79.7	77.1	37.9	48.4	26.2	23.6	44.4	54.9	18.3	24.9	10.5	5.2	2.7	13.1	+	+	+	6.6	32.7	34.0	71.9	128.0	94.1	128.0	2.7	44.1
22-abr	61.4	67.9	41.8	27.5	31.4	40.5	43.1	60.1	62.7	75.8	74.5	77.1	112.4	69.3	40.5	26.2	37.9	22.2	98.0	11.8	15.7	24.9	40.5	32.7	112.4	11.8	49.8
23-abr	62.7	129.3	113.7	148.9	126.7	98.0	56.2	37.9	60.1	23.6	30.1	11.8	32.7	44.5	54.9	31.4	11.8	+	+	+	+	48.4	22.2	15.7	148.9	11.8	58.0
24-abr	30.1	44.4	49.7	39.2	31.4	48.4	34.0	18.3	9.2	5.2	7.9	15.7	44.4	31.4	47.0	49.7	75.8	81.0	79.7	94.1	54.9	35.3	22.2	17.0	94.1	5.2	40.2
25-abr	64.0	83.6	19.6	84.9	112.4	109.7	126.7	99.3	51.0	17.0	2.6	35.3	22.2	27.5	61.4	54.9	51.0	34.0	19.6	6.6	32.7	22.2	41.8	22.2	126.7	2.6	50.1
26-abr	41.8	44.5	45.7	44.5	28.8	37.9	10.5	0.0	6.6	+	+	+	124.1	98.0	96.7	96.7	45.7	65.3	64.0	49.7	96.7	105.8	60.1	51.0	124.1	0.0	57.8
27-abr	75.8	113.7	24.9	60.1	44.4	35.3	45.7	44.4	66.7	98.0	90.1	71.9	53.6	43.1	41.8	18.3	3.9	14.4	7.9	6.5	14.4	9.2	0.0	5.3	113.7	0.0	41.2
28-abr	1.3	10.5	5.3	28.8	40.5	54.9	44.5	28.8	40.5	43.1	57.5	73.2	75.8	103.2	109.7	+	+	+	36.6	26.2	11.8	4.0	1.3	2.6	109.7	1.3	38.1
29-abr	137.2	120.2	107.1	139.8	128.0	142.4	139.8	115.0	129.3	121.5	117.6	137.2	124.1	160.7	142.4	138.5	145.0	147.6	126.7	160.7	146.3	128.0	128.0	94.1	160.7	94.1	132.4
30-abr	1.3	5.3	6.6	1.3	5.3	11.8	0.0	0.0	0.0	5.2	1.3	4.0	1.3	3.9	13.1	0.0	1.3	+	+	+	+	1.3	1.3	1.3	13.1	0.0	3.3
MAXIMA	141.1	129.3	117.6	148.9	137.2	145.0	139.8	130.6	142.4	128.0	117.6	172.5	126.7	160.7	168.5	207.7	163.3	163.3	135.9	160.7	146.3	128.0	128.0	94.1			
MINIMA	1.3	5.3	5.3	1.3	5.3	7.9	0.0	0.0	0.0	5.2	1.3	4.0	1.3	2.7	9.2	0.0	1.3	14.4	5.3	5.2	1.3	1.3	0.0	1.3			
MEDIA	46.8	49.3	49.3	51.6	53.6	54.7	56.0	57.7	55.7	53.8	60.9	58.9	62.4	66.8	65.9	72.6	70.0	71.2	65.0	57.2	45.8	39.1	29.3	25.6			

Código ausencia de datos por instalación de equipo : *
Código ausencia de datos por calibración del equipo : C
Código ausencia de datos por falta de energía eléctrica temporalmente : +
N° de datos validos : 675
Recuperación de datos : 93.8 %
D : Día de Medición
H : Hora de Medición

Nota Importante al reverso

AV. MARATHON 2595, COD. POSTAL 6900502 - MACUL - FONO 56-2-3502100 - FAX 56-2-2384135 - E-mail:cesmec@reuna.cl

MONITOREO DE CALIDAD DEL AIRE

TABLA 3.

LUGAR : CUERPO DE BOMBEROS

PERIODO : 1 AL 31 DE MARZO DE 1999

VARIABLE : ANHIDRIDO SULFUROSO (SO_2)

UNIDAD : µg/m³N

D/H	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	MAXIMA	MINIMA	MEDIA
1-mar	+	+	+	+	+	+	+	+	+	117.6	199.9	94.1	103.2	+	+	+	+	+	+	+	+	+	+	+	199.9	94.1	128.7
2-mar	+	+	+	+	+	+	+	+	74.5	15.7	216.8	115.0	26.1	94.1	0.0	37.9	31.4	113.7	47.1	115.0	103.2	84.9	47.1	6.5	216.8	0.0	70.5
3-mar	31.4	31.4	17.0	13.1	13.1	26.2	6.5	5.2	1.3	39.2	52.3	48.3	90.2	87.5	100.6	*	*	#	#	C	C	C	395.8	401.0	401.0	1.3	80.0
4-mar	416.7	419.3	433.7	448.0	467.6	491.2	499.0	266.5	116.3	74.5	128.0	101.9	96.7	113.7	58.8	87.5	158.1	116.3	87.5	61.4	17.0	10.5	5.2	7.9	499.0	5.2	195.1
5-mar	11.8	14.4	32.7	31.4	9.2	17.0	36.6	53.6	48.4	61.4	81.0	88.2	57.5	73.2	84.9	100.6	116.3	96.7	73.2	41.8	31.4	15.7	13.1	15.7	116.3	9.2	50.1
6-mar	32.7	44.4	32.7	47.0	58.8	62.7	67.9	109.7	62.7	78.4	152.8	48.4	45.7	27.5	101.9	+	+	158.4	130.7	169.8	109.8	54.9	18.3	23.6	169.8	18.3	74.5
7-mar	40.5	54.9	69.3	26.2	87.6	74.5	84.9	111.0	112.4	168.5	73.2	83.6	54.9	23.6	9.2	14.4	1.3	43.1	71.9	27.5	4.0	11.8	9.2	15.7	168.5	1.3	53.0
8-mar	20.9	36.6	22.2	31.4	13.1	31.4	69.3	54.9	34.0	57.5	65.3	180.3	295.2	142.4	142.4	107.1	82.3	+	+	35.3	15.7	1.3	5.3	+	295.2	1.3	68.7
9-mar	14.4	17.0	28.8	40.5	32.7	37.9	30.1	60.1	28.7	22.2	5.3	39.2	35.3	21.0	17.0	139.8	115.0	150.2	128.0	111.0	83.6	15.7	18.3	9.2	150.2	5.3	50.0
10-mar	28.8	44.5	40.5	18.3	+	+	39.2	47.0	34.0	18.3	81.0	139.8	53.6	49.6	39.2	54.9	17.0	26.1	30.1	11.8	5.2	15.7	6.6	10.5	139.8	5.2	36.9
11-mar	15.7	30.1	70.6	60.1	48.4	27.5	34.0	13.1	18.3	44.4	53.6	32.7	57.5	24.8	37.9	28.7	103.2	65.3	44.4	53.6	58.8	48.3	27.5	18.3	103.2	13.1	42.3
12-mar	23.5	11.8	13.1	7.8	20.9	24.8	35.3	43.1	27.5	28.7	34.0	19.6	35.3	23.6	34.0	44.4	75.8	101.9	142.4	126.7	146.3	122.8	71.9	41.8	146.3	7.8	52.3
13-mar	31.4	15.7	47.0	44.4	30.1	39.2	20.9	30.1	39.2	57.5	101.9	18.3	22.2	24.9	32.7	9.2	22.2	28.7	20.9	17.0	22.2	9.2	7.9	26.1	101.9	7.9	29.9
14-mar	51.0	73.2	101.9	44.4	61.4	41.8	53.6	75.8	148.9	155.4	154.2	88.2	81.0	37.9	13.1	0.0	17.0	11.8	1.3	5.2	17.0	19.6	5.2	15.7	155.4	0.0	53.0
15-mar	19.6	27.5	44.4	75.8	24.8	47.0	61.4	77.1	49.7	32.7	54.9	43.1	117.6	169.8	142.4	151.5	141.1	98.0	78.4	51.0	86.2	58.2	18.3	19.6	169.8	18.3	70.3
16-mar	48.4	57.5	40.5	52.3	143.7	103.2	111.0	116.3	81.0	64.0	90.1	41.8	31.4	91.5	60.1	79.7	30.1	20.9	20.9	32.7	48.3	17.0	22.2	13.1	143.7	13.1	59.0
17-mar	5.2	17.0	31.4	35.3	45.7	39.2	51.0	62.7	113.7	134.5	120.2	129.3	100.6	47.0	54.9	43.1	27.5	23.5	45.7	60.1	28.7	13.1	18.3	22.2	134.5	5.2	52.9
18-mar	30.1	24.8	20.9	20.9	14.4	14.4	36.6	22.2	18.3	13.1	15.7	32.7	49.6	113.6	143.7	117.6	71.9	26.1	44.4	101.9	75.8	128.0	27.5	75.8	143.7	13.1	51.6
19-mar	143.7	69.2	87.5	116.3	77.1	58.8	41.8	48.3	23.5	95.4	67.9	92.8	90.1	35.3	47.0	43.1	26.1	22.2	95.4	73.2	31.4	19.6	30.1	40.5	143.7	19.6	61.5
20-mar	66.6	61.4	95.4	58.8	103.2	30.1	47.0	78.4	101.9	26.1	48.4	69.3	78.4	34.0	19.6	20.9	9.2	31.4	98.0	40.5	49.6	36.6	18.3	22.2	103.2	9.2	51.9
21-mar	99.3	86.2	83.6	44.4	54.9	32.7	30.1	47.0	61.4	35.3	66.7	48.4	11.8	22.3	41.9	47.1	26.2	18.3	13.1	35.3	+	+	128.0	94.1	128.0	11.8	51.2
22-mar	61.4	67.9	41.8	31.4	35.3	44.4	47.0	60.1	62.7	75.8	78.4	81.0	122.8	82.3	53.6	41.8	41.8	26.1	101.9	15.7	19.6	28.8	44.4	36.6	122.8	15.7	54.3
23-mar	66.6	133.2	117.6	152.8	130.6	101.9	60.1	41.8	64.0	27.5	34.0	18.3	54.9	61.4	65.3	41.8	15.7	7.9	9.2	18.3	40.5	48.4	22.2	15.7	152.8	7.9	56.2
24-mar	30.1	44.4	49.7	39.2	31.4	48.4	34.0	18.3	9.2	7.8	17.0	24.8	51.0	37.9	47.0	62.7	75.8	84.9	83.6	98.0	58.8	48.4	28.1	30.1	98.0	7.8	44.1
25-mar	77.1	96.7	32.7	88.8	116.3	122.8	+	+	+	+	+	51.0	44.4	49.7	81.0	67.9	64.0	43.1	28.8	15.7	41.8	31.4	51.0	31.4	122.8	15.7	59.7
26-mar	41.8	44.5	54.9	44.5	28.8	34.0	3.9	3.9	3.9	2.7	60.1	95.4	108.4	88.9	78.4	87.5	58.8	74.5	60.1	45.8	92.8	115.0	56.2	51.0	115.0	2.7	55.6
27-mar	75.8	113.7	24.9	56.2	40.5	31.4	41.8	40.5	66.7	98.0	90.1	78.4	60.1	40.5	54.9	24.8	5.3	14.4	7.9	2.7	23.6	18.3	9.2	5.3	113.7	2.7	42.7
28-mar	1.3	10.5	14.4	37.9	40.5	54.9	44.5	32.7	44.4	65.3	92.8	126.7	101.9	109.8	118.9	94.1	56.2	54.9	45.8	26.2	11.8	4.0	1.3	11.8	126.7	1.3	50.1
29-mar	137.2	129.3	113.7	148.9	137.2	138.5	135.9	124.1	138.5	128.0	113.7	146.3	128.0	163.3	146.3	147.6	154.2	156.8	135.9	169.8	142.4	124.1	130.6	96.7	169.8	96.7	136.9
30-mar	7.8	11.8	13.1	7.8	11.8	14.4	2.6	2.6	2.6	7.8	11.8	10.5	7.8	130.7	82.3	79.7	23.5	10.5	11.8	7.8	7.8	7.8	7.8	7.8	130.7	2.6	20.4
31-mar	49.7	52.9	53.9	54.8	56.7	57.0	58.4	60.8	62.5	50.5	133.2	130.9	167.5	76.4	88.5	76.3	68.9	70.9	66.9	60.6	53.4	43.7	31.6	29.2	167.5	29.2	68.9
MAXIMA	416.7	419.3	433.7	448.0	467.6	491.2	499.0	266.5	148.9	168.5	216.8	180.3	295.2	169.8	146.3	151.5	158.1	158.4	142.4	169.8	146.3	128.0	395.8	401.0			
MINIMA	1.3	10.5	13.1	7.8	9.2	14.4	2.6	2.6	1.3	2.7	5.3	10.5	7.8	21.0	0.0	0.0	1.3	7.9	1.3	2.7	4.0	1.3	1.3	5.3			
MEDIA	57.9	63.5	83.1	64.8	69.1	65.9	63.7	60.9	56.9	80.1	83.1	74.6	76.8	69.9	66.6	66.1	58.4	60.6	61.6	56.2	50.9	41.1	42.5	41.2			

Código ausencia de datos por instalación de equipo : *
Código ausencia de datos por calibración del equipo : C
Código ausencia de datos por mantención del equipo : #
Código ausencia de datos por falta de energía eléctrica temporalmente : +
N° de datos validos : 696
Recuperación de datos : 93.5 %
D : Día de Medición
H : Hora de Medición

Nota Importante al reverso

AV. MARATHON 2595, COD. POSTAL 6900502 - MACUL - FONO 56-2-3502100 - FAX 56-2-2384135 - E-mail:cesmec@reuna.cl

MONITOREO DE CALIDAD DEL AIRE

TABLA 3.

LUGAR : CUERPO DE BOMBEROS

PERIODO : 1 AL 28 DE FEBRERO DE 1999

VARIABLE : ANHIDRIDO SULFUROSO (SO_2)

UNIDAD : $\mu g/m^3N$

AÑO 1999	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	MAXIMA	MINIMA	MEDIA
1-feb	154.1	141.1	229.9	190.7	172.4	284.7	248.2	180.2	201.1	101.9	156.7	182.9	232.5	321.3	287.3	282.1	148.9	138.4	135.8	193.3	141.1	104.5	128.0	109.7	321.3	101.9	186.1
2-feb	216.8	117.5	78.4	120.2	117.5	175.0	203.8	256.0	175.0	31.3	C	C	C	214.2	26.1	96.7	88.8	253.4	120.2	256.0	232.5	195.9	120.2	13.1	256.0	13.1	148.0
3-feb	88.8	88.8	60.1	52.2	52.2	78.4	13.1	15.7	23.5	65.3	78.4	117.5	188.1	195.9	227.3	250.8	266.4	321.3	227.3	245.5	146.3	36.6	13.1	23.5	321.3	13.1	119.8
4-feb	54.9	60.1	88.8	117.5	156.7	203.8	219.4	169.8	232.5	130.6	117.5	146.3	175.0	227.3	117.5	175.0	316.1	232.5	175.0	122.8	34.0	20.9	10.4	15.7	316.1	10.4	138.3
5-feb	23.5	28.7	65.3	62.7	18.3	34.0	73.1	88.8	78.4	91.4	148.9	172.4	114.9	146.3	169.8	201.1	232.5	193.3	146.3	83.6	62.7	31.3	26.1	31.3	232.5	18.3	96.9
6-feb	65.3	88.8	65.3	94.0	117.5	125.4	135.8	219.4	120.2	151.5	177.6	78.4	91.4	54.9	229.9	284.7	292.6	313.5	269.1	347.4	227.3	117.5	44.4	54.9	347.4	44.4	156.9
7-feb	88.8	117.5	146.3	60.1	182.9	156.7	177.6	222.0	206.4	235.1	146.3	175.0	117.5	54.9	26.1	36.6	10.4	94.0	151.5	62.7	15.7	31.3	26.1	39.2	235.1	10.4	107.5
8-feb	49.6	81.0	52.2	70.5	34.0	70.5	146.3	117.5	75.8	122.8	130.6	164.6	222.0	271.7	292.6	222.0	172.4	193.3	125.4	70.5	31.3	10.4	18.3	10.4	292.6	10.4	114.8
9-feb	28.7	34.0	65.3	88.8	73.1	83.6	67.9	120.2	31.3	39.2	10.4	15.7	39.2	54.9	60.1	266.4	256.0	308.2	263.8	222.0	167.2	39.2	44.4	26.1	308.2	10.4	100.2
10-feb	65.3	96.7	88.8	44.4	18.3	54.9	78.4	88.8	62.7	31.3	148.9	274.3	101.9	94.0	78.4	109.7	34.0	52.2	60.1	18.3	10.4	31.3	13.1	20.9	274.3	10.4	69.9
11-feb	31.3	60.1	141.1	120.2	96.7	54.9	67.9	20.9	31.3	52.2	75.8	52.2	88.8	31.3	57.5	31.3	180.2	125.4	83.6	101.9	112.3	91.4	54.9	31.3	180.2	20.9	74.8
12-feb	41.8	18.3	20.9	10.4	36.6	44.4	70.5	81.0	54.9	52.2	62.7	20.9	26.1	34.0	62.7	83.6	146.3	198.5	279.5	248.2	292.6	240.3	143.7	83.6	292.6	10.4	98.1
13-feb	62.7	31.3	88.8	83.6	60.1	73.1	36.6	47.0	65.3	109.7	203.8	62.7	26.1	75.8	91.4	44.4	70.5	52.2	62.7	28.7	39.2	13.1	10.4	47.0	203.8	10.4	61.9
14-feb	96.7	141.1	198.5	83.6	117.5	78.4	107.1	146.3	284.7	222.0	206.4	109.7	130.6	88.8	52.2	26.1	34.0	23.5	18.3	10.4	28.7	39.2	10.4	31.3	284.7	10.4	95.2
15-feb	60.1	54.9	88.8	146.3	44.4	88.8	117.5	148.9	99.3	60.1	104.5	81.0	198.5	308.2	279.5	303.0	276.9	195.9	156.7	96.7	172.4	112.3	31.3	39.2	308.2	31.3	136.1
16-feb	96.7	109.7	75.8	104.5	282.1	206.4	222.0	253.4	162.0	128.0	175.0	78.4	57.5	44.4	26.1	20.9	10.4	28.7	36.6	60.1	91.4	28.7	44.4	20.9	282.1	10.4	98.5
17-feb	10.4	34.0	62.7	70.5	91.4	78.4	96.7	120.2	227.3	263.8	235.1	245.5	188.1	88.8	104.5	81.0	54.9	47.0	91.4	120.2	52.2	20.9	31.3	39.2	263.8	10.4	102.3
18-feb	60.1	44.4	36.6	41.8	28.7	23.5	67.9	39.2	31.3	20.9	26.1	60.1	94.0	222.0	282.1	235.1	143.7	52.2	88.8	198.5	146.3	256.0	54.9	146.3	282.1	20.9	100.0
19-feb	282.1	133.2	175.0	232.5	148.9	112.3	78.4	91.4	28.7	88.8	52.2	122.8	154.1	57.5	88.8	81.0	52.2	44.4	190.7	141.1	62.7	39.2	60.1	81.0	282.1	28.7	108.3
20-feb	133.2	122.8	185.5	117.5	206.4	60.1	88.8	151.5	198.5	52.2	83.6	120.2	143.7	54.9	26.1	36.6	13.1	62.7	190.7	75.8	94.0	67.9	31.3	39.2	206.4	13.1	98.2
21-feb	193.3	167.2	162.0	83.6	104.5	60.1	54.9	88.8	117.5	44.4	57.5	20.9	10.4	13.1	34.0	62.7	39.2	31.3	20.9	65.3	75.8	151.5	256.0	188.1	256.0	10.4	87.6
22-feb	122.8	135.8	83.6	62.7	70.5	88.8	94.0	120.2	125.4	151.5	156.7	162.0	232.5	146.3	88.8	78.4	83.6	52.2	203.8	31.3	39.2	57.5	88.8	73.1	232.5	31.3	106.2
23-feb	133.2	266.4	235.1	305.6	261.2	203.8	120.2	83.6	128.0	54.9	67.9	31.3	73.1	96.7	117.5	70.5	31.3	15.7	18.3	36.6	81.0	96.7	44.4	31.3	305.6	15.7	108.5
24-feb	60.1	88.8	99.3	78.4	62.7	96.7	67.9	36.6	18.3	10.4	15.7	31.3	88.8	62.7	94.0	125.4	151.5	169.8	167.2	195.9	117.5	96.7	52.2	60.1	195.9	10.4	85.3
25-feb	154.1	193.3	65.3	177.6	232.5	245.5	279.5	198.5	122.8	60.1	31.3	96.7	70.5	81.0	148.9	135.8	128.0	94.0	65.3	39.2	91.4	70.5	109.7	70.5	279.5	31.3	123.4
26-feb	91.4	96.7	117.5	96.7	65.3	75.8	0.0	0.0	0.0	13.1	128.0	198.5	242.9	203.8	156.7	175.0	117.5	156.7	128.0	99.3	193.3	237.7	120.2	109.7	242.9	0.0	117.7
27-feb	159.3	235.1	57.5	120.2	88.8	70.5	91.4	88.8	141.1	203.8	180.2	151.5	114.9	94.0	91.4	44.4	18.3	36.6	23.5	13.1	54.9	44.4	26.1	18.3	235.1	13.1	90.3
28-feb	10.4	28.7	36.6	83.6	88.8	117.5	96.7	65.3	88.8	94.0	122.8	146.3	177.6	206.4	245.5	195.9	120.2	117.5	99.3	60.1	31.3	15.7	10.4	31.3	245.5	10.4	95.4
MAXIMA	282.1	266.4	235.1	305.6	282.1	284.7	279.5	256.0	284.7	263.8	235.1	274.3	242.9	321.3	292.6	303.0	316.1	321.3	279.5	347.4	292.6	256.0	256.0	188.1			
MINIMA	10.4	18.3	20.9	10.4	18.3	23.5	0.0	0.0	0.0	10.4	10.4	15.7	10.4	13.1	26.1	20.9	10.4	15.7	18.3	10.4	10.4	10.4	10.4	10.4			
MEDIA	94.1	100.6	102.5	104.3	108.2	108.8	111.5	116.4	111.9	95.8	114.8	115.5	126.0	126.6	127.3	134.2	124.6	128.7	128.6	115.9	101.6	82.1	58.0	53.1			

Código ausencia de datos por calibración del equipo : C
Código ausencia de datos por falta de energía eléctrica temporalmente : +
N° de datos validos : 669
Recuperación de datos : 100 %

Nota Importante al reverso

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MONITOREO DE CALIDAD DEL AIRE

TABLA 3.

LUGAR : CUERPO DE BOMBEROS

PERIODO : 1 AL 31 DE ENERO DE 1999

VARIABLE : ANHIDRIDO SULFUROSO (SO_2)

UNIDAD : $\mu g/m^3N$

AÑO 1999	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	MAXIMA	MINIMA	MEDIA
1-ene	6.3	17.0	11.8	14.1	35.0	60.1	114.9	144.7	146.8	64.3	60.1	32.9	12.8	20.4	15.7	11.8	11.8	7.8	11.8	15.7	23.2	6.3	10.4	44.1			
2-ene	35.0	8.4	20.4	20.9	20.4	17.5	20.4	11.8	17.5	25.6	32.1	37.9	31.9	61.4	84.0	40.8	23.2	25.6	17.0	12.0	17.0	20.4	15.7	12.3	146.8	6.3	37.5
3-ene	26.6	35.5	38.4	25.6	17.5	23.2	19.3	36.6	68.7	57.7	84.6	159.6	84.6	38.9	26.6	23.2	25.1	17.5	25.6	31.6	6.3	50.9	70.3	9.9	84.0	8.4	25.4
4-ene	6.3	31.3	38.4	28.1	34.0	52.2	20.9	18.3	23.0	17.5	17.8	19.1	15.7	18.3	23.2	31.3	179.2	216.8	133.0	189.4	148.4	52.5	251.3	204.8	159.6	6.3	41.8
5-ene	186.5	329.1	374.9	306.1	780.3	95.6	320.8	389.2	32.4	38.1	25.3	17.5	14.6	117.5	92.7	95.9	318.9	306.1	70.3	88.8	20.4	6.3	10.4	6.3	251.3	6.3	73.7
6-ene	25.6	89.3	363.6	191.5	216.8	148.9	175.0	299.9	408.3	421.1	64.0	88.8	91.4	60.1	41.8	85.4	518.5	71.1	216.8	175.0	32.4	25.6	25.6	51.7	780.3	6.3	168.5
7-ene	83.3	72.6	90.1	117.5	112.3	44.7	70.3	263.6	146.3	61.1	235.6	25.3	17.0	12.0	124.3	288.1	427.4	460.0	480.9	348.2	108.4	90.1	27.2	44.7	518.5	25.6	182.0
8-ene	56.2	44.7	108.4	100.8	90.1	35.0	90.1	55.6	44.7	48.8	43.6	48.6	35.0	23.2	17.5	35.0	299.1	252.3	79.9	137.7	236.9	140.0	71.1	454.8	480.9	12.0	156.3
9-ene	48.3	301.7	485.1	466.0	491.1	382.7	358.4	462.9	173.2	108.4	151.2	218.9	170.3	123.8	236.7	35.5	31.3	31.3	23.2	300.1	275.3	94.8	29.8	8.4	454.8	17.5	106.2
10-ene	45.7	194.6	105.5	99.5	112.6	223.3	60.1	84.6	66.9	14.6	11.8	40.5	158.3	97.2	216.8	115.5	70.3	223.9	430.5	85.2	127.5	63.0	42.8	39.4	491.1	8.4	208.7
11-ene	22.7	25.6	44.7	89.3	147.1	34.7	13.3	69.7	236.1	185.2	88.8	20.4	6.3	11.0	167.2	209.8	233.3	39.2	117.8	106.3	255.2	74.7	37.6	185.2	430.5	11.8	113.8
12-ene	255.2	31.3	23.5	25.6	14.1	8.9	32.4	229.9	102.4	36.6	75.2	34.5	22.7	31.6	26.1	81.8	76.8	51.7	75.2	32.9	17.5	11.2	18.3	35.0	255.2	6.3	100.9
13-ene	52.5	55.6	28.5	32.7	172.1	102.4	197.7	51.7	180.2	152.0	46.8	23.5	11.8	11.8	60.1	47.8	17.5	35.8	26.6	36.8	39.4	22.7	10.4	0.0	255.2	8.9	56.3
14-ene	17.0	44.7	72.4	89.3	115.5	88.8	108.4	99.3	34.0	20.1	44.7	63.7	20.4	17.5	6.3	12.0	8.6	23.2	31.3	8.9	16.2	13.1	26.1	44.7	197.7	0.0	59.0
15-ene	20.9	18.3	14.1	15.7	14.6	197.7	89.3	57.5	C	C	C	14.6	11.8	32.1	34.0	14.1	14.1	11.8	20.1	27.2	61.1	32.1	22.7	32.1	115.5	6.3	42.8
16-ene	20.4	20.4	12.0	31.9	86.2	88.8	62.7	37.9	36.6	40.5	23.2	22.7	16.7	13.1	12.8	6.3	12.8	32.4	141.1	117.5	52.2	19.1	14.6	22.5	197.7	11.8	36.0
17-ene	13.1	17.5	15.7	12.0	18.3	14.6	65.0	78.4	71.3	83.6	224.9	224.6	156.7	242.4	117.5	92.2	223.6	191.5	92.5	62.7	39.2	17.5	17.0	10.4	141.1	6.3	39.3
18-ene	19.1	20.4	44.4	65.3	35.3	91.4	90.1	69.7	37.6	140.5	255.2	233.8	204.8	90.1	118.1	54.9	85.3	59.3	198.3	144.7	75.0	32.4	40.2	38.4	242.4	10.4	87.6
19-ene	17.0	32.7	17.2	20.1	20.4	91.4	60.1	32.1	17.2	11.5	19.1	274.3	111.5	172.9	174.0	344.5	307.7	401.8	176.8	83.6	47.8	24.8	14.6	12.3	255.2	19.1	92.7
20-ene	48.6	45.2	20.9	36.6	62.7	87.2	16.7	12.8	32.4	32.1	62.7	64.3	188.0	141.8	64.0	60.1	62.7	108.4	153.9	53.8	29.0	19.1	22.2	17.0	401.8	11.5	103.6
21-ene	49.9	11.8	19.1	14.4	11.0	31.3	89.3	51.7	53.3	13.8	14.6	34.0	34.5	63.0	148.9	182.1	120.7	58.8	65.8	39.7	13.1	19.1	15.4	41.5	198.0	12.8	60.5
22-ene	44.1	32.1	98.2	42.6	56.9	98.2	34.0	44.7	18.3	27.4	180.2	32.4	25.3	17.0	27.4	10.4	6.8	41.0	14.1	38.1	37.4	17.8	8.1	20.4	182.1	11.0	49.9
23-ene	23.8	19.6	26.4	8.4	11.0	31.9	11.2	16.7	19.6	20.4	32.1	60.1	66.1	12.8	57.7	99.3	79.9	102.1	19.1	94.6	52.5	27.7	32.1	16.2	180.2	6.8	40.5
24-ene	13.1	16.2	36.0	17.5	23.0	48.6	47.8	36.0	19.6	32.7	64.0	53.6	45.7	60.1	91.4	95.6	35.0	23.2	19.9	36.6	18.0	22.5	8.1	17.0	102.1	8.4	39.2
25-ene	30.8	7.3	15.7	28.2	72.9	65.8	80.5	146.8	210.5	121.2	274.3	146.3	146.3	87.5	59.8	34.0	36.0	29.8	95.9	74.7	82.8	39.7	42.8	17.0	95.6	8.1	36.7
26-ene	20.4	38.4	43.1	17.5	22.7	65.3	36.6	55.4	49.1	57.5	44.9	26.1	23.2	17.5	14.6	17.5	34.5	43.1	15.7	8.6	13.8	23.0	12.3	16.7	274.3	7.3	81.1
27-ene	31.3	14.6	42.3	53.8	128.5	32.7	87.5	38.4	64.0	43.9	17.8	23.2	15.7	19.6	23.0	14.6	37.1	20.6	31.9	38.7	61.6	25.1	17.8	18.0	65.3	8.6	29.9
28-ene	27.2	40.5	32.7	20.4	42.3	21.9	19.1	25.6	11.8	45.2	46.8	56.2	27.4	25.6	15.7	20.4	12.0	20.6	30.3	44.7	96.4	27.4	13.1	20.4	128.5	14.6	37.6
29-ene	28.2	35.3	14.1	21.9	24.6	14.6	20.4	38.4	31.3	64.0	66.9	43.9	35.0	40.8	54.9	56.7	20.9	23.5	31.3	30.3	13.8	17.2	20.6	12.8	96.4	11.8	31.0
30-ene	11.2	25.6	6.3	30.8	64.0	58.5	62.7	39.2	33.2	17.5	17.0	26.1	34.2	32.9	41.5	17.8	10.4	17.5	17.0	31.3	36.8	30.6	18.3	15.4	66.9	12.8	31.7
31-ene	14.9	15.4	6.3	29.5	42.6	35.0	33.4	23.2	39.7	28.7	34.2	15.4	23.8	28.7	43.1	23.2	20.4	17.5	29.8	29.0	15.4	25.3	6.8	5.7	64.0	6.3	29.0
MAXIMA	255.2	329.1	485.1	466.0	780.3	382.7	358.4	462.9	408.3	421.1	274.3	274.3	204.8	242.4	236.7	344.5	518.5	460.0	480.9	348.2	275.3	140.0	251.3	454.8	43.1	5.7	24.5
MINIMA	6.3	7.3	6.3	8.4	11.0	8.9	11.2	11.8	11.8	11.5	11.8	14.6	6.3	11.0	6.3	6.3	6.8	7.8	11.8	8.6	6.3	6.3	6.8	0.0			
MEDIA	42.0	54.6	73.2	66.8	99.9	77.2	80.9	97.5	80.9	67.7	78.7	70.4	60.3	56.2	71.5	72.8	107.8	95.7	93.3	81.4	66.8	35.2	31.4	47.6			

Código ausencia de datos por calibración del equipo : C
Código ausencia de datos por falta de energía eléctrica temporalmente : +
N° de datos validos : 741
Recuperación de datos : 100 %

Nota Importante al reverso

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SEB-10200

MONITOREO DE CALIDAD DEL AIRE

TABLA 3.

LUGAR : CUERPO DE BOMBEROS

VARIABLE : ANHIDRIDO SULFUROSO (SO_2)

PERIODO : 1 AL 31 DE DICIEMBRE DE 1998

UNIDAD : $\mu g/m^3N$

AÑO 1998	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	MAXIMA	MINIMA	MEDIA
1-dic	10.4	8.4	9.9	11.8	9.1	10.4	20.4	23.2	18.0	17.5	20.4	C	C	C	7.3	18.3	14.6	14.6	8.9	14.1	20.4	8.9	9.1	5.7	25.6	5.7	13.6
2-dic	9.4	13.1	8.9	12.8	6.3	8.9	14.4	10.4	12.8	22.7	25.9	19.1	6.3	16.5	17.8	20.6	25.6	20.4	6.3	11.8	7.8	10.4	6.0	6.0	25.9	6.0	13.3
3-dic	11.8	14.4	14.6	13.1	15.7	13.1	17.0	20.4	14.6	26.1	26.6	25.6	19.1	23.2	9.7	23.2	23.5	17.8	20.4	6.8	17.2	14.4	8.9	6.0	26.6	6.0	16.8
4-dic	0.0	0.0	8.9	6.3	6.3	14.6	20.4	23.2	7.8	44.7	19.1	11.8	6.3	12.8	7.6	6.3	8.1	6.3	15.7	13.1	32.4	52.2	26.6	11.2	52.2	0.0	15.1
5-dic	12.0	17.5	21.9	24.8	31.3	26.1	34.5	52.5	32.1	37.9	20.9	25.1	14.6	172.1	61.1	19.1	25.6	12.8	20.4	14.6	32.4	12.8	14.6	11.8	172.1	11.8	31.2
6-dic	14.6	20.4	8.9	26.6	34.5	20.4	23.2	23.5	61.1	90.1	32.1	14.6	55.6	6.3	17.5	12.8	23.2	11.8	10.4	13.1	10.4	10.4	10.4	11.8	90.1	6.3	23.5
7-dic	14.6	13.1	32.1	36.6	32.7	23.2	18.3	20.9	24.8	15.7	121.2	61.1	25.6	31.3	34.0	229.6	114.9	17.5	20.9	22.5	20.9	31.3	15.7	11.8	229.6	11.8	41.3
8-dic	14.6	15.7	18.3	18.3	10.4	10.4	10.4	17.5	20.9	22.7	15.7	31.3	26.9	60.1	242.4	64.5	32.9	23.2	15.7	19.9	14.6	18.3	20.9	19.6	242.4	10.4	31.9
9-dic	17.5	31.6	6.3	11.8	15.7	15.7	20.4	14.1	23.5	44.4	35.0	6.3	268.0	114.9	90.4	31.3	14.6	15.7	78.4	31.3	25.6	14.1	15.7	19.1	268.0	6.3	40.1
10-dic	12.8	17.2	14.6	18.3	22.5	20.4	6.3	32.1	27.7	64.0	69.7	46.5	32.1	25.6	17.0	19.9	11.8	17.0	72.1	89.3	108.4	38.4	31.9	6.3	108.4	6.3	34.2
11-dic	19.9	20.4	25.6	43.6	9.1	7.8	11.8	19.1	50.9	91.4	299.9	370.9	119.1	19.1	25.6	37.6	26.1	32.4	90.1	248.7	153.1	216.8	7.3	8.9	370.9	7.3	81.5
12-dic	10.4	13.1	8.9	10.4	14.6	11.2	6.3	12.8	19.1	19.1	6.3	14.1	12.8	31.3	35.3	31.3	20.4	25.1	12.8	8.9	11.8	17.0	10.4	7.8	35.3	6.3	15.5
13-dic	8.9	10.4	13.1	8.9	11.2	13.1	11.2	34.7	54.9	52.2	58.3	34.0	36.6	20.9	17.5	23.2	24.8	62.7	299.9	117.5	60.1	32.4	15.7	37.1	299.9	8.9	44.1
14-dic	23.2	50.9	70.3	32.4	19.9	22.5	6.3	31.9	70.3	32.4	70.3	25.6	19.9	35.8	33.4	20.4	14.6	17.2	20.4	12.8	0.0	0.0	11.8	8.9	70.3	0.0	27.1
15-dic	11.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.8	14.6	37.6	31.3	58.3	32.4	+	+	22.5	13.1	11.8	11.8	58.3	0.0	12.7
16-dic	17.5	13.1	14.6	14.6	13.8	8.9	22.7	+	+	+	31.9	19.1	20.6	35.5	31.9	134.0	96.1	61.4	28.7	23.2	14.6	10.4	10.4	11.8	134.0	8.9	29.8
17-dic	8.9	11.5	12.8	6.3	31.3	32.4	89.9	114.9	60.1	41.8	57.5	76.5	19.1	6.3	17.5	14.4	15.7	10.4	13.1	14.4	17.0	10.4	6.3	12.5	114.9	6.3	29.2
18-dic	11.5	14.6	11.8	20.4	17.5	31.6	37.9	58.5	44.7	57.5	89.3	61.1	45.2	51.7	57.5	19.1	12.8	8.9	8.9	25.6	70.3	19.3	11.5	8.9	89.3	8.9	33.2
19-dic	14.6	20.4	23.2	20.4	40.8	31.3	60.1	83.6	88.8	44.7	38.9	20.9	24.6	31.1	31.3	49.4	93.0	504.7	453.0	153.1	117.5	31.3	23.2	11.8	504.7	11.8	83.8
20-dic	18.3	14.6	20.4	22.7	31.9	34.5	37.4	62.7	53.0	19.1	12.8	31.3	31.9	45.5	57.5	34.0	23.2	50.9	70.3	34.0	23.2	25.6	14.1	8.4	70.3	8.4	32.4
21-dic	14.1	20.4	14.6	25.3	23.5	36.6	28.7	34.0	17.5	14.6	11.8	20.4	38.4	66.3	60.1	35.0	22.7	17.0	6.3	11.8	8.9	16.7	6.3	20.9	66.3	6.3	23.8
22-dic	19.9	6.3	14.6	19.9	20.9	22.7	25.3	27.7	34.0	34.5	23.2	20.4	31.3	58.5	82.8	248.7	140.3	184.9	184.9	25.6	17.5	14.6	10.4	13.1	248.7	6.3	53.4
23-dic	15.7	17.5	35.0	13.1	8.9	11.5	10.4	13.8	25.9	33.4	19.1	32.4	61.1	63.7	31.9	64.0	32.9	13.1	8.9	13.1	19.6	22.2	14.6	14.1	64.0	8.9	24.8
24-dic	19.9	20.4	27.4	35.3	25.1	18.3	20.4	32.4	61.4	37.1	20.6	22.2	51.5	61.1	37.6	32.4	8.4	8.4	10.7	13.8	11.8	17.5	11.2	5.2	61.4	5.2	25.4
25-dic	8.8	0.0	0.0	10.4	0.0	8.4	8.9	6.3	12.8	44.7	60.1	31.9	38.9	45.2	24.3	12.8	19.1	19.1	11.2	0.0	0.0	11.0	10.4	7.8	60.1	0.0	16.3
26-dic	17.0	24.8	23.5	17.5	25.3	22.7	31.3	60.1	35.0	31.9	60.1	63.7	127.5	12.8	32.1	36.6	31.3	32.4	17.2	19.9	20.4	17.0	11.2	14.6	127.5	11.2	32.8
27-dic	11.5	11.8	7.8	14.4	17.5	34.0	37.4	40.0	63.5	+	19.1	12.8	11.5	43.1	38.4	70.3	35.0	25.1	14.6	17.0	8.9	17.0	14.1	18.3	70.3	7.8	25.9
28-dic	13.1	19.6	20.4	18.3	34.0	37.6	36.6	28.7	14.1	12.8	25.6	44.7	38.4	84.6	94.0	37.9	11.2	14.1	22.7	17.5	20.4	20.4	17.5	19.9	94.0	11.2	29.3
29-dic	11.2	11.8	15.7	8.9	31.3	28.2	17.0	22.7	6.3	38.4	127.5	76.5	76.5	140.3	127.5	70.3	61.1	40.8	17.0	8.9	12.3	10.4	10.4	11.5	140.3	6.3	40.9
30-dic	17.0	50.9	8.9	14.6	17.0	22.7	23.5	25.1	34.0	32.4	35.3	89.3	338.0	382.7	92.5	91.4	64.0	25.6	70.5	108.4	197.7	32.4	19.6	8.9	382.7	8.9	75.1
31-dic	11.8	17.0	17.2	19.6	22.7	19.9	25.6	38.9	60.1	32.1	60.9	89.9	61.1	89.9	70.3	383.5	112.3	90.4	112.3	51.5	45.5	15.7	70.3	14.1	383.5	11.8	66.0
MAXIMA	23.2	50.9	70.3	43.6	40.8	37.6	89.9	114.9	88.8	91.4	299.9	370.9	338.0	382.7	242.4	383.5	140.3	504.7	453.0	248.7	197.7	216.8	70.3	37.1			
MINIMA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.3	6.3	7.3	6.3	8.1	6.3	6.3	0.0	0.0	0.0	6.0	5.2			
MEDIA	13.6	16.8	17.1	18.0	19.4	20.0	23.7	32.3	34.9	36.4	48.9	46.0	54.1	58.6	49.7	62.0	39.3	46.3	57.0	38.2	36.9	25.2	15.4	12.4			

Código ausencia de datos por calibración del equipo : C
Código ausencia de datos por falta de energía eléctrica temporalmente : +
N° de datos validos : 735
Recuperación de datos : 100 %

Nota Importante al reverso

AV. MARATHON 2595, COD. POSTAL 6900502 - MACUL - FONO 56-2-3502100 - FAX 56-2-2384135 - E-mail:cesmec@reuna.cl

MONITOREO DE CALIDAD DEL AIRE

TABLA 3.

LUGAR : CUERPO DE BOMBEROS

PERIODO : 1 AL 30 DE NOVIEMBRE DE 1998

VARIABLE : ANHIDRIDO SULFUROSO (SO_2)

UNIDAD : µg/m³N

AÑO 1998	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	MAXIMA	MINIMA	MEDIA
1-nov	12.8	6.3	6.3	12.8	12.8	14.9	6.3	16.7	19.3	10.7	6.3	184.9	50.9	31.9	44.7	12.8	15.7	18.3	20.9	25.9	11.8	9.7	6.3	19.1	184.9	6.3	24.1
2-nov	19.1	6.3	8.9	6.3	12.8	19.1	12.8	6.3	14.4	6.3	70.3	76.5	19.1	12.8	0.0	17.0	16.5	11.8	14.9	6.0	11.2	8.4	7.1	5.7	76.5	0.0	16.2
3-nov	8.1	6.3	11.8	6.3	10.4	10.4	20.9	18.3	25.6	14.6	19.1	6.3	12.8	12.8	6.3	11.2	13.8	11.8	6.0	14.6	19.9	6.3	0.0	6.3	25.6	0.0	11.7
4-nov	6.3	10.4	18.8	17.8	25.1	6.0	10.7	6.3	19.1	44.7	146.8	89.3	89.3	19.1	19.1	57.5	70.3	31.9	6.3	25.6	17.8	8.9	6.3	8.9	146.8	6.0	31.7
5-nov	6.3	11.0	12.8	12.8	6.3	11.8	15.7	18.3	20.9	15.7	12.8	89.3	89.3	76.5	102.1	76.5	12.8	20.4	20.9	20.6	38.4	31.9	12.8	12.8	102.1	6.3	31.2
6-nov	57.5	25.6	19.1	6.3	14.4	6.3	57.5	57.5	12.8	12.8	127.5	31.9	44.7	19.1	8.9	11.8	17.5	11.8	0.0	0.0	0.0	7.8	6.0	6.0	127.5	0.0	23.4
7-nov	8.9	8.6	10.7	5.2	11.8	6.3	12.8	6.3	6.3	102.1	108.4	63.7	6.3	8.9	11.0	14.6	8.9	11.8	6.0	6.3	6.3	0.0	0.0	0.0	108.4	0.0	18.0
8-nov	0.0	0.0	10.4	11.5	11.8	17.5	17.5	8.9	13.1	14.6	13.1	25.6	25.6	17.5	17.8	15.7	15.7	13.1	17.2	11.8	8.9	6.0	5.7	11.8	25.6	0.0	12.9
9-nov	17.5	15.7	11.8	14.6	15.7	14.6	10.4	22.7	17.0	17.5	14.6	32.4	89.3	38.4	19.1	32.1	26.1	31.3	17.5	20.9	20.9	18.3	15.7	7.8	89.3	7.8	22.6
10-nov	10.4	13.1	15.7	13.1	13.1	13.1	0.0	15.7	14.6	14.1	12.8	25.6	31.9	12.8	6.0	11.8	14.6	23.2	25.6	11.8	10.4	7.8	6.3	6.0	31.9	0.0	13.7
11-nov	8.9	11.8	15.7	25.3	31.3	17.5	20.9	6.3	13.1	14.6	6.3	44.7	31.9	57.5	44.7	57.5	44.7	6.3	8.9	11.2	6.0	8.1	5.2	6.0	57.5	5.2	21.0
12-nov	11.8	14.6	20.6	11.8	8.1	8.9	15.2	20.6	26.9	44.7	63.7	38.4	19.1	19.1	25.6	6.3	17.5	20.4	25.6	8.9	14.6	11.0	8.9	9.1	63.7	6.3	19.6
13-nov	6.3	6.3	11.8	17.5	0.0	0.0	0.0	14.6	11.0	6.0	12.8	31.9	19.1	12.8	31.9	19.1	25.6	31.6	12.0	19.9	8.9	8.9	11.0	6.0	31.9	0.0	13.5
14-nov	5.2	5.2	8.9	14.6	8.4	6.3	6.3	14.6	15.7	17.5	25.6	19.1	6.3	25.9	17.5	18.3	14.6	11.8	26.4	20.4	20.1	15.7	8.4	8.4	26.4	5.2	14.2
15-nov	6.3	10.7	10.4	6.3	16.5	12.3	17.5	6.0	5.5	20.4	25.6	5.5	0.0	11.2	20.1	23.5	22.7	11.8	17.5	8.9	10.4	10.4	6.0	10.4	25.6	0.0	12.3
16-nov	13.1	17.0	14.4	11.5	14.1	5.2	6.3	6.3	50.9	57.5	31.9	12.8	6.3	25.6	50.9	31.9	70.3	38.4	12.8	38.4	6.3	7.8	7.8	5.2	70.3	5.2	22.6
17-nov	0.0	0.0	10.4	13.1	11.8	17.5	15.7	13.1	13.1	14.1	31.3	17.5	20.4	12.8	6.3	31.9	57.5	63.7	12.8	8.9	7.8	10.4	7.8	8.4	63.7	0.0	16.9
18-nov	11.8	13.1	13.1	6.3	6.3	11.5	6.3	15.7	18.3	20.4	23.5	6.3	19.1	6.3	8.9	0.0	12.8	6.0	11.8	10.4	15.7	7.8	6.0	5.7	23.5	0.0	10.9
19-nov	5.7	7.8	10.4	13.1	10.4	7.8	8.6	10.4	10.4	20.4	18.3	17.5	6.3	6.3	11.8	23.5	17.5	14.6	15.7	11.8	6.0	7.8	6.0	7.8	23.5	5.7	11.5
20-nov	6.0	20.9	20.1	14.6	6.0	12.0	17.0	19.6	7.8	10.4	8.9	6.3	8.9	14.4	17.5	20.9	17.5	17.5	14.6	10.4	7.8	19.1	11.8	6.0	20.9	6.0	13.2
21-nov	5.2	5.2	11.8	12.5	15.7	14.6	19.9	12.0	25.6	20.4	27.2	14.6	17.2	22.7	25.6	19.1	20.9	17.5	6.0	10.4	7.8	6.0	5.2	8.9	27.2	5.2	14.7
22-nov	6.0	11.8	17.5	18.3	22.2	20.1	12.0	20.6	15.2	23.2	25.6	19.3	27.2	7.3	6.3	19.1	23.5	17.5	17.5	12.8	8.9	8.9	6.0	0.0	27.2	0.0	15.3
23-nov	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	57.5	57.5	0.0	0.0	0.0	0.0	12.8	0.0	0.0	0.0	0.0	6.0	57.5	0.0	5.6
24-nov	8.1	6.0	8.9	8.9	6.0	12.0	15.2	6.3	20.4	25.6	114.9	44.7	23.2	25.1	12.8	12.8	6.3	0.0	14.6	0.0	10.4	7.8	5.2	8.9	114.9	0.0	16.8
25-nov	13.1	8.9	8.9	6.8	20.6	17.8	12.3	25.6	15.2	26.9	25.9	21.7	19.1	12.8	27.4	6.3	23.5	20.4	12.3	17.5	14.9	11.8	6.0	8.9	27.4	6.0	16.0
26-nov	11.8	7.8	6.0	17.8	14.6	23.2	20.4	11.8	25.6	17.5	17.2	82.8	76.5	7.3	14.6	27.2	11.8	25.1	20.4	9.7	14.6	11.8	8.9	8.4	82.8	6.0	20.5
27-nov	10.4	8.4	8.9	11.8	9.1	10.4	20.4	23.2	18.0	17.5	20.4	25.6	6.3	12.8	7.3	18.3	14.6	14.6	8.9	14.1	20.4	8.9	9.1	5.7	25.6	5.7	13.6
28-nov	9.4	13.1	8.9	12.8	6.3	8.9	14.4	10.4	12.8	22.7	25.9	19.1	6.3	16.5	17.8	20.6	25.6	20.4	6.3	11.8	7.8	10.4	6.0	6.0	25.9	6.0	13.3
29-nov	11.8	14.4	14.6	13.1	15.7	13.1	17.0	20.4	14.6	26.1	26.6	25.6	19.1	23.2	9.7	23.2	23.5	17.8	20.4	6.8	17.2	14.4	8.9	6.0	26.6	6.0	16.8
30-nov	0.0	0.0	8.9	6.3	6.3	14.6	20.4	23.2	18.3	20.6	17.5	24.8	25.6	23.2	23.2	17.5	31.6	9.1	25.6	23.2	14.6	14.4	8.9	8.9	31.6	0.0	16.4
MAXIMA	57.5	25.6	20.6	25.3	31.3	23.2	57.5	57.5	50.9	102.1	146.8	184.9	89.3	76.5	102.1	76.5	70.3	63.7	26.4	38.4	38.4	31.9	15.7	19.1			
MINIMA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
MEDIA	9.9	9.5	11.9	11.6	12.1	11.8	14.3	15.3	16.7	22.7	36.0	36.8	29.1	21.7	20.5	21.9	23.1	18.3	14.6	13.3	12.2	10.2	7.0	7.5			

Código ausencia de datos por calibración del equipo : C
Código ausencia de datos por falta de energía eléctrica temporalmente : +
N° de datos validos : 720
Recuperación de datos : 100 %

Nota Importante al reverso

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MONITOREO DE CALIDAD DEL AIRE

TABLA 3.

LUGAR : CUERPO DE BOMBEROS

PERIODO : 1 AL 31 DE OCTUBRE DE 1998

VARIABLE : ANHIDRIDO SULFUROSO (SO_2)

UNIDAD : µg/m³N

D/H	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	24:00	MAX.	MIN.	PROM
1	5.2	6.3	25.6	6.3	5.2	8.4	6.3	6.3	7.6	6.5	6.3	12.8	C	C	C	6.3	19.1	12.8	12.8	6.3	12.8	25.6	6.3	6.3	25.6	0.0	8.8
2	6.3	89.3	153.1	57.5	70.3	12.8	6.3	6.3	6.3	6.3	0.0	0.0	0.0	12.8	38.4	6.3	31.9	12.8	6.3	6.3	0.0	0.0	0.0	7.8	153.1	0.0	22.4
3	0.0	6.3	19.1	6.3	12.8	8.9	6.3	7.8	13.1	10.4	7.8	6.3	6.3	12.8	31.9	6.3	31.3	9.1	10.4	7.8	13.1	10.4	7.8	5.2	31.9	0.0	10.7
4	7.8	10.4	14.4	8.9	7.8	7.8	13.1	27.4	32.4	12.8	6.3	19.1	31.9	57.5	25.6	12.8	6.3	8.9	13.1	15.7	13.1	15.7	6.3	8.9	57.5	6.3	16.0
5	11.5	14.1	6.3	16.7	6.3	8.9	16.7	14.1	23.2	14.6	27.2	14.1	16.7	12.8	14.1	8.9	7.8	6.3	12.8	6.3	16.5	11.8	11.5	12.8	27.2	6.3	13.0
6	6.3	19.1	6.3	6.3	9.1	6.3	12.8	6.3	26.1	32.4	37.1	12.8	6.3	16.7	14.1	18.3	23.2	11.8	13.1	7.8	10.4	13.1	6.3	6.3	37.1	6.3	13.7
7	11.8	6.5	11.5	14.1	16.7	14.1	11.5	8.9	32.4	19.1	31.9	12.8	19.1	31.9	12.8	6.3	20.4	20.9	14.6	6.3	12.5	9.9	15.4	5.2	32.4	5.2	15.3
8	7.8	6.3	6.0	7.8	10.4	13.1	15.7	7.8	12.0	17.5	22.7	31.6	14.1	43.6	19.1	13.1	15.7	18.3	20.9	13.1	10.4	8.9	15.7	5.2	43.6	5.2	14.9
9	7.8	8.9	11.8	16.7	8.6	5.2	10.2	12.8	13.3	25.6	20.4	19.1	12.8	23.2	28.5	18.0	19.9	23.0	14.6	11.8	5.2	7.8	10.4	7.8	28.5	5.2	14.3
10	11.2	5.2	7.8	13.1	15.7	10.4	17.5	14.1	12.0	20.4	13.1	23.2	12.8	24.6	26.9	10.4	18.3	23.2	17.5	19.6	15.7	10.4	7.8	5.2	26.9	5.2	14.8
11	8.6	11.8	14.6	20.4	25.6	14.9	25.6	20.4	23.5	31.6	25.9	25.3	19.1	31.9	19.1	12.8	8.9	6.5	25.1	16.2	12.0	23.2	7.8	8.1	31.9	6.5	18.3
12	5.2	15.7	13.1	10.4	6.3	12.8	12.8	23.2	23.2	11.8	32.1	25.6	19.1	25.6	44.7	6.3	14.6	23.5	20.4	20.4	23.2	25.9	11.2	5.2	44.7	5.2	18.0
13	8.9	8.9	11.8	17.5	18.3	20.9	11.8	32.4	31.9	70.3	57.5	25.6	6.3	14.6	23.2	25.6	11.8	8.9	17.5	23.2	8.9	8.9	5.2	6.3	70.3	5.2	19.8
14	8.1	6.3	8.9	14.6	15.7	15.7	18.3	20.9	20.4	19.1	12.8	6.3	13.1	10.4	13.1	0.0	0.0	14.6	17.5	8.9	10.4	10.4	7.8	10.4	20.9	0.0	11.8
15	13.1	10.4	7.8	14.1	7.8	11.8	17.0	20.9	18.3	50.9	63.7	16.7	31.9	31.9	19.3	21.9	11.8	10.4	7.8	13.1	15.7	10.4	14.6	8.4	63.7	7.8	18.7
16	6.3	11.5	14.6	6.3	19.9	17.8	12.8	19.1	19.1	12.8	19.1	6.3	31.3	25.6	17.5	22.5	6.3	20.6	11.8	15.7	13.1	10.4	8.4	5.2	31.3	5.2	14.7
17	7.8	10.4	7.8	14.4	12.8	11.5	14.6	18.3	17.5	20.9	20.4	32.4	17.0	20.4	15.7	14.6	6.3	11.5	12.8	13.1	10.4	14.6	5.2	8.9	32.4	5.2	14.1
18	11.8	14.6	11.2	11.8	9.1	15.7	18.3	20.9	23.2	23.5	23.2	32.4	20.4	18.3	20.9	25.6	178.7	31.9	16.7	18.3	11.2	7.8	8.4	5.2	178.7	5.2	24.1
19	5.2	7.8	8.4	8.9	11.8	22.7	17.5	16.7	13.1	6.3	11.5	14.1	11.8	8.9	12.8	11.8	11.2	7.8	10.4	11.8	14.6	19.9	8.4	7.8	22.7	5.2	11.7
20	11.2	5.7	8.9	14.1	8.9	14.6	25.3	31.3	26.9	14.6	17.5	19.6	20.4	82.8	102.1	19.1	16.7	14.1	23.2	19.9	14.6	19.1	25.6	12.8	102.1	5.7	23.7
21	16.2	21.7	19.1	6.3	20.4	25.1	10.4	16.5	20.4	25.6	16.7	20.4	26.6	24.6	146.8	76.5	31.9	6.3	16.7	16.5	20.4	11.0	5.5	6.0	146.8	5.5	25.3
22	11.5	11.8	14.6	20.4	23.2	19.1	19.3	17.5	6.3	23.2	17.5	17.5	14.1	25.6	12.8	44.7	19.1	6.3	22.7	26.9	25.6	18.3	20.9	10.4	44.7	6.3	18.7
23	8.6	10.4	14.1	6.3	12.8	16.7	6.3	19.9	11.8	25.6	44.7	57.5	70.3	6.3	38.9	32.4	12.8	19.1	17.0	14.6	11.8	6.0	6.0	6.0	70.3	6.0	19.8
24	5.7	0.0	6.3	6.3	9.1	14.1	8.9	0.0	12.0	6.3	9.1	20.4	25.6	44.7	6.3	20.6	11.8	6.3	12.8	6.3	8.9	7.8	6.5	8.9	44.7	0.0	11.0
25	8.9	11.8	20.4	25.6	11.8	15.7	13.1	17.2	6.3	14.1	95.6	51.7	12.8	17.5	20.4	18.0	8.9	13.1	11.2	14.1	20.1	20.9	8.6	5.5	95.6	5.5	19.3
26	6.0	11.2	11.2	14.6	19.6	17.5	11.8	14.6	23.2	22.7	6.3	38.4	25.6	6.3	19.3	15.7	6.0	19.3	20.4	25.1	8.6	10.7	6.0	6.0	38.4	6.0	15.3
27	10.4	11.2	12.8	12.8	12.8	6.3	7.8	14.6	20.4	17.5	17.8	57.5	70.3	19.1	25.6	12.8	25.6	12.8	14.6	17.5	23.2	6.3	5.2	0.0	70.3	0.0	18.1
28	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.8	134.0	102.1	44.7	0.0	0.0	0.0	0.0	0.0	0.0	11.8	134.0	0.0	12.7
29	11.8	20.4	20.4	25.6	6.3	14.1	11.5	8.9	8.9	44.7	25.6	38.4	12.8	6.3	20.4	32.1	+	20.4	17.0	11.8	14.6	17.0	6.5	6.3	44.7	6.3	17.5
30	6.3	14.1	14.6	13.1	20.4	17.5	17.0	14.6	25.3	14.6	17.5	31.6	8.6	12.8	25.6	19.1	12.8	0.0	7.8	7.8	11.8	5.5	5.7	5.2	31.6	0.0	13.7
31	5.5	22.7	14.6	6.3	50.9	12.8	12.8	6.3	6.3	14.6	33.4	C	C	44.7	19.1	19.1	6.3	11.8	+	17.5	20.1	8.9	6.0	6.3	50.9	0.0	16.5
MAX.	16.2	89.3	153.1	57.5	70.3	25.1	25.6	32.4	32.4	70.3	95.6	57.5	70.3	82.8	146.8	102.1	178.7	31.9	25.1	26.9	25.6	25.9	25.6	12.8			
MIN.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
PROM	8.2	13.3	16.7	13.7	15.7	13.3	13.2	15.0	17.3	20.5	23.9	22.2	18.6	23.4	31.3	21.3	21.3	13.3	14.7	13.5	13.2	12.2	8.6	7.2			

Código ausencia de datos por instalación estación : *
Código ausencia de datos por falta de energía eléctrica temporalmente : +
N° de datos validos : 737
Recuperación de datos : 100 %
D : Día de medición, correspondiendo el día 1 al 01.10.98 y el día 31 al 31.10.98.
H : Hora de medición a la cual corresponde el promedio horario.
C : Calibración del equipo.

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MONITOREO DE CALIDAD DEL AIRE

TABLA 3.

LUGAR : CUERPO DE BOMBEROS

VARIABLE : ANHIDRIDO SULFUROSO (SO_2)

PERIODO : 1 AL 30 DE SEPTIEMBRE DE 1998

UNIDAD : $\mu g/m^3N$

D/H	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	24:00	MAX.	MIN.	PROM
1	7.8	6.3	6.3	6.3	6.3	6.3	10.4	7.8	13.1	13.1	10.4	23.5	6.3	8.4	13.1	6.3	6.3	6.3	18.3	15.7	20.9	24.6	7.8	6.3	24.6	6.3	10.7
2	6.3	6.3	0.0	0.0	5.2	7.8	13.1	16.7	14.1	25.6	76.5	44.7	19.1	6.3	6.3	7.8	7.8	0.0	0.0	5.2	5.2	5.2	6.3	6.3	76.5	0.0	12.2
3	6.3	0.0	6.3	20.4	14.1	6.3	22.7	6.3	17.0	6.3	19.1	63.7	19.1	6.3	34.5	26.6	25.6	17.5	14.1	14.4	13.1	5.2	5.2	0.0	63.7	0.0	15.4
4	5.2	6.3	6.3	14.1	19.9	25.6	6.3	6.3	6.3	25.6	50.9	50.9	76.5	12.8	6.3	0.0	0.0	11.8	14.1	6.0	6.5	9.4	6.3	10.4	76.5	0.0	16.0
5	10.4	13.1	10.4	0.0	0.0	5.2	5.2	6.3	15.4	20.4	27.2	6.3	19.1	44.7	50.9	25.6	6.3	0.0	8.9	11.8	12.8	12.8	5.2	7.8	50.9	0.0	13.6
6	11.0	5.2	0.0	0.0	0.0	0.0	11.0	16.2	8.1	21.9	22.7	25.1	26.6	6.3	6.3	12.8	6.3	0.0	0.0	8.4	10.4	8.4	5.2	8.4	26.6	0.0	9.2
7	11.0	5.2	5.2	0.0	0.0	12.3	16.2	22.7	12.8	44.7	6.3	12.8	19.1	31.6	35.0	25.6	22.7	6.3	9.4	22.7	17.8	8.9	6.8	6.3	44.7	0.0	15.1
8	9.4	6.3	0.0	6.3	8.9	17.8	11.5	6.3	12.8	44.7	19.1	76.5	6.3	22.7	32.1	23.5	23.2	26.6	19.1	12.8	6.3	11.2	6.3	12.8	76.5	0.0	17.6
9	6.3	12.3	6.3	8.4	6.3	12.8	12.8	44.7	108.4	38.4	63.7	82.8	25.6	89.3	50.9	44.7	6.3	6.3	19.1	6.3	19.9	5.2	5.2	5.2	108.4	5.2	28.6
10	5.2	8.9	19.1	6.0	12.8	22.7	17.5	12.0	5.2	16.2	8.9	16.5	0.0	0.0	23.2	12.8	108.4	6.3	26.9	25.3	22.5	6.3	5.2	6.0	108.4	0.0	16.4
11	5.2	17.5	23.2	16.2	12.8	22.7	6.3	5.2	12.8	12.8	127.5	63.7	25.6	25.6	6.3	17.5	6.3	6.3	11.2	7.6	22.7	17.8	10.4	6.3	127.5	5.2	20.4
12	6.3	0.0	0.0	16.7	25.6	76.5	63.7	38.4	19.1	19.1	44.7	31.9	6.3	12.0	22.7	25.6	32.1	45.5	25.6	19.1	12.8	6.3	6.3	6.3	76.5	0.0	23.4
13	6.3	16.7	15.7	12.8	25.6	31.9	12.8	19.1	25.6	12.8	6.3	8.4	6.3	16.7	26.6	95.6	31.9	19.1	95.6	280.6	95.6	44.7	25.6	12.8	280.6	6.3	39.4
14	6.3	12.8	38.4	114.9	70.3	63.7	31.9	38.4	19.1	14.6	24.8	26.9	18.0	18.8	12.8	19.1	6.3	12.8	12.8	8.9	6.3	12.8	6.3	6.3	114.9	6.3	25.1
15	12.8	12.8	31.9	38.4	82.8	82.8	31.9	6.3	6.3	12.0	14.6	25.1	19.6	27.4	24.8	23.0	11.2	6.3	9.4	12.0	6.3	6.3	8.1	9.1	82.8	6.3	21.7
16	13.6	5.2	6.5	0.0	0.0	12.8	31.9	25.6	9.1	6.3	11.8	12.8	6.3	6.3	9.1	6.3	19.6	17.2	9.1	12.0	14.9	9.1	9.7	8.4	31.9	0.0	11.0
17	8.9	0.0	5.2	5.2	6.0	11.8	19.9	6.3	21.9	11.5	24.8	27.4	21.7	6.3	6.3	11.5	11.8	17.5	24.8	15.2	20.1	15.2	6.5	0.0	27.4	0.0	12.7
18	0.0	7.8	11.0	13.8	6.5	6.0	12.0	6.3	19.1	6.3	95.6	25.6	26.9	24.8	14.1	19.9	25.6	14.9	14.6	10.4	7.8	6.5	11.8	5.2	95.6	0.0	16.4
19	6.3	9.1	14.6	11.8	22.7	11.8	14.1	11.8	7.8	7.8	8.4	6.3	6.3	14.4	23.2	12.3	9.1	6.3	14.1	9.1	5.2	0.0	0.0	7.8	23.2	0.0	10.0
20	9.1	6.5	5.2	5.2	5.2	0.0	0.0	5.2	14.1	17.5	22.2	25.6	6.3	50.9	31.9	14.4	19.6	12.0	11.2	19.6	25.6	7.8	10.4	7.8	50.9	0.0	13.9
21	11.8	11.5	14.6	17.5	23.2	26.6	14.9	22.2	24.8	23.2	31.6	6.3	12.8	6.3	9.1	13.6	13.3	9.1	25.6	20.6	11.8	17.5	9.1	5.2	31.6	5.2	15.9
22	11.8	14.6	19.6	8.4	25.6	26.6	20.4	14.6	9.1	19.1	25.6	6.3	12.8	14.1	6.3	25.6	19.1	6.0	14.6	9.1	11.8	7.8	7.8	5.2	26.6	5.2	14.2
23	7.8	11.0	9.1	14.1	13.6	17.5	14.6	5.2	5.2	8.1	11.8	23.2	12.8	14.6	14.9	11.8	10.4	10.4	0.0	8.4	5.2	5.2	7.3	5.2	23.2	0.0	10.3
24	5.2	5.2	11.8	8.9	14.6	14.4	23.2	20.4	32.7	22.2	22.2	6.3	6.3	14.6	14.4	8.9	8.9	0.0	0.0	0.0	10.4	10.4	9.4	7.8	32.7	0.0	11.6
25	7.8	12.0	13.1	13.6	9.1	17.5	23.2	24.6	27.4	30.0	17.5	6.3	12.8	6.3	22.7	11.8	8.9	7.8	5.2	6.3	0.0	0.0	5.2	7.8	30.0	0.0	12.4
26	10.4	7.8	13.1	6.3	6.3	14.4	17.0	6.3	20.4	25.9	17.5	27.7	17.5	22.7	14.6	14.4	24.8	27.4	17.0	14.4	8.9	10.4	14.6	7.8	27.7	6.3	15.3
27	10.4	10.4	0.0	0.0	14.4	17.0	20.4	6.3	25.6	44.7	6.3	6.3	25.6	17.8	25.9	27.4	22.7	14.6	22.7	13.8	11.2	8.9	7.8	5.2	44.7	0.0	15.2
28	5.2	5.2	0.0	11.8	14.6	23.2	25.6	14.6	6.3	12.8	6.3	19.1	12.8	9.1	12.3	22.7	6.3	12.0	12.0	22.7	6.0	5.2	5.2	10.4	25.6	0.0	11.7
29	7.8	7.8	11.8	14.1	14.9	24.8	9.1	8.4	6.5	22.7	26.6	15.2	12.8	19.1	12.8	19.1	25.6	19.6	9.1	14.9	14.1	22.7	7.8	7.8	26.6	6.5	14.8
30	7.8	7.8	0.0	11.8	13.1	6.3	17.5	25.6	22.7	11.8	14.6	25.6	27.2	38.4	12.8	12.8	6.3	25.6	28.5	14.6	6.3	6.3	5.2	7.8	38.4	0.0	14.9
MAX.	13.6	17.5	38.4	114.9	82.8	82.8	63.7	44.7	108.4	44.7	127.5	82.8	76.5	89.3	50.9	95.6	108.4	45.5	95.6	280.6	95.6	44.7	25.6	12.8			
MIN.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.2	5.2	6.3	6.3	6.3	0.0	0.0	6.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
PROM	8.0	8.4	10.2	13.4	16.0	20.8	17.9	15.2	18.3	19.9	28.8	26.6	17.1	19.8	19.4	20.0	17.8	12.4	16.4	21.6	14.6	10.6	7.8	7.0			

Código ausencia de datos por instalación estación : *

Código ausencia de datos por falta de energía eléctrica temporalmente : +

N° de datos validos : 720

Recuperación de datos : 100 %

D : Día de medición, correspondiendo el día 1 al 01.09.98 y el día 30 al 30.09.98.

H : Hora de medición a la cual corresponde el promedio horario.

Nota Importante al reverso

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MONITOREO DE CALIDAD DEL AIRE

TABLA 3.

LUGAR : CUERPO DE BOMBEROS

PERIODO : 1 AL 31 DE AGOSTO DE 1998

VARIABLE : ANHIDRIDO SULFUROSO (SO_2)

UNIDAD : $\mu g/m^3N$

D/H	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	24:00	MAX.	MIN.	PROM
1	7.8	7.8	5.2	5.2	5.2	10.4	10.4	7.8	7.8	7.8	18.3	101.9	86.2	13.1	7.8	7.8	7.8	5.2	5.2	5.2	10.4	10.4	10.4	7.8	101.9	5.2	15.6
2	5.2	5.2	18.3	5.2	5.2	5.2	20.9	7.8	5.2	13.1	31.3	5.2	5.2	13.1	5.2	7.8	10.4	7.8	5.2	7.8	5.2	0.0	5.2	5.2	31.3	0.0	8.6
3	10.4	5.2	5.2	13.1	2.6	2.6	23.5	10.4	7.8	5.2	5.2	7.8	5.2	10.4	15.7	7.8	5.2	13.1	20.9	7.8	5.2	10.4	5.2	5.2	23.5	2.6	8.8
4	2.6	2.6	10.4	13.1	2.6	7.8	5.2	7.8	10.4	13.1	15.7	13.1	13.1	5.2	10.4	13.1	7.8	13.1	10.4	10.4	13.1	5.2	5.2	5.2	15.7	2.6	9.0
5	5.2	23.5	5.2	13.1	5.2	5.2	7.8	20.9	7.8	15.7	7.8	5.2	18.3	26.1	39.2	10.4	5.2	20.9	18.3	18.3	5.2	7.8	7.8	10.4	39.2	5.2	13.0
6	13.1	10.4	7.8	10.4	15.7	10.4	18.3	10.4	7.8	10.4	10.4	23.5	20.9	13.1	10.4	7.8	23.5	7.8	20.9	7.8	10.4	10.4	7.8	7.8	23.5	7.8	12.4
7	5.2	5.2	7.8	15.7	23.5	34.0	7.8	7.8	10.4	10.4	10.4	36.6	20.9	10.4	13.1	10.4	7.8	7.8	18.3	20.9	34.0	7.8	7.8	5.2	36.6	5.2	14.1
8	7.8	7.8	7.8	13.1	15.7	15.7	7.8	5.2	5.2	18.3	10.4	36.6	10.4	34.0	7.8	10.4	10.4	7.8	23.5	7.8	13.1	10.4	7.8	5.2	36.6	5.2	12.5
9	7.8	13.1	15.7	7.8	7.8	20.9	23.5	34.0	7.8	23.5	10.4	7.8	10.4	34.0	20.9	10.4	7.8	31.3	26.1	7.8	7.8	10.4	7.8	7.8	34.0	7.8	15.1
10	13.1	15.7	15.7	20.9	34.0	28.7	26.1	7.8	13.1	10.4	10.4	10.4	20.9	44.4	13.1	10.4	7.8	7.8	7.8	31.3	28.7	18.3	7.8	5.2	44.4	5.2	17.1
11	5.2	28.7	7.8	26.1	7.8	20.9	23.5	7.8	7.8	10.4	26.1	28.7	26.1	15.7	36.6	39.2	36.6	13.1	23.5	20.9	20.9	23.5	13.1	10.4	39.2	5.2	20.0
12	7.8	15.7	10.4	10.4	18.3	10.4	7.8	10.4	10.4	10.4	15.7	C	C	28.7	7.8	7.8	10.4	7.8	5.2	10.4	7.8	5.2	7.8	5.2	34.0	5.2	12.5
13	5.2	13.1	31.3	5.2	7.8	5.2	20.9	18.3	7.8	20.9	54.9	36.6	39.2	60.1	75.8	26.1	31.3	10.4	7.8	10.4	28.7	10.4	7.8	5.2	75.8	5.2	22.5
14	0.0	18.3	23.5	15.7	31.3	41.8	60.1	28.7	36.6	15.7	20.9	10.4	23.5	13.1	7.8	20.9	7.8	28.7	13.1	49.6	18.3	5.2	5.2	5.2	60.1	0.0	20.9
15	13.1	15.7	20.9	23.5	10.4	5.2	10.4	28.7	15.7	23.5	15.7	60.1	62.7	31.3	7.8	7.8	23.5	31.3	18.3	13.1	10.4	5.2	5.2	5.2	62.7	5.2	19.4
16	18.3	13.1	34.0	7.8	31.3	34.0	26.1	20.9	23.5	31.3	5.2	18.3	26.1	36.6	34.0	28.7	20.9	23.5	15.7	31.3	28.7	5.2	10.4	7.8	36.6	5.2	22.2
17	7.8	5.2	5.2	7.8	7.8	5.2	5.2	5.2	7.8	10.4	15.7	13.1	7.8	10.4	10.4	54.9	31.3	10.4	7.8	7.8	5.2	5.2	7.8	7.8	54.9	5.2	11.0
18	7.8	7.8	7.8	7.8	7.8	10.4	10.4	10.4	10.4	13.1	18.3	15.7	10.4	10.4	47.0	18.3	7.8	7.8	7.8	5.2	7.8	5.2	5.2	7.8	47.0	5.2	11.2
19	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	10.4	10.4	10.4	10.4	7.8	10.4	7.8	5.2	7.8	5.2	5.2	5.2	5.2	5.2	5.2	7.8	10.4	5.2	7.6
20	7.8	7.8	7.8	18.3	5.2	23.5	20.9	7.8	7.8	10.4	10.4	18.3	13.1	10.4	36.6	78.4	31.3	13.1	23.5	15.7	10.4	10.4	10.4	7.8	78.4	5.2	17.0
21	7.8	5.2	5.2	0.0	0.0	10.4	5.2	13.1	7.8	7.8	15.7	7.8	10.4	18.3	7.8	7.8	15.7	13.1	7.8	13.1	13.1	13.1	10.4	10.4	18.3	0.0	9.5
22	13.1	13.1	7.8	20.9	20.9	18.3	7.8	13.1	13.1	7.8	7.8	15.7	10.4	5.2	5.2	15.7	18.3	5.2	5.2	13.1	5.2	5.2	5.2	5.2	20.9	5.2	10.8
23	28.7	5.2	31.3	13.1	5.2	10.4	15.7	18.3	20.9	18.3	18.3	34.0	44.4	15.7	31.3	28.7	7.8	13.1	5.2	18.3	18.3	20.9	7.8	5.2	44.4	5.2	18.2
24	10.4	10.4	13.1	7.8	31.3	34.0	28.7	20.9	13.1	18.3	10.4	31.3	23.5	20.9	36.6	36.6	7.8	31.3	7.8	28.7	20.9	18.3	5.2	5.2	36.6	5.2	19.7
25	20.9	2.6	13.1	20.9	18.3	34.0	31.3	7.8	28.7	10.4	36.6	31.3	23.5	20.9	23.5	10.4	10.4	7.8	7.8	20.9	5.2	15.7	13.1	5.2	36.6	2.6	17.5
26	5.2	7.8	15.7	18.3	18.3	31.3	28.7	26.1	7.8	18.3	20.9	7.8	10.4	34.0	23.5	10.4	31.3	28.7	5.2	10.4	13.1	10.4	15.7	7.8	34.0	5.2	17.0
27	23.5	13.1	23.5	7.8	13.1	15.7	7.8	7.8	20.9	10.4	36.6	10.4	20.9	44.4	13.1	10.4	7.8	7.8	7.8	23.5	23.5	7.8	7.8	5.2	44.4	5.2	15.5
28	5.2	10.4	7.8	28.7	28.7	20.9	18.3	20.9	20.9	10.4	10.4	10.4	10.4	5.2	10.4	10.4	28.7	26.1	7.8	15.7	13.1	7.8	7.8	7.8	28.7	5.2	14.4
29	7.8	10.4	7.8	10.4	31.3	7.8	23.5	20.9	13.1	10.4	10.4	10.4	10.4	7.8	7.8	10.4	10.4	28.7	15.7	15.7	7.8	5.2	13.1	7.8	31.3	5.2	12.7
30	13.1	10.4	7.8	7.8	7.8	7.8	20.9	18.3	23.5	7.8	10.4	7.8	10.4	34.0	20.9	36.6	31.3	28.7	34.0	34.0	7.8	10.4	7.8	7.8	36.6	7.8	17.0
31	13.1	13.1	5.2	26.1	23.5	20.9	20.9	28.7	28.7	28.7	36.6	36.6	47.0	44.4	39.2	C	C	C	C	7.8	15.7	15.7	5.2	7.8	47.0	5.2	25.9
MAX.	28.7	28.7	34.0	28.7	34.0	41.8	60.1	34.0	36.6	31.3	54.9	101.9	86.2	60.1	75.8	78.4	36.6	34.0	34.0	49.6	34.0	23.5	15.7	10.4			
MIN.	0.0	2.6	5.2	0.0	0.0	2.6	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	0.0	5.2	5.2			
PROM	9.9	10.7	12.7	13.2	14.6	16.7	17.9	14.9	13.6	14.0	17.4	22.5	22.1	22.0	20.5	19.3	16.3	16.1	13.7	16.0	13.6	9.8	8.1	6.8			

Código ausencia de datos por instalación estación : *
Código ausencia de datos por falta de energía eléctrica temporalmente : +
N° de datos validos : 738
Recuperación de datos : 100 %
D : Día de medición, correspondiendo el día 1 al 01.08.98 y el día 31 al 31.08.98.
H : Hora de medición a la cual corresponde el promedio horario.
C : Calibración del equipo

Nota Importante al reverso

AV. MARATHON 2595, FONO: 3502100 - CASILLA 14036 CORREO 21 COD. POSTAL 6900502 FAX 56-2 - 2384135 - SANTIAGO - CHILE - E-mail: cesmec@reuna.cl

MONITOREO DE CALIDAD DEL AIRE

TABLA 3.

LUGAR : CUERPO DE BOMBEROS

PERIODO : 1 AL 31 DE JULIO DE 1998

VARIABLE : ANHIDRIDO SULFUROSO (SO_2)

UNIDAD : $\mu g/m^3N$

D/H	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	24:00	MAX.	MIN.	PROM
1	7.8	13.1	13.1	26.1	18.3	15.7	26.1	15.7	13.1	26.1	28.7	5.2	31.3	70.5	47.0	7.8	5.2	7.8	28.7	15.7	7.8	7.8	5.2	5.2	70.5	5.2	18.7
2	5.2	5.2	15.7	15.7	5.2	2.6	2.6	20.9	31.3	5.2	13.1	31.3	7.8	5.2	23.5	15.7	5.2	28.7	7.8	5.2	20.9	5.2	10.4	5.2	31.3	2.6	12.3
3	5.2	28.7	28.7	15.7	13.1	10.4	10.4	13.1	18.3	18.3	15.7	15.7	13.1	10.4	15.7	20.9	7.8	5.2	5.2	5.2	7.8	44.4	15.7	15.7	44.4	5.2	15.0
4	13.1	13.1	10.4	7.8	10.4	10.4	7.8	10.4	7.8	5.2	20.9	31.3	5.2	13.1	5.2	5.2	2.6	15.7	2.6	5.2	23.5	2.6	5.2	2.6	31.3	2.6	9.9
5	2.6	2.6	2.6	13.1	28.7	20.9	2.6	5.2	10.4	23.5	2.6	5.2	13.1	49.6	162.0	60.1	7.8	5.2	5.2	31.3	28.7	5.2	2.6	2.6	162.0	2.6	20.6
6	5.2	5.2	5.2	13.1	18.3	28.7	28.7	2.6	31.3	57.5	60.1	34.0	7.8	41.8	73.1	20.9	5.2	5.2	2.6	5.2	7.8	13.1	10.4	7.8	73.1	2.6	20.5
7	7.8	7.8	7.8	7.8	7.8	10.4	13.1	10.4	10.4	10.4	7.8	13.1	20.9	28.7	23.5	5.2	5.2	5.2	2.6	5.2	7.8	7.8	7.8	7.8	28.7	2.6	10.1
8	5.2	5.2	5.2	2.6	5.2	5.2	23.5	20.9	5.2	7.8	7.8	5.2	5.2	7.8	13.1	10.4	39.2	20.9	39.2	7.8	5.2	5.2	5.2	5.2	39.2	2.6	11.0
9	2.6	20.9	2.6	2.6	5.2	7.8	7.8	13.1	15.7	18.3	7.8	36.6	52.2	36.6	26.1	13.1	7.8	5.2	5.2	5.2	54.9	18.3	13.1	13.1	54.9	2.6	16.3
10	13.1	13.1	13.1	10.4	10.4	10.4	15.7	15.7	18.3	36.6	15.7	15.7	28.7	23.5	20.9	13.1	10.4	10.4	10.4	7.8	10.4	7.8	7.8	7.8	36.6	7.8	14.5
11	10.4	10.4	10.4	10.4	10.4	10.4	39.2	15.7	13.1	13.1	13.1	13.1	15.7	26.1	26.1	52.2	23.5	10.4	7.8	10.4	10.4	7.8	7.8	10.4	52.2	7.8	15.8
12	10.4	23.5	10.4	13.1	10.4	13.1	10.4	20.9	10.4	23.5	10.4	13.1	34.0	41.8	31.3	10.4	7.8	23.5	7.8	15.7	34.0	5.2	7.8	7.8	41.8	5.2	16.5
13	10.4	18.3	23.5	10.4	13.1	20.9	10.4	10.4	13.1	13.1	15.7	15.7	13.1	23.5	20.9	18.3	10.4	7.8	15.7	7.8	34.0	7.8	5.2	7.8	34.0	5.2	14.5
14	7.8	10.4	15.7	10.4	36.6	20.9	10.4	13.1	10.4	10.4	15.7	10.4	15.7	23.5	15.7	10.4	7.8	7.8	34.0	13.1	7.8	7.8	5.2	7.8	36.6	5.2	13.7
15	7.8	15.7	13.1	7.8	34.0	7.8	20.9	13.1	10.4	18.3	10.4	23.5	23.5	10.4	7.8	7.8	10.4	10.4	20.9	28.7	15.7	5.2	10.4	7.8	34.0	5.2	14.3
16	7.8	10.4	20.9	10.4	13.1	10.4	28.7	7.8	36.6	31.3	10.4	13.1	7.8	23.5	18.3	7.8	7.8	15.7	5.2	7.8	23.5	10.4	7.8	7.8	36.6	5.2	14.4
17	7.8	20.9	5.2	23.5	18.3	5.2	7.8	7.8	7.8	34.0	10.4	13.1	18.3	10.4	7.8	7.8	5.2	7.8	7.8	13.1	20.9	5.2	7.8	7.8	34.0	5.2	11.8
18	7.8	10.4	20.9	5.2	7.8	10.4	20.9	23.5	13.1	13.1	10.4	7.8	7.8	7.8	26.1	60.1	44.4	23.5	10.4	15.7	15.7	7.8	10.4	10.4	60.1	5.2	16.3
19	10.4	10.4	13.1	18.3	18.3	18.3	7.8	7.8	36.6	31.3	10.4	13.1	13.1	18.3	31.3	5.2	7.8	15.7	7.8	7.8	23.5	10.4	5.2	10.4	36.6	5.2	14.7
20	7.8	7.8	10.4	36.6	36.6	10.4	7.8	10.4	10.4	10.4	7.8	7.8	7.8	7.8	7.8	7.8	10.4	7.8	5.2	5.2	5.2	5.2	7.8	5.2	36.6	5.2	10.3
21	0.0	0.0	5.2	15.7	7.8	31.3	18.3	18.3	7.8	20.9	65.3	36.6	65.3	169.8	128.0	130.6	31.3	10.4	7.8	10.4	28.7	10.4	7.8	7.8	169.8	0.0	34.8
22	7.8	7.8	7.8	31.3	31.3	5.2	7.8	15.7	7.8	18.3	7.8	10.4	7.8	7.8	7.8	7.8	7.8	23.5	5.2	31.3	7.8	5.2	5.2	5.2	31.3	5.2	11.8
23	7.8	7.8	20.9	20.9	10.4	13.1	10.4	7.8	7.8	7.8	34.0	34.0	20.9	20.9	7.8	7.8	15.7	10.4	13.1	13.1	7.8	5.2	5.2	5.2	34.0	5.2	13.2
24	5.2	13.1	13.1	31.3	31.3	7.8	7.8	13.1	20.9	36.6	28.7	20.9	18.3	10.4	7.8	7.8	7.8	5.2	23.5	7.8	15.7	10.4	7.8	7.8	36.6	5.2	15.0
25	7.8	5.2	5.2	7.8	7.8	31.3	31.3	5.2	7.8	10.4	15.7	13.1	7.8	10.4	10.4	54.9	31.3	10.4	7.8	7.8	5.2	5.2	7.8	7.8	54.9	5.2	13.2
26	7.8	7.8	7.8	7.8	7.8	10.4	10.4	10.4	10.4	13.1	18.3	15.7	10.4	10.4	47.0	18.3	7.8	7.8	7.8	5.2	7.8	5.2	5.2	7.8	47.0	5.2	11.2
27	7.8	7.8	7.8	7.8	34.0	7.8	7.8	7.8	10.4	36.6	10.4	10.4	7.8	10.4	7.8	5.2	7.8	5.2	31.3	31.3	5.2	5.2	5.2	7.8	36.6	5.2	12.0
28	7.8	7.8	7.8	5.2	5.2	7.8	7.8	7.8	7.8	36.6	10.4	18.3	13.1	10.4	36.6	78.4	31.3	13.1	23.5	15.7	10.4	10.4	10.4	7.8	78.4	5.2	16.3
29	7.8	5.2	5.2	7.8	7.8	7.8	5.2	5.2	7.8	7.8	7.8	7.8	10.4	18.3	7.8	7.8	15.7	13.1	7.8	13.1	13.1	13.1	10.4	10.4	18.3	5.2	9.4
30	13.1	13.1	7.8	7.8	7.8	34.0	34.0	7.8	23.5	20.9	7.8	7.8	7.8	5.2	10.4	10.4	5.2	5.2	5.2	31.3	23.5	5.2	5.2	2.6	34.0	2.6	12.6
31	2.6	5.2	5.2	5.2	20.9	10.4	5.2	20.9	5.2	7.8	7.8	7.8	44.4	23.5	7.8	7.8	7.8	7.8	5.2	5.2	5.2	5.2	7.8	7.8	44.4	2.6	10.0
MAX.	13.1	28.7	28.7	36.6	36.6	34.0	39.2	23.5	36.6	57.5	65.3	36.6	65.3	169.8	162.0	130.6	44.4	28.7	39.2	31.3	54.9	44.4	15.7	15.7			
MIN.	0.0	0.0	2.6	2.6	5.2	2.6	2.6	2.6	5.2	5.2	2.6	5.2	5.2	5.2	5.2	5.2	2.6	5.2	2.6	5.2	5.2	2.6	2.6	2.6			
PROM.	7.5	10.8	11.0	13.2	15.9	13.5	14.6	12.2	14.2	20.1	16.4	16.3	17.9	26.1	28.5	22.5	13.0	11.4	12.0	12.6	16.0	8.8	7.7	7.6			

Código ausencia de datos por instalación estación : *
Código ausencia de datos por falta de energía eléctrica temporalmente : +
N° de datos validos : 744
Recuperación de datos : 100 %
D : Día de medición, correspondiendo el día 1 al 01.07.98 y el día 31 al 31.07.98.
H : Hora de medición a la cual corresponde el promedio horario.

Nota Importante al reverso

AV. MARATHON 2595. FONO: 2380556 - CASILLA 14036 CORREO 21 FAX 56-2 - 2384135 - SANTIAGO - CHILE - E-MAIL: cesmec@reuna.cl

MONITOREO DE CALIDAD DEL AIRE

TABLA 3.

LUGAR : CUERPO DE BOMBEROS

VARIABLE : ANHIDRIDO SULFUROSO (SO2)

PERIODO : 1 AL 30 DE JUNIO DE 1998

UNIDAD : µg/m3N

D/H	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	24:00	MAX.	MIN.	PROM
1	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	10.4	13.1	15.7	13.1	13.1	15.7	36.6	26.1	10.4	10.4	7.8	7.8	7.8	7.8	10.4	36.6	7.8	11.5
2	10.4	10.4	10.4	31.3	73.1	60.1	44.4	54.9	57.5	41.8	28.7	15.7	10.4	7.8	5.2	7.8	26.1	54.9	114.9	86.2	86.2	54.9	13.1	7.8	114.9	5.2	38.1
3	5.2	7.8	7.8	7.8	7.8	5.2	5.2	10.4	13.1	7.8	7.8	5.2	5.2	5.2	5.2	13.1	7.8	5.2	5.2	5.2	5.2	5.2	5.2	5.2	13.1	5.2	6.9
4	5.2	5.2	5.2	5.2	5.2	5.2	5.2	7.8	10.4	10.4	15.7	13.1	7.8	5.2	5.2	5.2	5.2	2.6	2.6	2.6	5.2	2.6	2.6	2.6	15.7	2.6	6.0
5	5.2	2.6	2.6	5.2	5.2	5.2	2.6	5.2	5.2	5.2	2.6	2.6	5.2	2.6	5.2	2.6	5.2	2.6	0.0	2.6	5.2	5.2	2.6	2.6	5.2	0.0	3.8
6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	5.2	5.2	15.7	34.0	7.8	7.8	52.2	13.1	5.2	2.6	2.6	5.2	2.6	5.2	5.2	5.2	52.2	2.6	8.2
7	2.6	2.6	2.6	2.6	5.2	2.6	2.6	0.0	2.6	5.2	44.4	122.8	20.9	13.1	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	2.6	122.8	0.0	11.6
8	2.6	2.6	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	2.6	5.2	2.6	2.6	2.6	2.6	0.0	2.6	2.6	2.6	2.6	5.2	0.0	3.8
9	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	5.2	5.2	5.2	5.2	7.8	13.1	7.8	5.2	5.2	2.6	0.0	0.0	0.0	2.6	2.6	13.1	0.0	3.8
10	2.6	2.6	2.6	2.6	2.6	2.6	0.0	2.6	2.6	2.6	2.6	0.0	5.2	5.2	5.2	5.2	2.6	2.6	2.6	2.6	2.6	5.2	5.2	5.2	5.2	0.0	3.2
11	5.2	5.2	5.2	5.2	2.6	2.6	2.6	2.6	5.2	5.2	5.2	5.2	5.2	7.8	20.9	20.9	20.9	28.7	41.8	10.4	7.8	5.2	5.2	5.2	41.8	2.6	9.7
12	5.2	5.2	5.2	2.6	2.6	2.6	2.6	2.6	2.6	5.2	5.2	18.3	54.9	10.4	7.8	10.4	10.4	2.6	2.6	2.6	2.6	5.2	18.3	13.1	54.9	2.6	8.4
13	10.4	10.4	7.8	7.8	7.8	5.2	7.8	7.8	7.8	7.8	7.8	7.8	5.2	5.2	5.2	5.2	5.2	2.6	2.6	2.6	2.6	2.6	2.6	2.6	10.4	2.6	5.9
14	2.6	2.6	2.6	5.2	2.6	2.6	2.6	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	2.6	6.4
15	7.8	7.8	7.8	7.8	7.8	5.2	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	5.2	7.8	5.2	7.6
16	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	13.1	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	13.1	7.8	8.1
17	7.8	10.4	10.4	15.7	15.7	10.4	10.4	10.4	10.4	10.4	15.7	15.7	18.3	13.1	13.1	15.7	13.1	10.4	10.4	10.4	15.7	13.1	10.4	13.1	18.3	7.8	12.5
18	10.4	10.4	10.4	10.4	10.4	10.4	10.4	10.4	10.4	10.4	10.4	10.4	41.8	20.9	20.9	20.9	10.4	7.8	7.8	7.8	7.8	7.8	7.8	10.4	41.8	7.8	12.4
19	10.4	10.4	10.4	7.8	7.8	7.8	7.8	7.8	10.4	15.7	318.7	0.0	5.2	5.2	20.9	36.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	318.7	0.0	20.1
20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	28.7	0.0	0.0	7.8	5.2	5.2	5.2	5.2	5.2	28.7	0.0	2.6
21	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.2	0.0	2.7
22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23	0.0	0.0	15.7	23.5	7.8	15.7	23.5	5.2	2.6	0.0	0.0	0.0	0.0	10.4	18.3	44.4	20.9	5.2	0.0	0.0	5.2	18.3	13.1	5.2	44.4	0.0	9.8
24	2.6	0.0	2.6	5.2	5.2	0.0	2.6	13.1	13.1	39.2	18.3	2.6	0.0	0.0	0.0	0.0	0.0	0.0	167.2	112.3	138.4	60.1	2.6	0.0	167.2	0.0	24.4
25	0.0	0.0	2.6	5.2	2.6	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.8	0.0	0.0	2.6	0.0	0.0	0.0	0.0	0.0	0.0	10.4	10.4	0.0	1.4
26	7.8	26.1	7.8	7.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	26.1	0.0	2.2
27	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.2	2.6	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.2	0.0	0.4
28	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
29	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.4	0.0	0.4
MAX.	10.4	26.1	15.7	31.3	73.1	60.1	44.4	54.9	57.5	41.8	318.7	122.8	54.9	20.9	52.2	44.4	26.1	54.9	167.2	112.3	138.4	60.1	18.3	13.1			
MIN.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
PROM	4.4	5.0	5.1	6.4	6.8	5.9	5.7	6.3	6.8	7.4	18.5	10.4	8.4	5.8	8.6	10.3	6.6	5.8	13.8	9.8	11.1	7.8	4.7	4.4			

Código ausencia de datos por instalación estación : *
Código ausencia de datos por falta de energía eléctrica temporalmente : +
N° de datos validos : 720
Recuperación de datos : 100 %
D : Dia de medición, correspondiendo el día 1 al 01.06.98 y el día 30 al 30.06.98.
H : Hora de medición a la cual corresponde el promedio horario.

Nota importante al reverso

AV. MARATHON 2595, FONO: 2380556 - CASILLA 14036 CORREO 21 FAX 56-2 - 2384135 - SANTIAGO - CHILE

MONITOREO DE CALIDAD DEL AIRE

TABLA 3.

LUGAR : CUERPO DE BOMBEROS

PERIODO : 1 AL 31 DE MAYO DE 1998

VARIABLE : ANHIDRIDO SULFUROSO (SO2)

UNIDAD : µg/m3N

D/H	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	24:00	MAX.	MIN.	PROM
1	2.6	5.2	2.6	0.0	0.0	0.0	0.0	0.0	2.6	5.2	10.4	7.8	7.8	26.1	7.8	5.2	2.6	2.6	0.0	10.4	15.7	7.8	2.6	2.6	26.1	0.0	5.3
2	2.6	2.6	0.0	2.6	2.6	2.6	2.6	0.0	0.0	2.6	2.6	0.0	0.0	0.0	26.1	141.1	34.0	5.2	0.0	0.0	0.0	0.0	0.0	0.0	141.1	0.0	9.5
3	2.6	5.2	2.6	0.0	2.6	2.6	5.2	7.8	7.8	0.0	0.0	20.9	34.0	39.2	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	39.2	0.0	5.6
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.6	23.5	7.8	15.7	7.8	5.2	0.0	0.0	2.6	2.6	5.2	7.8	5.2	2.6	23.5	0.0	3.7
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.2	7.8	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.8	0.0	0.7
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.6	154.1	96.7	13.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	154.1	0.0	11.1
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	18.3	7.8	7.8	7.8	7.8	7.8	7.8	7.8	18.3	0.0	3.0
9	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	0.0	0.0	0.0	0.0	0.0	0.0	28.7	5.2	7.8	5.2	5.2	5.2	5.2	7.8	5.2	28.7	0.0	6.1
10	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2
11	5.2	5.2	5.2	5.2	5.2	7.8	7.8	7.8	7.8	7.8	7.8	54.9	109.7	18.3	10.4	13.1	15.7	7.8	5.2	5.2	5.2	5.2	5.2	5.2	109.7	5.2	13.9
12	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	7.8	7.8	10.4	10.4	5.2	5.2	5.2	5.2	5.2	5.2	7.8	7.8	7.8	10.4	5.2	6.2
13	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	7.8	7.8	28.7	39.2	7.8	5.2	5.2	5.2	5.2	5.2	5.2	7.8	7.8	7.8	39.2	5.2	8.3
14	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	7.8	7.8	13.1	10.4	10.4	10.4	39.2	67.9	13.1	7.8	7.8	10.4	10.4	10.4	7.8	7.8	67.9	5.2	11.9
15	7.8	7.8	7.8	10.4	10.4	7.8	7.8	7.8	7.8	15.7	18.3	7.8	7.8	20.9	23.5	13.1	10.4	20.9	10.4	5.2	5.2	5.2	5.2	5.2	23.5	5.2	10.4
16	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	2.6	2.6	2.6	5.2	2.6	4.9
17	5.2	2.6	5.2	18.3	31.3	13.1	5.2	7.8	67.9	47.0	54.9	36.6	23.5	23.5	15.7	10.4	7.8	7.8	7.8	54.9	112.3	20.9	10.4	7.8	112.3	2.6	24.9
18	5.2	5.2	5.2	7.8	10.4	10.4	15.7	7.8	7.8	7.8	34.0	49.6	34.0	67.9	20.9	7.8	10.4	5.2	2.6	2.6	5.2	7.8	28.7	20.9	67.9	2.6	15.9
19	26.1	34.0	34.0	26.1	23.5	20.9	13.1	7.8	7.8	7.8	5.2	5.2	5.2	5.2	2.6	2.6	70.5	20.9	7.8	5.2	5.2	5.2	5.2	2.6	70.5	2.6	14.6
20	2.6	5.2	5.2	7.8	5.2	7.8	7.8	5.2	7.8	10.4	7.8	10.4	28.7	10.4	10.4	5.2	5.2	5.2	2.6	2.6	2.6	2.6	5.2	5.2	28.7	2.6	7.1
21	5.2	5.2	5.2	5.2	2.6	2.6	2.6	5.2	5.2	5.2	5.2	7.8	15.7	36.6	15.7	5.2	5.2	5.2	5.2	2.6	2.6	5.2	7.8	10.4	36.6	2.6	7.3
22	7.8	7.8	13.1	7.8	7.8	5.2	5.2	5.2	7.8	7.8	5.2	5.2	5.2	31.3	7.8	5.2	2.6	2.6	2.6	5.2	5.2	5.2	7.8	7.8	31.3	2.6	7.3
23	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	+	10.4	7.8	7.8	7.8	7.8	2.6	2.6	2.6	2.6	2.6	2.6	2.6	7.8	10.4	2.6	5.2
24	7.8	5.2	2.6	2.6	2.6	2.6	2.6	2.6	5.2	5.2	7.8	10.4	5.2	5.2	2.6	2.6	5.2	7.8	10.4	7.8	7.8	10.4	13.1	7.8	13.1	2.6	6.0
25	10.4	10.4	7.8	5.2	5.2	5.2	5.2	2.6	5.2	5.2	5.2	2.6	13.1	23.5	13.1	7.8	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	23.5	2.6	6.2
26	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	7.8	15.7	26.1	23.5	23.5	13.1	13.1	13.1	10.4	13.1	62.7	154.1	117.5	154.1	2.6	21.8
27	39.2	15.7	15.7	18.3	13.1	10.4	10.4	10.4	10.4	10.4	15.7	67.9	57.5	10.4	10.4	10.4	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	67.9	7.8	16.2
28	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	10.4	7.8	10.4	10.4	10.4	7.8	7.8	7.8	13.1	13.1	7.8	7.8	7.8	7.8	7.8	13.1	7.8	8.7
29	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	18.3	52.2	36.6	28.7	20.9	15.7	10.4	10.4	23.5	13.1	52.2	7.8	14.1
30	10.4	10.4	10.4	10.4	7.8	7.8	7.8	15.7	18.3	83.6	39.2	34.0	54.9	125.4	26.1	67.9	49.6	44.4	10.4	7.8	7.8	7.8	7.8	7.8	125.4	7.8	28.1
31	7.8	7.8	7.8	7.8	10.4	10.4	7.8	7.8	10.4	10.4	10.4	10.4	10.4	13.1	15.7	13.1	10.4	7.8	7.8	7.8	7.8	7.8	7.8	7.8	15.7	7.8	9.5
MAX.	39.2	34.0	34.0	26.1	31.3	20.9	15.7	15.7	67.9	83.6	54.9	67.9	154.1	125.4	39.2	141.1	70.5	44.4	20.9	54.9	112.3	62.7	154.1	117.5			
MIN.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
PROM	6.7	6.2	6.1	6.2	6.4	5.6	5.3	5.1	7.8	9.3	9.4	13.9	21.7	22.5	11.8	17.0	11.5	8.3	5.7	6.8	8.9	7.8	11.5	9.6			

Código ausencia de datos por instalación estación : *
Código ausencia de datos por falta de energía eléctrica temporalmente : +
N° de datos validos : 743
Recuperación de datos : 100 %
D : Día de medición, correspondiendo el día 1 al 01.05.98 y el día 31 al 31.05.98.
H : Hora de medición a la cual corresponde el promedio horario.

Nota importante al reverso

AV. MARATHON 2595, FONO: 2380556 - CASILLA 14036 CORREO 21 FAX 56-2 - 2384135 - SANTIAGO - CHILE

MONITOREO DE CALIDAD DEL AIRE

TABLA 3.

LUGAR : CUERPO DE BOMBEROS

PERIODO : 1 AL 30 DE ABRIL DE 1998

VARIABLE : ANHIDRIDO SULFUROSO (SO2)

UNIDAD : µg/m3N

D/H	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	24:00	MAX.	MIN.	PROM
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	44.4	0.0	185.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	185.5	0.0	9.6
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.2	7.8	0.0	5.2	10.4	13.1	2.6	0.0	0.0	13.1	0.0	1.9
11	0.0	0.0	0.0	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.2	15.7	20.9	15.7	0.0	0.0	0.0	0.0	5.2	5.2	5.2	0.0	0.0	20.9	0.0	3.2
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	52.2	13.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.6	52.2	0.0	2.8
13	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.8	7.8	67.9	10.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	67.9	0.0	4.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.6	0.0	0.0	10.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.4	0.0	0.5
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.6	0.0	5.2	7.8	18.3	41.8	26.1	13.1	2.6	2.6	5.2	26.1	18.3	20.9	41.8	0.0	7.9
17	13.1	7.8	5.2	5.2	5.2	5.2	7.8	7.8	10.4	26.1	26.1	15.7	31.3	73.1	67.9	49.6	13.1	7.8	20.9	57.5	2.6	2.6	2.6	2.6	73.1	2.6	19.5
18	2.6	7.8	15.7	23.5	15.7	15.7	28.7	122.8	83.6	39.2	26.1	7.8	2.6	2.6	2.6	2.6	2.6	2.6	5.2	7.8	2.6	2.6	2.6	28.7	122.8	2.6	18.9
19	60.1	47.0	20.9	20.9	44.4	54.9	34.0	20.9	26.1	57.5	78.4	44.4	28.7	44.4	62.7	28.7	7.8	13.1	5.2	2.6	2.6	2.6	2.6	5.2	78.4	2.6	29.7
20	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	5.2	13.1	13.1	2.6	2.6	13.1	62.7	20.9	10.4	2.6	2.6	2.6	2.6	2.6	2.6	5.2	62.7	2.6	7.7
21	5.2	2.6	2.6	2.6	2.6	2.6	5.2	5.2	7.8	7.8	10.4	5.2	23.5	20.9	36.6	10.4	2.6	2.6	2.6	2.6	2.6	2.6	5.2	7.8	36.6	2.6	7.5
22	5.2	2.6	13.1	10.4	7.8	7.8	5.2	2.6	5.2	2.6	2.6	2.6	2.6	2.6	2.6	2.6	7.8	7.8	5.2	2.6	2.6	2.6	2.6	2.6	13.1	2.6	4.7
23	5.2	7.8	5.2	7.8	7.8	5.2	5.2	5.2	5.2	2.6	47.0	44.4	54.9	34.0	23.5	5.2	2.6	2.6	2.6	2.6	2.6	5.2	10.4	10.4	54.9	2.6	12.7
24	5.2	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	5.2	2.6	2.6	2.6	2.6	2.6	5.2	2.6	2.8
25	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	7.8	7.8	5.2	7.8	5.2	2.6	2.6	2.6	2.6	0.0	0.0	0.0	2.6	0.0	2.6	0.0	7.8	0.0	2.9
26	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
27	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.6	2.6	10.4	15.7	54.9	18.3	2.6	2.6	2.6	2.6	0.0	2.6	2.6	2.6	2.6	54.9	0.0	5.3
28	2.6	2.6	0.0	0.0	0.0	0.0	2.6	5.2	7.8	18.3	28.7	28.7	49.6	54.9	2.6	0.0	0.0	0.0	0.0	10.4	13.1	2.6	2.6	2.6	54.9	0.0	9.8
29	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.6	5.2	28.7	15.7	5.2	2.6	13.1	15.7	31.3	2.6	0.0	2.6	2.6	2.6	5.2	0.0	31.3	0.0	5.8
30	0.0	2.6	2.6	5.2	5.2	5.2	2.6	2.6	2.6	2.6	0.0	0.0	0.0	0.0	0.0	2.6	5.2	2.6	0.0	7.8	2.6	0.0	0.0	0.0	7.8	0.0	2.2
MAX.	60.1	47.0	20.9	23.5	44.4	54.9	34.0	122.8	83.6	57.5	78.4	44.4	67.9	73.1	67.9	49.6	185.5	13.1	20.9	57.5	13.1	26.1	18.3	28.7			
MIN.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
PROM	3.7	3.0	2.4	2.9	3.2	3.5	3.3	6.0	5.6	6.4	9.4	6.7	12.5	12.0	12.5	6.4	10.4	2.1	2.0	4.0	2.3	2.2	2.1	3.0			

Código ausencia de datos por instalación estación : *
Código ausencia de datos por falta de energía eléctrica temporalmente : +
N° de datos validos : 720
Recuperación de datos : 100 %
D : Día de medición, correspondiendo el día 1 al 01.04.98 y el día 30 al 30.04.98.
H : Hora de medición a la cual corresponde el promedio horario.

Nota importante al reverso

cesmec

SEB-10081

MONITOREO DE CALIDAD DEL AIRE

TABLA 3.

LUGAR : Cuerpo de Bomberos

PERIODO : 2 al 31 de Marzo de 1998

VARIABLE : ANHIDRIDO SULFUROSO (SO2)

UNIDAD : µg/m3N

D/H	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	24:00	MAX.	MIN.	PROM
1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	240.3	305.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	305.6	0.0	22.7
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	49.6	15.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	49.6	0.0	2.7
5	0.0	0.0	0.0	0.0	20.9	5.2	0.0	0.0	0.0	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.9	5.2	0.0	20.9	0.0	2.3
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.2	13.1	0.0	0.0	0.0	13.1	0.0	0.8
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	44.4	96.7	94.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	62.7	0.0	0.0	96.7	0.0	12.4
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	86.2	47.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	86.2	0.0	5.6
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	54.9	62.7	2.6	5.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	62.7	0.0	5.2
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	337.0	138.4	86.2	23.5	13.1	0.0	0.0	0.0	0.0	0.0	0.0	65.3	0.0	0.0	337.0	0.0	27.6
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	143.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	143.7	0.0	6.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	18.3	0.0	0.0	0.0	0.0	0.0	0.0	31.3	2.6	135.8	23.5	0.0	135.8	0.0	8.8
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.1	18.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	18.3	0.0	1.3
17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	39.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	39.2	0.0	1.6
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.2	15.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	15.7	0.0	0.9
21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.2	0.0	0.2
22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23	0.0	0.0	0.0	0.0	13.1	54.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	54.9	0.0	2.8
24	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
26	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.2	0.0	0.2
27	0.0	0.0	0.0	0.0	0.0	0.0	0.0	15.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	15.7	0.0	0.7
28	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	18.3	0.0	18.3	0.0	0.8
29	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	159.3	99.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	159.3	0.0	11.2
MAX.	0.0	0.0	0.0	0.0	20.9	54.9	0.0	15.7	0.0	2.6	337.0	138.4	96.7	143.7	39.2	240.3	305.6	0.0	0.0	31.3	13.1	135.8	23.5	0.0			
MIN.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
PROM	0.0	0.0	0.0	0.0	1.1	2.0	0.0	0.5	0.0	0.1	13.1	11.5	10.8	9.6	2.4	13.3	13.5	0.0	0.0	1.2	0.5	9.5	1.6	0.0			

Código ausencia de datos por instalación estación : *
Código ausencia de datos por falta de energía eléctrica temporalmente : +
N° de datos validos : 704
Recuperación de datos : 100 %
D : Día de medición, correspondiendo el día 1 al 02.03.98 y el día 30 al 31.03.98.
H : Hora de medición a la cual corresponde el promedio horario.

TABLA N°2
ESTACION : BOMBEROS
PARAMETRO : SO_2
UNIDAD : ug/m3N
PERIODO : Febrero 1998

DIA	HORAS 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	PROM	MAX	MIN
1	5	5	5	5	3	3	3	10	18	13	8	3	3	8	37	238	55	26	44	21	10	5	8	5	23	238	3
2	5	5	5	3	3	3	3	3	5	8	10	16	21	8	13	18	68	24	5	5	5	5	5	5	10	68	3
3	10	8	8	8	8	8	8	5	5	8	5	3	3	5	50	29	44	5	5	5	3	3	5	5	10	50	3
4	5	3	5	8	5	5	3	5	5	8	18	10	13	37	21	31	10	3	3	3	3	3	5	5	9	37	3
5	8	10	5	3	3	3	3	3	3	3	3	3	3	8	50	31	21	8	5	5	5	5	8	5	8	50	3
6	5	10	8	5	5	10	5	5	5	10	5	3	21	18	18	26	5	5	16	3	3	3	5	8	9	26	3
7	13	5	3	3	3	3	3	3	3	3	3	3	3	16	78	58	21	29	5	3	3	3	3	3	11	78	3
8	5	8	13	8	5	8	5	3	3	3	3	5	8	8	5	16	31	24	31	10	8	5	8	8	10	31	3
9	5	5	3	3	3	3	3	3	3	3	3	10	5	10	34	13	5	34	21	55	42	26	5	8	13	55	3
10	5	5	5	3	3	3	3	3	3	5	5	21	52	42	8	24	31	58	65	58	58	31	3	3	21	65	3
11	5	5	10	10	8	8	8	8	8	10	5	5	5	5	39	55	21	39	29	8	5	5	5	5	13	55	5
12	5	5	8	3	3	3	3	3	3	3	18	24	13	110	21	18	31	16	5	3	3	5	3	3	13	110	3
13	13	8	5	3	3	3	3	0	3	5	3	3	5	42	29	8	3	3	3	3	3	5	5	13	7	42	0
14	8	5	3	3	3	3	3	3	3	3	5	5	8	58	18	18	5	5	5	5	5	5	8	5	8	58	3
15	8	3	3	8	3	0	0	0	*	*	21	3	3	3	71	44	26	26	21	13	5	5	5	5	12	71	0
16	5	5	5	5	3	3	3	3	3	3	5	5	5	3	5	26	26	5	5	0	5	5	18	26	7	26	0
17	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*			
18	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*			
19	5	21	26	21	5	0	0	3	3	3	3	3	3	8	31	63	16	3	3	3	3	5	8	5	10	63	0
20	5	3	3	3	3	3	0	3	5	5	10	16	24	31	47	86	44	55	81	8	8	8	10	10	20	86	0
21	8	8	8	8	8	5	10	8	5	21	157	63	21	13	58	207	71	34	16	73	34	16	73	34	40	207	5
22	10	16	16	5	3	3	3	3	5	8	13	8	29	29	68	31	10	16	42	31	5	5	8	5	15	68	3
23	5	5	5	3	3	3	5	3	3	8	5	3	5	52	31	44	8	8	5	5	5	8	8	8	10	52	3
24	8	8	5	5	5	3	5	5	5	8	8	8	29	92	16	5	5	5	5	3	3	5	5	5	10	92	3
25	26	16	5	5	3	3	3	3	3	3	3	5	3	5	5	10	71	65	5	5	5	8	8	8	11	71	3
26	8	5	10	24	37	21	21	13	18	34	24	8	5	5	8	13	21	13	5	3	3	5	5	5	13	37	3
27	5	89	37	18	10	13	10	10	8	13	5	5	5	29	110	16	8	13	5	3	3	5	8	5	18	110	3
28	34	10	13	29	10	5	8	5	3	0	3	3	3	3	5	10	10	5	3	3	3	5	8	5	8	34	0

(*) = Sin Dato

CIMM T & S S.A.
Unidad de Gestión Ambiental

000134

TABLA N°2
ESTACION : BOMBEROS
PARAMETRO : SO2
UNIDAD : ug/m3N
PERIODO : Enero 1998

DIA	HORAS 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	PROM	MAX	MIN
1	10	5	3	5	3	3	5	3	3	3	3	3	3	10	71	37	3	3	3	3	3	3	5	10	8	71	3
2	10	5	3	3	0	3	3	3	3	3	10	21	8	5	3	5	3	3	3	3	3	5	8	5	5	21	0
3	5	3	3	3	3	3	3	3	0	3	3	8	21	5	8	5	5	5	3	5	5	5	8	13	5	21	0
4	8	10	10	8	5	5	5	5	3	5	16	10	8	5	3	3	16	10	5	3	3	3	5	5	7	16	3
5	16	8	3	3	3	3	3	3	3	3	10	34	8	8	5	3	3	3	3	3	3	5	5	5	6	34	3
6	8	8	10	8	8	5	5	3	5	5	5	13	10	31	58	60	21	10	5	5	5	5	5	5	13	60	3
7	3	3	3	3	0	0	0	0	0	3	5	3	3	50	21	8	3	3	3	3	3	3	3	3	5	50	0
8	3	0	3	0	0	0	0	0	0	0	0	0	3	0	13	16	5	5	3	3	3	3	3	3	3	16	0
9	5	3	3	3	3	3	3	3	3	3	3	3	10	16	16	8	13	5	8	10	8	5	5	5	6	16	3
10	5	8	5	3	3	3	3	3	3	3	3	3	3	5	10	3	3	3	3	3	3	3	5	5	4	10	3
11	5	3	3	3	3	3	0	0	5	5	3	3	5	37	18	5	8	16	5	3	3	5	5	5	6	37	0
12	5	5	3	3	3	3	3	3	3	5	5	5	5	5	8	81	50	13	8	18	8	5	8	5	11	81	3
13	5	3	10	5	3	3	3	3	3	3	3	3	3	3	18	42	24	5	13	3	3	3	5	3	7	42	3
14	5	5	5	3	3	3	3	3	3	5	3	3	5	10	21	10	3	3	8	5	3	3	5	5	5	21	3
15	10	13	5	5	5	3	3	3	3	5	5	16	29	13	16	8	5	5	5	13	5	5	8	10	8	29	3
16	8	5	3	3	3	3	3	3	3	5	3	3	8	13	21	5	5	29	8	5	5	5	5	5	7	29	3
17	5	5	3	3	3	3	3	3	3	3	3	5	5	10	68	81	73	37	21	5	5	5	8	5	15	81	3
18	5	5	5	5	5	3	5	3	3	5	5	5	5	5	24	10	16	42	21	21	47	10	10	10	12	47	3
19	8	5	5	3	3	5	8	16	21	18	8	10	47	26	39	16	8	8	5	5	5	5	5	5	12	47	3
20	5	5	5	3	5	5	3	3	3	3	3	5	26	26	13	5	3	3	3	3	3	5	5	5	6	26	3
21	5	5	3	3	3	3	3	3	3	3	10	34	13	5	8	8	8	8	5	5	5	8	16	16	8	34	3
22	13	10	10	8	5	5	5	5	5	5	8	29	73	84	24	21	5	26	5	8	5	5	5	5	16	84	5
23	13	13	5	3	3	0	0	0	0	0	0	0	0	24	58	8	3	3	5	3	0	0	0	0	6	58	0
24	0	5	8	8	5	8	8	8	8	8	8	16	42	31	31	21	24	5	5	5	5	5	8	8	12	42	0
25	8	5	5	3	3	3	3	3	3	3	3	3	3	5	13	21	5	55	10	3	3	8	16	21	9	55	3
26	13	13	10	10	8	10	8	3	3	10	16	16	31	58	47	18	10	3	3	3	3	3	5	3	13	58	3
27	5	8	10	8	8	5	8	5	5	5	5	5	5	47	37	42	10	5	5	5	5	5	8	10	11	47	5
28	10	5	3	3	3	0	0	3	0	3	3	8	44	50	37	21	5	5	5	3	8	5	5	10	10	50	0
29	31	16	10	8	8	8	8	8	13	13	8	71	26	31	8	5	5	5	3	5	5	5	8	5	13	71	3
30	5	5	5	5	5	5	5	5	10	18	39	39	63	71	71	55	50	37	52	13	5	5	3	3	24	71	3
31	5	3	3	0	0	0	3	5	8	8	3	3	5	39	42	42	24	34	42	13	5	5	5	5	13	42	0

(*) = Sin Dato

CIMM T & S S.A.
Unidad de Gestión Ambiental

000135

TABLA N°2
ESTACION : BOMBEROS
PARAMETRO : SO2
UNIDAD : ug/m3N
PERIODO : Diciembre 1997

DIA	HORAS																								PROM	MAX	MIN
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24			
1	5	5	5	3	3	3	3	3	5	5	5	21	26	21	13	13	31	16	18	10	29	13	5	5	11	31	3
2	3	3	3	3	3	3	3	5	13	18	16	5	8	10	16	21	16	18	10	5	3	5	10	5	9	21	3
3	5	3	3	3	3	3	3	3	3	3	3	3	3	5	39	39	13	18	24	26	29	8	5	31	11	39	3
4	8	5	10	18	13	13	8	8	5	5	5	5	5	44	63	65	50	39	42	42	10	26	3	3	21	65	3
5	5	16	8	3	3	3	3	5	5	8	5	21	55	47	21	39	21	5	5	3	3	5	3	3	12	55	3
6	5	5	3	3	3	3	3	0	3	3	3	3	3	3	47	21	21	24	16	3	5	8	3	10	8	47	0
7	21	8	5	5	5	3	3	3	5	5	5	3	5	5	5	5	5	29	18	21	10	13	26	13	9	29	3
8	5	5	5	5	3	3	3	3	3	3	3	3	3	3	13	366	8	21	10	5	5	5	5	3	20	366	3
9	5	5	26	47	94	196	94	10	5	3	3	3	3	0	0	3	3	16	152	*	*	24	13	8	32	196	0
10	16	10	5	5	5	3	5	26	42	29	18	5	3	3	3	202	21	21	26	18	5	5	3	3	20	202	3
11	5	5	5	3	5	5	5	5	18	21	16	13	37	144	26	21	97	89	10	21	8	5	5	3	24	144	3
12	5	3	3	3	3	3	3	3	8	3	10	21	18	10	18	16	18	8	3	5	5	5	5	3	8	21	3
13	5	21	31	18	10	8	8	5	8	10	29	65	55	81	16	5	8	5	5	3	3	5	3	31	18	81	3
14	5	5	3	3	3	0	0	0	3	5	10	42	5	3	5	10	3	16	13	5	5	5	5	5	7	42	0
15	5	5	3	3	3	3	3	3	3	3	0	0	0	0	3	3	3	8	8	5	5	5	3	3	3	8	0
16	3	8	3	5	3	3	3	3	3	3	5	26	10	3	5	10	10	13	5	5	5	5	5	5	6	26	3
17	8	8	5	5	5	5	5	5	3	5	5	31	42	34	13	21	13	16	13	5	3	5	3	3	11	42	3
18	3	5	5	8	5	5	3	3	3	5	5	5	26	44	13	8	16	13	5	13	5	8	5	5	9	44	3
19	5	5	5	5	5	5	5	5	5	8	10	5	5	34	18	29	16	5	5	5	5	5	5	5	9	34	5
20	5	5	3	3	3	3	3	3	3	5	5	3	3	3	39	5	16	8	5	3	3	3	5	5	6	39	3
21	5	3	3	3	5	3	3	5	3	3	5	29	24	37	31	10	5	5	10	5	3	5	5	5	9	37	3
22	5	5	3	5	3	3	3	3	3	5	5	16	24	5	5	5	5	5	5	5	5	5	5	5	6	24	3
23	5	8	5	3	3	0	3	3	3	3	3	3	3	10	37	21	3	5	3	3	3	5	5	3	6	37	0
24	5	5	5	3	5	5	3	3	3	3	3	3	3	3	5	10	21	21	21	3	3	3	5	5	6	21	3
25	8	8	10	10	5	3	3	3	3	3	5	3	3	8	16	13	31	10	16	8	5	5	8	5	8	31	3
26	5	3	3	3	0	3	3	3	3	10	55	76	79	29	18	10	5	3	3	5	3	3	5	5	14	79	0
27	5	8	5	5	5	3	3	3	3	3	3	3	3	5	5	5	3	0	0	3	3	3	5	5	4	8	0
28	8	8	3	3	3	3	3	0	3	3	0	0	21	37	29	26	18	5	5	5	5	5	8	5	9	37	0
29	5	8	8	5	5	3	3	3	5	5	5	5	39	34	29	13	5	5	3	3	3	3	5	5	9	39	3
30	5	5	8	3	3	3	3	3	3	3	3	3	3	3	3	10	39	37	5	5	5	5	5	5	7	39	3
31	8	5	5	5	5	3	3	3	5	3	16	37	10	5	5	5	5	5	5	3	3	3	5	8	7	37	3

(*) = Sin Dato

TABLA N°2
ESTACION : BOMBEROS
PARAMETRO : SO2
UNIDAD : ug/m3N
PERIODO : Noviembre 1997

DIA	HORAS 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	PROM	MAX	MIN
1	3	3	3	3	3	0	0	0	3	3	3	3	3	3	5	5	16	21	24	21	5	8	8	5	6	24	0
2	5	5	3	3	3	3	3	3	3	3	8	8	13	16	3	3	3	3	3	3	3	5	5	5	5	16	3
3	3	3	3	0	0	0	0	0	3	0	3	3	0	0	0	21	3	5	3	3	3	5	5	3	3	21	0
4	3	3	0	0	0	0	0	0	0	3	18	10	76	34	5	5	5	5	5	5	5	5	5	5	8	76	0
5	5	3	3	3	3	3	3	3	3	3	3	3	18	26	86	84	39	8	3	3	3	5	5	3	13	86	3
6	3	3	3	0	0	0	0	0	0	0	0	3	3	3	0	3	10	10	3	16	3	5	5	5	3	16	0
7	5	3	3	3	3	3	3	3	3	3	3	3	5	3	3	5	44	29	21	8	5	5	5	3	7	44	3
8	3	3	3	0	0	0	0	0	0	0	3	3	8	5	3	3	5	8	8	18	8	5	8	5	4	18	0
9	5	5	3	3	3	3	3	3	0	3	3	3	10	10	8	13	16	8	3	3	3	3	5	3	5	16	0
10	3	3	3	3	3	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	3	3	1	3	0
11	3	0	0	0	0	0	0	0	0	0	0	3	3	10	5	5	3	3	3	3	3	3	3	3	2	10	0
12	0	3	3	3	0	0	3	3	0	3	3	3	3	3	3	3	3	3	3	3	3	3	5	5	2	5	0
13	5	3	3	3	3	3	3	3	3	3	5	5	5	5	5	5	5	3	5	5	3	5	8	5	4	8	3
14	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	5	3	3	3	3	3	5	3	3	3	5	3
15	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	5	5	3	3	3	3	5	5	5	3	5	3
16	5	5	5	5	5	5	3	3	3	3	3	5	5	5	5	5	5	5	5	5	5	8	8	5	5	8	3
17	3	3	3	3	3	3	0	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	0
18	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	0	0	0	2	3	0
19	3	0	0	0	0	0	0	3	3	0	3	3	0	0	3	3	3	3	3	3	3	5	3	3	2	5	0
20	5	5	3	3	3	3	3	3	5	3	3	3	3	5	10	5	3	3	3	5	5	3	3	3	4	10	3
21	3	3	3	0	0	0	3	3	3	3	0	3	3	0	5	3	3	3	3	3	3	3	3	3	2	5	0
22	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	5	5	3	3	3	3	5	5	3	5	3
23	5	5	5	5	5	5	5	3	3	3	3	3	5	5	5	5	5	5	5	5	5	5	8	8	5	8	3
24	5	3	3	3	3	3	3	0	3	3	3	3	3	3	3	3	3	3	3	3	3	3	5	5	3	5	0
25	5	5	3	3	3	3	3	3	5	5	21	55	47	26	8	5	5	8	5	5	8	8	0	3	10	55	0
26	3	3	3	3	3	3	3	3	3	3	3	31	89	89	3	5	5	3	5	5	3	5	8	16	12	89	3
27	5	5	3	5	8	5	3	3	3	*	*	*	*	*	*	39	5	5	5	5	5	8	8	5			
28	8	5	5	5	3	3	3	5	5	5	5	5	42	34	10	8	5	5	5	5	5	5	3	5	8	42	3
29	5	5	3	3	3	3	3	3	3	3	3	3	8	8	16	8	5	5	5	3	3	5	3	3	4	16	3
30	8	5	3	3	3	3	3	5	8	5	3	5	5	10	21	16	10	8	13	8	10	10	10	8	8	21	3

(*) = Sin Dato

TABLA N°2
ESTACION : BOMBEROS
PARAMETRO : SO2
UNIDAD : ug/m3N
PERIODO : Octubre 1997

DIA	HORAS 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	PROM	MAX	MIN
1	5	3	3	3	3	3	3	3	3	3	5	29	13	10	5	8	39	18	21	5	5	5	5	5	9	39	3
2	5	3	3	3	3	3	3	0	3	3	3	3	3	8	16	29	5	3	3	3	5	5	5	3	5	29	0
3	0	0	0	0	0	0	0	3	3	5	5	78	18	5	3	3	3	3	0	3	3	3	3	3	6	78	0
4	3	0	0	0	0	0	0	0	0	0	0	0	0	0	*	8	0	0	0	0	3	3	3	5	1	8	0
5	3	3	3	0	0	0	0	0	0	3	5	5	3	3	3	3	3	3	3	5	5	5	8	5	3	8	0
6	3	0	0	0	0	0	0	0	0	3	3	21	24	39	76	21	5	3	3	3	5	5	3	3	9	76	0
7	3	3	0	0	0	0	0	0	0	0	3	0	3	8	8	8	13	5	3	3	5	5	5	5	3	13	0
8	5	5	3	3	3	3	3	3	3	3	3	3	5	24	21	29	24	5	5	5	8	5	5	5	7	29	3
9	3	3	3	0	0	0	0	0	0	0	5	21	29	89	21	5	3	3	3	3	5	5	5	3	9	89	0
10	3	3	0	0	0	0	0	0	0	3	0	3	10	42	26	10	16	24	8	5	5	8	5	5	7	42	0
11	5	3	3	0	3	3	3	0	3	5	5	5	5	5	8	10	10	13	10	5	5	5	8	5	5	13	0
12	5	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	0	0	3	5	5	5	5	3	5	0
13	3	3	3	3	3	3	3	3	3	3	3	3	3	37	0	0	0	3	3	3	5	5	*	5	4	37	0
14	5	5	3	3	3	3	3	3	3	3	3	3	3	3	3	5	10	5	3	5	5	8	8	5	4	10	3
15	5	3	3	3	0	0	0	3	3	0	3	5	13	16	10	10	10	8	3	3	3	5	5	5	5	16	0
16	3	3	3	3	0	0	0	0	0	0	3	3	3	13	5	3	3	3	3	5	5	8	8	8	3	13	0
17	5	5	5	5	3	3	3	3	3	5	3	3	5	5	13	16	26	13	5	3	3	5	5	5	6	26	3
18	3	3	3	3	3	3	3	0	0	3	3	0	3	3	3	10	34	5	8	5	3	5	5	5	5	34	0
19	3	3	3	3	3	3	3	3	0	0	0	5	5	29	21	5	3	3	3	5	5	8	8	5	5	29	0
20	5	5	5	5	3	3	3	3	3	3	31	5	5	13	13	8	5	5	5	3	3	5	5	5	6	31	3
21	3	3	3	3	3	3	3	3	3	3	3	3	3	3	16	21	10	5	3	3	3	5	5	5	5	21	3
22	3	3	3	3	0	3	0	3	3	3	3	3	3	3	3	3	3	3	3	3	5	5	5	5	3	5	0
23	5	5	3	3	3	3	3	3	3	3	*	*	*	*	16	5	5	3	3	3	3	5	5	3	4	16	3
24	3	3	3	3	3	0	0	0	3	3	3	3	3	31	5	5	5	5	3	3	5	5	5	5	4	31	0
25	3	3	3	3	3	3	3	3	3	3	3	3	3	3	5	8	10	8	5	5	5	5	5	5	4	10	3
26	3	5	5	5	5	3	3	3	3	3	3	3	3	5	10	5	3	3	3	5	5	8	8	8	4	10	3
27	5	3	3	3	0	3	3	3	0	3	3	3	18	16	16	3	3	3	3	3	3	3	3	3	4	18	0
28	3	3	0	0	0	0	0	0	0	0	0	3	3	0	0	0	0	3	0	0	3	3	3	3	1	3	0
29	3	3	3	3	3	3	3	3	3	3	5	13	21	8	5	5	5	5	3	0	0	3	3	3	4	21	0
30	3	0	0	0	0	0	0	0	0	0	3	21	47	8	3	3	3	3	3	3	5	5	5	5	5	47	0
31	5	5	5	3	3	3	3	3	5	5	5	5	5	5	5	5	5	44	97	26	5	5	5	5	11	97	3

(*) = Sin Dato

TABLA N°2
ESTACION : BOMBEROS
PARAMETRO : SO2
UNIDAD : ug/m3N
PERIODO : Septiembre 1997

DIA	HORAS 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	PROM	MAX	MIN
1	5	3	3	3	3	3	3	3	3	3	5	3	8	13	13	16	8	13	5	5	8	8	5	5	6	16	3
2	5	5	5	5	5	5	5	5	5	5	5	10	13	21	10	8	10	16	5	5	8	13	21	16	9	21	5
3	21	13	10	5	5	3	3	3	3	5	5	10	16	31	8	5	5	5	3	5	8	8	5	5	8	31	3
4	3	3	3	3	3	3	3	3	3	3	5	5	5	8	10	8	10	8	5	8	13	10	13	10	6	13	3
5	16	10	8	5	5	3	3	3	3	3	5	5	5	3	3	5	5	5	3	3	5	5	5	3	5	16	3
6	3	3	0	3	3	3	0	0	0	3	0	0	3	0	3	0	0	3	3	3	5	3	5	3	2	5	0
7	5	3	3	3	0	0	3	3	0	0	0	5	10	3	3	3	0	0	3	5	8	8	8	5	3	10	0
8	5	5	3	3	3	3	3	3	3	3	5	13	42	37	8	5	5	5	3	3	5	5	5	5	7	42	3
9	3	3	3	3	0	0	0	0	0	0	3	5	13	3	3	3	3	3	3	3	5	5	5	3	3	13	0
10	3	3	0	0	0	0	0	0	0	0	0	3	3	3	8	8	3	0	0	3	5	5	5	5	2	8	0
11	3	3	3	3	3	3	3	3	3	3	3	3	5	3	3	3	3	3	3	3	3	3	3	3	3	5	3
12	3	0	0	0	0	0	0	0	0	0	3	8	10	10	5	3	3	3	3	3	5	5	5	3	3	10	0
13	3	3	3	3	0	0	0	0	0	0	3	0	3	5	5	3	3	0	3	5	8	8	5	5	3	8	0
14	5	3	3	3	3	3	3	3	3	5	44	47	52	238	123	21	10	8	5	10	5	5	5	5	26	238	3
15	3	3	0	0	0	0	0	0	0	0	0	0	0	3	3	3	3	18	16	5	8	8	8	5	3	18	0
16	5	3	3	3	3	3	5	5	3	3	3	3	3	3	3	5	5	21	10	5	8	5	5	5	5	21	3
17	3	3	3	3	3	3	3	3	3	5	5	5	3	5	5	5	3	3	5	5	8	8	8	8	4	8	3
18	5	5	3	3	3	3	3	0	0	3	3	3	3	3	3	3	3	3	3	3	3	5	5	5	3	5	0
19	3	3	3	0	0	0	3	0	3	0	3	3	3	3	16	13	29	31	24	5	5	5	5	5	7	31	0
20	5	3	3	3	3	3	3	0	0	3	3	26	24	5	5	3	3	3	8	5	5	5	5	5	5	26	0
21	5	3	3	3	3	3	3	3	0	3	3	3	3	3	5	16	8	16	37	8	10	8	8	5	7	37	0
22	5	5	3	3	5	5	5	3	5	5	8	8	5	5	8	13	5	3	3	5	8	8	8	5	6	13	3
23	5	5	3	3	3	3	3	*	113	5	5	5	5	3	5	8	10	5	3	5	8	8	8	8	10	113	3
24	5	3	3	3	3	3	3	0	0	3	3	5	10	5	5	3	3	3	3	3	5	5	5	5	4	10	0
25	5	3	3	3	3	3	3	0	3	3	3	5	21	13	8	24	8	8	24	8	10	8	8	8	8	24	0
26	5	3	3	5	3	3	3	3	3	3	5	5	5	3	3	5	5	5	*	31	5	5	5	5	5	31	3
27	5	8	5	3	3	3	3	3	5	3	8	13	5	10	16	5	3	3	3	5	5	5	5	5	5	16	3
28	5	3	3	3	3	3	3	3	3	3	13	31	16	10	5	3	3	3	3	3	5	8	5	5	6	31	3
29	5	3	3	3	3	3	3	3	3	3	3	10	31	21	8	5	3	10	3	3	5	5	5	8	6	31	3
30	5	5	5	3	3	3	5	5	3	3	5	13	13	10	5	5	5	5	5	5	8	8	8	5	6	13	3

(*) = Sin Dato

TABLA N°3
ESTACION : BOMBEROS
PARAMETRO : SO2
UNIDAD : ug/m3N
PERIODO : Agosto 1997

DIA	HORAS 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	PROM	MAX	MIN
1	3	3	3	3	0	0	0	3	3	3	5	5	21	13	3	3	3	3	3	3	3	3	5	3	4	21	0
2	3	3	3	0	3	0	0	0	0	3	3	5	8	8	3	3	3	3	3	3	5	3	5	5	3	8	0
3	3	3	3	3	3	3	3	3	3	3	3	10	16	26	18	16	5	5	5	8	10	8	5	5	7	26	3
4	3	3	0	0	0	0	0	0	0	3	5	13	21	29	50	110	123	39	16	18	16	8	5	5	19	123	0
5	3	3	3	0	0	0	0	0	3	3	10	21	13	29	44	55	13	8	21	13	8	8	8	5	11	55	0
6	5	3	3	3	3	3	3	0	3	3	10	5	5	3	3	5	5	5	5	5	13	10	5	3	5	13	0
7	3	3	3	3	0	0	0	0	0	3	*	*	*	*	29	5	3	5	8	8	5	5	5	3	4	29	0
8	3	3	0	0	0	0	0	0	0	0	3	3	3	3	3	8	34	13	8	8	8	8	8	8	5	34	0
9	5	5	3	5	8	8	5	5	3	3	5	5	5	5	3	3	3	3	3	3	5	5	5	3	4	8	3
10	3	5	5	5	5	3	3	3	3	3	13	18	34	34	29	24	24	21	13	37	26	31	10	10	15	37	3
11	5	3	3	5	3	5	3	3	3	3	8	10	58	99	199	99	97	94	13	8	8	8	8	18	32	199	3
12	26	8	5	5	3	3	3	8	8	8	21	16	31	50	42	39	52	52	16	10	8	8	5	8	18	52	3
13	13	13	10	8	10	16	5	5	5	8	29	29	5	8	8	5	13	10	10	5	8	8	5	5	10	29	5
14	5	3	3	5	5	3	3	3	3	5	10	5	5	3	3	3	3	3	3	5	5	8	8	5	4	10	3
15	5	8	8	5	5	5	5	5	5	8	10	8	5	5	5	5	5	5	5	5	5	5	5	5	6	10	5
16	3	3	3	3	0	0	0	0	0	3	3	3	3	3	3	3	3	3	3	5	5	5	5	5	3	5	0
17	3	3	3	0	0	*	*	*	*	*	*	29	3	3	0	*	*	76	3	3	3	3	3	0			
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0	0	0	3	0
20	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	3	3	0	0	0	3	0
21	0	0	0	0	0	0	0	0	0	0	0	0	3	3	3	3	0	3	0	3	5	5	5	3	1	5	0
22	3	3	0	3	3	3	3	3	3	3	3	3	3	0	0	3	3	3	3	3	3	3	3	3	2	3	0
23	0	0	0	0	0	0	0	0	0	0	0	3	3	39	8	24	52	10	10	8	5	5	5	3	7	52	0
24	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	3	3	5	5	5	5	5	2	5	0
25	0	3	3	3	3	3	3	3	3	3	3	3	3	3	3	5	5	5	5	5	5	5	5	5	3	5	0
26	3	3	0	0	0	0	0	3	3	3	3	3	0	0	0	3	3	3	3	3	5	5	8	8	2	8	0
27	5	3	3	3	0	0	3	3	3	0	3	13	29	24	24	5	*	*	*	31	8	8	5	5	8	31	0
28	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	5	5	3	3	5	5	5	5	5	3	5	3
29	3	3	3	0	0	0	0	0	0	3	3	3	0	3	3	3	3	3	3	3	5	5	5	5	2	5	0
30	5	3	3	3	0	0	0	0	0	3	3	10	5	13	13	5	13	5	3	3	5	5	5	3	4	13	0
31	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	5	3	3	3	5	5	5	5	5	3	5	3

(*) = Sin Dato

TABLA N°2
ESTACION : BOMBEROS
PARAMETRO : SO2
UNIDAD : ug/m3N
PERIODO : Julio 1997

DIA	HORAS 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	PROM	MAX	MIN
1	0	0	0	0	0	0	0	0	0	3	3	3	3	0	0	5	3	3	3	5	3	3	3	3	2	5	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	16	3	0	3	3	0	3	0	1	16	0
3	0	0	0	0	0	0	0	0	0	0	0	3	5	10	8	13	18	63	24	10	8	5	5	3	7	63	0
4	3	0	0	0	0	0	0	0	0	3	3	3	3	3	3	3	3	3	0	3	0	0	3	0	1	3	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	3	3	3	1	3	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	5	3	3	3	1	5	0
7	0	0	0	0	0	0	0	0	0	0	0	3	3	0	0	3	3	3	0	0	3	3	3	0	1	3	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0	3	0	0	3	0
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	3	5	3	1	5	0
10	3	3	3	3	3	3	3	5	3	3	3	5	5	5	5	5	8	5	5	8	8	5	3	3	4	8	3
11	3	3	0	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	3	3	0	1	3	0
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	3	3	3	1	3	0
13	3	3	3	0	0	0	0	0	0	0	0	0	3	3	13	5	5	3	5	5	5	3	3	0	3	13	0
14	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	3	0	3	3	3	3	3	1	3	0
15	3	0	0	5	3	3	8	5	5	5	5	5	5	5	8	3	8	5	16	8	5	8	5	5	5	16	0
16	3	3	3	3	0	3	3	3	3	3	3	3	3	8	8	8	8	8	8	8	8	8	13	13	5	13	0
17	10	8	5	3	3	3	3	10	8	5	5	8	10	8	5	5	5	13	24	47	29	18	18	16	11	47	3
18	16	16	16	10	8	3	3	0	0	3	3	3	3	16	13	8	8	3	3	3	3	5	5	5	6	16	0
19	3	3	3	3	0	0	0	0	0	3	5	5	13	47	42	24	34	8	5	5	5	3	3	3	9	47	0
20	3	3	0	3	0	0	0	0	3	10	18	8	18	8	31	16	58	26	8	5	5	3	3	3	10	58	0
21	3	0	0	0	0	3	3	3	3	3	8	5	3	3	5	8	8	5	10	8	5	5	5	8	4	10	0
22	16	18	13	5	5	3	5	3	3	3	5	5	5	5	5	10	10	10	5	5	5	5	5	5	7	18	3
23	5	3	3	3	3	0	0	3	3	3	3	10	73	97	24	13	24	37	58	149	102	65	42	18	31	149	0
24	26	26	16	13	16	47	26	13	8	13	13	21	16	13	10	8	5	55	21	29	16	13	10	8	18	55	5
25	18	16	10	10	10	8	8	5	5	10	16	21	18	10	8	5	5	5	5	5	31	84	81	68	19	84	5
26	52	34	13	8	5	3	3	3	3	*	42	8	8	5	3	3	3	3	24	34	21	29	31	29	16	52	3
27	24	24	47	34	18	13	16	13	10	8	5	5	3	3	10	26	55	21	39	16	16	16	10	16	19	55	3
28	16	8	5	5	3	3	3	5	5	8	5	5	5	16	18	8	5	3	3	5	5	5	5	5	6	18	3
29	5	3	3	3	3	3	3	3	3	3	5	16	10	5	3	3	3	5	5	5	5	5	5	5	5	16	3
30	5	5	3	3	3	3	3	3	3	3	3	3	3	3	3	5	3	5	8	5	5	5	8	5	4	8	3
31	5	3	3	3	3	3	3	3	3	3	5	5	5	5	18	5	3	5	5	5	5	5	5	5	5	18	3

(*) = Sin Dato

000141

TABLA N°2
ESTACION : BOMBEROS
PARAMETRO : SO2
UNIDAD : ug/m3N
PERIODO : Junio 1997

DIA	HORAS 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	PROM	MAX	MIN
1	13	10	10	10	10	10	10	10	10	10	10	10	24	21	21	16	13	13	13	16	16	16	16	13	14	24	10
2	13	13	10	10	10	10	10	10	10	10	13	13	16	29	47	24	26	16	13	13	16	13	13	10	15	47	10
3	10	10	10	13	10	16	18	18	18	16	13	13	10	16	10	10	10	10	10	16	16	16	16	13	13	18	10
4	13	13	10	10	10	10	10	10	10	10	10	10	10	10	13	13	13	13	13	13	13	13	13	10	12	13	10
5	10	10	8	8	8	8	8	10	10	10	10	10	10	10	29	13	10	10	10	13	13	16	13	13	11	29	8
6	13	10	8	8	8	8	8	8	10	10	10	10	10	10	18	84	68	34	18	18	18	16	16	16	18	84	8
7	13	13	13	13	10	10	10	10	10	13	13	13	13	13	13	16	26	24	16	16	16	13	13	13	14	26	10
8	13	13	10	10	10	8	8	10	8	10	10	10	10	10	10	10	13	10	10	13	13	13	13	10	11	13	8
9	10	10	10	10	8	8	8	10	10	10	13	13	13	13	13	13	13	10	10	13	13	13	13	13	11	13	8
10	13	10	10	10	10	10	10	10	10	10	10	13	13	13	13	13	13	13	13	16	16	16	16	13	13	16	10
11	10	10	10	8	8	8	8	10	10	10	10	13	10	10	10	13	13	13	13	16	16	13	13	13	11	16	8
12	13	10	10	8	8	8	8	8	8	8	8	10	8	8	0	10	10	10	13	10	10	10	10	10	9	13	0
13	10	10	16	16	16	16	16	16	13	13	13	13	13	13	13	13	10	10	10	10	10	10	10	10	13	16	10
14	13	13	16	16	16	16	16	16	16	13	13	13	13	13	10	13	13	10	10	10	10	10	10	10	13	16	10
15	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	0	0	0	8	8	8	8	10	10	10	13	0
16	10	10	13	13	13	13	13	13	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	11	13	10
17	10	13	13	13	13	13	13	13	13	13	13	13	10	3	10	10	10	10	10	13	13	13	13	10	12	13	3
18	10	10	8	8	8	8	8	8	10	8	10	10	10	10	10	10	10	10	10	16	16	16	16	13	11	16	8
19	13	10	10	10	10	10	10	8	8	10	10	10	10	8	8	10	10	10	10	10	13	13	10	10	10	13	8
20	10	8	8	8	8	8	8	8	8	8	8	10	10	10	10	10	10	10	10	13	13	13	13	10	10	13	8
21	13	47	5	8	8	8	8	8	8	8	10	10	10	10	10	10	10	10	16	16	16	16	16	13	12	47	5
22	13	13	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	13	13	13	13	13	13	11	13	10
23	10	10	10	10	8	8	8	8	10	10	10	10	10	10	10	10	10	10	10	13	16	13	16	13	11	16	8
24	10	10	8	5	8	8	8	10	10	10	*	*	*	*	*	*	58	10	8	10	10	10	10	10			
25	10	10	8	8	8	8	8	8	10	10	8	10	*	*	3	5	3	0	0	5	5	5	3	3	6	10	0
26	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	3	3	0	1	3	0
27	0	0	0	0	0	0	0	0	0	0	0	0	0	3	13	5	3	3	0	3	3	3	3	3	2	13	0
28	0	0	3	3	0	0	0	0	0	3	3	3	3	3	3	3	0	0	3	5	5	5	5	5	2	5	0
29	5	0	0	0	0	0	0	0	0	0	0	0	0	3	3	3	3	0	0	3	5	3	3	3	1	5	0
30	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	3	0	0	3	0

(*) = Sin Dato

CIMM Gorencia-Ambiental

000142

TABLA N°2
ESTACION : BOMBEROS
PARAMETRO : SO2
UNIDAD : ug/m3N
PERIODO : Mayo 1997

DIA	HORAS 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	PROM	MAX	MIN
1	8	8	8	8	*	31	8	5	8	8	8	10	10	10	8	8	8	8	8	10	13	10	10	10	10	31	5
2	47	10	8	8	8	8	8	8	8	8	8	10	13	10	10	10	10	13	13	16	16	13	13	13	12	47	8
3	10	10	8	8	8	8	8	8	8	8	8	10	10	10	10	10	8	10	10	13	13	13	13	10	10	13	8
4	10	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	10	39	21	16	16	13	11	39	8
5	13	10	10	8	8	8	8	10	10	10	13	16	18	18	13	13	10	10	10	10	13	13	13	10	12	18	8
6	10	8	8	8	8	8	8	8	8	8	8	8	10	34	39	31	18	24	18	18	18	21	26	18	16	39	8
7	16	13	10	10	10	8	8	8	8	8	8	8	8	10	8	8	8	18	68	16	21	21	18	16	14	68	8
8	13	10	10	10	10	8	10	10	10	13	18	34	50	21	13	*	*	34	13	13	13	13	13	10	16	50	8
9	10	8	8	8	8	8	8	8	8	8	8	8	8	8	8	10	13	16	10	13	13	13	10	10	10	16	8
10	10	8	8	8	8	8	8	8	8	8	13	16	13	16	18	13	13	10	10	3	16	16	16	16	11	18	3
11	13	13	10	10	8	8	8	8	8	10	10	10	13	10	10	10	10	10	10	13	13	13	13	10	11	13	8
12	10	8	8	8	8	10	8	8	8	10	10	24	47	168	34	13	13	*	10	13	13	13	10	8	20	168	8
13	8	8	8	8	5	5	5	8	8	8	21	29	37	13	13	10	10	10	10	13	16	13	13	10	12	37	5
14	10	10	8	8	8	8	8	10	10	10	10	10	10	13	34	63	24	16	13	13	13	13	10	10	14	63	8
15	13	10	8	8	8	10	8	10	10	10	10	10	10	10	10	10	10	10	10	13	13	13	13	10	11	13	8
16	10	10	8	8	8	8	8	8	10	10	10	10	10	10	10	10	10	10	10	16	16	16	16	13	11	16	8
17	13	10	10	10	10	10	10	10	10	10	16	34	47	65	24	18	16	13	13	13	13	13	10	10	17	65	10
18	10	10	8	8	8	8	8	8	8	8	10	13	10	10	10	102	21	13	10	13	13	13	13	13	15	102	8
19	10	10	8	8	8	8	8	8	8	8	13	31	259	105	16	13	13	10	10	10	13	13	13	13	26	259	8
20	13	10	10	10	10	10	10	10	10	13	16	16	24	21	26	24	13	13	13	16	16	13	13	10	14	26	10
21	10	10	8	8	8	8	8	8	8	10	13	31	44	39	13	10	10	10	10	13	13	13	13	10	14	44	8
22	10	8	8	8	8	8	13	13	21	76	37	21	26	58	42	39	52	42	26	13	13	13	13	10	24	76	8
23	10	10	10	8	8	8	8	8	8	10	10	10	10	10	10	10	13	13	13	16	16	16	16	13	11	16	8
24	13	13	10	10	10	10	10	10	10	10	21	44	21	16	13	10	10	10	10	13	13	13	13	13	14	44	10
25	10	10	10	8	8	8	8	8	8	8	10	10	10	10	10	21	16	10	10	13	16	13	13	13	11	21	8
26	10	10	*	*	*	*	*	*	*	*	37	13	13	13	13	10	10	13	37	16	16	16	16	16			
27	13	13	10	10	10	10	10	10	10	10	16	29	37	31	21	16	13	10	10	13	16	13	13	13	15	37	10
28	13	10	10	8	8	8	8	8	10	10	10	10	10	10	10	10	10	10	13	16	16	16	16	16	11	16	8
29	13	13	13	13	10	10	10	10	10	10	13	13	13	13	13	10	13	13	10	13	13	13	13	13	12	13	10
30	13	13	13	13	10	10	10	10	10	13	18	21	21	18	18	16	13	13	13	13	13	13	13	13	14	21	10
31	13	10	10	10	10	8	8	8	8	10	10	13	13	13	13	10	10	10	13	16	16	16	13	13	12	16	8

(*) = Sin Dato

TABLA N°2
ESTACION : BOMBEROS
PARAMETRO : SO2
UNIDAD : ug/m3N
PERIODO : Abril 1997

DIA	HORAS 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	PROM	MAX	MIN
1	0	0	0	0	0	0	0	0	0	0	5	3	0	0	8	0	0	0	0	0	0	0	0	0	1	8	0
2	0	0	0	0	0	0	0	0	0	0	0	0	3	3	3	8	0	0	0	0	0	0	0	0	1	8	0
3	0	0	0	0	0	0	0	0	0	0	0	0	3	34	128	107	63	31	8	0	3	3	0	0	16	128	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	10	3	3	3	3	3	0	1	10	0
5	0	0	0	0	0	0	0	0	0	3	3	0	0	0	0	0	0	99	128	10	3	3	3	0	10	128	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	26	10	3	0	3	3	0	0	2	26	0
7	0	0	0	0	0	0	0	0	0	0	0	3	3	5	5	8	10	8	3	0	3	3	3	0	2	10	0
8	0	0	0	0	0	0	0	0	0	*	*	*	*	*	*	*	*	*	10	10	13	10	10	8			
9	8	8	5	5	5	5	5	8	5	5	8	8	24	34	10	8	8	8	10	13	10	10	10	8	10	34	5
10	8	5	5	5	5	5	8	8	8	8	8	8	8	5	5	8	8	8	10	10	10	10	8	8	8	10	5
11	5	5	5	5	5	5	5	5	8	8	8	8	8	8	10	84	63	13	13	10	10	8	8	8	13	84	5
12	5	5	5	3	3	3	3	3	5	5	5	5	5	5	5	5	8	8	8	8	8	8	8	5	5	8	3
13	5	5	5	5	5	5	5	3	5	5	5	8	8	5	8	52	16	13	8	8	8	8	8	5	9	52	3
14	5	5	5	5	5	5	5	5	5	8	8	8	8	8	8	42	13	21	10	10	10	10	8	8	9	42	5
15	5	3	3	3	3	3	3	3	5	10	*	16	16	10	10	13	10	8	8	10	8	8	8	5	7	16	3
16	5	5	3	3	3	3	5	3	5	5	8	8	8	18	21	34	113	29	10	10	10	8	8	8	14	113	3
17	8	8	5	5	5	5	8	8	13	13	10	8	10	31	63	10	16	24	18	13	10	10	10	8	13	63	5
18	5	5	5	5	5	5	5	5	5	10	18	10	16	16	26	24	10	8	10	10	10	8	8	8	10	26	5
19	8	8	8	8	8	8	8	5	8	10	18	71	37	8	8	8	8	8	10	13	10	10	10	8	13	71	5
20	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	10	13	13	13	10	10	9	13	8
21	8	10	8	8	8	8	8	10	8	10	10	10	10	10	13	10	10	8	10	10	10	10	8	8	9	13	8
22	5	5	5	5	5	5	5	5	5	8	10	10	8	8	8	8	8	8	10	10	10	10	10	8	8	10	5
23	8	10	8	8	8	8	10	8	8	16	26	29	50	52	29	34	21	13	13	79	13	13	13	13	20	79	8
24	10	8	8	8	8	8	8	10	10	13	21	21	13	10	10	8	10	10	13	16	13	13	10	10	11	21	8
25	8	8	8	8	8	8	10	10	10	10	10	10	10	21	16	10	8	10	10	13	10	13	13	10	11	21	8
26	10	8	8	8	8	8	8	8	10	10	13	16	16	13	13	13	16	13	13	13	13	13	10	10	11	16	8
27	8	8	8	5	5	8	8	10	10	13	16	13	10	18	31	18	13	13	16	16	16	21	16	16	13	31	5
28	13	10	8	8	8	5	5	8	5	8	8	10	8	8	8	10	10	16	16	18	16	13	10	18	10	18	5
29	37	31	13	10	8	8	8	8	10	10	10	10	10	10	10	89	50	13	13	13	13	13	10	10	18	89	8
30	8	5	5	5	5	5	5	5	5	10	44	63	24	60	73	50	16	21	18	13	10	10	10	10	20	73	5

(*) = Sin Dato

TABLA N°2
ESTACION : BOMBEROS
PARAMETRO : SO2
UNIDAD : ug/m3N
PERIODO : Marzo 1997

DIA	HORAS 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	PROM	MAX	MIN
1	13	10	10	10	8	8	8	8	8	8	8	18	24	21	13	76	13	10	10	10	10	13	13	13	14	76	8
2	10	10	8	8	8	8	8	8	8	8	8	10	13	21	16	16	10	8	8	8	8	10	13	13	10	21	8
3	10	10	8	8	8	8	5	8	8	8	8	13	29	113	136	34	13	13	10	13	13	13	16	13	22	136	5
4	13	10	10	8	8	8	8	8	10	8	10	13	13	16	50	16	13	10	8	10	10	13	13	13	13	50	8
5	10	10	8	8	8	8	8	8	8	8	8	8	10	26	29	16	10	8	8	8	10	10	13	13	11	29	8
6	13	10	8	8	8	8	8	8	10	10	10	10	13	84	21	13	10	10	10	10	10	13	13	10	14	84	8
7	10	8	8	5	5	5	5	5	8	8	8	13	10	18	24	8	8	8	8	8	8	10	10	10	9	24	5
8	10	8	8	5	5	5	5	5	5	5	8	8	8	16	29	13	8	8	8	8	8	13	13	13	9	29	5
9	13	10	8	8	8	8	8	8	8	8	8	8	8	8	8	8	10	10	10	10	10	10	10	10	9	13	8
10	10	8	8	8	5	5	5	8	8	8	8	8	10	18	16	10	13	10	8	8	8	10	10	10	9	18	5
11	8	8	8	5	5	5	5	5	8	8	8	8	5	5	16	13	10	8	10	8	10	13	13	13	9	16	5
12	10	10	8	8	8	8	8	8	8	8	8	10	10	10	10	10	44	18	10	10	10	10	10	10	11	44	8
13	10	8	8	8	8	5	5	8	8	8	8	8	8	8	8	8	8	8	31	10	10	10	13	10	9	31	5
14	10	8	8	8	5	5	5	8	8	8	8	8	8	8	8	10	10	10	8	10	10	13	13	13	9	13	5
15	10	10	10	8	8	8	8	8	8	8	8	8	10	10	31	21	10	10	10	10	10	13	13	10	11	31	8
16	10	8	8	8	5	5	5	5	5	5	5	8	24	21	34	34	16	13	18	10	8	13	10	10	12	34	5
17	10	8	8	8	5	5	5	5	8	5	8	8	8	13	13	31	13	8	8	8	8	13	13	13	10	31	5
18	10	10	8	8	8	8	8	8	10	10	10	10	18	31	16	16	18	13	13	13	13	13	13	10	12	31	8
19	8	8	8	8	8	5	5	8	8	8	10	52	47	73	47	86	29	39	13	10	10	13	13	10	22	86	5
20	10	8	8	8	8	5	5	8	8	8	8	8	8	8	8	8	16	13	47	13	10	13	13	13	11	47	5
21	13	10	10	8	8	8	8	8	10	8	10	47	13	0	5	0	3	3	29	0	0	3	3	3	9	47	0
22	3	5	5	5	5	5	5	5	5	5	3	0	0	0	13	3	3	3	3	3	3	0	0	0	3	13	0
23	0	3	3	3	3	3	3	3	3	3	3	3	0	0	0	47	5	0	0	0	0	0	0	0	3	47	0
24	0	0	0	0	0	3	3	0	0	0	0	0	0	3	5	29	68	21	0	0	0	0	0	0	5	68	0
25	0	0	0	0	0	0	3	0	0	0	0	0	0	0	5	34	24	0	0	3	0	0	0	0	3	34	0
26	0	0	0	0	0	0	0	0	0	0	0	13	47	29	68	39	10	0	0	0	0	0	0	0	9	68	0
27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	86	44	71	181	58	3	0	0	0	0	18	181	0
28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0	3	0	0	0	0	0	0	0	3	0
29	0	0	0	0	0	0	0	0	0	0	0	0	16	29	10	3	5	0	0	0	0	0	0	0	3	29	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	3	0
31	0	0	0	0	0	0	0	0	0	0	0	0	0	3	26	5	5	0	0	0	0	0	0	0	2	26	0

(*) = Sin Dato

TABLA N°2
ESTACION : BOMBEROS
PARAMETRO : SO2
UNIDAD : ug/m3N
PERIODO : Febrero 1997

	HORAS																									
DIA	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	PROM	MAX	MIN
1	0	0	0	0	0	0	0	0	0	0	0	0	3	21	10	26	24	21	39	21	0	0	0	0	7	39	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	55	71	84	42	21	0	0	0	0	11	84	0
3	0	0	0	0	0	0	0	0	0	0	0	0	8	128	34	34	39	31	18	10	0	3	0	0	13	128	0
4	0	0	0	0	0	0	0	0	0	8	86	201	209	47	29	26	8	3	0	0	0	0	0	0	26	209	0
5	0	0	0	0	0	0	0	0	0	3	24	136	152	65	113	55	13	3	5	0	0	3	0	0	24	152	0
6	0	0	0	0	0	0	0	0	0	0	0	24	63	37	0	0	0	16	42	3	0	0	0	0	8	63	0
7	0	0	0	0	0	0	0	0	0	0	0	5	0	5	10	0	0	0	0	0	0	0	0	0	1	10	0
8	0	0	0	0	0	0	0	0	0	0	5	52	3	0	0	0	0	0	0	0	0	0	0	0	3	52	0
9	0	0	0	0	0	0	0	0	0	0	0	0	84	42	0	0	0	*	26	0	0	3	3	10	7	84	0
10	3	0	0	0	0	0	0	0	0	0	3	3	58	141	47	13	16	24	13	5	3	5	3	3	14	141	0
11	3	3	0	0	0	0	0	3	3	3	3	3	50	126	94	107	128	8	5	5	5	8	5	3	23	128	0
12	3	3	3	3	0	3	0	0	3	3	5	5	5	65	42	26	8	13	18	8	8	8	5	5	10	65	0
13	3	3	0	0	0	0	0	0	0	0	8	18	13	18	37	78	55	29	10	3	3	5	3	3	12	78	0
14	3	0	0	0	0	0	0	0	0	0	3	3	94	235	97	60	44	5	3	3	3	5	3	3	23	235	0
15	3	3	3	3	0	0	0	0	0	0	3	3	42	97	42	34	13	8	8	8	8	10	8	8	13	97	0
16	5	3	3	3	3	3	3	3	0	5	37	16	10	5	5	10	10	3	3	3	3	5	5	3	6	37	0
17	3	0	0	0	0	0	0	0	3	3	3	3	50	26	13	8	13	3	5	3	3	5	3	3	6	50	0
18	3	3	3	3	0	0	0	0	3	5	13	220	102	37	34	8	5	5	5	8	8	10	8	8	20	220	0
19	3	3	0	0	0	0	0	0	0	0	3	60	327	123	147	10	24	24	18	8	5	5	5	3	32	327	0
20	3	0	0	0	0	0	0	0	0	0	0	3	3	3	5	10	21	8	3	3	3	5	5	3	3	21	0
21	5	3	0	0	0	0	3	3	3	3	3	3	5	3	5	8	3	5	5	5	8	10	8	8	4	10	0
22	5	3	0	0	0	0	0	0	0	3	3	3	31	133	58	39	29	5	3	3	3	5	3	3	14	133	0
23	5	3	3	3	0	0	3	3	3	3	3	3	5	26	21	5	5	3	3	3	5	8	5	5	5	26	0
24	5	3	3	3	0	0	0	3	3	3	3	16	13	10	5	3	3	3	3	3	5	8	8	5	4	16	0
25	3	3	0	0	0	0	0	0	0	0	0	18	92	183	8	5	3	3	3	3	3	5	3	3	14	183	0
26	3	0	0	0	0	0	0	0	0	0	0	3	3	3	489	65	16	5	5	3	5	5	5	3	26	489	0
27	3	0	0	0	0	0	0	0	0	0	3	3	3	47	34	5	5	3	3	3	5	5	5	5	5	47	0
28	3	0	0	0	0	3	3	3	3	3	3	3	3	3	165	26	8	5	5	5	5	8	5	5	11	165	0

(*) = Sin Dato

CIMM-Ambiental

000146

TABLA N°3
ESTACION : BOMBEROS
PARAMETRO : SO2
UNIDAD : ug/m3N
PERIODO : Enero 1997

	HORAS																										
DIA	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	PROM	MAX	MIN
1	3	3	3	3	0	0	0	3	16	73	52	73	58	39	21	8	42	8	8	10	5	5	5	5	18	73	0
2	3	3	3	0	0	0	3	0	0	5	21	16	16	5	10	3	3	3	0	0	0	3	3	3	4	21	0
3	0	0	0	0	0	0	0	0	0	0	13	34	16	16	5	3	3	3	3	3	3	5	5	3	5	34	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	84	76	81	21	5	8	5	5	12	84	0
5	3	3	0	0	0	0	3	0	3	3	8	50	120	68	31	16	13	3	3	0	3	5	3	3	14	120	0
6	0	0	0	0	0	0	0	0	0	0	0	0	10	21	50	16	42	39	58	31	5	3	3	3	12	58	0
7	0	0	0	0	0	0	0	0	0	0	0	16	29	8	63	34	10	5	16	10	3	5	3	3	9	63	0
8	3	0	0	0	0	0	0	0	0	13	18	24	18	18	31	31	34	29	21	10	3	3	3	0	11	34	0
9	0	0	0	0	0	0	0	0	0	37	18	13	13	37	8	13	24	5	5	0	3	3	5	5	8	37	0
10	3	0	0	0	0	0	0	0	0	3	8	29	8	5	5	3	3	3	3	3	5	8	5	5	4	29	0
11	3	3	3	0	0	0	0	0	0	0	3	3	3	13	60	37	26	34	8	3	3	5	3	3	9	60	0
12	3	3	3	0	0	0	0	0	3	5	3	3	3	5	44	76	29	8	10	26	10	8	5	5	10	76	0
13	5	3	0	0	0	0	0	0	0	3	26	60	21	10	34	26	3	3	31	24	5	5	5	3	11	60	0
14	3	3	0	0	0	0	0	0	3	26	29	55	31	94	68	50	50	73	42	31	5	5	5	3	24	94	0
15	0	0	0	0	0	0	0	0	10	29	68	44	29	16	21	44	24	5	3	3	3	5	5	5	13	68	0
16	3	0	0	0	0	0	0	0	0	0	3	55	79	65	18	26	10	8	10	5	5	8	8	5	13	79	0
17	3	3	0	0	0	0	0	0	3	3	26	34	10	18	31	24	18	29	8	5	3	8	5	5	10	34	0
18	3	3	0	0	0	0	0	0	0	0	3	3	42	136	79	47	31	42	31	8	5	8	5	5	19	136	0
19	5	5	3	3	3	3	3	3	3	3	10	37	31	34	21	26	31	26	24	5	5	8	5	5	13	37	3
20	3	3	0	0	0	0	0	0	0	0	3	5	63	24	42	13	5	5	5	3	5	8	8	5	8	63	0
21	5	3	3	3	3	3	3	3	3	5	8	97	42	39	42	39	16	3	5	8	5	8	5	5	15	97	3
22	3	3	3	3	3	0	0	0	0	3	3	3	47	52	**	**	**	26	10	3	3	5	8	5	9	52	0
23	0	0	0	0	13	13	13	13	5	8	5	0	136	65	29	5	0	0	0	0	0	0	0	0	13	136	0
24	3	3	3	3	0	0	3	3	3	0	0	0	0	3	131	55	29	5	21	0	0	0	0	0	11	131	0
25	0	0	3	3	3	3	0	0	0	0	0	0	0	47	178	26	0	0	5	0	0	0	0	0	11	178	0
26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	128	26	58	5	18	0	0	3	0	0	10	128	0
27	0	0	0	0	0	0	0	0	0	0	0	0	0	21	31	24	55	8	31	34	3	0	0	0	9	55	0
28	0	0	0	0	0	0	0	0	0	5	89	55	94	21	0	0	0	0	0	0	0	0	0	3	11	94	0
29	0	0	0	0	0	0	0	0	0	0	26	34	37	107	34	8	0	0	0	0	0	0	0	0	10	107	0
30	0	0	0	0	0	0	0	0	0	0	65	71	47	5	21	37	16	0	0	0	0	0	0	0	11	71	0
31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	113	81	8	8	8	0	0	0	0	0	9	113	0

(**) = Calibración

MONITOREO DE DIOXIDO DE NITROGENO

MONITOREO DE CALIDAD DEL AIRE

TABLA 7.

LUGAR : CUERPO DE BOMBEROS

PERIODO : 1 AL 30 DE SEPTIEMBRE DE 1999

VARIABLE : DIOXIDO DE NITROGENO (NO_2)

UNIDAD : $\mu g/m^3N$

D/H	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	MAXIMA	MINIMA	MEDIA
1-Sep	13.1	9.4	9.4	16.9	16.9	13.1	18.8	31.9	28.2	22.5	18.8	18.8	13.1	9.4	9.4	3.8	7.5	9.4	13.1	28.2	16.9	22.5	22.5	22.5	31.9	3.8	16.5
2-Sep	13.1	13.1	9.4	13.1	16.9	13.1	18.8	18.8	5.6	13.1	9.4	9.4	13.1	13.1	7.5	7.5	3.8	7.5	3.8	7.5	3.8	3.8	7.5	9.4	18.8	3.8	10.1
3-Sep	9.4	7.5	9.4	13.1	7.5	9.4	7.5	28.2	13.1	13.1	31.9	31.9	13.1	13.1	16.9	18.8	13.1	13.1	7.5	7.5	28.2	16.9	18.8	16.9	31.9	7.5	15.2
4-Sep	13.1	7.5	9.4	5.6	0.0	0.0	7.5	31.9	7.5	7.5	5.6	7.5	1.9	7.5	3.8	7.5	5.6	7.5	1.9	13.1	22.5	18.8	7.5	13.1	31.9	0.0	8.9
5-Sep	7.5	7.5	16.9	13.1	13.1	13.1	16.9	22.5	22.5	22.5	22.5	22.5	7.5	13.1	22.5	9.4	9.4	9.4	13.1	13.1	7.5	9.4	11.3	11.3	22.5	7.5	14.1
6-Sep	3.8	9.4	9.4	13.1	13.1	18.8	18.8	28.2	18.8	13.1	45.1	18.8	13.1	33.8	184.0	28.2	18.8	13.1	9.4	3.8	9.4	3.8	5.6	3.8	184.0	3.8	22.4
7-Sep	3.8	0.0	3.8	7.5	3.8	13.1	13.1	5.6	9.4	18.8	18.8	9.4	3.8	9.4	11.3	9.4	15.0	15.0	5.6	9.4	22.5	18.8	13.1	9.4	22.5	0.0	10.4
8-Sep	9.4	7.5	3.8	3.8	3.8	9.4	18.8	22.5	18.8	18.8	13.1	9.4	3.8	3.8	9.4	9.4	#	C	C	C	C	11.3	3.8	9.4	22.5	3.8	10.0
9-Sep	13.1	16.9	9.4	3.8	3.8	9.4	28.2	9.4	7.5	5.6	3.8	56.3	15.0	9.4	5.6	22.5	9.4	5.6	13.1	16.9	22.5	22.5	18.8	5.6	56.3	3.8	13.9
10-Sep	9.4	9.4	13.1	13.1	13.1	9.4	18.8	31.9	13.1	9.4	16.9	22.5	18.8	9.4	13.1	18.8	13.1	18.8	18.8	22.5	15.0	18.8	16.9	22.5	31.9	9.4	16.1
11-Sep	16.9	16.9	18.8	13.1	11.3	13.1	13.1	22.5	16.9	9.4	9.4	13.1	9.4	22.5	28.2	9.4	5.6	9.4	13.1	13.1	5.6	9.4	13.1	5.6	28.2	5.6	13.3
12-Sep	3.8	0.0	0.0	9.4	9.4	5.6	13.1	16.9	9.4	13.1	37.6	54.5	54.5	18.8	13.1	13.1	18.8	9.4	13.1	0.0	5.6	5.6	9.4	9.4	54.5	0.0	14.3
13-Sep	7.5	9.4	16.9	9.4	9.4	5.6	3.8	13.1	26.3	22.5	9.4	5.6	9.4	7.5	9.4	3.8	9.4	3.8	13.1	35.7	26.3	18.8	22.5	22.5	35.7	3.8	13.4
14-Sep	18.8	13.1	18.8	13.1	13.1	13.1	24.4	28.2	18.8	18.8	13.1	13.1	9.4	16.9	22.5	9.4	5.6	9.4	133.3	41.3	41.3	41.3	26.3	28.2	133.3	5.6	24.6
15-Sep	13.1	18.8	13.1	5.6	9.4	13.1	28.2	35.7	28.2	16.9	13.1	13.1	16.9	18.8	9.4	3.8	9.4	22.5	35.7	22.5	13.1	9.4	3.8	3.8	35.7	3.8	15.7
16-Sep	5.6	5.6	3.8	5.6	1.9	5.6	7.5	9.4	7.5	9.4	3.8	3.8	15.0	13.1	18.8	22.5	13.1	9.4	46.9	82.6	238.5	50.7	45.1	31.9	238.5	1.9	27.4
17-Sep	9.4	9.4	3.8	5.6	9.4	3.8	9.4	9.4	9.4	9.4	9.4	13.1	9.4	22.5	22.5	9.4	13.1	9.4	9.4	9.4	13.1	18.8	13.1	9.4	22.5	3.8	10.9
18-Sep	13.1	13.1	18.8	9.4	9.4	0.0	3.8	9.4	82.6	73.2	63.8	26.3	16.9	15.0	15.0	16.9	5.6	18.8	3.8	5.6	3.8	3.8	5.6	3.8	82.6	0.0	18.2
19-Sep	5.6	9.4	3.8	3.8	5.6	3.8	5.6	9.4	7.5	9.4	5.6	9.4	9.4	9.4	3.8	3.8	9.4	3.8	5.6	3.8	3.8	7.5	3.8	3.8	9.4	3.8	6.1
20-Sep	5.6	0.0	3.8	0.0	1.9	0.0	5.6	3.8	1.9	9.4	9.4	5.6	9.4	3.8	9.4	28.2	18.8	13.1	5.6	9.4	13.1	26.3	13.1	13.1	28.2	0.0	8.8
21-Sep	9.4	3.8	5.6	3.8	7.5	3.8	9.4	9.4	3.8	9.4	13.1	9.4	9.4	7.5	5.6	3.8	3.8	9.4	24.4	13.1	5.6	9.4	5.6	9.4	24.4	3.8	8.1
22-Sep	3.8	9.4	11.3	3.8	9.4	7.5	13.1	15.0	13.1	9.4	9.4	9.4	7.5	7.5	3.8	7.5	13.1	7.5	9.4	7.5	9.4	5.6	7.5	3.8	15.0	3.8	8.5
23-Sep	5.6	9.4	9.4	9.4	11.3	9.4	7.5	22.5	28.2	22.5	13.1	13.1	13.1	13.1	5.6	7.5	5.6	9.4	5.6	3.8	18.8	13.1	18.8	22.5	28.2	3.8	12.4
24-Sep	5.6	7.5	5.6	11.3	0.0	9.4	11.3	16.9	5.6	9.4	9.4	9.4	16.9	13.1	9.4	5.6	5.6	3.8	5.6	9.4	3.8	5.6	13.1	9.4	16.9	0.0	8.4
25-Sep	9.4	5.6	3.8	5.6	3.8	5.6	9.4	9.4	7.5	3.8	7.5	22.5	13.1	9.4	5.6	9.4	9.4	5.6	13.1	22.5	18.8	11.3	13.1	13.1	22.5	3.8	9.9
26-Sep	13.1	13.1	11.3	9.4	9.4	18.8	13.1	28.2	13.1	9.4	13.1	13.1	11.3	9.4	3.8	5.6	3.8	5.6	3.8	9.4	28.2	13.1	13.1	26.3	28.2	3.8	12.4
27-Sep	18.8	9.4	5.6	3.8	5.6	5.6	18.8	33.8	16.9	13.1	31.9	22.5	13.1	5.6	7.5	5.6	3.8	13.1	13.1	22.5	37.6	22.5	18.8	9.4	37.6	3.8	14.9
28-Sep	9.4	13.1	9.4	7.5	9.4	9.4	16.9	22.5	16.9	13.1	9.4	28.2	13.1	5.6	5.6	9.4	11.3	5.6	9.4	31.9	41.3	31.9	18.8	13.1	41.3	5.6	15.1
29-Sep	9.4	13.1	9.4	3.8	5.6	5.6	13.1	9.4	28.2	7.5	7.5	9.4	9.4	33.8	18.8	9.4	5.6	7.5	3.8	9.4	7.5	9.4	15.0	5.6	33.8	3.8	10.7
30-Sep	5.6	5.6	0.0	0.0	0.0	0.0	5.6	9.4	3.8	11.3	5.6	9.4	13.1	13.1	5.6	7.5	3.8	7.5	7.5	13.1	108.9	50.7	31.9	31.9	108.9	0.0	14.6
MAXIMA	18.8	18.8	18.8	16.9	16.9	18.8	28.2	35.7	82.6	73.2	63.8	56.3	54.5	33.8	184.0	28.2	18.8	22.5	133.3	82.6	238.5	50.7	45.1	31.9			
MINIMA	3.8	0.0	0.0	0.0	0.0	0.0	3.8	3.8	1.9	3.8	3.8	3.8	1.9	3.8	3.8	3.8	3.8	3.8	1.9	0.0	3.8	3.8	3.8	3.8			
MEDIA	9.5	9.1	8.9	7.9	7.8	8.3	13.3	18.8	16.3	14.8	16.0	17.0	12.8	12.9	16.9	10.9	9.3	9.8	15.9	16.8	27.3	17.0	14.6	13.3			

Código ausencia de datos por mantención del equipo : #
Código ausencia de datos por calibración del equipo : C
Código ausencia de datos por falta de energía eléctrica temporalmente : +
N° de datos validos : 715
Recuperación de datos : 99.3 %
D : Día de Medición
H : Hora de Medición

Nota importante al reverso

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Nota Importante al reverso

MONITOREO DE CALIDAD DEL AIRE

TABLA 7.

LUGAR : CUERPO DE BOMBEROS

PERIODO : 01 DE JULIO AL 31 DE JULIO DE 1999

VARIABLE : DIOXIDO DE NITROGENO (NO_2)

UNIDAD : $\mu g/m^3N$

D/H	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	MAXIMA	MINIMA	MEDIA
1-Jul	18.8	16.9	13.1	13.1	13.1	13.1	16.9	16.9	22.5	22.5	18.8	9.4	13.1	13.1	18.8	9.4	9.4	C	C	28.2	45.1	28.2	22.5	28.2	45.1	9.4	18.7
2-Jul	13.1	18.8	13.1	7.5	13.1	7.5	22.5	31.9	33.8	28.2	18.8	31.9	26.3	9.4	9.4	3.8	5.6	13.1	24.4	41.3	9.4	13.1	105.1	41.3	105.1	3.8	22.6
3-Jul	31.9	31.9	13.1	3.8	9.4	9.4	9.4	24.4	123.9	60.1	31.9	18.8	22.5	18.8	46.9	37.6	9.4	9.4	13.1	28.2	22.5	37.6	50.7	31.9	123.9	3.8	29.0
4-Jul	28.2	9.4	18.8	9.4	9.4	9.4	9.4	22.5	22.5	18.8	22.5	18.8	18.8	24.4	13.1	15.0	15.0	18.8	48.8	50.7	28.2	45.1	50.7	41.3	50.7	9.4	23.7
5-Jul	28.2	28.2	22.5	22.5	28.2	18.8	37.6	31.9	26.3	58.2	50.7	54.5	65.7	31.9	18.8	28.2	41.3	45.1	35.7	31.9	24.4	15.0	18.8	13.1	65.7	13.1	32.4
6-Jul	13.1	18.8	13.1	9.4	9.4	3.8	9.4	9.4	9.4	9.4	18.8	18.8	13.1	9.4	9.4	22.5	28.2	28.2	18.8	22.5	37.6	31.9	31.9	18.8	37.6	3.8	17.3
7-Jul	9.4	9.4	13.1	9.4	9.4	5.6	9.4	18.8	9.4	18.8	37.6	18.8	24.4	18.8	18.8	15.0	13.1	24.4	26.3	60.1	41.3	28.2	24.4	24.4	60.1	5.6	20.3
8-Jul	15.0	5.6	5.6	9.4	9.4	9.4	22.5	13.1	31.9	46.9	31.9	18.8	28.2	18.8	16.9	9.4	13.1	9.4	3.8	13.1	37.6	16.9	13.1	13.1	46.9	3.8	17.2
9-Jul	22.5	18.8	13.1	22.5	18.8	18.8	22.5	33.8	22.5	16.9	16.9	18.8	13.1	9.4	13.1	13.1	26.3	31.9	9.4	7.5	7.5	9.4	16.9	9.4	33.8	7.5	17.2
10-Jul	7.5	7.5	7.5	7.5	13.1	22.5	26.3	18.8	22.5	16.9	13.1	26.3	41.3	37.6	13.1	13.1	225.3	28.2	13.1	28.2	41.3	28.2	16.9	13.1	225.3	7.5	28.7
11-Jul	7.5	3.8	9.4	3.8	13.1	3.8	7.5	9.4	13.1	16.9	31.9	13.1	16.9	18.8	13.1	5.6	9.4	3.8	9.4	18.8	37.6	22.5	31.9	26.3	37.6	3.8	14.5
12-Jul	22.5	16.9	13.1	7.5	13.1	13.1	22.5	41.3	41.3	31.9	28.2	50.7	16.9	7.5	7.5	9.4	7.5	7.5	13.1	31.9	41.3	31.9	28.2	31.9	50.7	7.5	22.4
13-Jul	16.9	16.9	13.1	13.1	13.1	22.5	22.5	41.3	33.8	18.8	15.0	13.1	18.8	9.4	9.4	13.1	9.4	9.4	13.1	28.2	69.5	50.7	46.9	41.3	69.5	9.4	23.3
14-Jul	28.2	28.2	28.2	22.5	13.1	26.3	31.9	45.1	18.8	31.9	50.7	31.9	15.0	9.4	9.4	9.4	9.4	9.4	26.3	41.3	45.1	56.3	50.7	35.7	56.3	9.4	28.1
15-Jul	41.3	48.8	41.3	28.2	31.9	48.8	35.7	60.1	41.3	31.9	24.4	18.8	18.8	28.2	18.8	9.4	3.8	26.3	46.9	69.5	45.1	41.3	45.1	31.9	69.5	3.8	34.9
16-Jul	28.2	28.2	26.3	41.3	63.8	54.5	45.1	41.3	37.6	31.9	18.8	13.1	31.9	31.9	28.2	35.7	18.8	58.2	50.7	50.7	58.2	46.9	50.7	54.5	63.8	13.1	39.4
17-Jul	31.9	13.1	9.4	9.4	5.6	5.6	18.8	18.8	15.0	9.4	22.5	18.8	31.9	13.1	13.1	28.2	18.8	18.8	37.6	28.2	35.7	28.2	31.9	18.8	37.6	5.6	20.1
18-Jul	15.0	9.4	15.0	9.4	9.4	9.4	9.4	15.0	9.4	35.7	92.0	18.8	41.3	22.5	3.8	3.8	3.8	5.6	13.1	22.5	28.2	28.2	18.8	28.2	92.0	3.8	19.5
19-Jul	22.5	18.8	15.0	15.0	18.8	31.9	26.3	31.9	41.3	31.9	31.9	37.6	24.4	18.8	13.1	3.8	9.4	9.4	5.6	26.3	26.3	22.5	22.5	41.3	41.3	3.8	22.8
20-Jul	39.4	18.8	15.0	15.0	28.2	35.7	31.9	35.7	31.9	35.7	28.2	28.2	24.4	31.9	35.7	18.8	28.2	18.8	37.6	45.1	37.6	31.9	45.1	45.1	45.1	15.0	31.0
21-Jul	31.9	26.3	45.1	41.3	22.5	35.7	45.1	45.1	41.3	22.5	18.8	18.8	18.8	46.9	73.2	18.8	18.8	31.9	46.9	86.4	28.2	35.7	35.7	45.1	86.4	18.8	36.7
22-Jul	24.4	18.8	18.8	9.4	22.5	18.8	28.2	+	+	+	+	+	+	+	54.5	31.9	13.1	26.3	13.1	13.1	16.9	35.7	95.8	35.7	95.8	9.4	28.1
23-Jul	37.6	37.6	13.1	13.1	13.1	16.9	28.2	50.7	26.3	28.2	37.6	16.9	18.8	13.1	13.1	50.7	28.2	37.6	41.3	54.5	31.9	31.9	35.7	35.7	54.5	13.1	29.7
24-Jul	31.9	16.9	28.2	35.7	31.9	31.9	31.9	41.3	37.6	46.9	31.9	16.9	58.2	22.5	140.8	22.5	54.5	73.2	77.0	41.3	60.1	54.5	41.3	22.5	140.8	16.9	43.8
25-Jul	22.5	22.5	22.5	16.9	18.8	7.5	13.1	28.2	13.1	13.1	28.2	18.8	13.1	56.3	45.1	18.8	22.5	28.2	37.6	54.5	73.2	48.8	31.9	16.9	73.2	7.5	28.0
26-Jul	16.9	13.1	13.1	7.5	13.1	13.1	22.5	31.9	24.4	16.9	13.1	13.1	7.5	13.1	26.3	22.5	22.5	31.9	26.3	16.9	13.1	13.1	16.9	16.9	31.9	7.5	17.7
27-Jul	22.5	13.1	22.5	22.5	26.3	26.3	31.9	46.9	31.9	26.3	22.5	22.5	22.5	28.2	37.6	22.5	22.5	45.1	31.9	13.1	13.1	13.1	9.4	3.8	46.9	3.8	24.1
28-Jul	3.8	3.8	3.8	3.8	9.4	3.8	9.4	16.9	13.1	13.1	7.5	13.1	7.5	13.1	9.4	9.4	13.1	16.9	28.2	41.3	46.9	45.1	31.9	28.2	46.9	3.8	16.4
29-Jul	13.1	13.1	9.4	13.1	9.4	9.4	13.1	24.4	18.8	28.2	22.5	22.5	22.5	22.5	7.5	9.4	3.8	41.3	48.8	45.1	37.6	229.1	56.3	35.7	229.1	3.8	31.5
30-Jul	22.5	22.5	13.1	13.1	18.8	16.9	35.7	35.7	33.8	16.9	16.9	33.8	45.1	56.3	63.8	48.8	22.5	18.8	13.1	9.4	13.1	13.1	9.4	13.1	63.8	9.4	25.3
31-Jul	3.8	3.8	3.8	9.4	9.4	3.8	7.5	16.9	31.9	7.5	13.1	13.1	16.9	22.5	7.5	13.1	138.9	63.8	35.7	22.5	13.1	16.9	16.9	18.8	138.9	3.8	21.3
MAXIMA	41.3	48.8	45.1	41.3	63.8	54.5	45.1	60.1	123.9	60.1	92.0	54.5	65.7	56.3	140.8	50.7	225.3	73.2	77.0	86.4	73.2	229.1	105.1	54.5			
MINIMA	3.8	3.8	3.8	3.8	5.6	3.8	7.5	9.4	9.4	7.5	7.5	9.4	7.5	7.5	3.8	3.8	3.8	3.8	3.8	7.5	7.5	9.4	9.4	3.8			
MEDIA	21.7	18.1	16.5	15.0	17.4	17.9	22.7	30.0	29.3	26.4	27.2	22.3	24.6	22.6	26.1	18.5	27.9	26.4	28.2	34.6	34.4	37.1	35.6	27.8			

Código ausencia de datos por mantención del equipo : #
Código ausencia de datos por calibración del equipo : C
Código ausencia de datos por falta de energía eléctrica temporalmente : +
N° de datos validos : 735
Recuperación de datos : 98.8 %
D : Día de Medición
H : Hora de Medición

AV. MARATHON 2595, COD. POSTAL 6900502 - MACUL - FONO 56-2-3502100 - FAX 56-2-2384135 - E-mail:cesmec@reuna.cl

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MONITOREO DE CALIDAD DEL AIRE

TABLA 7.

LUGAR : CUERPO DE BOMBEROS

VARIABLE : DIOXIDO DE NITROGENO (NO_2)

PERIODO : 1 AL 30 DE JUNIO DE 1999

UNIDAD : µg/m³N

D/H	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	MAXIMA	MINIMA	MEDIA
1-jun	15.0	9.4	9.4	9.4	9.4	5.6	5.6	9.4	9.4	9.4	16.9	9.4	3.8	9.4	C	C	C	C	C	9.4	18.8	22.5	13.1	9.4	22.5	3.8	10.8
2-jun	3.8	5.6	3.8	5.6	5.6	5.6	3.8	15.0	18.8	9.4	9.4	13.1	13.1	9.4	9.4	3.8	5.6	9.4	5.6	13.1	31.9	26.3	9.4	9.4	31.9	3.8	10.2
3-jun	13.1	15.0	3.8	9.4	15.0	5.6	18.8	15.0	15.0	15.0	15.0	5.6	9.4	15.0	22.5	18.8	22.5	16.9	13.1	22.5	13.1	22.5	28.2	18.8	28.2	3.8	15.4
4-jun	13.1	9.4	18.8	18.8	35.7	22.5	9.4	9.4	9.4	15.0	9.4	9.4	9.4	9.4	18.8	15.0	16.9	18.8	35.7	39.4	31.9	9.4	3.8	3.8	39.4	3.8	16.4
5-jun	5.6	3.8	5.6	9.4	3.8	0.0	9.4	31.9	16.9	22.5	31.9	31.9	9.4	9.4	13.1	15.0	9.4	9.4	9.4	15.0	31.9	28.2	13.1	18.8	31.9	0.0	14.8
6-jun	9.4	9.4	9.4	9.4	9.4	3.8	5.6	22.5	16.9	15.0	13.1	13.1	28.2	9.4	7.5	3.8	3.8	3.8	3.8	3.8	31.9	16.9	5.6	9.4	31.9	3.8	11.0
7-jun	3.8	0.0	9.4	5.6	9.4	15.0	18.8	16.9	22.5	18.8	18.8	24.4	22.5	26.3	18.8	18.8	18.8	5.6	9.4	3.8	16.9	22.5	13.1	9.4	26.3	0.0	14.6
8-jun	9.4	0.0	3.8	3.8	3.8	15.0	24.4	18.8	9.4	18.8	9.4	9.4	9.4	9.4	9.4	9.4	9.4	5.6	5.6	9.4	16.9	22.5	18.8	18.8	24.4	0.0	11.3
9-jun	9.4	9.4	15.0	9.4	9.4	3.8	37.6	41.3	28.2	16.9	22.5	26.3	16.9	9.4	9.4	5.6	9.4	18.8	50.7	41.3	56.3	37.6	31.9	35.7	56.3	3.8	23.0
10-jun	41.3	60.1	54.5	45.1	13.1	13.1	31.9	24.4	+	+	16.9	22.5	35.7	35.7	60.1	45.1	45.1	69.5	26.3	26.3	26.3	22.5	13.1	9.4	69.5	9.4	33.5
11-jun	9.4	9.4	3.8	7.5	13.1	9.4	22.5	41.3	22.5	22.5	31.9	22.5	50.7	279.8	63.8	41.3	41.3	37.6	18.8	9.4	37.6	37.6	31.9	13.1	279.8	3.8	36.6
12-jun	13.1	18.8	16.9	22.5	31.9	28.2	22.5	31.9	48.8	41.3	18.8	9.4	9.4	24.4	45.1	24.4	18.8	73.2	63.8	37.6	28.2	18.8	15.0	31.9	73.2	9.4	28.9
13-jun	16.9	18.8	13.1	13.1	16.9	13.1	22.5	31.9	22.5	26.3	108.9	28.2	16.9	41.3	13.1	18.8	18.8	31.9	58.2	50.7	35.7	41.3	22.5	13.1	108.9	13.1	28.9
14-jun	9.4	16.9	3.8	9.4	15.0	18.8	28.2	31.9	28.2	26.3	13.1	15.0	28.2	22.5	18.8	24.4	22.5	26.3	13.1	46.9	54.5	26.3	41.3	37.6	54.5	3.8	24.1
15-jun	35.7	37.6	35.7	31.9	22.5	22.5	28.2	37.6	31.9	28.2	15.0	15.0	13.1	35.7	31.9	18.8	13.1	22.5	35.7	15.0	13.1	22.5	22.5	18.8	37.6	13.1	25.2
16-jun	5.6	3.8	7.5	3.8	13.1	18.8	22.5	22.5	28.2	37.6	37.6	18.8	15.0	18.8	41.3	24.4	28.2	31.9	50.7	41.3	41.3	41.3	37.6	13.1	50.7	3.8	25.2
17-jun	13.1	16.9	16.9	13.1	9.4	9.4	15.0	13.1	13.1	26.3	18.8	28.2	26.3	35.7	28.2	24.4	24.4	24.4	37.6	28.2	35.7	28.2	22.5	13.1	37.6	9.4	21.8
18-jun	18.8	18.8	15.0	15.0	9.4	16.9	18.8	22.5	26.3	28.2	28.2	28.2	18.8	31.9	13.1	9.4	9.4	13.1	24.4	45.1	13.1	37.6	31.9	35.7	45.1	9.4	22.1
19-jun	31.9	28.2	37.6	26.3	28.2	28.2	26.3	31.9	26.3	31.9	45.1	56.3	54.5	28.2	28.2	24.4	9.4	31.9	37.6	41.3	50.7	41.3	37.6	35.7	56.3	9.4	34.1
20-jun	31.9	45.1	41.3	35.7	31.9	35.7	41.3	37.6	46.9	50.7	133.3	200.9	16.9	48.8	22.5	18.8	9.4	9.4	3.8	13.1	33.8	45.1	16.9	18.8	200.9	3.8	41.2
21-jun	9.4	22.5	9.4	9.4	15.0	26.3	13.1	28.2	31.9	26.3	22.5	13.1	9.4	9.4	9.4	15.0	13.1	9.4	3.8	3.8	24.4	24.4	13.1	13.1	31.9	3.8	15.6
22-jun	9.4	9.4	13.1	9.4	9.4	9.4	9.4	35.7	13.1	16.9	7.5	13.1	7.5	31.9	54.5	37.6	22.5	31.9	45.1	13.1	13.1	60.1	22.5	18.8	60.1	7.5	21.4
23-jun	22.5	13.1	13.1	13.1	22.5	16.9	16.9	31.9	22.5	18.8	13.1	9.4	9.4	13.1	15.0	24.4	22.5	31.9	24.4	28.2	33.8	26.3	22.5	22.5	33.8	9.4	20.3
24-jun	18.8	16.9	16.9	13.1	9.4	9.4	16.9	18.8	22.5	31.9	33.8	28.2	13.1	13.1	18.8	13.1	31.9	54.5	37.6	22.5	31.9	37.6	31.9	35.7	54.5	9.4	24.1
25-jun	31.9	37.6	35.7	41.3	31.9	37.6	45.1	41.3	41.3	46.9	13.1	7.5	7.5	13.1	9.4	13.1	15.0	31.9	54.5	58.2	48.8	46.9	31.9	45.1	58.2	7.5	32.8
26-jun	28.2	22.5	13.1	3.8	7.5	9.4	9.4	18.8	13.1	18.8	18.8	170.9	60.1	18.8	9.4	9.4	13.1	26.3	50.7	33.8	31.9	37.6	18.8	15.0	170.9	3.8	27.5
27-jun	9.4	7.5	7.5	5.6	7.5	3.8	5.6	9.4	7.5	7.5	28.2	13.1	13.1	35.7	18.8	9.4	13.1	7.5	13.1	28.2	16.9	22.5	13.1	9.4	35.7	3.8	13.1
28-jun	9.4	9.4	15.0	9.4	3.8	3.8	5.6	18.8	24.4	9.4	22.5	18.8	18.8	15.0	13.1	3.8	9.4	16.9	18.8	28.2	31.9	31.9	31.9	28.2	31.9	3.8	16.6
29-jun	18.8	13.1	15.0	15.0	18.8	13.1	13.1	22.5	22.5	22.5	41.3	26.3	31.9	63.8	15.0	9.4	9.4	3.8	9.4	9.4	16.9	45.1	26.3	13.1	63.8	3.8	20.6
30-jun	9.4	9.4	9.4	22.5	28.2	22.5	28.2	35.7	22.5	28.2	18.8	16.9	41.3	26.3	15.0	15.0	9.4	9.4	18.8	24.4	22.5	22.5	28.2	28.2	41.3	9.4	21.4
MAXIMA	41.3	60.1	54.5	45.1	35.7	37.6	45.1	41.3	48.8	50.7	133.3	200.9	60.1	279.8	63.8	45.1	45.1	73.2	63.8	58.2	56.3	60.1	41.3	45.1			
MINIMA	3.8	0.0	3.8	3.8	3.8	0.0	3.8	9.4	7.5	7.5	7.5	5.6	3.8	9.4	7.5	3.8	3.8	3.8	3.8	3.8	13.1	9.4	3.8	3.8			
MEDIA	15.9	16.6	15.8	14.9	15.3	14.8	19.2	25.6	22.8	23.7	27.8	30.2	20.7	31.7	22.5	17.7	17.1	23.6	26.9	25.4	29.7	30.9	22.3	20.1			

Código ausencia de datos por mantención del equipo : #
Código ausencia de datos por calibración del equipo : C
Código ausencia de datos por falta de energía eléctrica temporalmente : +
N° de datos validos : 712
Recuperación de datos : 98.9 %
D : Día de Medición
H : Hora de Medición

Nota Importante al reverso

AV. MARATHON 2595 COD POSTAL 6900502 - MACUL - FONO 56-2-3502100 - FAX 56-2 2384135 E-mail: cesmec@reuna.cl

MONITOREO DE CALIDAD DEL AIRE

TABLA 7.

LUGAR : CUERPO DE BOMBEROS

VARIABLE : DIOXIDO DE NITROGENO (NO_2)

PERIODO : 1 AL 31 DE MAYO DE 1999

UNIDAD : $\mu g/m^3N$

D/H	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	MAXIMA	MINIMA	MEDIA
1-may	18.8	9.4	13.1	15.0	41.3	22.5	13.1	22.5	20.7	18.8	3.8	5.6	5.6	22.5	22.5	15.0	9.4	22.5	15.0	9.4	9.4	9.4	22.5	18.8	41.3	3.8	16.1
2-may	9.4	5.6	9.4	1.9	3.8	1.9	3.8	5.6	5.6	5.6	15.0	9.4	13.1	22.5	16.9	5.6	5.6	9.4	3.8	5.6	3.8	1.9	9.4	22.5	22.5	1.9	8.2
3-may	13.1	13.1	9.4	3.8	9.4	9.4	9.4	28.2	9.4	+	+	31.9	22.5	13.1	9.4	5.6	9.4	5.6	16.9	22.5	31.9	28.2	16.9	9.4	31.9	3.8	14.9
4-may	16.9	18.8	13.1	22.5	16.9	26.3	31.9	46.9	22.5	9.4	9.4	0.0	15.0	18.8	13.1	13.1	5.6	5.6	18.8	22.5	22.5	37.6	16.9	15.0	46.9	0.0	18.3
5-may	15.0	9.4	9.4	13.1	11.3	18.8	16.9	15.0	31.9	15.0	15.0	18.8	9.4	13.1	5.6	+	+	0.0	1.9	5.6	7.5	15.0	9.4	9.4	31.9	0.0	12.1
6-may	5.6	11.3	5.6	13.1	5.6	1.9	5.6	9.4	3.8	9.4	18.8	18.8	9.4	9.4	5.6	3.8	5.6	13.1	9.4	18.8	28.2	22.5	16.9	9.4	28.2	1.9	10.9
7-may	5.6	9.4	1.9	3.8	5.6	9.4	9.4	31.9	3.8	9.4	9.4	3.8	5.6	9.4	9.4	9.4	9.4	+	+	5.6	9.4	3.8	5.6	9.4	31.9	1.9	8.2
8-may	3.8	9.4	1.9	9.4	18.8	9.4	22.5	28.2	15.0	13.1	15.0	9.4	3.8	9.4	3.8	9.4	3.8	18.8	13.1	18.8	31.9	22.5	24.4	26.3	31.9	1.9	14.2
9-may	15.0	9.4	5.6	5.6	9.4	3.8	13.1	13.1	13.1	13.1	9.4	3.8	15.0	9.4	9.4	9.4	3.8	13.1	18.8	26.3	28.2	26.3	22.5	18.8	28.2	3.8	13.1
10-may	22.5	15.0	18.8	18.8	22.5	18.8	31.9	28.2	+	+	+	22.5	9.4	5.6	18.8	26.3	35.7	5.6	5.6	3.8	9.4	5.6	9.4	9.4	35.7	3.8	16.4
11-may	18.8	3.8	3.8	9.4	9.4	13.1	22.5	15.0	18.8	9.4	13.1	5.6	5.6	7.5	5.6	3.8	5.6	11.3	15.0	3.8	15.0	3.8	15.0	9.4	22.5	3.8	10.2
12-may	3.8	22.5	9.4	5.6	11.3	9.4	18.8	33.8	C	C	C	C	C	18.8	73.2	+	+	28.2	200.9	22.5	9.4	13.1	5.6	13.1	200.9	3.8	29.4
13-may	9.4	15.0	0.0	0.0	0.0	5.6	13.1	24.4	9.4	9.4	9.4	9.4	22.5	9.4	7.5	9.4	5.6	3.8	5.6	9.4	9.4	22.5	13.1	11.3	24.4	0.0	9.8
14-may	9.4	13.1	7.5	5.6	1.9	11.3	9.4	7.5	7.5	5.6	7.5	1.9	7.5	9.4	7.5	3.8	7.5	7.5	15.0	11.3	7.5	7.5	9.4	11.3	15.0	1.9	8.1
15-may	3.8	13.1	1.9	7.5	3.8	7.5	5.6	9.4	13.1	9.4	15.0	9.4	13.1	9.4	1.9	9.4	1.9	15.0	3.8	9.4	15.0	9.4	3.8	7.5	15.0	1.9	8.3
16-may	7.5	5.6	7.5	9.4	1.9	9.4	1.9	9.4	11.3	9.4	9.4	9.4	9.4	9.4	9.4	0.0	9.4	9.4	9.4	9.4	1.9	9.4	9.4	7.5	11.3	0.0	7.8
17-may	9.4	1.9	9.4	3.8	9.4	7.5	9.4	5.6	9.4	13.1	9.4	9.4	9.4	9.4	9.4	9.4	9.4	13.1	9.4	5.6	9.4	13.1	22.5	15.0	22.5	1.9	9.7
18-may	13.1	11.3	16.9	5.6	15.0	5.6	11.3	13.1	18.8	3.8	18.8	31.9	28.2	22.5	15.0	11.3	9.4	15.0	9.4	7.5	5.6	13.1	7.5	9.4	31.9	3.8	13.3
19-may	7.5	9.4	13.1	3.8	13.1	9.4	18.8	35.7	9.4	9.4	9.4	9.4	7.5	18.8	18.8	7.5	3.8	5.6	7.5	3.8	3.8	3.8	5.6	3.8	35.7	3.8	9.9
20-may	3.8	9.4	5.6	7.5	5.6	9.4	9.4	31.9	15.0	22.5	26.3	28.2	28.2	18.8	5.6	15.0	7.5	15.0	41.3	41.3	28.2	28.2	22.5	33.8	41.3	3.8	19.2
21-may	31.9	26.3	22.5	31.9	31.9	26.3	22.5	22.5	28.2	22.5	46.9	50.7	46.9	22.5	50.7	28.2	33.8	41.3	41.3	45.1	82.6	46.9	31.9	31.9	82.6	22.5	36.1
22-may	28.2	22.5	22.5	22.5	22.5	22.5	18.8	22.5	22.5	37.6	18.8	9.4	7.5	9.4	9.4	3.8	7.5	22.5	54.5	28.2	41.3	45.1	24.4	9.4	54.5	3.8	22.2
23-may	18.8	31.9	18.8	9.4	9.4	9.4	18.8	31.9	15.0	15.0	18.8	18.8	18.8	18.8	22.5	9.4	9.4	9.4	9.4	0.0	3.8	15.0	9.4	13.1	31.9	0.0	14.8
24-may	5.6	3.8	5.6	1.9	15.0	13.1	9.4	-	9.4	18.8	9.4	9.4	9.4	9.4	9.4	15.0	3.8	5.6	13.1	9.4	13.1	13.1	13.1	18.8	18.8	1.9	10.2
25-may	5.6	5.6	5.6	9.4	5.6	13.1	18.8	18.8	16.9	9.4	9.4	5.6	9.4	9.4	18.8	18.8	9.4	15.0	9.4	3.8	13.1	13.1	18.8	5.6	18.8	3.8	11.2
26-may	3.8	5.6	9.4	9.4	9.4	5.6	9.4	28.2	18.8	18.8	15.0	16.9	26.3	13.1	9.4	5.6	9.4	3.8	26.3	31.9	22.5	18.8	18.8	15.0	31.9	3.8	14.6
27-may	22.5	18.8	18.8	15.0	18.8	18.8	18.8	22.5	18.8	24.4	41.3	16.9	9.4	5.6	9.4	9.4	13.1	9.4	5.6	0.0	3.8	13.1	3.8	3.8	41.3	0.0	14.2
28-may	3.8	0.0	5.6	9.4	3.8	13.1	13.1	9.4	13.1	18.8	16.9	9.4	15.0	9.4	9.4	5.6	5.6	22.5	9.4	16.9	18.8	26.3	18.8	22.5	26.3	0.0	12.4
29-may	37.6	15.0	22.5	37.6	22.5	26.3	31.9	41.3	22.5	13.1	13.1	31.9	28.2	13.1	16.9	16.9	28.2	35.7	31.9	37.6	26.3	31.9	22.5	9.4	41.3	9.4	25.6
30-may	11.3	22.5	18.8	13.1	9.4	3.8	9.4	13.1	9.4	5.6	9.4	22.5	9.4	9.4	9.4	9.4	7.5	11.3	7.5	7.5	13.1	11.3	22.5	31.9	31.9	3.8	12.4
31-may	13.1	9.4	0.0	3.8	7.5	3.8	5.6	9.4	9.4	15.0	13.1	9.4	9.4	9.4	9.4	3.8	11.3	16.9	18.8	22.5	41.3	16.9	15.0	13.1	41.3	0.0	12.0
MAXIMA	37.6	31.9	22.5	37.6	41.3	26.3	31.9	46.9	31.9	37.6	46.9	50.7	46.9	22.5	73.2	28.2	35.7	41.3	200.9	45.1	82.6	46.9	31.9	33.8			
MINIMA	3.8	0.0	0.0	0.0	0.0	1.9	1.9	5.6	3.8	3.8	3.8	0.0	3.8	5.6	1.9	0.0	1.9	0.0	1.9	0.0	1.9	1.9	3.8	3.8			
MEDIA	12.7	12.2	10.1	10.6	12.0	11.8	14.7	21.1	14.6	13.7	15.2	14.7	14.3	12.8	14.3	10.1	9.9	13.7	21.6	15.0	18.3	17.7	15.1	14.4			

Código ausencia de datos por calibración del equipo : C
Código ausencia de datos por falta de energía eléctrica temporalmente : +
N° de datos validos : 728
Recuperación de datos : 97.8 %
D : Día de Medición
H : Hora de Medición

Nota Importante al reverso

AV. MARATHON 2595, COD. POSTAL 6900502 - MACUL - FONO 56-2-3502100 - FAX 56-2-2384135 - E-mail:cesmec@reuna.cl

MONITOREO DE CALIDAD DEL AIRE

TABLA 7.

LUGAR : CUERPO DE BOMBEROS

PERIODO : 1 AL 30 DE ABRIL DE 1999

VARIABLE : DIOXIDO DE NITROGENO (NO_2)

UNIDAD : $\mu g/m^3N$

D/H	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	MAXIMA	MINIMA	MEDIA
1-abr	7.5	3.8	2.8	4.7	6.6	0.0	0.0	1.9	27.2	26.3	18.8	4.7	4.7	0.9	12.2	27.2	28.2	26.3	10.3	33.8	56.3	13.2	3.8	2.8	56.3	0.0	13.5
2-abr	1.9	2.8	11.3	14.1	0.0	1.0	13.1	1.9	7.5	15.0	24.4	4.7	5.7	9.4	9.4	4.7	8.5	+	+	+	+	7.5	10.3	2.8	24.4	0.0	7.8
3-abr	1.0	0.0	1.9	2.8	2.8	8.5	1.9	2.9	1.0	6.6	6.6	0.9	0.0	1.9	2.8	1.0	1.0	0.0	0.0	4.7	1.9	5.7	1.9	4.7	8.5	0.0	2.6
4-abr	5.6	1.9	1.0	1.9	2.8	4.7	3.7	4.7	2.8	2.9	0.0	3.8	0.0	1.9	3.8	5.7	6.6	6.6	5.7	11.3	0.0	2.8	2.8	0.0	11.3	0.0	3.4
5-abr	4.7	0.9	0.9	3.8	1.9	3.8	6.6	1.9	0.0	+	+	+	0.9	8.5	1.9	2.8	1.9	0.0	0.0	4.7	1.9	2.9	4.7	4.7	8.5	0.0	2.8
6-abr	10.4	16.9	8.5	1.9	1.0	1.9	4.7	6.6	7.5	6.2	5.7	0.0	6.6	3.8	1.9	1.0	C	C	C	C	5.6	5.7	2.9	0.0	16.9	0.0	4.9
7-abr	2.8	0.0	4.7	1.9	2.8	3.8	1.0	2.8	0.9	1.9	8.4	6.6	12.2	8.5	13.1	+	+	+	2.8	4.7	0.0	1.9	8.5	3.8	13.1	0.0	4.4
8-abr	2.8	0.9	0.0	3.8	4.7	16.0	25.4	24.4	18.8	12.2	6.6	7.5	13.1	4.7	2.9	1.9	3.8	2.9	1.9	1.9	13.1	10.3	10.4	6.6	25.4	0.0	8.2
9-abr	2.8	1.9	2.8	5.6	16.0	6.6	1.9	6.6	4.7	2.9	3.7	3.8	6.6	1.9	0.9	3.8	2.8	+	+	+	+	9.4	10.4	12.2	16.0	0.9	5.3
10-abr	1.9	1.0	3.7	0.9	3.7	2.9	0.9	15.0	0.9	22.5	6.6	12.2	0.0	6.6	6.6	3.8	2.9	2.9	10.3	4.7	6.6	2.8	9.4	3.8	22.5	0.0	5.5
11-abr	1.9	0.0	0.9	9.4	18.8	9.4	1.9	0.9	4.7	4.7	7.5	0.0	2.9	8.5	9.4	4.7	0.0	0.9	0.9	2.8	7.5	7.5	9.4	9.4	18.8	0.0	5.2
12-abr	7.5	1.0	2.8	6.6	5.6	4.7	2.8	0.9	5.6	+	+	+	4.7	5.7	0.9	1.9	0.9	2.8	0.0	7.5	6.6	2.8	8.5	7.5	8.5	0.0	4.1
13-abr	4.7	6.6	2.8	6.6	1.9	1.9	1.9	3.8	3.7	0.9	0.0	4.7	6.6	5.6	6.6	3.8	7.5	2.8	0.9	2.8	1.9	0.0	5.7	4.7	7.5	0.0	3.7
14-abr	0.0	5.6	1.0	2.8	1.9	2.8	7.5	5.6	2.8	4.7	1.9	1.9	6.6	4.7	7.5	+	+	+	0.9	9.4	0.9	6.6	4.7	11.3	11.3	0.0	4.3
15-abr	7.5	1.9	4.7	2.8	8.4	1.9	9.4	1.0	0.0	3.8	4.7	1.0	4.7	12.2	17.8	7.5	7.5	4.7	1.9	7.5	8.5	14.1	16.9	13.2	17.8	0.0	6.8
16-abr	14.1	6.6	2.8	2.9	1.9	3.8	8.5	4.7	1.9	5.6	7.5	4.7	4.7	4.7	0.9	0.9	16.9	+	+	+	+	0.9	0.0	0.9	16.9	0.0	4.7
17-abr	0.0	7.5	0.0	1.0	4.7	7.5	2.8	4.7	13.2	1.9	1.0	0.0	4.7	0.0	0.0	0.9	1.9	12.2	5.7	6.6	2.8	1.0	0.0	4.7	13.2	0.0	3.5
18-abr	6.6	3.8	5.6	0.0	0.9	0.0	6.6	3.8	8.5	9.4	4.7	3.8	2.8	5.6	1.9	4.7	1.9	1.9	2.8	0.9	3.8	1.0	0.9	0.0	9.4	0.0	3.4
19-abr	0.9	1.9	1.0	0.0	3.7	1.9	1.9	1.9	6.6	+	+	+	9.4	1.9	5.7	3.8	2.9	3.8	3.8	3.8	4.7	4.7	7.5	7.5	9.4	0.0	3.8
20-abr	9.4	6.6	2.8	2.8	5.7	3.8	0.0	3.8	2.8	3.8	3.8	3.8	2.8	6.6	4.7	3.8	1.9	3.8	13.1	1.9	0.0	5.7	4.7	3.7	13.1	0.0	4.2
21-abr	1.9	3.8	2.8	3.8	11.3	13.1	12.2	10.3	4.7	1.0	2.9	4.7	0.0	0.9	0.9	+	+	+	5.6	16.0	16.0	17.8	18.8	6.6	18.8	0.0	7.4
22-abr	7.5	4.7	3.7	4.7	2.8	0.0	8.5	16.9	5.7	2.8	7.5	9.4	6.6	10.3	0.0	3.8	4.7	2.8	3.8	10.4	13.2	13.1	4.7	0.9	16.9	0.0	6.2
23-abr	2.9	1.9	2.9	1.9	3.8	4.7	1.9	11.3	3.7	1.9	6.6	6.6	2.8	4.7	0.9	2.8	8.4	+	+	+	+	3.8	1.9	1.9	11.3	0.9	3.8
24-abr	2.9	1.0	4.7	0.9	3.8	0.9	8.5	11.3	4.7	1.9	6.6	8.5	12.2	1.9	3.8	6.6	9.4	2.8	5.7	4.7	0.0	0.0	0.9	6.6	12.2	0.0	4.6
25-abr	4.7	6.6	2.8	6.6	6.6	2.8	2.8	27.3	4.7	9.4	3.8	2.9	0.9	1.9	2.9	9.4	3.8	0.9	1.9	1.9	0.9	5.7	1.9	3.8	27.3	0.9	4.9
26-abr	5.7	13.1	4.7	4.7	0.9	6.6	5.6	9.4	3.8	+	+	+	3.8	9.4	10.4	15.0	13.1	3.8	1.9	10.3	4.7	13.1	8.5	8.4	15.0	0.9	7.5
27-abr	4.7	0.0	4.7	13.2	16.9	9.4	15.1	21.6	0.0	2.8	3.8	0.9	8.5	6.6	8.5	1.9	7.5	6.6	3.8	0.9	4.7	4.7	4.7	4.7	21.6	0.0	6.5
28-abr	15.1	0.0	3.8	0.0	4.7	1.9	1.9	12.2	13.2	3.8	0.0	11.3	1.0	2.8	1.0	+	+	+	5.6	2.9	0.0	1.9	0.9	5.6	15.1	0.0	4.2
29-abr	9.4	9.4	16.9	4.7	3.8	16.0	15.0	17.9	22.5	35.7	25.4	9.4	14.1	8.5	8.5	11.3	14.1	16.9	10.3	38.5	70.4	20.7	19.8	9.4	70.4	3.8	17.8
30-abr	2.8	2.9	4.7	4.7	2.9	1.9	0.0	1.9	1.9	4.7	4.7	7.5	4.7	2.9	2.9	0.0	6.6	+	+	+	+	5.7	4.7	4.7	7.5	0.0	3.6
MAXIMA	15.1	16.9	16.9	14.1	18.8	16.0	25.4	27.3	27.2	35.7	25.4	12.2	14.1	12.2	17.8	27.2	28.2	26.3	13.1	38.5	70.4	20.7	19.8	13.2			
MINIMA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0			
MEDIA	5.0	3.8	3.8	4.0	5.1	4.8	5.8	8.0	6.2	7.5	6.6	4.8	5.1	5.1	5.0	5.2	6.6	5.3	4.1	8.1	9.3	6.4	6.3	5.2			

Código ausencia de datos por instalación y/o retiro de equipo : *
Código ausencia de datos por calibración del equipo : C
Código ausencia de datos por falta de energía eléctrica temporalmente : +
N° de datos validos : 673
Recuperación de datos : 78.0 %
D : Día de Medición
H : Hora de Medición

Nota Importante al reverso

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MONITOREO DE CALIDAD DEL AIRE

TABLA 7.

LUGAR : CUERPO DE BOMBEROS

PERIODO : 1 AL 31 DE MARZO DE 1999

VARIABLE : DIOXIDO DE NITROGENO (NO_2)

UNIDAD : $\mu g/m^3N$

D/H	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	MAXIMA	MINIMA	MEDIA
1-mar	+	+	+	+	+	+	+	+	+	29.1	16.9	0.0	0.0	+	+	+	+	+	+	+	+	+	+	+	29.1	0.0	11.5
2-mar	+	+	+	+	+	+	+	+	7.5	7.5	27.3	1.9	18.8	18.8	18.8	9.4	3.8	4.7	1.9	1.8	1.9	5.7	2.9	3.8	27.3	1.8	8.5
3-mar	3.8	4.7	3.8	7.5	4.7	0.9	9.4	9.4	#	#	#	C	C	C	4.7	3.8	0.9	4.7	4.7	4.7	4.7	3.8	4.7	1.9	9.4	0.9	4.6
4-mar	1.9	4.7	0.9	2.9	1.9	9.4	2.9	9.4	1.9	9.4	7.5	7.5	6.6	2.9	0.9	1.0	1.9	1.9	3.8	1.9	4.7	1.9	7.5	4.7	9.4	0.9	4.2
5-mar	4.7	3.8	1.9	3.8	2.9	6.6	1.9	2.9	2.9	4.7	2.9	7.5	7.5	9.4	9.4	1.9	2.9	1.9	1.9	1.9	2.9	1.0	0.0	9.4	9.4	0.0	4.0
6-mar	1.0	7.5	1.0	0.0	0.9	3.8	1.9	25.3	1.0	6.6	5.7	2.9	1.9	5.7	4.7	+	+	2.8	6.6	3.8	5.7	1.0	1.0	2.9	25.3	0.0	4.2
7-mar	1.9	9.4	9.4	9.4	7.5	1.0	3.8	4.7	5.7	4.7	2.9	2.9	1.0	0.0	1.9	1.0	1.9	0.9	4.7	1.9	2.9	4.7	4.7	3.8	9.4	0.0	3.9
8-mar	3.8	5.7	4.7	3.8	2.9	4.7	7.5	8.5	9.4	4.7	4.7	2.8	2.9	6.6	9.4	4.7	5.7	+	+	15.9	1.9	0.9	1.0	+	15.9	0.9	5.3
9-mar	1.9	3.8	1.9	0.9	0.0	0.0	2.9	4.7	9.4	9.4	2.9	7.5	7.5	7.5	5.7	5.7	4.7	0.0	1.0	0.0	0.9	1.9	3.8	6.6	9.4	0.0	3.8
10-mar	2.9	8.5	2.9	5.7	+	+	6.6	10.9	18.3	20.7	5.6	2.8	4.7	3.8	3.8	4.7	2.9	3.8	0.0	0.0	7.5	0.9	0.9	2.9	20.7	0.0	5.5
11-mar	3.8	6.6	3.8	3.8	1.9	0.9	0.9	2.8	2.9	1.0	2.9	0.0	4.7	3.8	7.5	0.9	6.6	0.0	0.0	5.6	0.9	2.8	0.9	0.9	7.5	0.0	2.7
12-mar	3.8	0.9	2.8	9.4	15.0	6.6	2.8	2.8	3.7	6.6	0.9	0.9	4.7	1.0	2.8	0.0	2.9	0.0	1.9	1.0	0.0	3.8	0.0	1.0	15.0	0.0	3.1
13-mar	0.0	0.0	2.8	4.7	1.9	0.0	9.4	0.9	9.4	3.7	4.7	7.5	8.4	1.9	0.9	5.7	2.8	0.9	0.0	0.0	2.8	11.3	10.4	7.5	11.3	0.0	4.1
14-mar	0.9	0.9	5.7	1.9	1.0	1.9	2.8	1.9	5.6	9.4	1.9	4.7	3.8	1.9	1.9	0.0	1.9	0.0	3.8	1.9	0.9	0.0	6.6	1.9	9.4	0.0	2.6
15-mar	1.9	4.7	0.9	2.8	13.1	4.7	9.4	2.8	0.0	6.6	9.4	5.6	9.4	7.5	4.7	5.7	5.7	1.9	0.0	3.8	6.6	2.8	2.8	3.8	13.1	0.0	4.8
16-mar	2.8	3.8	1.0	4.7	3.8	0.9	3.8	1.0	0.0	5.6	1.9	7.5	4.7	6.6	5.6	7.5	3.8	3.7	9.4	0.9	2.8	6.6	2.8	2.8	9.4	0.0	3.9
17-mar	2.8	6.6	0.9	0.9	3.8	4.7	3.8	9.4	9.4	5.7	4.7	1.9	7.5	2.8	1.9	2.8	4.7	1.0	1.9	1.9	6.6	5.7	4.7	4.7	9.4	0.9	4.2
18-mar	2.8	2.8	5.6	0.0	2.9	0.0	4.7	7.5	10.3	7.5	2.9	3.8	2.8	0.0	1.9	4.7	1.9	2.8	2.8	0.9	1.9	1.0	3.8	7.5	10.3	0.0	3.4
19-mar	6.6	7.5	8.5	5.6	6.6	0.9	5.7	0.0	6.6	12.2	3.8	1.9	4.7	0.0	5.7	1.9	2.9	1.9	3.8	15.0	4.7	4.7	4.7	0.9	15.0	0.0	4.8
20-mar	0.9	0.0	0.9	5.7	4.7	3.8	0.9	0.9	7.5	3.8	5.6	7.5	5.6	3.8	4.7	0.9	1.9	5.7	6.6	2.8	1.9	1.0	1.9	4.7	7.5	0.0	3.5
21-mar	1.9	3.8	4.7	1.9	6.6	3.8	10.4	9.4	9.4	15.0	1.9	2.9	0.0	1.9	2.8	0.0	3.8	0.9	0.9	4.7	+	+	3.8	0.0	15.0	0.0	4.1
22-mar	2.8	2.8	1.9	3.8	0.9	0.0	7.5	5.6	2.9	4.7	7.5	9.4	8.4	13.2	2.8	6.6	7.5	2.8	8.5	3.8	1.9	1.9	1.9	0.9	13.2	0.0	4.6
23-mar	8.5	7.5	8.5	11.3	1.9	0.0	5.6	0.0	1.9	1.9	4.7	8.5	14.1	11.3	2.8	4.7	6.6	4.7	1.9	1.9	1.9	5.7	5.6	9.4	14.1	0.0	5.4
24-mar	3.8	3.8	6.6	0.0	0.9	6.6	11.3	2.8	1.9	4.7	11.3	7.5	10.3	1.9	3.8	6.6	5.7	0.9	5.7	9.4	0.0	0.0	0.9	1.9	11.3	0.0	4.5
25-mar	4.7	3.8	1.9	4.7	9.4	9.4	+	+	+	+	+	2.9	8.5	6.6	3.7	7.5	1.0	6.6	2.8	0.0	6.6	7.5	5.7	6.6	9.4	0.0	5.2
26-mar	3.8	6.6	4.7	1.9	6.6	0.0	1.9	2.8	2.8	0.0	1.9	0.0	0.0	2.8	2.8	10.3	3.7	1.0	1.9	10.3	1.9	0.0	1.9	0.9	10.3	0.0	2.9
27-mar	0.0	3.8	0.0	3.8	5.7	3.8	7.5	3.8	0.0	4.7	5.8	1.9	11.3	8.4	10.3	0.9	7.5	4.7	5.7	2.8	2.8	4.7	1.9	2.8	11.3	0.0	4.3
28-mar	5.7	0.0	1.9	4.7	9.4	3.7	8.4	10.3	3.8	7.5	3.7	9.4	10.4	6.6	5.7	1.9	5.7	8.5	9.4	3.8	3.7	1.9	1.9	0.9	10.4	0.0	5.3
29-mar	7.5	10.3	7.5	5.6	6.6	7.5	15.0	11.3	24.4	26.3	22.6	14.1	12.2	10.3	11.3	16.0	14.1	15.0	15.0	26.3	62.9	9.4	7.5	9.4	62.9	5.6	15.3
30-mar	0.0	0.0	1.9	2.9	4.7	2.9	2.9	4.7	4.7	7.5	4.7	7.5	7.5	6.6	4.7	9.4	0.0	3.8	8.5	4.7	0.9	2.8	1.9	1.9	9.4	0.0	4.0
31-mar	9.7	5.6	6.5	8.6	3.6	0.5	11.3	6.4	4.7	6.5	14.3	10.8	11.6	3.0	6.2	3.0	3.1	10.4	10.7	7.2	12.6	6.4	1.2	3.8	14.3	0.5	7.0
MAXIMA	9.7	10.3	9.4	11.3	15.0	9.4	15.0	25.3	24.4	29.1	27.3	14.1	18.8	18.8	18.8	16.0	14.1	15.0	15.0	26.3	62.9	11.3	10.4	9.4			
MINIMA	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
MEDIA	3.3	4.5	3.6	4.2	4.7	3.2	5.8	5.8	6.0	8.2	6.7	5.1	6.7	5.4	5.1	4.4	4.1	3.4	4.3	4.7	5.4	3.5	3.3	3.8			

Código ausencia de datos por instalación y/o retiro de equipo : *
Código ausencia de datos por mantención del equipo : #
Código ausencia de datos por calibración del equipo : C
Código ausencia de datos por falta de energía eléctrica temporalmente : +
N° de datos validos : 697
Recuperación de datos : 93.7 %
D : Día de Medición
H : Hora de Medición

Nota Importante al reverso

AV. MARATHON 2595, COD. POSTAL 6900502 - MACUL - FONO 56-2-3502100 - FAX 56-2-2384135 - E-mail:cesmec@reuna.cl

MONITOREO DE CALIDAD DEL AIRE

TABLA 7.

LUGAR : CUERPO DE BOMBEROS

PERIODO : 1 AL 28 DE FEBRERO DE 1999

VARIABLE : DIOXIDO DE NITROGENO (NO_2)

UNIDAD : µg/m^{3}N

AÑO 1999	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	MAXIMA	MINIMA	MEDIA
1-feb	24.4	20.7	18.8	3.8	26.3	15.0	5.6	5.6	63.8	62.0	43.2	18.8	18.8	5.6	20.7	41.3	37.6	39.4	39.4	58.2	131.4	28.2	7.5	3.8	131.4	3.8	30.8
2-feb	5.6	15.0	28.2	24.4	9.4	11.3	31.9	13.1	3.8	30.0	54.5	13.1	C	C	C	0.0	26.3	28.2	15.0	15.0	15.0	7.5	13.1	11.3	54.5	3.8	20.0
3-feb	11.3	9.4	11.3	3.8	9.4	16.9	0.0	0.0	16.9	9.4	9.4	7.5	15.0	13.1	9.4	11.3	16.9	9.4	9.4	9.4	9.4	11.3	9.4	15.0	16.9	0.0	10.2
4-feb	15.0	9.4	16.9	13.1	15.0	0.0	13.1	0.0	15.0	0.0	3.8	3.8	5.6	13.1	16.9	20.7	22.5	22.5	11.3	15.0	9.4	15.0	3.8	9.4	22.5	0.0	11.3
5-feb	9.4	11.3	15.0	11.3	13.1	5.6	22.5	13.1	13.1	9.4	13.1	3.8	3.8	0.0	0.0	15.0	13.1	15.0	15.0	15.0	13.1	20.7	18.8	0.0	22.5	0.0	11.3
6-feb	20.7	33.8	20.7	18.8	16.9	11.3	15.0	0.0	20.7	5.6	7.5	13.1	22.5	7.5	9.4	11.3	26.3	24.4	5.6	11.3	7.5	20.7	20.7	13.1	33.8	0.0	15.2
7-feb	15.0	0.0	0.0	0.0	3.8	20.7	11.3	9.4	7.5	9.4	13.1	13.1	20.7	18.8	22.5	20.7	15.0	16.9	9.4	22.5	13.1	9.4	9.4	11.3	22.5	0.0	12.2
8-feb	11.3	7.5	9.4	11.3	13.1	28.2	33.8	35.7	37.6	28.2	28.2	24.4	13.1	5.6	0.0	9.4	7.5	7.5	5.6	0.0	22.5	16.9	20.7	13.1	37.6	0.0	16.3
9-feb	15.0	11.3	15.0	16.9	18.8	18.8	13.1	9.4	0.0	0.0	13.1	3.8	3.8	3.8	7.5	7.5	9.4	18.8	20.7	18.8	16.9	15.0	11.3	5.6	20.7	0.0	11.4
10-feb	13.1	1.9	13.1	7.5	13.1	0.0	5.6	24.4	5.6	31.9	16.9	15.0	0.0	5.6	5.6	3.8	7.5	20.7	13.1	9.4	18.8	15.0	15.0	7.5	31.9	0.0	11.3
11-feb	5.6	0.0	5.6	5.6	5.6	5.6	3.8	15.0	0.0	3.8	0.0	9.4	0.0	16.9	18.8	0.0	15.0	13.1	13.1	15.0	5.6	15.0	15.0	15.0	18.8	0.0	8.4
12-feb	20.7	11.3	15.0	18.8	16.9	0.0	3.8	7.5	13.1	16.9	7.5	7.5	9.4	11.3	3.8	9.4	7.5	9.4	9.4	11.3	9.4	1.9	9.4	11.3	20.7	0.0	10.1
13-feb	9.4	13.1	15.0	18.8	13.1	5.6	13.1	7.5	13.1	13.1	18.8	3.8	22.5	15.0	16.9	7.5	24.4	15.0	15.0	9.4	11.3	15.0	20.7	15.0	24.4	3.8	13.8
14-feb	5.6	3.8	11.3	9.4	11.3	9.4	15.0	7.5	15.0	18.8	9.4	13.1	16.9	5.6	15.0	18.8	16.9	13.1	7.5	5.6	5.6	9.4	0.0	9.4	18.8	0.0	10.6
15-feb	11.3	0.0	5.6	5.6	22.5	9.4	15.0	3.8	9.4	16.9	18.8	16.9	18.8	15.0	22.5	20.7	20.7	9.4	9.4	7.5	3.8	15.0	15.0	16.9	22.5	0.0	12.9
16-feb	15.0	16.9	11.3	0.0	5.6	7.5	16.9	11.3	13.1	3.8	18.8	0.0	0.0	0.0	7.5	7.5	11.3	13.1	9.4	7.5	5.6	3.8	0.0	15.0	18.8	0.0	8.4
17-feb	15.0	0.0	15.0	11.3	5.6	0.0	9.4	24.4	28.2	11.3	11.3	5.6	0.0	9.4	5.6	3.8	3.8	11.3	11.3	5.6	9.4	11.3	15.0	13.1	28.2	0.0	9.9
18-feb	15.0	9.4	15.0	9.4	7.5	9.4	0.0	16.9	26.3	24.4	0.0	16.9	15.0	15.0	13.1	0.0	13.1	18.8	18.8	7.5	16.9	11.3	11.3	15.0	26.3	0.0	12.8
19-feb	13.1	11.3	16.9	15.0	13.1	0.0	3.8	3.8	9.4	16.9	7.5	3.8	15.0	9.4	20.7	5.6	7.5	16.9	20.7	16.9	13.1	18.8	18.8	15.0	20.7	0.0	12.2
20-feb	15.0	13.1	11.3	1.9	3.8	7.5	3.8	0.0	11.3	16.9	16.9	20.7	15.0	16.9	0.0	5.6	16.9	20.7	22.5	3.8	5.6	11.3	13.1	13.1	22.5	0.0	11.1
21-feb	13.1	16.9	18.8	16.9	22.5	22.5	20.7	22.5	24.4	16.9	0.0	0.0	9.4	7.5	11.3	5.6	5.6	15.0	15.0	22.5	18.8	13.1	5.6	9.4	24.4	0.0	13.9
22-feb	15.0	15.0	13.1	5.6	15.0	9.4	20.7	24.4	20.7	18.8	24.4	28.2	22.5	26.3	5.6	16.9	0.0	15.0	16.9	20.7	16.9	13.1	13.1	7.5	28.2	0.0	16.0
23-feb	20.7	18.8	20.7	22.5	7.5	5.6	16.9	5.6	13.1	13.1	18.8	26.3	18.8	18.8	15.0	18.8	22.5	22.5	9.4	11.3	3.8	11.3	15.0	22.5	26.3	3.8	15.8
24-feb	20.7	20.7	5.6	13.1	7.5	13.1	18.8	9.4	5.6	9.4	22.5	20.7	30.0	5.6	16.9	22.5	20.7	15.0	20.7	18.8	9.4	9.4	7.5	5.6	30.0	5.6	14.6
25-feb	3.8	5.6	9.4	22.5	22.5	24.4	24.4	35.7	0.0	37.6	11.3	13.1	16.9	15.0	13.1	0.0	11.3	16.9	15.0	15.0	13.1	11.3	11.3	7.5	37.6	0.0	14.9
26-feb	11.3	22.5	3.8	9.4	0.0	9.4	5.6	9.4	9.4	3.8	13.1	9.4	9.4	15.0	11.3	26.3	13.1	11.3	13.1	24.4	5.6	13.1	9.4	13.1	26.3	0.0	11.3
27-feb	13.1	5.6	13.1	16.9	20.7	11.3	11.3	16.9	9.4	18.8	16.9	7.5	26.3	22.5	26.3	5.6	24.4	22.5	1.9	15.0	15.0	9.4	9.4	15.0	26.3	1.9	14.8
28-feb	20.7	9.4	5.6	9.4	18.8	13.1	13.1	24.4	16.9	20.7	13.1	18.8	20.7	18.8	20.7	13.1	20.7	16.9	15.0	7.5	13.1	5.6	7.5	7.5	24.4	5.6	14.6
MAXIMA	24.4	33.8	28.2	24.4	26.3	28.2	33.8	35.7	63.8	62.0	54.5	28.2	30.0	26.3	26.3	41.3	37.6	39.4	39.4	58.2	131.4	28.2	20.7	22.5			
MINIMA	3.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.5	1.9	0.0	3.8	1.9	0.0	0.0			
MEDIA	13.7	11.2	12.9	11.5	12.8	10.4	13.1	12.7	15.1	16.7	15.4	12.1	13.7	11.7	12.4	11.7	15.6	17.1	13.9	14.3	15.7	12.8	11.7	11.3			

Código ausencia de datos por falta de energía eléctrica temporalmente : C
N° de datos validos : +
Recuperación de datos : 669
: 100 %

Nota Importante al reverso

AV. MARATHON 2595, COD. POSTAL 6900502 - MACUL - FONO 56-2-3502100 - FAX 56-2-2384135 - E-mail:cesmec@reuna.cl

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SEB-10207

MONITOREO DE CALIDAD DEL AIRE

TABLA 7.

LUGAR : CUERPO DE BOMBEROS

PERIODO : 1 AL 31 DE ENERO DE 1999

VARIABLE : DIOXIDO DE NITROGENO (NO_2)

UNIDAD : $\mu g/m^3N$

AÑO 1999	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	MAXIMA	MINIMA	MEDIA
1-ene	1.9	1.9	3.8	0.0	1.9	0.0	1.9	0.0	1.9	0.0	0.0	1.9	5.6	1.9	1.9	3.8	5.6	1.9	5.6	1.9	1.9	1.9	3.8	0.0	5.6	0.0	2.1
2-ene	1.9	1.9	9.4	1.9	1.9	3.8	5.6	13.1	0.0	1.9	7.5	1.9	1.9	1.9	0.0	4.3	3.8	0.0	1.9	5.6	1.9	1.9	1.9	7.5	13.1	0.0	3.5
3-ene	3.8	5.6	1.9	3.8	0.0	1.9	1.9	5.6	0.0	3.8	9.4	5.6	1.9	0.0	1.9	3.8	1.9	3.8	1.9	1.9	1.9	1.9	1.9	1.9	9.4	0.0	2.8
4-ene	1.9	3.8	0.0	3.8	5.6	0.0	0.0	1.9	3.8	1.9	3.8	0.0	1.9	3.8	3.8	3.8	7.5	5.6	3.8	0.0	1.9	1.9	1.9	1.9	7.5	0.0	2.7
5-ene	0.0	1.9	1.9	3.8	3.8	0.0	3.8	13.1	11.3	5.6	3.8	0.0	1.9	1.9	1.9	1.9	1.9	7.5	5.6	0.0	0.0	1.9	1.9	1.9	13.1	0.0	3.2
6-ene	1.9	1.9	1.9	3.8	1.9	5.6	3.8	3.8	3.8	1.9	1.9	0.0	1.9	1.9	0.0	0.0	1.9	3.8	3.8	3.8	9.4	3.8	1.9	0.0	9.4	0.0	2.7
7-ene	1.9	1.9	3.8	1.9	3.8	1.9	1.9	1.9	0.0	1.9	1.9	1.9	1.9	1.9	1.9	1.9	0.0	1.9	1.9	1.9	1.9	1.9	3.8	1.9	3.8	0.0	2.0
8-ene	0.0	1.9	1.9	1.9	1.9	1.9	0.0	1.9	3.8	15.0	3.8	3.8	11.3	1.9	1.9	1.9	1.9	0.0	1.9	0.0	0.0	1.9	0.0	3.8	15.0	0.0	2.7
9-ene	1.9	1.9	1.9	1.9	5.6	1.9	1.9	1.9	3.8	1.9	0.0	0.0	0.0	3.8	3.8	0.0	0.0	1.9	1.9	1.9	1.9	1.9	1.9	1.9	5.6	0.0	1.9
10-ene	1.9	1.9	1.9	1.9	1.9	1.9	3.8	0.0	1.9	3.8	3.8	3.8	1.9	1.9	3.8	1.9	3.8	1.9	1.9	1.9	0.0	0.0	0.0	3.8	3.8	0.0	2.1
11-ene	1.9	3.8	5.6	1.9	5.6	3.8	0.0	1.9	1.9	1.9	3.8	0.0	5.6	3.8	1.9	3.8	3.8	3.8	3.8	1.9	1.9	3.8	1.9	0.0	5.6	0.0	2.8
12-ene	1.9	0.0	1.9	1.9	1.9	5.6	0.0	5.6	3.8	1.9	1.9	1.9	1.9	5.6	1.9	1.9	3.8	1.9	1.9	1.9	1.9	1.9	1.9	1.9	5.6	0.0	2.4
13-ene	1.9	0.0	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	3.8	5.6	1.9	3.8	1.9	3.8	1.9	1.9	1.9	1.9	3.8	3.8	1.9	5.6	0.0	2.4
14-ene	1.9	0.0	1.9	1.9	3.8	3.8	1.9	1.9	3.8	7.5	5.6	3.8	7.5	3.8	5.6	1.9	9.4	7.5	1.9	7.5	7.5	1.9	1.9	1.9	9.4	0.0	4.0
15-ene	1.9	5.6	5.6	5.6	7.5	1.9	3.8	5.6	5.6	43.2	C	C	C	1.9	0.0	3.8	3.8	3.8	1.9	1.9	3.8	0.0	3.8	1.9	43.2	0.0	5.4
16-ene	5.6	7.5	7.5	1.9	3.8	3.8	3.8	1.9	0.0	1.9	1.9	0.0	0.0	0.0	3.8	9.4	0.0	5.6	3.8	1.9	7.5	3.8	3.8	3.8	9.4	0.0	3.5
17-ene	1.9	1.9	0.0	3.8	3.8	5.6	5.6	5.6	1.9	0.0	0.0	0.0	1.9	3.8	0.0	1.9	1.9	1.9	1.9	0.0	1.9	0.0	1.9	1.9	5.6	0.0	2.0
18-ene	5.6	1.9	1.9	0.0	0.0	0.0	3.8	3.8	3.8	1.9	0.0	1.9	1.9	1.9	1.9	0.0	0.0	0.0	0.0	1.9	0.0	0.0	0.0	1.9	5.6	0.0	1.4
19-ene	7.5	3.8	1.9	0.0	1.9	1.9	5.6	0.0	0.0	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	0.0	0.0	0.0	1.9	1.9	7.5	0.0	1.9
20-ene	1.9	0.0	3.8	5.6	1.9	3.8	18.8	18.8	1.9	1.9	1.9	0.0	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	18.8	0.0	3.5
21-ene	1.9	1.9	1.9	0.0	0.0	0.0	3.8	0.0	1.9	0.0	1.9	1.9	0.0	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	3.8	0.0	1.5
22-ene	0.0	0.0	1.9	9.4	1.9	1.9	13.1	1.9	3.8	3.8	1.9	0.0	1.9	1.9	1.9	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.1	0.0	2.0
23-ene	0.0	1.9	0.0	1.9	0.0	5.6	1.9	1.9	1.9	1.9	1.9	0.0	0.0	0.0	1.9	0.0	1.9	0.0	0.0	0.0	0.0	0.0	1.9	0.0	5.6	0.0	1.0
24-ene	1.9	0.0	0.0	0.0	3.8	1.9	1.9	0.0	0.0	0.0	1.9	3.8	1.9	0.0	0.0	0.0	1.9	1.9	1.9	1.9	0.0	0.0	0.0	1.9	3.8	0.0	1.1
25-ene	0.0	1.9	0.0	0.0	1.9	3.8	1.9	0.0	1.9	0.0	0.0	0.0	0.0	1.9	1.9	0.0	0.0	0.0	1.9	0.0	0.0	1.9	3.8	0.0	3.8	0.0	1.0
26-ene	0.0	1.9	1.9	0.0	3.8	1.9	35.7	3.8	3.8	0.0	1.9	1.9	3.8	0.0	1.9	1.9	1.9	5.6	5.6	3.8	0.0	0.0	1.9	1.9	35.7	0.0	3.5
27-ene	1.9	1.9	3.8	3.8	3.8	1.9	1.9	1.9	1.9	0.0	0.0	1.9	0.0	1.9	1.9	1.9	5.6	1.9	1.9	1.9	1.9	1.9	1.9	1.9	5.6	0.0	2.1
28-ene	1.9	1.9	1.9	0.0	1.9	1.9	13.1	7.5	3.8	1.9	1.9	1.9	1.9	0.0	0.0	0.0	1.9	0.0	1.9	1.9	0.0	1.9	0.0	1.9	13.1	0.0	2.1
29-ene	0.0	0.0	1.9	5.6	1.9	7.5	15.0	9.4	1.9	3.8	1.9	3.8	0.0	1.9	0.0	1.9	0.0	1.9	3.8	1.9	7.5	1.9	1.9	1.9	15.0	0.0	3.2
30-ene	1.9	0.0	0.0	1.9	5.6	5.6	9.4	0.0	1.9	3.8	3.8	1.9	0.0	1.9	0.0	1.9	5.6	1.9	3.8	1.9	5.6	1.9	1.9	1.9	9.4	0.0	2.7
31-ene	1.9	0.0	0.0	1.9	1.9	3.8	13.1	0.0	1.9	1.9	3.8	1.9	1.9	1.9	1.9	1.9	3.8	1.9	1.9	1.9	3.8	3.8	1.9	3.0	13.1	0.0	2.6
MAXIMA	7.5	7.5	9.4	9.4	7.5	7.5	35.7	18.8	11.3	43.2	9.4	5.6	11.3	5.6	5.6	9.4	9.4	7.5	5.6	7.5	9.4	3.8	3.8	7.5			
MINIMA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
MEDIA	2.0	2.0	2.4	2.4	2.8	2.8	5.8	3.8	2.6	3.8	2.5	1.7	2.3	2.0	1.8	2.1	2.7	2.4	2.4	1.8	2.3	1.7	1.9	1.9			

: C

Código ausencia de datos por falta de energía eléctrica temporalmente : +

N° de datos validos : 741

Recuperación de datos : 100 %

Nota Importante al reverso

AV. MARATHON 2595, COD. POSTAL 6900502 - MACUL - FONO 56-2-3502100 - FAX 56-2-2384135 - E-mail:cesmec@reuna.cl

MONITOREO DE CALIDAD DEL AIRE

TABLA 7.

LUGAR : CUERPO DE BOMBEROS

PERIODO : 1 AL 31 DE DICIEMBRE DE 1998

VARIABLE : DIOXIDO DE NITROGENO (NO_2)

UNIDAD : µg/m³N

AÑO 1998	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	MAXIMA	MINIMA	MEDIA
1-dic	5.6	1.9	13.1	5.6	9.4	1.9	1.9	1.9	1.9	3.8	1.9	3.8	C	C	C	1.9	1.9	0.0	1.9	1.9	1.9	1.9	1.9	0.0	13.1	0.0	13.1
2-dic	1.9	0.0	13.1	13.1	5.6	1.9	1.9	0.0	1.9	0.0	7.5	0.0	3.8	1.9	5.6	0.0	0.0	1.9	0.0	11.3	1.9	0.0	0.0	3.8	13.1	0.0	13.1
3-dic	0.0	3.8	1.9	1.9	1.9	0.0	0.0	0.0	3.8	1.9	0.0	0.0	3.8	0.0	5.6	5.6	5.6	3.8	0.0	3.8	3.8	3.8	0.0	0.0	5.6	0.0	5.6
4-dic	0.0	0.0	1.9	0.0	3.8	1.9	9.4	1.9	1.9	5.6	15.0	3.8	7.5	13.1	13.1	5.6	5.6	3.8	5.6	5.6	1.9	0.0	0.0	11.3	15.0	0.0	15.0
5-dic	13.1	11.3	0.0	1.9	5.6	5.6	7.5	0.0	1.9	0.0	1.9	1.9	0.0	1.9	7.5	11.3	13.1	0.0	3.8	3.8	3.8	5.6	3.8	1.9	13.1	0.0	13.1
6-dic	3.8	3.8	0.0	1.9	9.4	5.6	1.9	3.8	1.9	3.8	3.8	1.9	1.9	5.6	3.8	1.9	3.8	0.0	7.5	5.6	9.4	11.3	0.0	3.8	11.3	0.0	11.3
7-dic	9.4	1.9	3.8	1.9	3.8	0.0	9.4	7.5	1.9	5.6	9.4	1.9	11.3	0.0	1.9	1.9	1.9	1.9	3.8	3.8	5.6	1.9	3.8	0.0	11.3	0.0	11.3
8-dic	1.9	3.8	9.4	3.8	0.0	0.0	3.8	3.8	9.4	9.4	3.8	1.9	3.8	7.5	3.8	1.9	1.9	3.8	5.6	5.6	9.4	9.4	1.9	0.0	9.4	0.0	9.4
9-dic	1.9	1.9	7.5	0.0	0.0	0.0	7.5	3.8	1.9	3.8	3.8	9.4	3.8	1.9	5.6	7.5	11.3	5.6	3.8	3.8	7.5	3.8	0.0	15.0	15.0	0.0	15.0
10-dic	11.3	1.9	3.8	0.0	3.8	3.8	3.8	1.9	0.0	9.4	7.5	3.8	5.6	1.9	1.9	5.6	1.9	3.8	3.8	3.8	1.9	0.0	3.8	3.8	11.3	0.0	11.3
11-dic	1.9	5.6	5.6	1.9	3.8	5.6	1.9	5.6	7.5	9.4	5.6	5.6	0.0	9.4	3.8	9.4	3.8	5.6	1.9	1.9	3.8	1.9	3.8	0.0	9.4	0.0	9.4
12-dic	5.6	9.4	5.6	5.6	3.8	5.6	0.0	0.0	15.0	1.9	5.6	1.9	9.4	7.5	5.6	5.6	1.9	0.0	5.6	3.8	1.9	3.8	9.4	7.5	15.0	0.0	15.0
13-dic	7.5	9.4	0.0	1.9	9.4	9.4	3.8	3.8	7.5	3.8	5.6	3.8	5.6	3.8	5.6	5.6	5.6	3.8	5.6	3.8	9.4	5.6	1.9	3.8	9.4	0.0	9.4
14-dic	1.9	1.9	0.0	1.9	5.6	9.4	1.9	1.9	1.9	9.4	0.0	3.8	3.8	1.9	3.8	3.8	3.8	5.6	5.6	5.6	3.8	0.0	1.9	1.9	9.4	0.0	9.4
15-dic	1.9	0.0	0.0	1.9	1.9	1.9	9.4	3.8	3.8	3.8	5.6	1.9	7.5	3.8	0.0	9.4	15.0	9.4	+	+	1.9	3.8	1.9	1.9	15.0	0.0	15.0
16-dic	7.5	0.0	3.8	1.9	1.9	0.0	0.0	+	+	+	0.0	9.4	9.4	3.8	3.8	1.9	1.9	0.0	9.4	0.0	5.6	3.8	3.8	0.0	9.4	0.0	9.4
17-dic	1.9	0.0	0.0	3.8	3.8	3.8	3.8	7.5	0.0	3.8	0.0	0.0	7.5	3.8	9.4	1.9	0.0	3.8	1.9	0.0	0.0	3.8	0.0	1.9	9.4	0.0	9.4
18-dic	1.9	0.0	0.0	5.6	0.0	5.6	1.9	1.9	11.3	9.4	0.0	7.5	3.8	3.8	3.8	9.4	1.9	3.8	0.0	0.0	1.9	9.4	3.8	1.9	11.3	0.0	11.3
19-dic	0.0	5.6	3.8	3.8	0.0	0.0	3.8	1.9	5.6	3.8	0.0	1.9	0.0	0.0	1.9	0.0	1.9	3.8	5.6	1.9	9.4	1.9	13.1	1.9	13.1	0.0	13.1
20-dic	1.9	3.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.9	3.8	1.9	1.9	3.8	1.9	1.9	3.8	0.0	0.0	1.9	1.9	0.0	0.0	0.0	3.8	0.0	3.8
21-dic	0.0	0.0	0.0	5.6	3.8	3.8	3.8	0.0	3.8	1.9	1.9	1.9	0.0	5.6	5.6	1.9	1.9	5.6	1.9	1.9	1.9	0.0	0.0	0.0	5.6	0.0	5.6
22-dic	0.0	0.0	1.9	0.0	0.0	7.5	1.9	3.8	3.8	7.5	15.0	5.6	1.9	1.9	3.8	13.1	9.4	18.8	22.5	0.0	1.9	3.8	1.9	5.6	22.5	0.0	22.5
23-dic	5.6	0.0	3.8	3.8	3.8	0.0	9.4	13.1	9.4	9.4	1.9	3.8	9.4	18.8	3.8	3.8	9.4	3.8	7.5	0.0	1.9	3.8	1.9	3.8	18.8	0.0	18.8
24-dic	0.0	3.8	5.6	3.8	1.9	3.8	13.1	7.5	7.5	1.9	1.9	5.6	5.6	5.6	3.8	3.8	3.8	3.8	0.0	1.9	0.0	1.9	0.0	5.6	13.1	0.0	13.1
25-dic	3.8	7.5	5.6	7.5	0.0	9.4	3.8	3.8	7.5	15.0	0.0	13.1	5.6	13.1	9.4	5.6	3.8	11.3	3.8	3.8	1.9	5.6	0.0	0.0	15.0	0.0	15.0
26-dic	1.9	3.8	1.9	1.9	3.8	0.0	5.6	0.0	0.0	0.0	7.5	9.4	11.3	1.9	1.9	0.0	1.9	0.0	0.0	0.0	3.8	0.0	0.0	0.0	11.3	0.0	11.3
27-dic	0.0	1.9	0.0	0.0	0.0	3.8	1.9	1.9	3.8	+	3.8	3.8	3.8	1.9	1.9	0.0	1.9	1.9	0.0	1.9	3.8	3.8	1.9	7.5	7.5	0.0	7.5
28-dic	7.5	3.8	0.0	1.9	1.9	5.6	7.5	5.6	5.6	5.6	3.8	3.8	5.6	9.4	1.9	3.8	5.6	5.6	5.6	9.4	5.6	5.6	1.9	3.8	9.4	0.0	9.4
29-dic	1.9	1.9	3.8	3.8	1.9	1.9	9.4	1.9	1.9	0.0	3.8	0.0	0.0	3.8	3.8	0.0	0.0	1.9	1.9	9.4	0.0	1.9	1.9	3.8	9.4	0.0	9.4
30-dic	1.9	1.9	0.0	1.9	1.9	0.0	20.7	9.4	5.6	5.6	1.9	0.0	5.6	5.6	0.0	0.0	0.0	0.0	1.9	1.9	3.8	1.9	1.9	1.9	20.7	0.0	20.7
31-dic	1.9	9.4	0.0	3.8	3.8	9.4	7.5	0.0	1.9	0.0	1.9	3.8	1.9	1.9	3.8	5.6	5.6	7.5	5.6	1.9	3.8	0.0	1.9	3.8	9.4	0.0	9.4
MAXIMA	13.1	11.3	13.1	13.1	9.4	9.4	20.7	13.1	15.0	15.0	15.0	13.1	11.3	18.8	13.1	13.1	15.0	18.8	22.5	11.3	9.4	11.3	13.1	15.0			
MINIMA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
MEDIA	3.4	3.2	3.1	3.0	3.1	3.5	5.1	3.3	4.3	4.7	4.0	3.8	4.7	4.8	4.3	4.2	4.2	3.9	4.1	3.3	3.7	3.2	2.2	3.1			

Código ausencia de datos por calibración del equipo : C
Código ausencia de datos por falta de energía eléctrica temporalmente : +
N° de datos validos : 735
Recuperación de datos : 100 %

Nota Importante al reverso

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MONITOREO DE CALIDAD DEL AIRE

TABLA 7.

LUGAR : CUERPO DE BOMBEROS

PERIODO : 1 AL 30 DE NOVIEMBRE DE 1998

VARIABLE : DIOXIDO DE NITROGENO (NO_2)

UNIDAD : $\mu g/m^3N$

AÑO 1998	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	MAXIMA	MINIMA	MEDIA
1-nov	9.4	9.4	7.5	9.4	1.9	1.9	3.8	0.0	5.6	1.9	1.9	13.1	0.0	0.0	9.4	1.9	0.0	1.9	1.9	1.9	5.6	1.9	3.8	15.0	15.0	0.0	4.5
2-nov	9.4	1.9	0.0	3.8	9.4	15.0	0.0	0.0	5.6	5.6	3.8	3.8	9.4	3.8	3.8	0.0	1.9	1.9	3.8	1.9	0.0	0.0	0.0	1.9	15.0	0.0	3.6
3-nov	0.0	0.0	3.8	5.6	5.6	3.8	11.3	9.4	3.8	5.6	3.8	0.0	9.4	7.5	9.4	0.0	0.0	5.6	3.8	3.8	5.6	5.6	5.6	0.0	11.3	0.0	4.5
4-nov	0.0	0.0	0.0	3.8	3.8	1.9	5.6	0.0	3.8	3.8	9.4	3.8	9.4	15.0	0.0	3.8	9.4	0.0	3.8	0.0	0.0	0.0	1.9	0.0	15.0	0.0	3.3
5-nov	5.6	0.0	3.8	5.6	3.8	3.8	0.0	0.0	3.8	3.8	7.5	3.8	9.4	9.4	9.4	3.8	5.6	5.6	3.8	0.0	18.8	13.1	5.6	1.9	18.8	0.0	5.3
6-nov	9.4	3.8	0.0	0.0	0.0	5.6	13.1	3.8	1.9	1.9	13.1	1.9	9.4	9.4	5.6	1.9	1.9	1.9	0.0	0.0	0.0	5.6	5.6	3.8	13.1	0.0	4.1
7-nov	0.0	0.0	0.0	0.0	3.8	1.9	1.9	1.9	0.0	9.4	9.4	3.8	3.8	1.9	0.0	1.9	1.9	0.0	7.5	0.0	5.6	5.6	1.9	3.8	9.4	0.0	2.7
8-nov	3.8	1.9	0.0	5.6	9.4	9.4	5.6	0.0	3.8	3.8	3.8	1.9	7.5	3.8	1.9	1.9	0.0	1.9	0.0	0.0	0.0	1.9	1.9	0.0	9.4	0.0	2.9
9-nov	0.0	0.0	3.8	1.9	3.8	1.9	5.6	0.0	3.8	9.4	0.0	0.0	9.4	1.9	9.4	1.9	1.9	5.6	0.0	0.0	1.9	0.0	1.9	1.9	9.4	0.0	2.7
10-nov	1.9	3.8	1.9	1.9	0.0	0.0	0.0	0.0	1.9	3.8	5.6	7.5	9.4	5.6	3.8	3.8	0.0	0.0	0.0	0.0	7.5	5.6	9.4	3.8	9.4	0.0	3.2
11-nov	7.5	7.5	1.9	3.8	7.5	9.4	9.4	18.8	5.6	3.8	9.4	18.8	15.0	13.1	11.3	13.1	9.4	3.8	1.9	0.0	1.9	0.0	0.0	0.0	18.8	0.0	7.2
12-nov	1.9	1.9	0.0	1.9	1.9	3.8	1.9	3.8	0.0	15.0	20.7	11.3	7.5	9.4	15.0	1.9	3.8	0.0	1.9	0.0	0.0	11.3	15.0	1.9	20.7	0.0	5.5
13-nov	1.9	0.0	0.0	0.0	0.0	1.9	0.0	0.0	3.8	0.0	5.6	1.9	9.4	9.4	7.5	7.5	3.8	0.0	0.0	0.0	3.8	1.9	11.3	1.9	11.3	0.0	3.0
14-nov	0.0	0.0	0.0	0.0	5.6	1.9	3.8	0.0	3.8	9.4	13.1	7.5	1.9	3.8	1.9	1.9	1.9	1.9	0.0	0.0	0.0	3.8	9.4	3.8	13.1	0.0	3.1
15-nov	3.8	0.0	5.6	1.9	1.9	3.8	7.5	1.9	0.0	0.0	0.0	0.0	5.6	3.8	1.9	0.0	0.0	0.0	0.0	7.5	15.0	3.8	3.8	0.0	15.0	0.0	2.8
16-nov	0.0	3.8	3.8	1.9	3.8	3.8	1.9	3.8	5.6	3.8	5.6	9.4	3.8	0.0	0.0	7.5	1.9	5.6	3.8	22.5	3.8	9.4	0.0	1.9	22.5	0.0	4.5
17-nov	3.8	3.8	3.8	1.9	1.9	3.8	9.4	3.8	3.8	3.8	3.8	5.6	3.8	1.9	1.9	1.9	3.8	9.4	1.9	3.8	0.0	0.0	0.0	0.0	9.4	0.0	3.2
18-nov	0.0	1.9	1.9	3.8	0.0	3.8	5.6	0.0	0.0	0.0	1.9	7.5	1.9	0.0	0.0	0.0	0.0	3.8	0.0	0.0	0.0	0.0	3.8	1.9	7.5	0.0	1.6
19-nov	0.0	0.0	1.9	5.6	0.0	0.0	0.0	1.9	1.9	1.9	1.9	5.6	5.6	3.8	1.9	3.8	1.9	1.9	1.9	0.0	0.0	9.4	5.6	0.0	9.4	0.0	2.3
20-nov	1.9	1.9	1.9	3.8	0.0	1.9	0.0	0.0	0.0	0.0	9.4	1.9	1.9	1.9	1.9	1.9	0.0	3.8	1.9	0.0	0.0	1.9	0.0	5.6	9.4	0.0	1.9
21-nov	0.0	1.9	1.9	1.9	1.9	0.0	1.9	1.9	1.9	0.0	9.4	9.4	9.4	9.4	1.9	3.8	1.9	5.6	3.8	1.9	5.6	3.8	3.8	1.9	9.4	0.0	3.5
22-nov	1.9	1.9	3.8	1.9	1.9	0.0	1.9	1.9	0.0	5.6	5.6	1.9	0.0	5.6	5.6	0.0	0.0	0.0	1.9	1.9	0.0	0.0	0.0	1.9	5.6	0.0	1.9
23-nov	0.0	0.0	1.9	0.0	1.9	1.9	0.0	1.9	7.5	1.9	1.9	5.6	9.4	3.8	0.0	0.0	3.8	1.9	1.9	1.9	5.6	3.8	3.8	13.1	13.1	0.0	3.1
24-nov	1.9	1.9	1.9	0.0	3.8	1.9	0.0	1.9	13.1	1.9	13.1	0.0	0.0	1.9	1.9	1.9	5.6	1.9	0.0	3.8	5.6	5.6	5.6	0.0	13.1	0.0	3.1
25-nov	5.6	1.9	0.0	0.0	0.0	0.0	3.8	0.0	0.0	3.8	7.5	15.0	11.3	5.6	5.6	5.6	0.0	0.0	1.9	0.0	7.5	0.0	0.0	0.0	15.0	0.0	3.1
26-nov	1.9	1.9	1.9	1.9	3.8	3.8	7.5	0.0	0.0	3.8	0.0	22.5	9.4	0.0	1.9	1.9	5.6	0.0	0.0	0.0	5.6	3.8	5.6	1.9	22.5	0.0	3.5
27-nov	5.6	1.9	13.1	3.8	9.4	1.9	1.9	1.9	0.0	3.8	1.9	3.8	1.9	1.9	0.0	1.9	0.0	0.0	0.0	0.0	1.9	1.9	1.9	0.0	13.1	0.0	2.5
28-nov	1.9	0.0	13.1	13.1	5.6	1.9	1.9	0.0	1.9	0.0	7.5	0.0	3.8	1.9	5.6	0.0	0.0	1.9	0.0	11.3	1.9	0.0	0.0	3.8	13.1	0.0	3.2
29-nov	0.0	3.8	1.9	1.9	1.9	0.0	0.0	0.0	3.8	1.9	0.0	0.0	3.8	0.0	5.6	5.6	5.6	3.8	0.0	3.8	3.8	3.8	0.0	0.0	5.6	0.0	2.1
30-nov	0.0	0.0	1.9	0.0	3.8	1.9	9.4	1.9	0.0	3.8	0.0	1.9	7.5	0.0	1.9	0.0	0.0	0.0	0.0	1.9	0.0	3.8	0.0	1.9	9.4	0.0	1.7
MAXIMA	9.4	9.4	13.1	13.1	9.4	15.0	13.1	18.8	13.1	15.0	20.7	22.5	15.0	15.0	15.0	13.1	9.4	9.4	7.5	22.5	18.8	13.1	15.0	15.0			
MINIMA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
MEDIA	2.6	1.9	2.8	2.9	3.3	3.1	3.8	2.1	2.9	3.8	5.9	5.6	6.3	4.5	4.2	2.7	2.4	2.3	1.6	2.3	3.6	3.6	3.6	2.5			

Código ausencia de datos por calibración del equipo : C
Código ausencia de datos por falta de energía eléctrica temporalmente : +
N° de datos validos : 720
Recuperación de datos : 100 %

Nota Importante al reverso

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MONITOREO DE CALIDAD DEL AIRE

TABLA 7.

LUGAR : CUERPO DE BOMBEROS

VARIABLE : DIOXIDO DE NITROGENO (NO_2)

PERIODO : 1 AL 31 DE OCTUBRE DE 1998

UNIDAD : $\mu g/m^3N$

D/H	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	24:00	MAX.	MIN.	PROM
1	0.0	15.0	13.1	0.0	0.0	3.8	0.0	9.4	9.4	15.0	15.0	18.8	7.5	7.5	C	C	C	9.4	9.4	13.1	3.8	13.1	1.9	1.9	18.8	0.0	7.0
2	3.8	28.2	37.6	3.8	22.5	1.9	3.8	3.8	1.9	5.6	1.9	3.8	1.9	9.4	0.0	11.3	5.6	1.9	3.8	1.9	3.8	0.0	0.0	1.9	37.6	0.0	6.6
3	3.8	1.9	11.3	5.6	5.6	1.9	3.8	0.0	0.0	3.8	0.0	3.8	3.8	3.8	9.4	5.6	3.8	3.8	0.0	1.9	0.0	1.9	3.8	5.6	11.3	0.0	3.5
4	11.3	11.3	13.1	7.5	5.6	3.8	0.0	13.1	3.8	7.5	3.8	9.4	9.4	3.8	9.4	3.8	1.9	0.0	3.8	3.8	18.8	1.9	28.2	16.9	28.2	0.0	8.0
5	5.6	0.0	0.0	3.8	3.8	1.9	15.0	5.6	3.8	5.6	3.8	3.8	0.0	3.8	3.8	1.9	9.4	7.5	9.4	3.8	1.9	5.6	5.6	3.8	15.0	0.0	4.5
6	0.0	7.5	7.5	3.8	3.8	1.9	5.6	1.9	5.6	9.4	3.8	3.8	7.5	0.0	1.9	0.0	0.0	0.0	3.8	3.8	5.6	3.8	3.8	1.9	9.4	0.0	3.6
7	0.0	3.8	1.9	3.8	3.8	3.8	15.0	5.6	5.6	0.0	3.8	3.8	7.5	7.5	5.6	5.6	5.6	3.8	1.9	24.4	5.6	0.0	3.8	3.8	24.4	0.0	5.2
8	1.9	0.0	5.6	7.5	3.8	0.0	1.9	1.9	1.9	1.9	3.8	7.5	5.6	13.1	20.7	1.9	0.0	1.9	9.4	7.5	0.0	0.0	1.9	5.6	20.7	0.0	4.4
9	3.8	5.6	7.5	5.6	3.8	7.5	7.5	13.7	11.3	3.8	0.0	7.5	7.5	9.4	9.4	1.9	5.6	5.6	7.5	1.9	0.0	15.0	9.4	9.4	15.0	0.0	6.7
10	7.5	5.6	1.9	3.8	1.9	9.4	3.8	9.4	1.9	1.9	1.9	15.0	7.5	5.6	5.6	1.9	1.9	3.8	0.0	5.6	5.6	5.6	5.6	3.8	15.0	0.0	4.9
11	3.8	11.3	9.4	9.4	7.5	1.9	9.4	11.3	7.5	5.6	1.9	3.8	9.4	15.0	9.4	5.6	5.6	7.5	7.5	5.6	9.4	9.4	7.5	3.8	15.0	1.9	7.4
12	3.8	3.8	9.4	9.4	9.4	16.9	7.5	7.5	0.0	3.8	5.6	15.0	9.4	1.9	3.8	1.9	11.3	7.5	3.8	7.5	7.5	7.5	3.8	1.9	16.9	0.0	6.6
13	5.6	3.8	7.5	3.8	1.9	3.8	3.8	3.8	0.0	3.8	0.0	5.6	1.9	3.8	3.8	5.6	0.0	7.5	3.8	0.0	5.6	3.8	7.5	9.4	9.4	0.0	4.0
14	13.1	3.8	1.9	1.9	3.8	9.4	0.0	1.9	7.5	3.8	13.1	9.4	3.8	1.9	1.9	0.0	1.9	0.0	1.9	1.9	1.9	3.8	3.8	0.0	13.1	0.0	3.8
15	1.9	3.8	1.9	0.0	1.9	0.0	0.0	0.0	1.9	3.8	3.8	3.8	3.8	7.5	1.9	1.9	0.0	1.9	0.0	0.0	0.0	9.4	9.4	9.4	9.4	0.0	2.8
16	11.3	3.8	9.4	1.9	7.5	13.1	3.8	7.5	0.0	0.0	13.1	1.9	0.0	0.0	1.9	0.0	3.8	0.0	3.8	5.6	1.9	0.0	0.0	1.9	13.1	0.0	3.8
17	3.8	1.9	5.6	7.5	9.4	3.8	5.6	1.9	0.0	0.0	3.8	3.8	1.9	1.9	3.8	0.0	3.8	5.6	5.6	0.0	1.9	3.8	0.0	1.9	9.4	0.0	3.2
18	3.8	1.9	3.8	3.8	0.0	1.9	3.8	1.9	3.8	3.8	3.8	3.8	3.8	5.6	7.5	7.5	13.1	0.0	3.8	3.8	1.9	3.8	9.4	0.0	13.1	0.0	4.0
19	1.9	1.9	0.0	0.0	0.0	0.0	9.4	1.9	3.8	9.4	3.8	5.6	5.6	7.5	1.9	3.8	0.0	0.0	0.0	3.8	1.9	1.9	3.8	0.0	9.4	0.0	2.8
20	0.0	5.6	1.9	0.0	1.9	5.6	13.1	3.8	0.0	0.0	0.0	0.0	1.9	0.0	9.4	9.4	5.6	0.0	0.0	5.6	0.0	18.8	16.9	3.8	18.8	0.0	4.3
21	1.9	0.0	0.0	0.0	0.0	0.0	5.6	0.0	1.9	3.8	9.4	3.8	0.0	3.8	18.8	3.8	0.0	0.0	3.8	3.8	0.0	3.8	1.9	1.9	18.8	0.0	2.8
22	1.9	0.0	1.9	0.0	0.0	9.4	9.4	18.8	9.4	3.8	0.0	9.4	1.9	3.8	13.1	3.8	1.9	1.9	0.0	3.8	1.9	3.8	0.0	1.9	18.8	0.0	4.2
23	3.8	1.9	0.0	0.0	7.5	7.5	5.6	0.0	1.9	0.0	9.4	3.8	0.0	7.5	3.8	5.6	3.8	3.8	0.0	0.0	1.9	0.0	1.9	0.0	9.4	0.0	2.9
24	0.0	3.8	1.9	0.0	1.9	5.6	0.0	1.9	7.5	9.4	3.8	0.0	0.0	3.8	9.4	1.9	0.0	3.8	9.4	3.8	0.0	0.0	0.0	5.6	9.4	0.0	3.1
25	5.6	1.9	0.0	3.8	0.0	1.9	1.9	0.0	9.4	7.5	13.1	9.4	3.8	0.0	0.0	0.0	3.8	3.8	0.0	3.8	3.8	0.0	0.0	5.6	13.1	0.0	3.3
26	3.8	5.6	0.0	5.6	0.0	0.0	3.8	0.0	0.0	0.0	5.6	0.0	9.4	1.9	3.8	0.0	1.9	1.9	1.9	3.8	0.0	0.0	1.9	1.9	9.4	0.0	2.2
27	1.9	0.0	11.3	5.6	5.6	1.9	3.8	1.9	0.0	3.8	3.8	0.0	3.8	9.4	11.3	5.6	0.0	9.4	0.0	1.9	5.6	7.5	1.9	3.8	11.3	0.0	4.2
28	5.6	1.9	5.6	3.8	5.6	0.0	1.9	0.0	0.0	1.9	3.8	1.9	5.6	13.1	18.8	13.1	0.0	1.9	0.0	0.0	0.0	7.5	3.8	0.0	18.8	0.0	4.0
29	0.0	1.9	1.9	0.0	11.3	13.1	0.0	9.4	3.8	3.8	3.8	0.0	1.9	5.6	3.8	0.0	+	0.0	3.8	0.0	0.0	5.6	9.4	9.4	13.1	0.0	3.7
30	3.8	3.8	0.0	1.9	3.8	0.0	0.0	3.8	5.6	1.9	3.8	3.8	0.0	7.5	7.5	7.5	3.8	1.9	3.8	1.9	0.0	1.9	1.9	1.9	7.5	0.0	3.0
31	1.9	0.0	3.8	0.0	22.5	7.5	0.0	1.9	5.6	1.9	15.0	13.1	4.5	C	C	C	1.9	3.8	+	3.8	3.8	1.9	0.0	2.8	22.5	0.0	4.0
MAX.	13.1	28.2	37.6	9.4	22.5	16.9	15.0	18.8	11.3	15.0	15.0	18.8	9.4	15.0	20.7	13.1	13.1	9.4	9.4	24.4	18.8	18.8	28.2	16.9			
MIN.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
PROM	3.8	4.5	5.7	3.3	5.0	4.5	4.8	4.4	3.7	4.1	5.1	5.6	4.2	5.3	6.5	3.6	3.1	3.2	3.3	4.1	3.0	4.5	4.8	3.9			

Código ausencia de datos por instalación estación : *
Código ausencia de datos por falta de energía eléctrica temporalmente : +
N° de datos validos : 736
Recuperación de datos : 100 %
D : Día de medición, correspondiendo el día 1 al 01.10.98 y el día 31 al 31.10.98.
H : Hora de medición a la cual corresponde el promedio horario.
C : Calibración del equipo.

Nota Importante al reverso

AV. MARATHON 2595, FONO: 3502100 - CASILLA 14036 CORREO 21 COD. POSTAL 6900502 FAX 56-2 - 2384135 - SANTIAGO - CHILE - E-mail: cesmec@reuna.cl

cesmec

SEB-10150

MONITOREO DE CALIDAD DEL AIRE

TABLA 7.

LUGAR : CUERPO DE BOMBEROS

VARIABLE : DIOXIDO DE NITROGENO (NO_2)

PERIODO : 1 AL 30 DE SEPTIEMBRE DE 1998

UNIDAD : µg/m³N

D/H	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	24:00	MAX.	MIN.	PROM
1	0.0	3.8	0.0	0.0	3.8	3.8	3.8	0.0	3.8	5.6	5.6	3.8	C	C	C	9.4	3.8	1.9	1.9	0.0	9.4	7.5	9.4	9.4	9.4	0.0	3.6
2	7.5	5.6	5.6	5.6	3.8	3.8	18.8	13.1	15.0	18.8	18.8	15.0	5.6	5.6	5.6	5.6	7.5	3.8	3.8	3.8	9.4	18.8	0.0	18.8	18.8	0.0	9.2
3	13.1	5.6	0.0	0.0	3.8	9.4	18.8	22.5	9.4	5.6	18.8	18.8	9.4	5.6	3.8	0.0	0.0	0.0	1.9	1.9	1.9	9.4	9.4	9.4	22.5	0.0	7.4
4	5.6	7.5	5.6	3.8	9.4	3.8	18.8	22.5	9.4	13.1	22.5	18.8	22.5	5.6	3.8	9.4	5.6	0.0	0.0	18.8	0.0	15.0	18.8	5.6	22.5	0.0	10.2
5	3.8	1.9	3.8	5.6	1.9	0.0	7.5	13.1	0.0	3.8	5.6	5.6	18.8	28.2	0.0	9.4	18.8	3.8	0.0	3.8	9.4	3.8	3.8	7.5	28.2	0.0	6.6
6	5.6	5.6	7.5	3.8	3.8	0.0	5.6	18.8	9.4	11.3	7.5	1.9	3.8	5.6	13.1	9.4	13.1	5.6	0.0	0.0	3.8	9.4	5.6	5.6	18.8	0.0	6.5
7	3.8	7.5	5.6	11.3	7.5	3.8	13.1	13.1	15.0	18.8	1.9	9.4	7.5	9.4	9.4	9.4	9.4	3.8	0.0	22.5	1.9	3.8	9.4	5.6	22.5	0.0	8.4
8	3.8	3.8	1.9	7.5	5.6	7.5	31.9	22.5	9.4	24.4	13.1	28.2	9.4	9.4	5.6	3.8	3.8	15.0	45.1	31.9	28.2	31.9	28.2	9.4	45.1	1.9	15.9
9	0.0	15.0	9.4	9.4	16.9	9.4	31.9	28.2	28.2	18.8	28.2	28.2	15.0	31.9	18.8	15.0	3.8	15.0	28.2	22.5	5.6	1.9	1.9	0.0	31.9	0.0	16.0
10	5.6	1.9	3.8	5.6	5.6	5.6	5.6	3.8	1.9	3.8	5.6	3.8	11.3	3.8	7.5	3.8	18.8	5.6	3.8	0.0	18.8	22.5	9.4	7.5	22.5	0.0	6.9
11	1.9	9.4	9.4	1.9	5.6	5.6	13.1	13.1	13.1	9.4	22.5	15.0	11.3	7.5	5.6	0.0	5.6	3.8	5.6	1.9	11.3	13.1	9.4	9.4	22.5	0.0	8.5
12	18.8	9.4	5.6	9.4	22.5	18.8	22.5	18.8	9.4	3.8	13.1	11.3	3.8	1.9	5.6	3.8	7.5	7.5	9.4	28.2	11.3	13.1	22.5	18.8	28.2	1.9	12.4
13	9.4	13.1	18.8	22.5	9.4	5.6	15.0	41.3	1.9	3.8	3.8	3.8	3.8	5.6	0.0	16.9	3.8	3.8	30.0	60.1	24.4	13.1	5.6	3.8	60.1	0.0	13.3
14	3.8	3.8	5.6	26.3	18.8	9.4	5.6	16.9	3.8	0.0	0.0	0.0	0.0	1.9	9.4	7.5	9.4	5.6	7.5	3.8	9.4	22.5	15.0	18.8	26.3	0.0	8.5
15	13.1	13.1	16.9	18.8	41.3	41.3	22.5	11.3	3.8	3.8	5.6	5.6	5.6	3.8	0.0	1.9	3.8	5.6	3.8	3.8	13.1	9.4	5.6	5.6	41.3	0.0	10.8
16	1.9	0.0	3.8	0.0	0.0	7.5	24.4	26.3	9.4	1.9	9.4	9.4	5.6	9.4	1.9	5.6	3.8	5.6	1.9	5.6	3.8	15.0	9.4	5.6	26.3	0.0	7.0
17	0.0	1.9	5.6	1.9	0.0	3.8	22.5	13.1	5.6	7.5	3.8	3.8	5.6	5.6	1.9	1.9	3.8	3.8	0.0	0.0	20.7	13.1	18.8	9.4	22.5	0.0	6.4
18	1.9	3.8	3.8	0.0	5.6	0.0	1.9	7.5	15.0	5.6	28.2	9.4	3.8	1.9	5.6	5.6	3.8	5.6	5.6	9.4	1.9	7.5	5.6	5.6	28.2	0.0	6.0
19	9.4	9.4	3.8	1.9	3.8	0.0	0.0	0.0	0.0	5.6	3.8	1.9	1.9	5.6	3.8	0.0	3.8	0.0	7.5	20.7	13.1	22.5	31.9	28.2	31.9	0.0	7.4
20	16.9	11.3	5.6	5.6	3.8	5.6	7.5	9.4	9.4	3.8	1.9	0.0	3.8	28.2	5.6	0.0	0.0	0.0	5.6	16.9	16.9	16.9	1.9	0.0	28.2	0.0	7.4
21	1.9	5.6	3.8	5.6	5.6	5.6	1.9	9.4	1.9	3.8	5.6	11.3	9.4	5.6	5.6	5.6	3.8	0.0	3.8	7.5	3.8	3.8	5.6	5.6	11.3	0.0	5.1
22	0.0	0.0	1.9	3.8	5.6	5.6	0.0	3.8	9.4	16.9	28.2	7.5	9.4	9.4	7.5	7.5	3.8	3.8	1.9	18.8	7.5	9.4	5.6	3.8	28.2	0.0	7.1
23	1.9	5.6	3.8	7.5	16.9	18.8	28.2	16.9	1.9	9.4	5.6	9.4	13.1	5.6	3.8	1.9	0.0	5.6	28.2	18.8	5.6	9.4	3.8	5.6	28.2	0.0	9.5
24	7.5	5.6	3.8	0.0	3.8	1.9	9.4	1.9	7.5	3.8	7.5	7.5	3.8	5.6	5.6	3.8	3.8	9.4	0.0	7.5	1.9	3.8	5.6	9.4	9.4	0.0	5.0
25	9.4	0.0	5.6	0.0	0.0	0.0	0.0	5.6	0.0	1.9	9.4	9.4	7.5	3.8	5.6	3.8	3.8	5.6	15.0	1.9	3.8	13.1	15.0	15.0	15.0	0.0	5.6
26	9.4	5.6	7.5	3.8	1.9	3.8	5.6	9.4	5.6	5.6	1.9	3.8	7.5	5.6	0.0	0.0	3.8	0.0	5.6	3.8	5.6	18.8	15.0	22.5	22.5	0.0	6.3
27	9.4	5.6	7.5	13.1	7.5	9.4	22.5	3.8	20.7	22.5	7.5	5.6	3.8	7.5	5.6	5.6	1.9	0.0	3.8	9.4	11.3	9.4	9.4	3.8	22.5	0.0	8.6
28	7.5	3.8	9.4	1.9	7.5	15.0	13.1	18.8	0.0	15.0	9.4	7.5	0.0	5.6	0.0	3.8	3.8	3.8	3.8	13.1	7.5	0.0	0.0	0.0	18.8	0.0	6.3
29	0.0	0.0	18.8	5.6	3.8	0.0	0.0	3.8	0.0	1.9	1.9	5.6	13.1	13.1	3.8	0.0	1.9	3.8	5.6	28.2	9.4	3.8	0.0	3.8	28.2	0.0	5.3
30	1.9	1.9	3.8	5.6	22.5	3.8	5.6	0.0	5.6	5.6	3.8	3.8	5.6	28.2	5.6	7.5	3.8	0.0	9.4	20.7	16.9	5.6	0.0	0.8	28.2	0.0	7.0
MAX.	18.8	15.0	18.8	26.3	41.3	41.3	31.9	41.3	28.2	24.4	28.2	28.2	22.5	31.9	18.8	16.9	18.8	15.0	45.1	60.1	28.2	31.9	31.9	28.2			
MIN.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
PROM	5.8	5.6	6.3	6.3	8.3	6.9	12.6	13.0	7.5	8.5	10.0	8.8	7.6	9.2	5.2	5.3	5.3	4.3	7.9	12.8	9.6	11.6	9.4	8.5			

Código ausencia de datos por instalación estación : *
Código ausencia de datos por falta de energía eléctrica temporalmente : +
N° de datos validos : 717
Recuperación de datos : 100 %
D : Día de medición, correspondiendo el día 1 al 01.09.98 y el día 30 al 30.09.98.
H : Hora de medición a la cual corresponde el promedio horario.
C : Calibración del equipo.

Nota Importante al reverso

AV. MARATHON 2595, FONO: 3502100 - CASILLA 14036 CORREO 21 COD. POSTAL 6900502 FAX 56-2 - 2384135 - SANTIAGO - CHILE - E-mail: cesmec@reuna.cl

MONITOREO DE CALIDAD DEL AIRE

TABLA 7.

LUGAR : CUERPO DE BOMBEROS

VARIABLE : DIOXIDO DE NITROGENO (NO_2)

PERIODO : 1 AL 31 DE AGOSTO DE 1998

UNIDAD : $\mu g/m^3N$

D/H	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	24:00	MAX.	MIN.	PROM
1	26.3	16.9	13.1	13.1	15.0	26.3	11.3	11.3	18.8	13.1	15.0	30.0	22.5	11.3	9.4	7.5	11.3	7.5	15.0	24.4	33.8	20.7	13.1	9.4	33.8	7.5	16.5
2	3.8	5.6	9.4	5.6	9.4	5.6	7.5	9.4	7.5	11.3	7.5	7.5	1.9	5.6	1.9	13.1	9.4	7.5	5.6	5.6	18.8	7.5	5.6	11.3	18.8	1.9	7.7
3	7.5	5.6	5.6	5.6	5.6	5.6	7.5	16.9	26.3	13.1	9.4	13.1	13.1	9.4	7.5	3.8	5.6	7.5	1.9	3.8	15.0	13.1	20.7	13.1	26.3	1.9	9.9
4	15.0	7.5	11.3	13.1	11.3	3.8	3.8	18.8	31.9	5.6	11.3	7.5	9.4	3.8	18.8	9.4	16.9	16.9	11.3	26.3	18.8	16.9	18.8	18.8	31.9	3.8	13.6
5	15.0	7.5	7.5	15.0	11.3	9.4	3.8	11.3	13.1	16.9	9.4	13.1	16.9	15.0	16.9	13.1	7.5	7.5	9.4	11.3	18.8	13.1	22.5	7.5	22.5	3.8	12.2
6	9.4	9.4	9.4	1.9	5.6	0.0	3.8	3.8	1.9	3.8	9.4	28.2	11.3	1.9	0.0	1.9	1.9	1.9	7.5	13.1	7.5	7.5	9.4	3.8	28.2	0.0	7.1
7	11.3	0.0	0.0	0.0	7.5	1.9	3.8	5.6	5.6	9.4	15.0	3.8	1.9	0.0	3.8	0.0	1.9	5.6	1.9	0.0	16.9	7.5	9.4	9.4	16.9	0.0	5.2
8	7.5	9.4	9.4	0.0	1.9	3.8	1.9	5.6	15.0	13.1	16.9	24.4	1.9	1.9	1.9	1.9	1.9	0.0	0.0	7.5	15.0	5.6	5.6	5.6	24.4	0.0	6.6
9	7.5	3.8	3.8	3.8	1.9	1.9	1.9	3.8	5.6	13.1	13.1	3.8	11.3	22.5	9.4	1.9	1.9	3.8	1.9	5.6	9.4	3.8	1.9	9.4	22.5	1.9	6.3
10	5.6	0.0	3.8	1.9	1.9	1.9	3.8	11.3	35.7	11.3	1.9	3.8	9.4	16.9	3.8	1.9	5.6	3.8	0.0	5.6	9.4	11.3	9.4	18.8	35.7	0.0	7.4
11	16.9	15.0	11.3	9.4	15.0	7.5	13.1	16.9	11.3	9.4	3.8	C	C	C	C	C	C	C	13.1	1.9	16.9	7.5	9.4	13.1	16.9	1.9	10.9
12	9.4	3.8	5.6	1.9	5.6	5.6	11.3	13.1	28.2	7.5	3.8	9.4	16.9	11.3	16.9	13.1	1.9	22.5	7.5	11.3	24.4	16.9	31.9	13.1	31.9	1.9	12.2
13	18.8	7.5	1.9	7.5	11.3	5.6	13.1	16.9	9.4	9.4	13.1	9.4	13.1	7.5	18.8	7.5	16.9	15.0	11.3	28.2	26.3	5.6	3.8	11.3	28.2	1.9	12.0
14	5.6	5.6	7.5	9.4	9.4	15.0	16.9	9.4	22.5	15.0	15.0	11.3	15.0	20.7	13.1	13.1	0.0	9.4	9.4	13.1	11.3	13.1	7.5	5.6	22.5	0.0	11.4
15	13.1	3.8	11.3	9.4	3.8	1.9	13.1	16.9	3.8	3.8	11.3	9.4	18.8	18.8	15.0	16.9	11.3	26.3	7.5	13.1	18.8	13.1	9.4	16.9	26.3	1.9	12.0
16	11.3	3.8	5.6	18.8	13.1	18.8	5.6	15.0	5.6	9.4	9.4	15.0	13.1	7.5	0.0	3.8	7.5	5.6	16.9	18.8	13.1	15.0	15.0	26.3	26.3	0.0	11.4
17	11.3	9.4	11.3	18.8	7.5	9.4	18.8	15.0	16.9	13.1	5.6	11.3	7.5	9.4	9.4	18.8	16.9	9.4	9.4	5.6	20.7	24.4	22.5	16.9	24.4	5.6	13.3
18	15.0	13.1	18.8	11.3	11.3	13.1	9.4	18.8	15.0	31.9	13.1	9.4	15.0	7.5	16.9	7.5	5.6	5.6	5.6	7.5	7.5	9.4	13.1	15.0	31.9	5.6	12.4
19	9.4	7.5	7.5	9.4	11.3	9.4	7.5	18.8	16.9	28.2	11.3	18.8	7.5	9.4	9.4	7.5	9.4	3.8	1.9	13.1	31.9	15.0	18.8	26.3	31.9	1.9	12.9
20	9.4	5.6	9.4	5.6	3.8	9.4	5.6	16.9	7.5	7.5	11.3	9.4	7.5	5.6	16.9	26.3	16.9	7.5	24.4	31.9	16.9	33.8	31.9	7.5	33.8	3.8	13.7
21	7.5	7.5	9.4	9.4	9.4	3.8	5.6	7.5	18.8	9.4	7.5	13.1	11.3	9.4	5.6	0.0	13.1	13.1	7.5	11.3	13.1	13.1	3.8	11.3	18.8	0.0	9.2
22	13.1	9.4	3.8	9.4	9.4	5.6	11.3	11.3	13.1	11.3	9.4	11.3	9.4	11.3	5.6	9.4	9.4	3.8	13.1	11.3	9.4	20.7	15.0	15.0	20.7	3.8	10.5
23	11.3	7.5	5.6	18.8	9.4	3.8	5.6	13.1	7.5	5.6	5.6	13.1	16.9	11.3	5.6	11.3	13.1	22.5	5.6	11.3	7.5	5.6	18.8	16.9	22.5	3.8	10.6
24	9.4	0.0	9.4	0.0	9.4	9.4	11.3	9.4	15.0	3.8	16.9	15.0	5.6	3.8	7.5	5.6	15.0	11.3	3.8	16.9	20.7	9.4	11.3	9.4	20.7	0.0	9.5
25	11.3	5.6	11.3	1.9	3.8	7.5	9.4	5.6	15.0	7.5	13.1	7.5	1.9	1.9	0.0	11.3	15.0	3.8	5.6	11.3	16.9	3.8	16.9	11.3	16.9	0.0	8.3
26	22.5	3.8	9.4	5.6	9.4	11.3	5.6	13.1	7.5	11.3	16.9	5.6	13.1	13.1	15.0	3.8	5.6	3.8	9.4	9.4	5.6	9.4	9.4	9.4	22.5	3.8	9.5
27	5.6	11.3	7.5	1.9	1.9	1.9	3.8	11.3	35.7	11.3	1.9	3.8	9.4	16.9	3.8	9.4	5.6	3.8	0.0	5.6	9.4	11.3	9.4	3.8	35.7	0.0	7.7
28	11.3	0.0	7.5	0.0	7.5	1.9	3.8	5.6	5.6	9.4	15.0	3.8	1.9	11.3	3.8	9.4	7.5	0.0	1.9	0.0	16.9	7.5	9.4	9.4	16.9	0.0	6.4
29	7.5	9.4	9.4	0.0	1.9	3.8	1.9	5.6	15.0	13.1	16.9	24.4	1.9	7.5	5.6	1.9	7.5	0.0	0.0	7.5	15.0	5.6	5.6	5.6	24.4	0.0	7.2
30	7.5	3.8	3.8	13.1	1.9	1.9	7.5	3.8	5.6	13.1	13.1	3.8	11.3	22.5	9.4	1.9	1.9	3.8	1.9	5.6	9.4	3.8	1.9	9.4	22.5	1.9	6.9
31	5.6	7.5	3.8	1.9	9.4	1.9	3.8	11.3	35.7	11.3	1.9	3.8	9.4	16.9	3.8	9.4	5.6	3.8	0.0	5.6	9.4	11.3	9.4	3.8	35.7	0.0	7.9
MAX.	26.3	16.9	18.8	18.8	15.0	26.3	18.8	18.8	35.7	31.9	16.9	30.0	22.5	22.5	18.8	26.3	16.9	26.3	24.4	31.9	33.8	33.8	31.9	26.3			
MIN.	3.8	0.0	0.0	0.0	1.9	0.0	1.9	3.8	1.9	3.8	1.9	3.8	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.6	3.8	1.9	3.8			
PROM	11.0	6.7	7.9	7.2	7.6	6.7	7.5	11.4	15.3	11.4	10.5	11.5	10.2	10.4	8.5	8.1	8.3	7.9	7.1	11.1	15.6	11.7	12.6	12.0			

Código ausencia de datos por instalación estación : *
Código ausencia de datos por falta de energía eléctrica temporalmente : +
N° de datos validos : 737
Recuperación de datos : 100 %
D : Día de medición, correspondiendo el día 1 al 01.08.98 y el día 31 al 31.08.98.
H : Hora de medición a la cual corresponde el promedio horario.
C : Calibración del equipo.

Nota Importante al reverso

AV. MARATHON 2595, FONO: 3502100 - CASILLA 14036 CORREO 21 COD. POSTAL 6900502 FAX 56-2 - 2384135 - SANTIAGO - CHILE - E-mail: cesmec@reuna.cl

MONITOREO DE CALIDAD DEL AIRE

TABLA 7.

LUGAR : CUERPO DE BOMBEROS

PERIODO : 1 AL 31 DE JULIO DE 1998

VARIABLE : DIOXIDO DE NITROGENO (NO_2)

UNIDAD : µg/m³N

D/H	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	24:00	MAX.	MIN.	PROM
1	13.1	11.3	3.8	3.8	1.9	3.8	5.6	16.9	1.9	1.9	3.8	7.5	5.6	15.0	5.6	13.1	5.6	7.5	18.8	9.4	9.4	1.9	7.5	26.3	26.3	1.9	8.4
2	1.9	16.9	15.0	1.9	16.9	0.0	0.0	22.5	24.4	16.9	5.6	5.6	1.9	18.8	22.5	5.6	13.1	3.8	5.6	18.8	0.0	30.0	15.0	0.0	30.0	0.0	11.0
3	0.0	7.5	5.6	0.0	0.0	5.6	3.8	13.1	1.9	15.0	1.9	9.4	5.6	16.9	0.0	5.6	1.9	0.0	0.0	11.3	1.9	9.4	3.8	11.3	16.9	0.0	5.5
4	0.0	1.9	11.3	11.3	9.4	16.9	1.9	11.3	15.0	3.8	7.5	1.9	0.0	1.9	0.0	5.6	7.5	15.0	22.5	3.8	3.8	15.0	1.9	16.9	22.5	0.0	7.7
5	13.1	13.1	15.0	5.6	1.9	15.0	15.0	13.1	16.9	22.5	31.9	5.6	0.0	13.1	26.3	15.0	0.0	11.3	9.4	1.9	13.1	16.9	5.6	5.6	31.9	0.0	12.0
6	11.3	5.6	15.0	3.8	7.5	13.1	3.8	9.4	35.7	7.5	5.6	16.9	15.0	9.4	15.0	5.6	5.6	3.8	7.5	3.8	20.7	3.8	5.6	7.5	35.7	3.8	9.9
7	0.0	1.9	0.0	13.1	9.4	9.4	7.5	20.7	7.5	0.0	5.6	5.6	5.6	3.8	5.6	13.1	11.3	9.4	22.5	5.6	22.5	3.8	20.7	3.8	22.5	0.0	8.7
8	0.0	3.8	7.5	1.9	7.5	3.8	13.1	18.8	5.6	5.6	13.1	13.1	5.6	7.5	11.3	7.5	3.8	5.6	5.6	16.9	1.9	5.6	9.4	3.8	18.8	0.0	7.4
9	16.9	0.0	11.3	7.5	5.6	5.6	20.7	1.9	18.8	1.9	9.4	9.4	7.5	5.6	5.6	3.8	3.8	20.7	7.5	13.1	16.9	3.8	5.6	5.6	20.7	0.0	8.7
10	7.5	3.8	3.8	5.6	11.3	5.6	18.8	13.1	37.6	9.4	9.4	13.1	11.3	13.1	5.6	5.6	9.4	9.4	3.8	3.8	1.9	9.4	1.9	5.6	37.6	1.9	9.2
11	9.4	9.4	7.5	7.5	3.8	3.8	9.4	1.9	3.8	13.1	13.1	15.0	39.4	9.4	7.5	26.3	9.4	5.6	0.0	7.5	7.5	1.9	13.1	11.3	39.4	0.0	9.9
12	3.8	9.4	5.6	5.6	7.5	16.9	9.4	7.5	1.9	5.6	15.0	3.8	7.5	11.3	1.9	3.8	13.1	18.8	5.6	5.6	3.8	15.0	15.0	3.8	18.8	1.9	8.2
13	13.1	7.5	1.9	1.9	7.5	3.8	1.9	11.3	13.1	18.8	16.9	16.9	7.5	11.3	3.8	7.5	0.0	3.8	3.8	35.7	33.8	11.3	5.6	7.5	35.7	0.0	10.2
14	5.6	3.8	9.4	7.5	5.6	7.5	1.9	5.6	30.0	37.6	28.2	13.1	9.4	13.1	5.6	1.9	11.3	11.3	3.8	7.5	9.4	9.4	11.3	7.5	37.6	1.9	10.7
15	5.6	7.5	1.9	3.8	5.6	0.0	0.0	18.8	13.1	13.1	1.9	3.8	7.5	3.8	1.9	3.8	9.4	3.8	7.5	7.5	3.8	26.3	13.1	5.6	26.3	0.0	7.3
16	5.6	7.5	0.0	3.8	1.9	7.5	1.9	5.6	26.3	3.8	5.6	7.5	0.0	0.0	3.8	5.6	5.6	3.8	1.9	1.9	3.8	11.3	11.3	22.5	26.3	0.0	6.2
17	15.0	9.4	3.8	5.6	9.4	3.8	3.8	3.8	16.9	7.5	11.3	11.3	9.4	7.5	5.6	5.6	3.8	1.9	11.3	9.4	7.5	7.5	13.1	18.8	18.8	1.9	8.4
18	3.8	1.9	3.8	0.0	7.5	3.8	3.8	22.5	16.9	9.4	3.8	3.8	3.8	7.5	13.1	18.8	20.7	3.8	3.8	7.5	1.9	16.9	26.3	20.7	26.3	0.0	9.4
19	13.1	11.3	1.9	1.9	3.8	3.8	5.6	5.6	11.3	13.1	15.0	18.8	18.8	20.7	3.8	9.4	3.8	7.5	3.8	1.9	18.8	3.8	7.5	13.1	20.7	1.9	9.1
20	9.4	7.5	7.5	0.0	1.9	3.8	0.0	15.0	28.2	1.9	0.0	11.3	16.9	5.6	5.6	0.0	7.5	9.4	11.3	5.6	28.2	3.8	24.4	15.0	28.2	0.0	9.6
21	11.3	0.0	5.6	9.4	11.3	3.8	1.9	11.3	9.4	9.4	13.1	9.4	13.1	26.3	16.9	20.7	3.8	15.0	5.6	35.7	22.5	5.6	3.8	13.1	35.7	0.0	11.6
22	9.4	7.5	5.6	5.6	5.6	15.0	13.1	15.0	18.8	24.4	24.4	13.1	20.7	20.7	9.4	7.5	9.4	9.4	9.4	7.5	3.8	11.3	7.5	7.5	24.4	3.8	11.7
23	5.6	7.5	22.5	3.8	3.8	1.9	3.8	13.1	18.8	16.9	7.5	5.6	13.1	9.4	3.8	3.8	5.6	5.6	11.3	33.8	33.8	30.0	7.5	9.4	33.8	1.9	11.6
24	1.9	16.9	9.4	7.5	5.6	9.4	0.0	16.9	11.3	13.1	15.0	9.4	15.0	7.5	1.9	0.0	7.5	7.5	5.6	30.0	30.0	24.4	16.9	26.3	30.0	0.0	12.0
25	11.3	9.4	1.9	18.8	7.5	3.8	18.8	15.0	16.9	13.1	5.6	11.3	1.9	1.9	9.4	18.8	16.9	9.4	9.4	5.6	20.7	24.4	22.5	16.9	24.4	1.9	12.1
26	15.0	13.1	18.8	11.3	11.3	13.1	9.4	18.8	15.0	31.9	13.1	9.4	15.0	7.5	16.9	7.5	5.6	5.6	5.6	7.5	7.5	9.4	13.1	15.0	31.9	5.6	12.4
27	9.4	7.5	7.5	9.4	11.3	9.4	7.5	18.8	16.9	28.2	11.3	18.8	7.5	9.4	9.4	7.5	9.4	3.8	1.9	13.1	31.9	15.0	18.8	26.3	31.9	1.9	12.9
28	9.4	11.3	9.4	5.6	3.8	3.8	5.6	16.9	7.5	7.5	11.3	9.4	7.5	5.6	16.9	26.3	16.9	7.5	24.4	31.9	16.9	33.8	31.9	7.5	33.8	3.8	13.7
29	7.5	7.5	9.4	9.4	1.9	3.8	5.6	7.5	18.8	9.4	7.5	13.1	11.3	9.4	5.6	5.6	16.9	13.1	7.5	11.3	13.1	13.1	3.8	11.3	18.8	1.9	9.3
30	13.1	9.4	7.5	9.4	9.4	5.6	11.3	15.0	13.1	11.3	9.4	11.3	9.4	11.3	5.6	9.4	9.4	3.8	13.1	7.5	9.4	7.5	15.0	13.1	15.0	3.8	10.0
31	11.3	9.4	9.4	9.4	7.5	7.5	5.6	11.3	15.0	16.9	5.6	13.1	24.4	7.5	1.9	9.4	3.8	5.6	5.6	13.1	11.3	9.4	16.9	7.8	24.4	1.9	9.9
MAX.	16.9	16.9	22.5	18.8	16.9	16.9	20.7	22.5	37.6	37.6	31.9	18.8	39.4	26.3	26.3	26.3	20.7	20.7	24.4	35.7	33.8	33.8	31.9	26.3			
MIN.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.9	1.9	0.0	1.9	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.9	0.0	1.9	1.9	0.0			
PROM.	8.2	7.8	7.7	6.2	6.6	7.0	6.8	12.8	15.7	12.6	11.0	10.2	10.2	10.1	8.0	9.0	8.1	7.8	8.2	12.1	13.3	12.6	12.1	11.8			

Código ausencia de datos por instalación estación : *
Código ausencia de datos por falta de energía eléctrica temporalmente : +
N° de datos validos : 744
Recuperación de datos : 100 %
D : Día de medición, correspondiendo el día 1 al 01.07.98 y el día 31 al 31.07.98.
H : Hora de medición a la cual corresponde el promedio horario.

Nota Importante al reverso

AV. MARATHON 2595, FONO: 2380556 - CASILLA 14036 CORREO 21 FAX 56-2 - 2384135 - SANTIAGO - CHILE - E-MAIL: cesmec@reuna.cl

MONITOREO DE CALIDAD DEL AIRE

TABLA 7.

LUGAR : CUERPO DE BOMBEROS

PERIODO : 1 AL 30 DE JUNIO DE 1998

VARIABLE : DIOXIDO DE NITROGENO (NO2)

UNIDAD : µg/m3N

D/H	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	24:00	MAX.	MIN.	PROM
1	5.8	3.7	2.3	3.1	1.5	2.6	3.8	6.5	10.2	7.0	9.3	4.8	8.8	5.2	3.5	2.9	5.3	5.3	10.6	14.6	11.9	11.8	9.0	5.0	14.6	1.5	6.4
2	5.8	3.7	2.2	3.0	1.4	2.6	3.7	6.4	10.1	7.0	9.1	4.8	8.8	5.1	3.5	2.9	5.2	5.2	10.7	14.8	12.1	11.8	8.9	5.0	14.8	1.4	6.4
3	5.8	3.6	2.1	2.9	1.4	2.5	3.6	6.5	10.2	7.0	8.7	4.6	8.9	5.0	3.4	2.8	4.9	5.0	10.7	14.9	12.1	11.6	8.6	4.9	14.9	1.4	6.3
4	5.7	3.5	2.0	2.8	1.3	2.3	3.6	6.7	10.2	6.9	8.0	4.4	8.8	4.6	3.3	2.7	4.5	4.6	10.5	14.8	12.1	11.3	8.2	5.0	14.8	1.3	6.2
5	5.7	4.4	2.2	2.9	1.4	2.6	3.9	7.2	10.6	6.6	8.7	4.5	9.4	4.3	3.1	2.9	4.7	4.6	8.4	10.6	10.8	10.6	7.9	4.3	10.8	1.4	5.9
6	5.3	4.3	2.4	3.0	1.5	2.8	4.3	7.7	10.7	6.6	7.6	4.3	10.1	4.3	2.8	3.2	4.7	4.1	8.8	10.5	10.7	10.7	7.9	4.7	10.7	1.5	6.0
7	3.6	3.5	2.7	2.9	1.7	3.1	4.8	8.1	11.1	7.3	9.0	5.2	5.4	4.2	3.1	3.5	5.2	4.6	9.8	11.7	11.9	11.9	8.8	5.2	11.9	1.7	6.2
8	4.1	3.8	3.1	2.8	1.9	2.8	4.9	8.4	10.8	7.7	10.1	5.9	6.1	4.7	3.5	4.0	5.9	5.2	11.0	13.1	13.4	13.4	9.6	5.4	13.4	1.9	6.7
9	5.4	4.2	2.7	3.0	2.1	2.7	5.1	8.6	11.8	8.3	11.5	6.7	7.0	5.1	3.5	2.7	6.2	5.9	12.6	13.7	12.6	12.3	9.1	4.8	13.7	2.1	7.0
10	5.0	4.8	3.1	3.4	2.5	2.8	5.3	7.8	10.6	7.2	12.5	5.9	8.1	5.9	4.1	3.1	7.2	6.6	9.1	11.3	9.7	11.9	10.6	5.6	12.5	2.5	6.8
11	6.0	4.5	3.0	4.1	2.3	3.4	4.1	5.6	9.0	7.5	14.3	7.1	8.3	7.1	4.9	3.8	8.6	7.9	10.9	13.5	11.6	14.3	12.8	5.3	14.3	2.3	7.5
12	7.5	5.2	3.3	5.2	2.8	4.2	4.2	4.2	10.3	8.4	17.8	8.0	10.3	8.9	4.2	4.7	9.4	9.9	13.6	16.9	12.2	14.6	13.1	4.2	17.8	2.8	8.5
13	6.3	2.5	0.0	1.3	0.0	0.0	0.0	1.3	6.3	7.5	16.9	6.3	15.6	10.6	3.8	0.0	4.4	6.3	12.5	16.3	14.4	11.9	10.0	5.6	16.9	0.0	6.6
14	9.4	3.8	0.0	1.9	0.0	0.0	0.0	1.9	9.4	6.6	19.7	7.5	3.8	3.8	5.6	0.0	4.7	9.4	4.7	11.3	12.2	9.4	8.4	0.0	19.7	0.0	5.6
15	15.0	7.5	0.0	3.8	0.0	0.0	0.0	3.8	7.5	9.4	16.9	7.5	5.6	5.6	11.3	0.0	0.0	11.3	0.0	3.8	13.1	11.3	13.1	0.0	16.9	0.0	6.1
16	5.0	4.1	3.1	3.4	2.5	2.8	5.3	7.8	10.6	7.2	12.5	5.9	8.1	5.9	4.1	3.1	7.2	6.6	9.1	11.3	9.7	11.9	10.6	5.6	12.5	2.5	6.8
17	6.0	4.5	3.0	4.1	2.3	3.4	4.1	5.6	9.0	7.5	14.3	7.1	8.3	7.1	4.9	3.8	8.6	7.9	10.9	13.5	11.6	14.3	12.8	5.3	14.3	2.3	7.5
18	7.5	5.2	3.3	5.2	2.8	4.2	4.2	4.2	10.3	8.4	17.8	8.0	10.3	8.9	4.2	4.7	9.4	9.9	13.6	16.9	12.2	14.6	13.1	4.2	17.8	2.8	8.5
19	6.3	2.5	0.0	1.3	0.0	0.0	0.0	1.3	6.3	10.0	1.9	3.1	2.5	8.8	5.6	0.0	2.5	4.4	32.5	60.7	26.3	19.4	11.3	13.1	60.7	0.0	9.2
20	9.4	3.8	0.0	1.9	0.0	0.0	0.0	1.9	9.4	6.6	19.7	7.5	3.8	3.8	5.6	0.0	4.7	9.4	4.7	11.3	12.2	9.4	8.4	0.0	19.7	0.0	5.6
21	15.0	7.5	0.0	3.8	0.0	0.0	0.0	3.8	7.5	0.0	C	C	C	5.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	15.0	0.0	2.1
22	0.0	1.9	0.0	3.8	0.0	5.6	3.8	5.6	13.1	3.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.9	3.8	13.1	0.0	1.8
23	0.0	0.0	5.6	1.9	0.0	3.8	3.8	7.5	3.8	3.8	0.0	0.0	0.0	1.9	3.8	13.1	3.8	0.0	0.0	9.4	18.8	20.7	13.1	9.4	20.7	0.0	5.2
24	7.5	1.9	0.0	0.0	0.0	1.9	3.8	13.1	18.8	15.0	5.6	11.3	0.0	0.0	0.0	0.0	0.0	1.9	33.8	28.2	30.0	15.0	0.0	0.0	33.8	0.0	7.8
25	0.0	1.9	3.8	0.0	3.8	0.0	11.3	18.8	18.8	5.6	3.8	0.0	7.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.5	18.8	0.0	3.4
26	0.0	1.9	1.9	0.0	0.0	0.0	3.8	11.3	3.8	3.8	0.0	3.8	0.0	0.0	7.5	0.0	5.6	0.0	0.0	0.0	9.4	13.1	11.3	9.4	13.1	0.0	3.6
27	11.3	13.1	13.1	16.9	11.3	16.9	16.9	13.1	22.5	11.3	20.7	13.1	18.8	20.7	1.9	11.3	18.8	16.9	16.9	18.8	5.6	22.5	22.5	0.0	22.5	0.0	14.8
28	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.4	11.3	3.8	15.0	7.5	3.8	7.5	9.4	3.8	28.2	26.3	18.8	16.9	13.1	16.9	28.2	0.0	8.0
29	3.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.3	3.8	22.5	7.5	1.9	1.9	0.0	0.0	9.4	7.5	9.4	18.8	11.3	7.5	3.8	0.0	22.5	0.0	5.0
30	15.0	7.5	0.0	3.8	0.0	0.0	0.0	3.8	7.5	9.4	16.9	7.5	5.6	5.6	11.3	0.0	0.0	11.3	0.0	3.8	13.1	11.3	13.1	0.0	16.9	0.0	6.1
MAX.	15.0	13.1	13.1	16.9	11.3	16.9	16.9	18.8	22.5	15.0	22.5	13.1	18.8	20.7	11.3	13.1	18.8	16.9	33.8	60.7	30.0	22.5	22.5	16.9			
MIN.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
PROM	6.1	4.0	2.2	3.1	1.5	2.4	3.6	6.3	10.0	7.2	11.3	5.7	7.1	5.4	3.9	2.8	5.3	5.8	10.1	13.7	12.0	11.8	9.4	4.7			

Código ausencia de datos por instalación estación : *
Código ausencia de datos por falta de energía eléctrica temporalmente : +
N° de datos validos : 717
Recuperación de datos : 100 %
D : Día de medición, correspondiendo el día 1 al 01.06.98 y el día 30 al 30.06.98.
H : Hora de medición a la cual corresponde el promedio horario.
C : Calibración equipo

Nota importante al reverso

TABLA 7.

MONITOREO DE CALIDAD DEL AIRE

LUGAR : CUERPO DE BOMBEROS

PERIODO : 1 AL 31 DE MAYO DE 1998

VARIABLE : DIOXIDO DE NITROGENO (NO2)

UNIDAD : µg/m3N

D/H	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	24:00	MAX.	MIN.	PROM
1	93.9	93.9	93.9	93.9	93.9	93.9	93.9	93.9	93.9	93.9	93.9	93.9	93.9	93.9	93.9	93.9	93.9	93.9	93.9	93.9	93.9	93.9	93.9	93.9	93.9	93.9	93.9
2	93.9	93.9	93.9	93.9	93.9	93.9	93.9	93.9	93.9	93.9	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	93.9	95.0
3	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8
4	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8
5	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	63.8	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	95.8	26.3	62.6
6	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3
7	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3
8	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	15.0	0.0	1.9	1.9	1.9	0.0	0.0	0.0	0.0	0.0	0.0	1.9	1.9	1.9	1.9	1.9	26.3	0.0	10.0
9	1.9	0.0	1.9	1.9	1.9	0.0	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	0.0	0.9
10	1.9	0.0	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	0.0	1.9	1.9	1.9	1.9	1.9	1.9	1.9	0.0	1.7
11	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	0.0	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	0.0	1.8
12	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9
13	1.9	1.9	1.9	1.9	1.9	1.9	0.0	1.9	0.0	0.0	1.9	0.0	1.9	1.9	1.9	1.9	0.0	1.9	0.0	1.9	1.9	0.0	0.0	1.9	1.9	0.0	1.3
14	1.9	0.0	1.9	0.0	1.9	1.9	0.0	1.9	1.9	1.9	1.9	1.9	1.9	1.9	0.0	1.9	0.0	1.9	1.9	0.0	1.9	1.9	1.9	1.9	1.9	0.0	1.4
15	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9
16	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	0.0	1.9	0.0	1.9	1.9	0.0	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	0.0	1.6
17	1.9	1.9	1.9	0.0	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	0.0	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	0.0	1.7
18	1.9	0.0	1.9	1.9	0.0	1.9	1.9	1.9	1.9	1.9	0.0	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	0.0	1.9	1.9	1.9	0.0	1.6
19	1.9	1.9	0.0	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	0.0	0.0	1.9	0.0	1.9	1.9	1.9	1.9	3.8	1.9	1.9	1.9	3.8	0.0	1.6
20	1.9	1.9	1.9	1.9	1.9	0.0	1.9	1.9	1.9	0.0	0.0	1.9	1.9	0.0	1.9	1.9	0.0	0.0	1.9	0.0	0.0	0.0	1.9	0.0	1.9	0.0	1.1
21	0.0	1.9	0.0	0.0	0.0	0.0	1.9	1.9	0.0	0.0	1.9	1.9	0.0	0.0	0.0	0.0	0.0	0.0	1.9	0.0	0.0	0.0	1.9	0.0	1.9	0.0	0.5
22	1.9	0.0	1.9	0.0	1.9	0.0	0.0	0.0	0.0	1.9	0.0	1.9	0.0	0.0	0.0	0.0	1.9	1.9	0.0	1.9	1.9	0.0	0.0	0.0	1.9	0.0	0.7
23	0.0	1.9	1.9	1.9	1.9	1.9	1.9	0.0	1.9	1.9	+	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	0.0	1.9	1.9	0.0	1.9	0.0	1.6
24	1.9	1.9	0.0	0.0	1.9	0.0	1.9	1.9	1.9	1.9	0.0	1.9	1.9	1.9	1.9	1.9	0.0	1.9	0.0	1.9	1.9	0.0	1.9	1.9	1.9	0.0	1.3
25	1.9	1.9	1.9	1.9	0.0	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	0.0	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	0.0	1.7
26	1.9	1.9	0.0	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.9	0.0	0.8
27	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.9	0.0	0.0	0.0	0.0	0.0	1.9	0.0	0.0	1.9	1.9	1.9	0.0	1.9	1.9	1.9	1.9	0.0	0.6
28	1.9	1.9	1.9	1.9	0.0	1.9	0.0	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	0.0	1.7
29	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	0.0	1.9	1.9	0.0	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	0.0	1.7
30	1.9	0.0	1.9	0.0	1.9	0.0	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	0.0	1.9	0.0	0.0	1.9	1.9	1.9	1.9	1.9	1.9	1.9	0.0	1.4
31	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9
MAX.	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8			
MIN.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
PROM	19.1	18.8	19.0	18.8	19.0	18.8	19.0	19.0	18.7	18.1	18.7	18.2	17.1	15.7	15.9	15.7	15.6	15.9	16.0	16.1	16.1	15.9	16.1	16.5			

Código ausencia de datos por instalación estación : *
Código ausencia de datos por falta de energía eléctrica temporalmente : +
N° de datos validos : 743
Recuperación de datos : 100 %
D : Día de medición, correspondiendo el día 1 al 01.05.98 y el día 31 al 31.05.98.
H : Hora de medición a la cual corresponde el promedio horario.

Nota importante al reverso

AV. MARATHON 2595, FONO: 2380556 - CASILLA 14036 CORREO 21 FAX 56-2- ...

MONITOREO DE CALIDAD DEL AIRE

TABLA 7.

LUGAR : CUERPO DE BOMBERO

VARIABLE : DIOXIDO DE NITROGENO (NO2)

PERIODO : 1 AL 30 DE ABRIL DE 1998

UNIDAD : µg/m3N

D/H	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	24:00	MAX.	MIN.	PROM
1	1.9	0.0	0.0	0.0	5.6	0.0	0.0	3.8	24.4	0.0	0.0	0.0	0.0	0.0	7.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.9	24.4	0.0	1.9
2	0.0	0.0	3.8	0.0	0.0	0.0	0.0	0.0	7.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.5	0.0	0.5
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.9	3.8	37.6	16.9	9.4	3.8	37.6	0.0	3.1
4	7.5	0.0	0.0	0.0	0.0	0.0	0.0	3.8	18.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.5	18.8	0.0	1.6
5	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	15.0	0.0	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	15.0	0.0	0.8
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	28.2	1.9	0.0	0.0	7.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.9	0.0	11.3	1.9	28.2	0.0	2.8
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	24.4	0.0	60.1	5.6	0.0	0.0	0.0	0.0	0.0	0.0	60.1	0.0	3.8
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.6	7.5	9.4	9.4	0.0	0.9
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.9	0.0	0.0	0.0	1.9	0.0	0.1
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.9	3.8	9.4	5.6	0.0	0.0	13.1	0.0	1.4
12	0.0	0.0	0.0	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.6	0.0	0.3
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	15.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	15.0	0.0	0.6
14	11.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	24.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.9	0.0	1.9	24.4	0.0	1.6
15	0.0	3.8	0.0	0.0	0.0	0.0	0.0	0.0	7.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.7	0.0	0.0	0.0	20.7	0.0	1.3
16	3.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.3	0.0	26.3	15.0	15.0	16.9	20.7	30.0	31.9	26.3	20.7	22.5	30.0	48.8	52.6	45.1	52.6	0.0	17.4
17	41.3	30.0	31.9	22.5	18.8	22.5	22.5	33.8	48.8	41.3	30.0	22.5	30.0	43.2	48.8	43.2	20.7	24.4	41.3	60.1	16.9	24.4	24.4	15.0	60.1	15.0	31.6
18	28.2	26.3	20.7	28.2	16.9	15.0	26.3	75.1	67.6	35.7	26.3	18.8	18.8	16.9	18.8	15.0	15.0	20.7	24.4	20.7	20.7	13.1	20.7	37.6	75.1	13.1	26.1
19	50.7	43.2	22.5	16.9	31.9	30.0	24.4	20.7	28.2	41.3	39.4	30.0	20.7	24.4	31.9	22.5	15.0	28.2	16.9	15.0	20.7	15.0	15.0	28.2	50.7	15.0	26.4
20	20.7	16.9	24.4	11.3	11.3	7.5	11.3	24.4	48.8	22.5	13.1	22.5	16.9	20.7	45.1	24.4	15.0	13.1	22.5	15.0	13.1	60.1	31.9	33.8	60.1	7.5	22.8
21	35.7	30.0	20.7	16.9	24.4	31.9	33.8	41.3	78.9	77.0	20.7	15.0	26.3	35.7	30.0	18.8	15.0	16.9	22.5	16.9	45.1	33.8	41.3	41.3	78.9	15.0	32.1
22	37.6	52.6	48.8	33.8	24.4	26.3	22.5	31.9	48.8	28.2	20.7	16.9	16.9	15.0	15.0	15.0	18.8	20.7	20.7	24.4	37.6	43.2	30.0	22.5	52.6	15.0	28.0
23	30.0	20.7	20.7	18.8	20.7	15.0	16.9	22.5	37.6	33.8	41.3	35.7	45.1	33.8	26.3	22.5	16.9	20.7	15.0	22.5	37.6	43.2	54.5	54.5	54.5	15.0	29.4
24	46.9	52.6	24.4	16.9	9.4	9.4	9.4	18.8	30.0	39.4	26.3	28.2	24.4	15.0	15.0	13.1	18.8	26.3	30.0	15.0	31.9	41.3	31.9	26.3	52.6	9.4	25.0
25	33.8	20.7	18.8	16.9	20.7	18.8	22.5	33.8	31.9	46.9	20.7	18.8	20.7	16.9	15.0	13.1	11.3	13.1	15.0	15.0	18.8	30.0	24.4	28.2	46.9	11.3	21.9
26	16.9	24.4	11.3	15.0	9.4	7.5	15.0	7.5	13.1	15.0	16.9	11.3	11.3	13.1	15.0	13.1	13.1	11.3	18.8	15.0	39.4	46.9	35.7	20.7	46.9	7.5	17.4
27	18.8	11.3	20.7	13.1	11.3	11.3	16.9	22.5	33.8	48.8	28.2	26.3	28.2	39.4	26.3	15.0	18.8	18.8	16.9	35.7	48.8	41.3	50.7	37.6	50.7	11.3	26.7
28	31.9	30.0	31.9	22.5	16.9	28.2	54.5	67.6	46.9	39.4	39.4	41.3	46.9	37.6	16.9	15.0	15.0	16.9	26.3	92.0	93.9	93.9	93.9	93.9	93.9	15.0	45.5
29	93.9	93.9	93.9	93.9	93.9	93.9	93.9	93.9	93.9	93.9	93.9	93.9	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	93.9	93.9	95.8	93.9	94.7
30	93.9	93.9	93.9	93.9	93.9	93.9	93.9	93.9	93.9	93.9	93.9	93.9	93.9	93.9	93.9	95.8	95.8	95.8	93.9	93.9	93.9	93.9	93.9	93.9	95.8	93.9	94.1
MAX.	93.9	93.9	93.9	93.9	93.9	93.9	93.9	93.9	93.9	93.9	93.9	93.9	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	93.9	93.9			
MIN.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
PROM	20.2	18.3	16.3	14.1	13.6	13.7	15.5	19.8	28.4	22.0	18.0	16.3	18.0	17.3	18.2	15.1	15.9	15.1	16.1	18.9	24.3	25.2	24.1	23.3			

Código ausencia de datos por instalación estación : *

Código ausencia de datos por falta de energía eléctrica temporalmente : +

N° de datos validos : 720

Recuperación de datos : 100 %

D : Día de medición, correspondiendo el día 1 al 01.04.98 y el día 30 al 30.04.98.

H : Hora de medición a la cual corresponde el promedio horario.

Nota importante al reverso

MONITOREO DE CALIDAD DEL AIRE

TABLA 7.

LUGAR : Cuerpo de Bomberos

PERIODO : 2 al 31 de Marzo de 1998

VARIABLE : DIOXIDO DE NITROGENO (NO2)

UNIDAD : µg/m3N

D/H	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	24:00	MAX.	MIN.	PROM
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.5	0.0	28.2	9.4	5.6	1.9	1.9	0.0	3.8	28.2	0.0	2.4
3	0.0	0.0	0.0	0.0	0.0	0.0	9.4	16.9	20.7	20.7	18.8	13.1	5.6	1.9	1.9	0.0	0.0	0.0	0.0	1.9	1.9	7.5	3.8	3.8	20.7	0.0	5.3
4	5.6	0.0	0.0	0.0	1.9	0.0	28.2	15.0	9.4	1.9	3.8	3.8	15.0	7.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.9	0.0	0.0	28.2	0.0	3.9
5	0.0	0.0	0.0	0.0	0.0	0.0	7.5	20.7	1.9	1.9	0.0	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.6	1.9	0.0	20.7	0.0	1.7
6	0.0	0.0	0.0	0.0	0.0	0.0	3.8	0.0	1.9	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.8	0.0	0.3
7	0.0	0.0	0.0	1.9	0.0	0.0	0.0	1.9	0.0	0.0	0.0	5.6	13.1	9.4	0.0	0.0	0.0	0.0	0.0	0.0	11.3	13.1	0.0	0.0	13.1	0.0	2.3
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	30.0	1.9	0.0	0.0	11.3	5.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.9	0.0	30.0	0.0	2.1
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.9	0.0	0.0	0.0	0.0	0.0	1.9	5.6	1.9	0.0	0.0	0.0	5.6	0.0	0.5
10	0.0	0.0	0.0	0.0	0.0	0.0	1.9	9.4	1.9	3.8	13.1	7.5	1.9	1.9	0.0	0.0	0.0	0.0	0.0	0.0	1.9	0.0	0.0	0.0	13.1	0.0	1.8
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.8	7.5	0.0	0.0	0.0	3.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.5	0.0	0.6
12	0.0	0.0	0.0	0.0	3.8	0.0	5.6	16.9	1.9	0.0	24.4	11.3	3.8	0.0	1.9	0.0	0.0	0.0	0.0	0.0	0.0	11.3	0.0	0.0	24.4	0.0	3.4
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.6	0.0	0.2
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.9	0.0	0.0	0.0	0.0	0.0	0.0	13.1	1.9	33.8	5.6	0.0	33.8	0.0	2.3
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.9	5.6	0.0	0.0	0.0	0.0	0.0	3.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.6	0.0	0.5
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.4	3.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.9	0.0	9.4	0.0	0.6
17	1.9	3.8	5.6	0.0	7.5	0.0	5.6	9.4	15.0	5.6	0.0	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.1	5.6	0.0	0.0	15.0	0.0	3.1
18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.8	9.4	0.0	0.0	0.0	0.0	0.0	0.0	1.9	0.0	0.0	9.4	0.0	0.6
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.8	0.0	3.8	0.0	0.3
20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.9	11.3	1.9	0.0	0.0	0.0	11.3	7.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.3	0.0	1.4
21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.6	1.9	0.0	3.8	0.0	0.0	0.0	0.0	7.5	3.8	0.0	1.9	7.5	0.0	1.0
22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.4	5.6	5.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	26.3	3.8	5.6	1.9	26.3	0.0	2.4
23	0.0	0.0	0.0	0.0	15.0	16.9	3.8	0.0	11.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.9	0.0	2.0
24	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.8	0.0	0.2
25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.9	3.8	3.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.8	0.0	0.4
26	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.9	9.4	0.0	0.0	1.9	0.0	0.0	5.6	0.0	0.0	0.0	1.9	3.8	5.6	0.0	0.0	3.8	9.4	0.0	1.4
27	0.0	0.0	0.0	0.0	1.9	0.0	0.0	33.8	9.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.8	1.9	0.0	18.8	0.0	0.0	0.0	0.0	33.8	0.0	2.9
28	1.9	1.9	0.0	0.0	0.0	0.0	1.9	1.9	7.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.9	0.0	16.9	0.0	1.3
29	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30	0.0	0.0	0.0	0.0	0.0	0.0	5.6	0.0	22.5	7.5	9.4	0.0	0.0	0.0	3.8	18.8	7.5	0.0	0.0	0.0	5.6	0.0	5.6	5.6	22.5	0.0	3.8
MAX.	5.6	3.8	5.6	1.9	15.0	16.9	28.2	33.8	22.5	20.7	24.4	13.1	15.0	11.3	9.4	18.8	7.5	28.2	9.4	18.8	26.3	33.8	16.9	5.6			
MIN.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
PROM	0.3	0.2	0.2	0.1	1.0	0.6	2.4	5.9	4.9	1.8	2.3	2.3	2.2	1.6	1.1	1.0	0.4	1.0	0.4	1.6	2.6	3.0	1.6	0.7			

Código ausencia de datos por instalación estación : *
Código ausencia de datos por falta de energía eléctrica temporalmente : +
N° de datos validos : 704
Recuperación de datos : 100 %
D : Día de medición, correspondiendo el día 1 al 02.03.98 y el día 30 al 31.03.98.
H : Hora de medición a la cual corresponde el promedio horario.

Nota importante al reverso

TABLA N° 6
ESTACION : BOMBEROS
PARAMETRO : NO2
UNIDAD : ug/m3N
PERIODO : Febrero 1998

DIA	HORAS 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	PROM	MAX	MIN
1	4	6	6	11	11	4	2	9	15	21	9	4	4	24	11	19	9	8	8	6	4	4	6	4	9	24	2
2	2	6	4	0	2	6	2	2	9	4	8	8	6	9	8	4	6	4	4	4	6	2	4	9	5	9	0
3	9	9	8	6	6	6	9	4	6	11	6	6	4	6	11	4	6	6	2	4	2	4	4	4	6	11	2
4	6	4	6	11	6	6	2	4	8	21	9	9	8	9	6	8	2	4	4	2	2	8	4	6	6	21	2
5	6	9	4	8	2	4	2	6	4	9	4	6	4	6	8	8	6	6	2	4	4	2	2	6	5	9	2
6	6	11	9	8	8	17	11	6	8	19	8	9	9	8	4	4	4	2	0	6	6	2	8	11	8	19	0
7	6	2	6	6	0	4	8	2	2	8	11	6	4	4	13	9	9	6	4	4	6	8	4	4	5	13	0
8	8	9	9	2	6	21	2	6	23	17	13	8	4	11	9	8	13	8	6	4	8	6	4	4	9	23	2
9	8	4	6	2	2	2	2	2	6	6	2	4	2	8	9	4	6	9	8	15	11	8	2	4	5	15	2
10	6	11	13	4	6	4	4	4	11	15	9	8	15	8	8	13	6	8	9	6	8	8	6	4	8	15	4
11	6	4	11	4	9	8	9	11	9	19	6	6	8	8	9	6	8	9	11	4	4	2	2	2	7	19	2
12	4	4	9	4	2	8	6	4	4	9	8	11	9	11	13	4	6	6	2	4	4	8	6	9	6	13	2
13	13	9	8	2	6	4	9	8	2	11	11	8	4	9	4	8	9	2	2	8	4	2	8	9	7	13	2
14	11	2	2	4	2	2	4	2	8	9	6	4	9	13	6	4	4	2	2	2	0	6	2	6	5	13	0
15	6	0	6	8	4	4	2	4	*	*	2	6	4	6	11	8	8	8	2	6	4	2	4	2	5	11	0
16	8	6	8	8	2	8	4	9	8	13	8	4	6	8	2	8	4	4	2	0	2	2	6	13	6	13	0
17	9	6	9	6	6	6	6	6	6	15	8	6	9	6	8	4	6	2	2	2	2	0	0	6	5	15	0
18	11	9	8	6	6	6	4	6	4	13	4	6	4	4	8	6	4	2	4	0	4	0	4	4	5	13	0
19	6	4	6	4	4	4	2	4	9	11	9	15	9	2	6	6	8	6	2	2	2	4	9	8	6	15	2
20	8	2	11	8	6	8	4	2	9	13	13	11	11	9	9	8	8	13	11	0	0	2	2	13	8	13	0
21	11	11	19	8	4	4	6	4	8	8	4	8	8	13	9	4	2	13	15	8	9	2	13	8	8	19	2
22	2	6	9	8	2	2	4	4	2	8	6	2	6	8	8	2	6	2	11	8	4	4	0	0	5	11	0
23	8	8	9	2	8	4	6	4	11	19	8	6	4	13	8	6	6	4	4	0	11	4	2	9	7	19	0
24	8	6	4	6	0	6	13	9	8	13	6	6	9	9	9	4	0	6	6	4	6	4	6	6	6	13	0
25	17	6	2	2	4	6	4	4	9	4	8	8	9	2	8	2	9	9	2	4	2	8	2	2	5	17	2
26	2	9	9	9	9	13	11	6	13	17	11	2	2	4	4	8	4	8	4	0	2	4	2	2	6	17	0
27	15	19	9	6	8	6	8	9	8	11	6	4	2	9	8	6	6	9	2	0	6	9	4	8	7	19	0
28	6	6	8	6	6	8	4	4	2	2	6	8	4	6	4	6	4	2	11	8	13	4	6	4	5	13	2

(*) = Sin datos

000167

CIMM T & S S.A.
Unidad de Gestión Ambiental

TABLA N° 6
ESTACION : BOMBEROS
PARAMETRO : NO2
UNIDAD : ug/m3N
PERIODO : Enero 1998

DIA	HORAS																								PROM	MAX	MIN
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23			
1	17	11	4	11	8	2	9	6	4	8	4	6	4	6	11	6	6	6	2	6	6	2	4	8	6	17	2
2	8	11	4	2	2	6	4	6	15	8	9	9	8	4	9	8	8	6	11	6	8	8	8	17	8	17	2
3	8	8	6	6	6	4	2	6	8	17	6	8	4	11	8	6	8	6	4	4	11	6	11	11	7	17	2
4	4	9	13	2	19	11	4	4	9	15	8	8	8	6	11	6	9	6	9	6	4	4	6	8	8	19	2
5	9	8	2	6	4	2	8	4	4	4	13	9	9	8	8	6	4	8	6	4	6	8	6	8	6	13	2
6	6	13	8	9	4	2	4	4	6	8	8	11	6	11	11	11	8	8	4	4	11	8	15	13	8	15	2
7	6	4	6	8	4	8	11	6	15	15	13	13	9	19	21	17	8	8	4	6	6	4	4	4	9	21	4
8	6	11	6	4	2	8	8	4	6	4	6	9	8	2	9	4	4	2	2	2	4	8	4	4	5	11	2
9	11	0	4	6	6	6	2	4	6	13	6	4	6	8	6	8	2	6	4	4	2	2	2	9	5	13	0
10	11	9	8	4	8	4	4	6	6	2	8	6	4	8	6	6	4	2	2	4	2	4	4	6	5	11	2
11	2	11	4	2	2	2	2	4	4	2	2	2	15	9	8	6	2	4	4	4	9	4	8	4	5	15	2
12	2	4	4	0	2	4	2	0	2	6	2	8	8	4	15	24	8	2	4	0	4	6	8	2	5	24	0
13	2	2	8	4	4	0	2	6	6	8	4	8	8	8	8	9	2	4	4	0	2	6	4	6	5	9	0
14	9	8	13	9	4	0	17	4	9	11	6	6	2	4	6	4	2	6	4	0	6	2	2	8	6	17	0
15	9	9	2	6	2	4	11	4	6	13	4	9	8	9	4	0	6	9	8	6	4	4	8	8	6	13	0
16	4	4	2	4	4	6	2	4	4	4	2	2	8	4	2	8	6	9	2	4	6	2	4	9	4	9	2
17	2	9	4	2	8	4	8	2	4	19	2	11	6	9	9	6	8	4	2	6	11	13	11	8	7	19	2
18	4	9	15	4	9	4	6	4	4	9	4	8	6	4	11	2	4	8	4	4	6	4	9	8	6	15	2
19	11	11	8	8	2	4	4	2	4	13	8	6	9	6	8	8	6	4	2	4	6	6	2	4	6	13	2
20	6	4	9	4	8	6	4	0	4	8	6	11	9	2	4	6	8	2	15	6	6	4	4	4	6	15	0
21	6	6	4	6	2	4	2	4	4	6	8	9	6	8	8	9	9	11	11	2	2	4	13	8	6	13	2
22	13	9	13	4	6	4	4	2	2	4	4	9	17	11	6	4	2	4	2	0	6	2	4	4	6	17	0
23	6	8	0	4	0	2	4	4	9	4	2	4	6	8	13	8	2	6	8	2	2	2	2	6	4	13	0
24	2	8	11	9	9	11	6	2	6	11	15	8	9	8	2	4	6	2	4	2	2	0	2	4	6	15	0
25	2	6	2	2	0	4	6	6	6	6	2	0	0	4	4	8	2	8	4	0	2	11	6	6	4	11	0
26	11	13	15	13	11	4	4	2	4	8	9	9	9	6	6	6	0	2	2	2	0	6	2	2	6	15	0
27	9	9	11	4	4	4	9	4	9	9	2	4	6	13	8	4	2	2	2	15	6	4	4	8	6	15	2
28	4	6	6	2	4	2	4	2	8	8	4	6	13	11	6	6	4	6	2	0	0	2	0	9	5	13	0
29	15	8	9	4	2	4	4	8	9	13	4	13	8	8	4	2	6	4	9	4	0	0	2	4	6	15	0
30	6	8	4	8	4	6	11	6	6	8	6	13	8	13	8	11	8	6	9	9	2	0	6	6	7	13	0
31	2	6	4	4	4	2	6	6	6	13	6	8	4	9	11	8	6	8	8	4	4	0	4	2	5	13	0

(*) = Sin datos

CIMM T & S S.A.
Unidad de Gestión Ambiental

000168

TABLA N° 6
ESTACION : BOMBEROS
PARAMETRO : NO2
UNIDAD : ug/m3N
PERIODO : Diciembre 1997

	HORAS																									
DIA	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	PROM	MAX	MIN
1	4	2	4	2	2	2	6	6	9	9	6	6	11	8	6	4	8	6	8	11	11	6	2	6	6	11	2
2	4	6	8	0	2	2	4	6	8	8	8	2	6	11	13	4	9	9	2	4	6	4	9	13	6	13	0
3	8	2	2	4	2	4	6	8	4	11	6	2	6	2	13	8	13	8	11	9	13	2	11	13	7	13	2
4	2	4	8	8	13	9	8	6	4	9	8	6	8	8	15	9	9	9	9	9	4	8	4	6	8	15	2
5	9	11	8	2	4	2	2	4	4	9	4	9	8	13	11	11	8	6	6	2	4	6	4	9	6	13	2
6	11	2	2	8	8	2	2	4	8	8	6	8	8	4	8	9	8	9	9	4	4	6	6	15	6	15	2
7	15	2	6	6	2	6	4	9	2	2	6	2	13	4	4	4	0	8	8	8	4	6	8	6	5	15	0
8	6	11	9	2	2	2	4	0	2	13	2	6	4	4	8	11	6	8	4	2	4	4	2	4	5	13	0
9	4	0	2	6	4	8	6	4	4	11	8	6	6	2	9	6	4	2	8	*	*	9	11	9	6	11	0
10	11	11	4	2	4	6	4	11	9	15	17	4	8	2	6	8	6	9	8	6	2	2	6	4	7	17	2
11	4	6	6	4	4	8	4	4	11	19	6	8	9	8	8	8	9	8	4	8	6	8	6	2	7	19	2
12	6	8	6	4	2	0	0	4	4	6	6	8	6	2	11	8	9	4	0	4	4	2	4	4	4	11	0
13	9	11	9	9	6	8	2	4	2	8	8	8	11	9	6	2	2	6	2	2	4	2	6	17	6	17	2
14	6	4	4	2	8	2	8	6	6	6	2	8	8	6	6	13	9	2	2	4	2	2	4	0	5	13	0
15	4	8	4	0	4	4	2	0	4	8	6	0	0	8	6	8	2	8	8	9	4	2	9	6	5	9	0
16	6	6	4	4	2	6	2	4	6	8	6	15	8	4	8	8	2	6	4	0	0	2	0	6	5	15	0
17	8	8	4	6	9	4	8	4	6	9	9	11	11	8	8	4	4	2	4	4	2	2	4	4	6	11	2
18	4	8	4	11	8	6	9	8	9	9	9	8	6	11	6	6	8	4	2	0	2	6	4	2	6	11	0
19	2	11	6	4	4	6	4	6	8	13	8	4	8	9	9	8	4	2	4	4	4	6	4	8	6	13	2
20	4	8	6	4	8	4	8	4	6	28	15	8	6	9	13	4	8	6	2	2	6	8	6	4	7	28	2
21	8	4	2	9	9	4	0	8	8	6	11	6	11	21	15	8	4	6	8	6	6	9	6	8	7	21	0
22	8	11	4	6	6	6	6	8	6	13	6	8	9	6	6	6	8	2	9	6	4	6	11	13	7	13	2
23	9	9	4	9	6	8	11	11	19	9	8	4	6	9	9	11	4	4	8	8	8	2	9	4	8	19	2
24	8	6	6	9	8	11	8	2	9	11	13	11	8	9	9	8	15	8	8	4	6	6	6	6	8	15	2
25	6	8	6	9	8	2	4	4	6	6	6	8	9	11	6	9	11	4	9	4	6	6	6	9	7	11	2
26	4	11	6	11	11	4	6	9	6	15	17	17	17	8	11	6	8	8	6	4	2	8	4	9	9	17	2
27	8	6	8	9	4	9	9	4	6	8	4	9	9	6	6	6	2	4	2	8	4	6	4	4	6	9	2
28	9	13	9	2	8	6	11	9	11	15	4	11	15	15	11	8	6	2	8	6	8	6	8	8	9	15	2
29	6	8	6	6	4	9	6	6	11	11	9	13	8	9	9	11	6	6	6	4	6	2	8	8	7	13	2
30	13	11	11	4	6	2	4	4	9	8	8	8	8	6	4	8	6	8	6	4	6	9	6	4	7	13	2
31	4	2	8	4	6	2	4	8	6	8	6	9	6	6	6	8	8	4	6	6	8	8	9	15	6	15	2

(*) = Sin datos

000169

TABLA N° 6
ESTACION : BOMBEROS
PARAMETRO : NO2
UNIDAD : ug/m3N
PERIODO : Noviembre 1997

	HORAS																										
DIA	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	PROM	MAX	MIN
1	2	2	0	0	0	2	2	2	4	13	6	6	8	9	9	8	9	8	8	8	4	0	4	2	5	13	0
2	4	6	2	6	2	8	9	4	11	11	8	9	11	8	2	4	2	4	6	4	2	8	11	11	6	11	2
3	6	9	4	4	6	4	4	0	6	11	4	4	11	2	6	8	4	6	4	4	2	0	2	4	5	11	0
4	0	0	0	4	4	2	4	4	9	28	15	9	19	6	6	6	4	4	4	4	4	9	4	8	6	28	0
5	4	6	2	2	0	2	6	9	17	24	4	6	11	11	21	19	21	6	6	9	6	8	4	4	9	24	0
6	0	2	4	2	6	4	4	2	4	15	4	9	8	9	4	2	6	13	6	11	11	8	2	9	6	15	0
7	4	2	2	4	8	2	2	2	4	2	8	8	11	4	6	6	13	13	11	6	15	6	4	9	6	15	2
8	6	2	2	0	0	2	2	0	9	15	6	6	13	11	4	4	8	11	8	17	13	6	2	0	6	17	0
9	0	2	6	4	0	11	4	6	6	11	9	6	11	6	8	2	4	6	2	0	0	4	8	4	5	11	0
10	0	2	0	2	2	2	4	2	4	6	6	8	8	9	4	2	4	11	2	2	0	2	11	2	4	11	0
11	2	0	0	4	4	6	6	6	8	9	6	6	9	13	6	4	8	8	4	4	8	8	4	8	6	13	0
12	8	8	11	8	6	6	9	8	9	13	11	9	9	8	4	6	6	8	4	6	4	8	6	11	8	13	4
13	9	11	9	11	15	11	8	11	15	13	8	8	8	11	2	8	6	8	8	9	4	8	13	8	9	15	2
14	4	6	4	6	2	2	8	4	9	15	6	4	4	13	8	6	8	6	4	6	6	9	15	4	6	15	2
15	2	6	4	4	8	4	8	2	4	11	8	6	11	11	9	8	6	6	4	4	4	6	4	8	6	11	2
16	4	9	9	2	4	4	4	8	4	4	2	6	9	11	8	11	6	11	9	2	2	4	6	8	6	11	2
17	9	2	2	6	6	11	11	9	15	17	4	6	11	6	9	11	13	17	4	2	6	6	9	19	9	19	2
18	8	6	4	2	6	9	6	6	8	4	4	6	6	4	6	8	9	9	8	9	4	4	8	8	6	9	2
19	9	8	4	2	4	2	2	2	2	8	2	6	6	4	9	11	8	6	4	4	4	6	6	6	5	11	2
20	9	8	11	8	6	4	4	8	9	13	9	9	9	15	11	6	2	6	9	6	2	6	11	13	8	15	2
21	8	4	4	6	8	9	6	2	9	9	6	9	4	6	9	15	6	6	11	9	4	6	4	11	7	15	2
22	2	6	2	2	4	2	2	2	6	0	4	9	8	8	13	9	6	8	4	4	4	9	2	2	5	13	0
23	8	6	6	6	6	6	4	4	6	15	4	6	4	9	11	4	9	4	4	6	2	4	8	9	6	15	2
24	9	4	6	0	4	0	0	2	2	6	8	4	8	6	6	9	8	9	6	4	2	2	2	2	4	9	0
25	2	2	2	0	4	4	2	13	13	23	8	11	8	6	8	4	2	4	2	4	2	2	0	2	5	23	0
26	2	4	4	2	2	0	2	6	4	4	8	8	13	11	4	2	4	4	2	2	4	4	8	11	5	13	0
27	8	8	6	6	8	2	6	11	13	*	*	*	*	*	*	2	0	0	2	0	2	2	8	6			
28	8	0	0	2	4	2	0	4	6	6	4	6	15	8	6	0	6	4	2	4	2	2	8	15	5	15	0
29	4	2	2	4	6	8	4	2	8	17	9	4	8	6	4	4	6	6	0	2	0	2	4	9	5	17	0
30	9	4	6	6	4	8	4	8	8	8	4	4	6	6	9	2	2	4	2	0	4	8	6	2	5	9	0

(*) = Sin datos

000170

TABLA N° 6

ESTACION : BOMBEROS
PARAMETRO : NO2
UNIDAD : ug/m3N
PERIODO : Octubre 1997

DIA	HORAS 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	PROM	MAX	MIN
1	17	11	13	15	21	23	15	15	13	23	17	21	13	19	8	19	23	11	13	19	24	19	11	15	17	24	8
2	13	11	8	13	6	19	8	11	15	19	24	21	6	17	23	30	21	2	4	4	8	6	8	8	13	30	2
3	9	9	6	8	0	0	6	11	9	19	9	19	9	8	2	2	4	8	2	4	2	6	4	8	7	19	0
4	4	8	6	2	0	4	0	6	2	8	8	8	8	0	*	6	6	2	2	0	4	6	9	9	4	9	0
5	13	8	8	8	11	11	13	11	9	8	9	11	8	6	4	0	0	0	0	4	9	4	4	11	7	13	0
6	13	15	6	8	9	9	6	21	17	13	13	17	21	19	24	9	4	2	2	9	19	15	6	9	12	24	2
7	0	2	4	6	8	11	2	4	6	2	4	8	8	9	8	6	8	8	2	2	2	0	13	13	5	13	0
8	4	0	2	0	0	2	2	0	2	8	2	9	4	13	9	9	9	2	2	4	4	6	6	13	5	13	0
9	15	8	6	4	0	2	4	4	11	13	8	15	15	17	2	2	2	0	2	2	6	4	17	15	7	17	0
10	17	15	9	8	2	0	2	6	6	19	6	15	11	19	6	2	2	8	4	0	4	4	2	6	7	19	0
11	6	6	6	6	0	8	2	6	6	19	13	9	9	8	8	6	8	6	8	6	0	4	4	4	6	19	0
12	6	8	4	2	4	2	0	4	8	4	2	8	9	6	4	2	2	6	2	2	2	0	2	2	4	9	0
13	0	0	0	0	0	0	2	0	6	4	2	8	8	2	4	4	2	0	8	6	0	4	2	0	2	8	0
14	0	0	2	2	0	0	0	0	4	4	6	9	11	13	4	8	8	6	4	4	4	4	9	8	4	13	0
15	13	19	2	8	6	4	4	4	8	23	13	17	17	15	8	8	8	9	4	6	2	4	4	8	9	23	2
16	9	8	6	8	4	4	11	8	9	17	9	13	9	13	4	2	6	2	2	4	2	15	13	4	8	17	2
17	6	0	0	4	0	0	2	2	8	30	9	6	6	9	13	9	8	4	6	6	2	2	2	15	6	30	0
18	11	8	6	6	9	9	6	2	11	21	9	8	8	6	8	8	9	4	2	4	2	4	4	2	7	21	2
19	2	6	13	8	8	8	11	13	8	6	6	11	11	6	8	8	2	2	0	2	0	4	9	11	7	13	0
20	9	8	9	23	11	9	17	9	13	19	8	11	11	8	6	2	8	2	2	2	4	2	6	8	9	23	2
21	0	4	4	2	4	2	0	11	13	9	9	15	11	23	15	11	4	4	4	0	4	6	9	8	7	23	0
22	2	0	0	4	4	4	4	0	13	6	0	6	8	8	2	8	6	8	4	2	0	4	11	13	5	13	0
23	8	6	6	6	8	8	2	4	13	23	*	*	*	*	2	2	0	2	0	0	0	2	9	2	5	23	0
24	2	2	4	2	0	2	0	2	2	6	6	2	0	13	8	4	8	6	2	2	4	4	15	9	4	15	0
25	11	11	9	6	8	2	0	2	6	15	9	6	2	4	4	9	6	6	4	2	8	8	4	6	6	15	0
26	8	6	4	8	6	8	6	13	4	8	6	6	6	8	8	4	4	4	0	0	2	2	0	6	5	13	0
27	8	6	11	9	6	8	15	8	9	23	13	6	11	9	11	4	8	4	2	8	2	2	2	0	8	23	0
28	2	4	2	6	6	4	2	4	9	13	6	13	8	6	2	2	6	2	2	2	2	4	8	13	5	13	2
29	9	9	6	11	6	8	4	13	13	28	9	11	13	8	2	4	4	4	6	4	6	2	2	6	8	28	2
30	11	0	2	4	9	4	2	6	8	23	9	15	15	4	6	4	4	2	4	4	0	2	13	8	7	23	0
31	9	8	6	4	6	8	6	8	19	23	9	8	11	6	6	4	4	11	23	4	6	13	6	13	9	23	4

(*) = Sin datos

CIMM Unidad de Gestión Ambiental
Sede Santiago

000171

TABLA N° 6
ESTACION : BOMBEROS
PARAMETRO : NO2
UNIDAD : ug/m3N
PERIODO : Septiembre 1997

DIA	HORAS 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	PROM	MAX	MIN
1	8	8	8	6	4	0	4	6	13	9	11	8	11	15	9	15	8	11	2	4	9	6	11	4	8	15	0
2	4	9	9	11	9	6	6	4	11	8	4	13	15	15	9	11	11	19	9	11	15	21	19	17	11	21	4
3	24	13	13	8	6	11	4	4	11	19	11	9	11	13	13	8	6	6	2	6	9	6	15	13	10	24	2
4	9	9	11	6	11	6	8	13	8	24	13	13	8	8	13	13	13	9	8	11	26	17	15	21	12	26	6
5	19	17	13	13	8	2	0	4	2	9	4	9	9	6	4	8	4	8	4	2	6	0	4	4	7	19	0
6	2	2	2	2	2	6	6	2	4	6	4	6	6	4	8	6	4	13	11	6	2	4	6	6	5	13	2
7	8	9	9	9	9	6	4	8	6	4	8	9	11	4	6	4	4	4	2	0	4	2	8	11	6	11	0
8	6	6	9	4	8	4	2	11	6	13	15	13	13	15	6	4	2	0	2	0	4	13	15	13	8	15	0
9	6	9	15	9	11	6	2	9	8	13	9	17	8	4	2	2	2	2	2	0	2	6	11	9	7	17	0
10	9	17	9	8	8	11	4	6	6	13	9	8	9	11	15	11	4	4	6	2	8	11	13	8	9	17	2
11	6	4	2	2	4	4	6	11	4	11	6	9	13	2	4	2	4	4	2	2	13	11	2	11	6	13	2
12	11	4	4	9	4	6	0	6	6	15	15	21	13	8	9	2	6	4	4	6	6	17	2	4	7	21	0
13	4	8	6	8	4	4	6	11	4	19	13	11	11	21	9	4	2	6	4	2	4	13	11	8	8	21	2
14	13	19	11	6	6	8	4	6	9	11	15	23	15	9	19	8	4	2	4	13	6	11	13	8	10	23	2
15	13	9	6	9	4	9	8	13	11	9	11	6	6	9	8	4	8	17	15	6	6	23	23	23	11	23	4
16	13	15	11	9	17	9	17	15	15	17	15	9	13	15	8	6	11	26	15	8	6	8	17	15	13	26	6
17	19	9	2	0	0	0	0	2	4	21	13	9	8	6	4	0	2	6	8	6	8	11	8	6	6	21	0
18	4	4	0	2	0	2	0	4	0	6	6	6	2	2	2	2	6	6	4	11	11	11	6	8	4	11	0
19	4	11	4	4	6	6	8	6	4	15	8	8	9	8	9	6	6	9	11	6	2	2	6	6	7	15	2
20	4	9	9	6	8	11	4	6	2	8	8	15	11	6	6	4	6	0	8	6	2	6	8	8	7	15	0
21	11	8	4	2	2	8	8	4	13	11	4	2	4	4	6	6	0	4	19	6	8	2	4	4	6	19	0
22	8	9	2	0	2	9	2	4	8	17	9	9	6	4	6	17	2	2	2	6	9	17	11	17	7	17	0
23	13	4	2	4	2	2	2	*	0	6	4	6	4	6	6	11	11	4	2	0	6	13	17	11	6	17	0
24	4	0	4	2	2	0	4	2	8	4	4	4	6	4	0	0	4	2	2	0	2	17	8	4	3	17	0
25	9	6	6	6	2	6	6	4	9	6	6	11	24	11	4	9	4	11	11	8	11	2	11	8	8	24	2
26	4	8	6	4	4	0	0	4	4	21	11	9	6	2	6	11	6	6	*	4	6	15	4	17	7	21	0
27	11	21	6	6	4	6	6	11	9	6	8	15	4	6	9	2	2	2	4	2	2	11	13	13	7	21	2
28	21	13	6	11	9	9	9	15	9	8	11	15	4	8	4	0	2	2	4	2	6	9	17	17	9	21	0
29	15	13	4	4	8	8	6	13	6	8	9	9	19	17	4	4	4	4	4	4	13	4	6	2	8	19	2
30	4	6	6	4	2	4	0	4	4	6	6	15	6	8	2	4	4	4	6	19	26	6	11	21	7	26	0

(*) = Sin datos

TABLA N° 9
ESTACION : BOMBEROS
PARAMETRO : NO2
UNIDAD : ug/m3N
PERIODO : Agosto 1997

DIA	HORAS 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	PROM	MAX	MIN
1	9	4	6	9	11	13	6	13	13	15	15	13	23	15	8	8	4	6	8	4	11	11	13	15	11	23	4
2	19	19	15	13	21	17	11	24	19	17	15	11	11	11	9	9	9	6	6	6	8	24	30	17	14	30	6
3	11	9	6	21	13	9	8	6	4	13	23	19	15	23	11	15	13	6	6	17	34	17	30	34	15	34	4
4	15	17	17	15	11	13	11	15	19	30	24	19	23	17	24	39	43	24	17	36	47	28	26	13	23	47	11
5	23	23	13	13	15	13	11	32	13	19	21	19	17	21	26	30	11	11	39	32	24	23	21	17	20	39	11
6	21	24	13	9	9	9	6	17	19	19	26	11	8	9	8	6	9	11	9	21	43	28	13	13	15	43	6
7	17	28	9	6	9	9	9	6	2	9	*	*	*	*	4	4	2	9	9	6	6	15	39	26	11	39	2
8	9	11	6	9	9	6	4	15	13	23	11	15	13	11	9	15	24	19	15	21	6	24	23	21	14	24	4
9	15	17	13	23	21	21	9	0	4	21	6	8	8	9	9	6	8	6	8	9	21	15	28	9	12	28	0
10	17	23	9	17	15	17	17	13	24	13	23	11	23	17	21	15	13	17	9	26	30	28	9	17	18	30	9
11	2	6	6	13	11	23	17	17	30	23	13	8	21	26	38	32	28	32	15	15	8	19	28	26	19	38	2
12	39	4	4	4	8	6	9	38	19	26	21	13	17	28	19	24	23	28	21	8	4	6	2	19	16	39	2
13	19	17	17	9	19	19	4	17	8	15	15	23	6	4	9	8	9	9	13	9	8	6	4	4	11	23	4
14	8	4	4	8	8	8	4	13	19	17	11	11	9	11	13	8	8	4	15	8	9	8	13	11	10	19	4
15	8	21	9	11	8	6	9	13	19	30	19	8	6	4	4	2	2	4	4	8	2	2	4	6	9	30	2
16	2	4	4	0	0	0	2	2	2	9	8	6	4	8	8	8	6	4	4	4	2	2	2	2	4	9	0
17	6	0	2	4	4	*	*	*	*	*	*	2	6	0	2	*	*	13	0	0	2	6	4	0			
18	0	2	0	0	0	0	0	8	6	15	11	9	6	8	8	8	4	4	4	6	4	2	6	9	5	15	0
19	9	4	8	6	2	2	2	2	6	13	9	9	17	9	2	2	6	6	6	2	6	15	11	11	7	17	2
20	15	11	8	6	4	6	8	2	13	13	11	17	17	8	6	4	9	6	8	6	8	13	21	15	10	21	2
21	8	19	11	8	6	4	6	9	13	13	15	21	13	8	8	6	6	2	4	6	19	19	19	9	10	21	2
22	13	9	9	4	6	8	6	6	8	13	9	9	8	8	9	8	2	2	2	8	9	11	11	13	8	13	2
23	9	8	13	9	6	8	9	15	13	11	9	17	15	32	9	19	21	11	15	24	15	24	17	9	14	32	6
24	8	13	8	6	8	11	9	8	9	23	21	17	6	6	8	9	4	11	4	4	4	6	6	6	9	23	4
25	2	2	4	2	2	4	4	4	2	9	9	13	4	17	6	4	2	9	9	13	8	23	8	8	7	23	2
26	6	4	4	4	4	4	2	4	2	8	4	6	9	9	8	8	6	8	9	23	19	11	24	15	8	24	2
27	9	8	6	2	4	2	2	6	9	11	11	19	28	21	15	4	*	*	*	0	4	6	6	0	8	28	0
28	4	2	4	4	2	4	9	8	8	8	11	9	8	4	8	11	4	4	8	6	11	6	6	4	6	11	2
29	9	6	4	4	6	4	2	9	13	6	11	11	6	6	4	8	4	2	6	2	6	6	19	11	7	19	2
30	9	21	9	4	11	8	6	2	19	9	9	9	11	13	9	13	4	4	4	2	6	4	6	2	8	21	2
31	6	17	8	4	4	2	4	6	17	8	4	9	4	6	19	13	8	4	11	15	21	15	9	8	9	21	2

(*) = Sin datos

000173

TABLA N° 6
ESTACION : BOMBEROS
PARAMETRO : NO2
UNIDAD : ug/m3N
PERIODO : Julio 1997

DIA	HORAS 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	PROM	MAX	MIN
1	4	4	4	8	6	2	6	8	15	23	9	13	9	9	11	23	6	6	*	4	4	6	0	4	8	23	0
2	6	8	6	6	8	4	4	2	17	21	19	11	11	9	17	11	23	4	2	17	30	30	19	21	13	30	2
3	24	21	13	13	11	9	11	13	11	15	11	28	21	21	15	19	19	38	36	41	40	36	30	30	22	41	9
4	30	24	13	13	13	13	13	13	24	24	17	13	6	8	9	8	11	9	19	21	4	6	24	21	15	30	4
5	13	8	13	11	8	9	13	4	8	23	23	17	19	13	11	6	6	9	9	24	24	34	28	28	15	34	4
6	34	11	13	9	6	6	4	2	4	6	6	4	15	4	2	2	2	0	0	2	6	11	21	13	8	34	0
7	17	11	9	8	8	11	11	13	9	23	32	19	26	23	13	9	23	11	8	6	6	21	23	23	15	32	6
8	15	11	8	6	6	6	9	2	9	15	9	13	19	11	15	8	13	6	13	26	24	30	23	21	13	30	2
9	17	9	9	9	8	8	11	13	13	24	28	11	9	15	13	13	9	15	13	21	32	26	30	21	16	32	8
10	26	21	15	11	9	17	23	19	21	17	19	15	19	21	19	15	15	15	23	30	36	28	15	11	19	36	9
11	15	9	26	23	13	15	8	6	11	23	26	26	13	11	13	11	6	4	4	6	6	8	6	13	13	26	4
12	4	4	2	2	2	11	11	11	15	15	17	15	6	6	9	2	2	0	0	2	17	6	28	23	9	28	0
13	15	15	9	17	17	13	23	17	11	15	21	13	15	19	19	6	6	4	17	28	26	19	17	11	16	28	4
14	11	9	11	13	15	24	21	17	23	23	30	23	8	9	8	21	21	13	13	9	9	8	11	11	15	30	8
15	8	6	4	11	9	4	15	9	21	23	19	15	13	11	11	6	17	9	32	11	6	21	32	21	14	32	4
16	13	8	9	8	9	6	9	9	9	9	21	24	19	21	6	11	15	15	13	15	11	15	26	15	13	26	6
17	15	17	13	15	8	6	8	30	17	11	13	17	17	15	9	13	6	19	34	40	23	34	36	41	19	41	6
18	32	32	24	21	11	6	6	4	8	13	8	15	8	17	15	13	13	8	4	0	9	6	19	19	13	32	0
19	21	17	4	8	4	8	9	19	13	15	23	13	15	24	30	17	24	8	6	4	26	26	30	15	16	30	4
20	26	23	23	17	26	26	32	24	23	30	21	24	23	13	36	13	40	24	9	6	13	2	4	6	20	40	2
21	9	2	2	4	4	26	9	11	9	21	32	6	9	11	15	15	21	11	23	15	6	15	13	17	13	32	2
22	28	28	17	8	8	8	6	8	11	19	19	9	6	13	8	13	13	8	9	21	23	13	17	17	14	28	6
23	13	13	8	8	6	9	15	11	15	17	23	28	32	34	15	11	24	32	45	47	47	49	34	11	23	49	6
24	19	30	21	19	11	36	30	11	8	21	19	21	13	13	11	8	13	32	23	36	11	11	9	8	18	36	8
25	28	9	13	11	11	9	9	11	15	24	19	21	13	15	4	9	11	11	17	6	23	47	62	51	19	62	4
26	43	28	13	8	9	6	6	9	9	*	15	9	11	11	8	6	9	8	24	30	15	21	23	19	15	43	6
27	17	17	40	32	15	9	19	15	8	9	8	4	8	4	9	21	30	9	21	6	13	24	8	19	15	40	4
28	21	6	2	4	2	2	4	23	17	23	6	8	6	9	11	6	2	4	4	9	13	23	21	26	10	26	2
29	8	6	8	8	9	8	4	15	13	15	21	17	15	9	8	6	6	8	11	15	9	13	15	23	11	23	4
30	17	6	4	2	15	8	6	17	17	28	15	6	9	6	8	8	2	4	4	8	6	4	6	2	8	28	2
31	4	4	0	6	15	6	8	15	15	19	11	13	19	11	19	6	2	6	6	6	11	11	17	21	10	21	0

(*) = Sin datos

TABLA N° 6
ESTACION : BOMBEROS
PARAMETRO : NO2
UNIDAD : ug/m3N
PERIODO : Junio 1997

DIA	HORAS 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	PROM	MAX	MIN
1	9	6	8	8	4	4	4	4	4	8	9	11	8	0	6	8	4	2	0	0	2	2	0	8	5	11	0
2	6	6	6	4	4	6	4	6	4	2	4	2	2	9	9	9	6	6	2	2	2	2	9	9	5	9	2
3	2	2	6	6	9	8	11	8	9	6	11	4	13	6	4	0	4	2	4	2	0	4	6	4	5	13	0
4	2	4	2	0	6	2	0	2	2	2	6	9	9	6	6	4	8	2	2	8	11	11	13	11	5	13	0
5	8	6	4	8	8	8	4	6	8	9	11	6	6	9	13	15	6	2	2	4	6	8	6	9	7	15	2
6	11	8	9	9	8	8	9	9	9	8	11	9	8	11	9	11	17	13	9	4	15	9	11	8	10	17	4
7	8	6	2	0	2	2	2	6	8	4	9	11	4	9	9	9	9	13	11	8	2	4	0	2	6	13	0
8	6	4	8	2	4	0	4	2	4	4	6	6	4	9	4	0	6	2	2	4	6	4	4	4	4	9	0
9	9	4	0	0	0	0	2	2	0	4	8	6	2	4	2	4	4	2	2	4	4	4	4	13	3	13	0
10	15	13	4	2	4	2	2	2	2	4	8	13	8	6	6	4	2	2	2	0	2	2	2	0	4	15	0
11	4	2	0	2	0	0	0	0	0	4	6	4	4	6	6	2	2	2	2	2	2	2	2	2	2	6	0
12	6	2	2	0	2	2	0	0	2	2	2	11	11	8	4	2	2	2	4	4	2	8	8	2	4	11	0
13	0	2	2	0	2	2	0	0	0	2	8	8	6	4	6	2	4	2	0	2	6	9	8	8	3	9	0
14	6	6	6	2	4	6	2	2	6	8	15	15	9	8	9	8	8	6	4	6	15	13	13	11	8	15	2
15	15	11	8	4	6	4	6	6	6	9	15	9	4	4	8	4	9	9	8	9	13	6	11	11	8	15	4
16	6	6	6	4	6	4	8	8	8	9	9	11	6	6	4	2	0	0	4	4	8	4	2	4	5	11	0
17	4	2	2	2	2	0	0	2	2	4	6	4	8	9	9	6	6	6	4	4	4	9	9	6	4	9	0
18	2	2	0	0	0	2	0	0	0	2	2	6	9	4	4	6	6	4	2	2	15	15	11	13	4	15	0
19	11	8	2	0	2	4	6	2	2	6	9	8	13	6	6	0	8	6	4	13	11	6	4	8	6	13	0
20	6	9	6	2	4	4	4	4	2	8	11	8	4	6	4	4	4	4	2	2	6	4	2	2	4	11	2
21	0	0	4	2	2	2	4	0	4	4	13	15	6	0	6	6	4	8	4	4	6	11	11	9	5	15	0
22	9	6	4	4	0	4	4	4	2	0	6	4	4	4	4	2	4	2	4	2	0	2	8	11	4	11	0
23	8	8	4	2	2	4	4	4	2	8	8	9	8	6	6	6	6	4	4	2	0	0	4	8	5	9	0
24	6	4	2	0	2	2	2	0	0	2	8	*	*	*	*	*	*	0	0	0	0	6	8	4			
25	8	11	6	2	4	2	2	2	2	4	8	6	4	8	4	0	0	0	0	0	6	8	11	2	4	11	0
26	6	8	4	4	6	9	6	8	8	8	8	4	4	6	0	0	0	0	9	19	17	8	2	19	7	19	0
27	17	9	24	19	17	21	15	13	23	19	23	23	13	28	38	9	4	2	2	26	40	26	36	32	20	40	2
28	21	21	19	17	15	11	8	13	21	21	19	13	11	13	6	11	9	15	8	9	21	26	19	24	15	26	6
29	26	28	13	11	8	13	11	6	8	6	9	9	15	11	19	21	15	11	6	32	40	41	40	36	18	41	6
30	19	13	8	11	13	11	9	17	13	21	19	8	9	6	9	8	2	8	13	11	8	9	9	13	11	21	2

(*) = Sin datos

TABLA Nº 6
ESTACION : BOMBEROS
PARAMETRO : NO2
UNIDAD : ug/m3N
PERIODO : Mayo 1997

DIA	HORAS 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	PROM	MAX	MIN
1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*			
2	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*			
3	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*			
4	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*			
5	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*			
6	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*			
7	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*			
8	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*			
9	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*			
10	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*			
11	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*			
12	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*			
13	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*			
14	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*			
15	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	13			
16	11	4	0	2	0	0	2	0	0	0	11	9	6	0	2	0	2	2	2	0	2	9	15	11	4	15	0
17	0	0	6	9	8	6	4	6	4	2	6	4	6	6	8	4	2	2	2	0	0	0	0	0	3	9	0
18	2	4	2	0	0	2	0	0	0	2	2	0	0	0	0	0	4	0	0	0	0	2	2	11	1	11	0
19	2	4	4	4	8	2	4	0	2	8	9	13	8	9	9	0	0	0	0	0	0	6	9	8	4	13	0
20	9	9	8	9	6	6	8	6	6	6	8	6	4	8	4	4	6	2	0	2	2	8	8	4	6	9	0
21	6	4	6	4	8	11	8	4	6	4	8	11	15	9	6	2	2	2	0	0	2	6	9	8	6	15	0
22	11	9	15	11	8	15	9	11	15	11	15	11	6	9	8	6	8	11	8	11	6	2	0	4	9	15	0
23	4	2	0	0	2	2	2	0	4	4	9	8	6	4	4	6	2	2	2	2	8	11	17	11	5	17	0
24	8	4	4	8	8	8	6	6	6	6	9	8	9	2	2	2	2	0	2	0	0	2	2	6	4	9	0
25	11	2	2	6	8	6	8	2	4	4	2	0	0	0	0	2	4	2	0	2	6	0	2	4	3	11	0
26	2	2	2	4	*	*	*	*	*	*	0	6	6	4	2	2	0	0	0	0	6	11	9	11			
27	4	0	2	6	4	0	2	0	0	4	8	6	8	6	6	0	4	0	0	0	0	0	8	2	3	8	0
28	2	4	6	2	2	2	6	4	4	4	8	6	6	2	2	0	0	0	0	0	0	0	2	0	2	8	0
29	0	0	0	0	0	0	0	0	0	0	4	4	2	0	4	2	2	0	0	2	4	6	8	9	2	9	0
30	6	8	8	6	4	4	4	2	4	6	6	8	4	4	2	2	0	0	4	0	6	6	9	8	4	9	0
31	9	9	6	8	13	4	4	4	8	8	8	6	4	4	6	4	0	2	2	0	0	0	4	9	5	13	0

(*) = Sin datos

000176

TABLA N° 6
ESTACION : BOMBEROS
PARAMETRO : NO2
UNIDAD : ug/m3N
PERIODO : Abril 1997

DIA	HORAS 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	PROM	MAX	MIN
1	0	0	8	6	2	4	6	0	4	2	2	2	17	2	9	6	6	9	11	8	4	4	6	13	5	17	0
2	6	11	6	11	6	2	9	8	9	13	4	6	2	9	13	8	11	8	4	2	0	6	8	6	7	13	0
3	6	8	4	2	8	4	4	4	2	6	23	21	15	17	9	9	4	4	6	6	4	6	4	6	7	23	2
4	8	6	4	6	6	8	6	13	8	11	6	2	8	17	21	13	11	8	17	36	15	15	19	34	12	36	2
5	8	4	15	17	17	19	21	4	19	23	38	83	47	9	19	23	19	15	13	9	0	6	4	0	18	83	0
6	4	17	11	11	21	9	2	13	8	6	8	2	30	9	2	9	8	4	9	11	2	13	4	19	10	30	2
7	21	23	4	23	9	17	30	23	11	24	8	34	11	4	9	11	32	28	66	36	9	13	21	66	22	66	4
8	9	49	55	21	8	21	19	43	56	*	*	*	*	*	*	*	9	0	92	145	75	71	19	15			
9	38	28	21	9	32	24	58	64	21	6	9	6	6	77	11	8	0	4	17	17	11	17	11	6	21	77	0
10	6	38	17	11	11	11	4	11	4	17	6	15	24	9	11	40	32	4	8	13	8	8	9	8	13	40	4
11	8	15	4	8	17	9	2	15	17	13	6	30	13	4	13	8	11	17	8	6	8	2	6	6	10	30	2
12	4	17	4	13	9	8	4	6	11	8	9	9	2	6	11	0	6	2	6	11	4	4	17	0	7	17	0
13	21	15	15	8	6	6	6	6	8	9	2	2	2	4	24	2	2	6	6	2	2	0	2	0	6	24	0
14	0	15	0	2	2	4	0	2	0	0	0	2	2	2	0	0	0	4	0	2	2	0	4	8	2	15	0
15	8	8	6	6	4	6	8	6	9	2	6	6	4	8	6	9	13	17	15	13	6	6	0	8	7	17	0
16	6	8	9	6	13	2	8	6	9	4	8	6	13	13	6	9	2	13	13	4	4	4	4	4	7	13	2
17	8	4	11	2	8	4	4	4	6	6	4	4	6	6	6	8	6	6	28	8	2	4	4	2	6	28	2
18	4	2	6	6	4	4	4	6	8	4	6	4	6	9	4	11	11	9	4	2	2	2	6	4	5	11	2
19	8	4	4	2	4	2	4	6	8	8	9	6	8	6	6	4	4	0	2	2	6	4	2	6	5	9	0
20	4	9	23	9	8	2	4	6	6	0	11	4	6	6	11	4	13	8	8	4	6	13	8	2	7	23	0
21	2	4	13	2	8	4	9	15	11	8	6	6	2	6	4	9	2	4	2	4	8	2	6	4	6	15	2
22	8	6	8	8	6	9	8	8	21	13	6	6	4	8	6	9	13	17	15	13	6	6	0	8	9	21	0
23	0	6	2	6	8	2	4	6	6	8	6	2	4	4	4	8	9	4	4	9	0	6	11	8	5	11	0
24	9	2	8	11	8	8	8	6	11	4	2	0	13	8	17	13	9	6	8	13	11	30	17	30	10	30	0
25	43	23	32	21	32	9	13	6	13	8	6	8	6	24	38	36	24	34	26	19	4	4	6	6	18	43	4
26	4	4	23	8	11	26	28	26	4	9	34	6	49	17	28	51	28	23	21	4	11	2	11	26	19	51	2
27	19	8	0	0	0	0	0	2	0	0	4	2	0	0	0	0	4	0	0	0	0	2	0	0	2	19	0
28	0	0	2	2	0	0	0	2	0	0	0	*	*	*	*	*	*	*	*	*	*	*	*	*			
29	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*			
30	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*			

(*) = Sin datos

TABLA Nº 6
ESTACION : BOMBEROS
PARAMETRO : NO2
UNIDAD : ug/m3N
PERIODO : Marzo 1997

DIA	HORAS 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	PROM	MAX	MIN
1	6	4	0	0	2	6	2	0	0	9	13	2	6	6	2	13	2	2	0	4	2	0	4	15	4	15	0
2	11	6	2	0	0	6	2	6	11	4	4	8	0	4	8	13	17	2	2	0	2	2	15	0	5	17	0
3	17	28	6	9	9	2	4	6	0	2	9	13	6	30	19	6	30	2	0	0	0	0	0	0	8	30	0
4	2	2	4	2	0	0	0	0	0	0	2	*	8	11	8	15	4	9	4	2	2	4	2	0	3	15	0
5	0	0	0	4	0	2	0	0	0	0	0	2	0	0	8	9	2	6	4	6	2	2	0	0	2	9	0
6	0	2	0	0	2	0	0	4	2	0	0	0	2	2	2	9	2	15	4	6	2	0	6	4	3	15	0
7	2	4	6	2	2	8	9	8	4	9	13	13	19	15	6	6	8	9	4	2	2	2	0	8	7	19	0
8	4	4	4	4	6	9	8	4	6	2	6	4	8	0	6	9	2	8	2	4	0	4	2	0	4	9	0
9	4	8	0	0	0	8	13	6	17	9	13	21	2	2	6	0	4	4	4	0	0	6	0	6	5	21	0
10	2	15	8	11	13	17	8	0	2	2	24	4	24	8	4	4	15	8	13	6	0	15	2	6	9	24	0
11	13	11	6	13	8	9	15	9	6	6	8	2	2	8	0	6	8	8	2	6	11	4	13	13	8	15	0
12	11	9	2	15	9	15	8	9	0	2	0	4	9	4	4	9	6	6	6	4	8	4	8	6	7	15	0
13	11	9	4	2	4	8	6	0	6	2	32	15	17	11	13	6	4	4	6	0	4	2	2	2	7	32	0
14	8	2	0	0	4	4	4	6	4	2	2	2	2	4	4	8	4	2	2	0	4	4	0	2	3	8	0
15	8	11	6	4	0	4	2	2	2	0	0	0	4	8	9	2	2	2	2	6	2	2	2	9	4	11	0
16	6	0	0	0	2	2	2	0	2	30	23	13	6	2	6	4	8	6	2	2	2	0	2	2	5	30	0
17	2	9	6	8	9	4	6	4	6	4	11	8	2	0	6	0	0	2	2	6	0	2	0	2	4	11	0
18	0	2	2	2	0	2	0	0	2	0	2	2	4	4	2	0	2	2	9	4	2	2	2	4	2	9	0
19	6	4	4	9	4	6	4	24	19	43	11	8	0	13	15	2	6	6	0	0	8	4	0	4	8	43	0
20	0	0	11	9	9	8	8	0	2	0	4	6	2	0	2	2	4	0	0	0	4	2	4	8	3	11	0
21	9	0	11	8	2	13	4	4	0	4	8	6	9	0	2	0	0	2	0	0	0	2	0	0	3	13	0
22	2	6	8	4	6	11	11	8	4	11	9	6	8	2	4	0	4	2	0	0	2	11	11	13	6	13	0
23	30	6	0	2	0	2	0	6	8	2	4	0	2	0	0	2	0	0	0	2	2	0	2	0	3	30	0
24	4	4	0	15	6	4	2	2	2	0	4	0	2	0	0	2	0	0	0	0	0	2	0	4	2	15	0
25	0	0	0	0	0	2	2	9	6	2	0	2	0	0	0	0	2	2	0	2	0	2	0	23	2	23	0
26	13	13	17	17	6	11	9	4	2	4	11	8	6	4	2	9	6	8	23	2	2	0	2	6	8	23	0
27	11	9	9	9	0	4	13	4	8	4	21	9	9	2	2	0	4	2	8	4	2	2	0	17	6	21	0
28	6	2	2	4	4	4	6	8	4	9	6	6	6	8	9	2	4	15	2	11	9	9	4	4	6	15	2
29	6	6	9	4	23	24	11	19	23	4	8	0	2	2	2	4	4	0	0	2	2	0	4	2	7	24	0
30	2	19	6	9	0	6	17	13	4	0	4	6	0	4	0	8	4	2	0	4	9	0	4	0	5	19	0
31	11	21	6	6	4	11	9	9	11	0	2	9	15	4	19	9	11	2	6	0	4	4	8	2	8	21	0

(*) = Sin datos

TABLA N° 6
ESTACION : BOMBEROS
PARAMETRO : NO2
UNIDAD : ug/m3N
PERIODO : Febrero 1997

DIA	HORAS 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	PROM	MAX	MIN
1	8	11	2	11	8	9	9	11	6	11	13	6	2	13	9	2	0	4	4	9	6	0	2	2	7	13	0
2	13	4	4	2	8	2	0	2	4	13	0	9	13	2	4	2	8	13	8	6	2	0	2	13	5	13	0
3	17	4	6	2	4	0	2	2	0	2	0	2	6	8	21	4	8	4	4	6	2	0	2	2	4	21	0
4	2	2	8	9	15	6	8	6	6	26	6	21	28	23	13	9	8	0	0	0	4	6	0	11	9	28	0
5	15	13	4	0	0	2	8	13	11	15	9	11	23	26	9	21	11	4	2	0	6	2	8	8	9	26	0
6	2	6	6	4	4	4	6	4	11	6	19	6	15	13	17	6	6	4	13	8	2	9	6	0	7	19	0
7	0	0	0	0	0	0	4	13	0	2	11	2	9	6	6	9	2	0	0	4	6	2	6	9	4	13	0
8	4	2	6	11	9	8	13	17	17	17	6	9	21	4	2	8	9	2	11	8	8	4	9	8	9	21	2
9	8	6	4	2	9	2	9	6	11	19	6	6	4	23	11	2	2	6	0	8	0	4	6	0	6	23	0
10	4	2	2	2	0	2	2	2	6	17	8	2	15	13	30	19	9	2	13	2	0	4	2	6	7	30	0
11	2	2	2	0	0	0	0	0	6	9	23	2	0	6	21	9	8	8	2	0	2	0	2	4	4	23	0
12	0	4	15	6	11	15	11	4	9	19	6	15	13	8	19	9	8	6	19	13	0	2	2	9	9	19	0
13	13	21	15	6	13	17	2	0	23	19	11	26	11	2	4	2	15	8	8	4	2	2	6	4	10	26	0
14	6	11	13	8	2	13	4	2	17	9	8	6	4	17	32	21	17	17	2	0	0	2	6	2	9	32	0
15	4	2	9	17	11	8	9	6	15	11	8	15	13	4	19	15	6	6	8	2	0	2	4	6	8	19	0
16	4	23	13	17	24	8	2	0	2	8	15	13	8	9	17	11	15	9	6	8	2	4	4	0	9	24	0
17	0	6	6	11	4	4	4	6	19	34	21	19	13	13	9	17	2	4	2	9	2	2	2	4	9	34	0
18	23	2	2	8	6	6	4	2	6	19	15	17	21	21	19	8	2	0	0	0	9	2	2	9	8	23	0
19	6	8	4	11	9	9	2	2	4	6	4	2	24	28	21	24	11	17	15	8	6	8	6	8	10	28	2
20	11	6	2	4	6	0	0	2	9	28	21	4	4	13	9	2	6	8	9	8	4	2	2	0	7	28	0
21	13	0	13	8	2	2	4	6	8	9	9	2	4	8	6	4	0	2	2	2	0	6	8	4	5	13	0
22	17	21	4	6	4	6	13	26	2	9	13	24	2	9	23	8	9	9	2	0	2	2	4	4	9	26	0
23	11	4	4	6	4	2	13	2	6	8	8	6	4	6	11	9	4	11	17	6	4	6	2	2	6	17	2
24	6	6	6	15	13	6	9	9	4	8	9	6	6	8	9	4	4	9	4	6	8	6	6	8	7	15	4
25	11	13	9	32	11	15	11	11	13	24	9	2	8	4	11	8	8	13	13	6	9	11	8	23	12	32	2
26	8	23	26	32	23	8	9	2	8	9	15	11	9	6	8	9	17	13	9	8	9	8	9	4	12	32	2
27	9	8	23	6	4	2	4	4	11	8	26	6	15	6	6	9	17	32	2	13	4	15	39	21	12	39	2
28	21	28	24	15	21	19	15	11	4	8	17	17	21	21	6	6	11	8	17	6	28	0	0	19	14	28	0

(*) = Sin datos

CIMM-Ambiental

000179

TABLA N° 9
ESTACION : BOMBEROS
PARAMETRO : NO2
UNIDAD : ug/m3N
PERIODO : Enero 1997

	HORAS																										
DIA	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	PROM	MAX	MIN
1	0	0	2	2	2	0	2	4	0	0	4	2	8	6	6	19	9	9	8	9	2	2	4	0	4	19	0
2	0	0	0	2	2	2	2	2	0	0	0	2	4	2	13	8	4	8	9	6	2	2	0	2	3	13	0
3	0	2	0	0	2	0	2	2	2	0	0	0	2	2	2	2	8	0	6	0	0	4	4	2	2	8	0
4	4	6	0	4	2	0	2	2	4	6	2	0	2	0	0	2	2	0	2	4	2	0	4	2	2	6	0
5	11	9	6	0	2	6	0	2	2	6	2	0	6	0	8	6	4	0	2	11	8	8	2	0	4	11	0
6	4	2	0	0	0	4	4	4	0	2	2	2	4	4	2	2	2	6	4	6	0	0	0	0	2	6	0
7	2	2	2	2	2	4	4	4	0	2	2	2	13	8	4	13	8	4	2	2	2	4	4	4	4	13	0
8	4	4	6	4	2	0	6	2	2	2	6	8	4	0	4	4	0	0	0	2	0	2	2	2	3	8	0
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REPUBLICA DE CHILE
MINISTERIO DE SALUD
DEPTO. PROGRAMAS SOBRE
EL AMBIENTE
SO: 12/6/78 Nº

RESOLUCION Nº 1215 000181

SANTIAGO, 22 de Junio 1978

(No publicada en el D.Of.)

VISTOS: Considerando que el adecuado control y prevención de la contaminación atmosférica exige disponer de normas que definan los valores de los parámetros que configuran la calidad del aire y establezcan criterios básicos operacionales, dicto la siguiente:

R E S O L U C I O N

NORMAS SANITARIAS MINIMAS DESTINADAS A PREVENIR Y CONTROLAR LA CONTAMINACION ATMOSFERICA

DISPOSICIONES PRELIMINARES:

1.- Las presentes normas se aplicarán en todo el territorio nacional y tienen por objeto proveer a los diversos niveles de salud los fundamentos técnicos y administrativos del sistema de prevención y control de la contaminación atmosférica. En todo caso se deberá considerar la armonización con los planes de desarrollo y la coordinación interinstitucional que permita el aprovechamiento integrado de los recursos. Sin embargo, ante cualquier situación crítica que implique riesgo inminente a la salud pública, la autoridad sanitaria deberá actuar de inmediato.

DEFINICIONES :

2.- Para los fines de la presente Resolución los términos que figuran a continuación tendrán el significado que en cada caso se especifica.

CONTAMINACION ATMOSFERICA : Es la presencia en el aire de uno o más contaminantes, o cualquier combinación de ellos, en concentraciones o niveles tales que perjudiquen o molesten la vida, la salud y el bienestar humano, la flora y la fauna, o degraden la calidad del aire, de los bienes, de los recursos nacionales o de los particulares.

CONTAMINANTES : Es toda substancia química o sus compuestos o derivados, agentes físicos y biológicos que al adicionarse al aire, pueden alterar o modificar sus características naturales o las del ambiente.

FUENTE DE CONTAMINACION ATMOSFERICA : Es toda actividad, proceso, operación o dispositivo móvil o estacionario que independiente de su campo de aplicación, produzca o pueda producir contaminantes del aire.

FUENTE DE CONTAMINACION ATMOSFERICA ESTACIONARIA : Es toda fuente diseñada para operar en lugar fijo. Se incluyen aquellas montadas sobre vehículos transportables para facilitar su desplazamiento.

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texto vigente al 26.08.91

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FUENTE DE CONTAMINACION ATMOSFERICA MOVIL : Es toda aquella fuente capaz de desplazarse entre distintos puntos, mediante un elemento propulsor propio (motor) que genera y emite contaminantes.

NORMA DE CALIDAD DEL AIRE : Son los valores que definen las concentraciones máximas permisibles para los contaminantes presentes en el aire, condicionados a variación según el desarrollo de las investigaciones pertinentes.

EMISION :Es la descarga directa o indirecta a la atmósfera de toda sustancia contaminante.

NORMA DE EMISION : Es la concentración máxima permitida para un determinado contaminante, medida en el efluente de las fuentes de contaminación, sin dilución previa.

ESTUDIO DE IMPACTO AMBIENTAL : Es el análisis teórico de la incidencia de los contaminantes emitidos por una fuente en el medio ambiente.

EQUIPO EXISTENTE : Es el instalado o en proceso de instalación a la fecha de vigencia de la presente resolución.

EQUIPO NUEVO : Es el instalado con posterioridad a la fecha indicada en el punto anterior.

EQUIPO DE CONTROL : Es cualquier aditamento o dispositivo que prevenga o reduzca las emisiones de contaminantes.

HUMO : Son partículas resultantes de una combustión incompleta constituídas en su mayoría de carbón y cenizas y que son visibles en la atmósfera.

POLVO : Son partículas pequeñas emitidas a la atmósfera por elementos naturales, por procesos mecánicos o industriales, por transporte de materiales, demoliciones y otros.

POLVO FUGITIVO : Son partículas sólidas suspendidas en el aire emitidas por cualquier fuente que no sea una chimenea.

PESO DE PROCESO : El peso de todos los materiales que se introducen en un proceso específico y que puedan causar emisiones contaminantes.

Los combustibles sólidos se consideran como parte del peso de proceso, pero no así los combustibles líquidos, gaseosos y el aire de combustión.

PESO DE PROCESO POR HORA : El peso total de proceso, dividido por el número de horas necesarias para una operación completa, excluyendo períodos de detención o de inactividad.

ESCALA RINGELMANN : Es el método de prueba para definir la densidad aparente visual del humo.

OPACIDAD : Estado en el cual uno o más contaminantes impiden parcial o totalmente el paso de los rayos luminosos, ocasionando falta de visibilidad a un observador.

NORMA DE CALIDAD DEL AIRE :

3.- Para los efectos de protección de la salud se permitirán las siguientes concentraciones máximas de los contaminantes del aire que se indican :

I.: Partículas en suspensión:

Setenta y cinco microgramos por metro cúbico (75 microgr/m^3 N) como concentración media geométrica anual; o doscientos sesenta microgramos por metro cúbico (260 microgr/m^3 N) como concentración media aritmética

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de veinticuatro horas consecutivas, no pudiéndose sobrepasar este último valor más de una vez por año.

II.: Anhídrido sulfuroso (SO_2) :

Ochenta microgramos por metro cúbico (80 microgr/m^3N) como concentración media aritmética anual, o trescientos sesenta y cinco microgramos por metro cúbico (365 microgr/m^3N) como concentración media aritmética durante veinticuatro horas consecutivas, no pudiéndose sobrepasar este último valor más de una vez por año.

III.: Monóxido de Carbono, (CO):

Diez mil microgramos por metro cúbico (10.000 microgr/m^3N) como concentración media aritmética máxima de ocho horas consecutivas. no debiendo sobrepasarse este valor más de una vez por año o cuarenta mil microgr/m^3N) como concentración media aritmética de una hora, no debiendo sobrepasarse este valor más de una vez por año.

IV.: Oxidantes fotoquímicos, expresados como ozono, (O_3).

Ciento sesenta microgramos por metro cúbico (160 microgr/m^3N) como concentración media aritmética de una hora, no debiendo sobrepasarse este valor más de una vez por año.

V.: Dióxido de nitrógeno (NO_2):

Cien microgramos por metro cúbico (100 microgr/m^3N) como concentración media aritmética anual.

4.- Todas las mediciones de estos contaminantes deberán se corregidas para una temperatura de veinticinco grados celsius (25ºC) y una presión de setecientos sesenta milímetros de mercurio (760 mm Hg).

El muestreo deberá ser efectuado con una frecuencia mínima de un período de veinticuatro horas cada seis días para anhídrido sulfuroso, dióxido de nitrógeno y partículas en suspensión y continuamente para fotoquímicos y monóxido de carbono.

5.- Para la determinación de concentraciones de los diferentes contaminantes, deberán utilizarse los siguientes métodos de análisis:

- Partículas en suspensión : método gravimétrico de muestreador de alto volumen o equivalente.
- Anhídrido sulfuroso : método colorimétrico de la pararrosanilina o equivalente.
- Monóxido de carbono : método de radiación infrarroja no dispersivo, o equivalente.
- Oxidantes fotoquímicos : método de quimiluminiscencia o equivalente.
- Dióxido de nitrógeno: método de quimiluminiscencia o equivalente.

Se considerarán equivalentes los métodos de análisis que, ensayados por el Laboratorio de Contaminación Atmosférica dependiente del Ministerio de Salud, suministren respuestas igualmente válidas respecto de los métodos de referencia ya especificados.

6.- La presente Resolución se modificará en la parte pertinente cuando a juicio de la autoridad sanitaria sea necesario incorporar otros contaminantes a la Norma de Calidad de Aire.

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A requerimiento específico de otros Ministerios o de las autoridades regionales correspondientes, el Ministerio de Salud establecerá por resolución normas especiales de calidad de aire más restrictivas en aquellas áreas en las cuales los objetivos de desarrollo de la región incluyan aspectos de relevante importancia, tales como la protección agrícola, turismo, recreación, balnearios o la preservación de las características naturales propias de parques o santuarios naturales.

7.- Se considera sobrepasada la Norma de Calidad de Aire cuendo la concentración detectada en cualquier estación de muestreo localizada en el área correspondiente se exceda una de las concentraciones ya especificadas.

Se considerará saturada, en términos de contaminación atmosférica, cualquier área en que el valor de la Norma de Calidad de Aire de uno o más contaminantes esté sobrepasado.

8.- Para los efectos de aplicación de estas normas en el contexto de una política de administración del recurso aire, el territorio nacional queda dividido en las trece regiones existentes que se denominarán Regiones de Control de Calidad del Aire. En la ejecución de programas de control de la contaminación atmosférica, cualquier región podrá ser dividida en sub-regiones, constituídas por una o más comunas o por parte de ellas.

En las regiones o sub-regiones consideradas saturadas, el nivel regional de salud deberá implantar y ejecutar un programa de control de la contaminación atmosférica, asignando recursos definidos que permitan controlar las emisiones contaminantes. En aquellas consideradas no saturadas corresponderá al nivel regional de salud aplicar las acciones de tipo preventivo pertinentes para no sobrepasar cualquier valor de la Norma de Calidad de Aire.

En ambos casos, el nivel regional de salud deberá considerar la adecuada coordinación interinstitucional que permita compatibilizar, en el marcho de la estrategia de desarrollo regional, los aspectos de protección ambiental.

PROHIBICIONES Y EXIGENCIAS GENERALES .

9.- Se prohibe quemar residuos sólidos, líquidos o cualquier otro material combustible a cielo abierto en áreas rurales, radio urbano, vía pública y recintos privados. Esta disposición regirá para áreas saturadas o en vías de saturación con las siguientes excepciones:

I.: Cuando se efectúe con permiso de la autoridad competente para:

a) Instruír sobre procedimientos que tengan como fin combatir el fuego y los incendios.
b) Destruír materiales peligrosos que no sea posible eliminar por otros medios sin causar un riesgo.

II.: Cuando se trate de prevenir la propagación del fuego que no pueda ser atacado de otro modo.

III.: Por razones sanitarias de protección comunitaria.

IV.: Cuando el fuego se use para cocinar al aire libre y no produzca molestias.

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10.- Prohíbese la emisión de humos con densidad colorimétrica superior al Nº 2 de la Escala de Ringelmann, provenientes de procesos de combustión estacionarios, con las siguientes excepciones:

a) Durante un período de quince (15) minutos al día, para las operaciones de calentamiento del equipo de combustión.

b) Durante un tiempo de tres (3) minutos, consecutivos o nó, en cualquier período de una (1) hora.

Prohíbese la emisión de humos con índice de opacidad superior al 40% de la escala respectiva, proveniente de procesos industriales estacionarios.

Aquellas fuentes de contaminación para las que no figure norma de emisión, deberán adoptar sistemas de control del o los contaminantes basados en la mejor tecnología disponible, sujetos a la aprobación de la autoridad sanitaria.

11.- La autoridad regional de salud deberá proponer al nivel central un proyecto de norma local de emisión cuando las circunstancias aconsejen criterios más estrictos que los contenidos en la norma nacional.

Estos proyectos de normas se elaborarán teniendo en cuenta los siguientes aspectos:

a) Los objetivos y estrategia de desarrollo definidos por el gobierno regional.

b) Las características geográficas, meteorológicas y topográficas del sector afectado.

c) El grado de urbanización, industrialización y localización de las actividades de acuerdo a planos reguladores comunales o intercomunales.

d) Niveles de contaminación a que se podría llegar a mediano plazo.

e) Implementación evaluativa que permita ejercer una adecuada vigilancia de la calidad del aire.

12.- La autoridad local de salud podrá exigir al responsable de una fuente emisora de contaminantes, la instalación y operación de equipos automáticos de medición y registro, para verificar las cantidades de contaminantes emitidos. Del examen periódico de los registros respectivos dependerá la formulación de nuevas exigencias de control.

Los responsables de las fuentes de contaminación deberán comprobar la cantidad y calidad de los contaminantes atmosféricos que emitan por chimeneas, utilizando métodos aprobados por la autoridad sanitaria, pudiendo recurrir a la asistencia o servicios técnicos ajenos si lo estiman conveniente.

Cada vez que la autoridad sanitaria resuelva efectuar por si misma estudios de una fuente de contaminación, los responsables deberán otorgar todas las facilidades necesarias y cancelar según arancel los análisis de laboratorio requeridos, si esto último dicha autoridad estima conveniente exigirlo.

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NORMAS SOBRE PROYECTOS DE CONTROL DE FUENTES ESTACIONARIAS.

13.- Previa a la instalación o puesta en marcha de todo nuevo proceso, actividad u operación que implique contaminación del aire, se deberán presentar todos los antecedentes necesarios para definir el peso del proceso, a fin de precisar su posible influencia en el nivel de contaminación local.

La autoridad sanitaria en casos calificados podrá exigir la presentación de un estudio de impacto ambiental cuando a juicio de ésta los contaminantes emitidos puedan ocasionar un riesgo inminente para la salud.

Los proyectos deberán ser presentados a las Regiones de Salud correspondientes. Si estas no cuentan con programa de contaminación atmosférica remitirán todos los antecedentes al nivel central para su estudio y aprobación.

14.- La evacuación de efluentes provenientes de quemar combustibles sólidos, líquidos o gaseosos, deberá ser realizada a través de chimeneas. Cualquier otra fuente de contaminación del aire deberá estar provista de un sistema de ventilación extractiva y el lanzamiento de efluentes a la atmósfera deberá ser realizado a través de chimeneas, con excepción de aquellos casos particulares calificados en que se especifique un procedimiento distinto. En ambos casos los efluentes deberán ajustarse a la norma de emisión respectiva.

15.- Las operaciones, procesos o funcionamiento de equipos de trituración, molienda, transporte, manipulación, carga y descarga de material fragmentado o particulado, podrá exceptuarse de las exigencias anteriores, siempre que se realicen mediante procesos de humidificación permanente, o empleando otro sistema de control de la contaminación atmosférica de eficiencia igual o superior.

El almacenamiento de material fragmentado o particulado deberá efectuarse en silos adecuadamente cerrados o en otro sistema de control de la contaminación del aire de eficiencia igual o superior, de tal modo de impedir el arrastre de material por acción de los vientos.

Las exigencias formuladas en los dos párrafos inmediatamente precedentes se aplicarán solo en aquellos casos en que el área se encuentre saturada y en situaciones que creen un problema puntual.

16.- En las áreas cuya finalidad preponderante sea la residencial o comercial, quedará a criterio del nivel regional de salud, previa consulta al nivel central, especificar el tipo de combustible que podrá ser utilizado por equipos o dispositivos de combustión. Quedan incluídos los hornos de panificación, de restaurant, fuentes de soda y similares y calderas destinadas a cualquier finalidad.

17.- Las sustancias odoríferas resultantes de las fuentes que se enumeran a continuación deberán ser incineradas en post quemadores, a una temperatura mínima de setecientos cincuenta grados celsius (750ºC) y un tiempo de residencia de los gases no inferior a cinco décimo (0,5) de segundo, o por otro sistema de control de contaminantes, de eficiencia igual o superior:

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Tostaduría de café, cebada, trigo, maní y similares.

Autoclaves y digestores utilizados en el aprovechamiento de material animal.

Estufas de secado o curado de piezas pintadas, barnizadas o litografiadas.

Oxidación de asfalto.

Ahumado de carnes y similares.

Fuentes de súlfuro de hidrógeno y mercaptanos.

Cuando las fuentes anteriores estén ubicadas en áreas cuyo uso preponderante sea residencial o comercial se deberá utilizar gas como combustible del quemador. En otras áreas quedará a criterio de la autoridad regional de salud definir el combustible.

El post-quemador deberá estar provisto de un indicador de temperatura de la cámara de combustión, en un lugar de fácil acceso y visibilidad.

18.- Las operaciones de cobertura de superficies realizadas por aspersión, tales como pintura o aplicación de barniz, deberá realizarse en un compartimento apropiado, provisto de adecuada ventilación local de extracción, complementada con un sistema eficiente de retención de material particulado. Se exceptúan las zonas residenciales en las cuales estas actividades quedan prohibidas.

REGISTROS Y PERMISOS DE LAS FUENTES DE CONTAMINACION.

19.- Para los efectos de inscripción de los registros y obtención de autorizaciones de instalación, ampliación o funcionamiento se consideran como fuentes de contaminación las siguientes:

Actividades de extracción y tratamiento de minerales.

Actividades industriales.

Servicios de reparación, mantención o de otro tipo y actividades comerciales que produzcan impacto en la contaminación atmosférica.

Sistemas públicos o privados de recolección, transposrte, tratamiento o disposición final de residuos o materiales sólidos, líquidos o gaseosos.

Fábricas de hormigón y de revestimiento asfáltico, de instalación transitoria o definitiva.

Actividades que utilicen o almacenen combustibles, sólidos, líquidos o gaseosos para fines comerciales o de servicios o industriales.

Demolición de construcciones.

Todas las actividades mencionadas en el párrafo anterior que a la fecha estuviesen instaladas, en ampliación o en funcionamiento estarán obligadas a suministrar a la autoridad sanitaria cuando ésta lo requiera, la siguiente información: ubicación, materias primas, productos terminados, sub-productos y residuos, descripción del o los procesos, distribución de maquinarias y equipo, cantidad y naturaleza de los contaminantes emitidos y equipos de control de la contaminación.

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FISCALIZACION Y SANCIONES :

20.- La fiscalización y sanción de las infracciones a lo dispuesto en la presente resolución corresponderá aplicarlas al Servicio Nacional de Salud, de acuerdo a lo dispuesto en el Código Sanitario con excepción de la quema a cielo abierto en áreas saturadas o en vías de saturación que corresponderá al Cuerpo de Carabineros de acuerdo a lo dispuesto en los Arts. 9º y 10º del D.S. Nº 144 del 2 de mayo de 1961.

Las excepciones referentes a la quema a cielo abierto en áreas anteriormente mencionadas corresponderá resolverlas a la autoridad sanitaria.

ANOTESE Y COMUNIQUESE

DR. FRANCISCO QUESNEY LANGLOIS
DELEGADO DE GOBIERNO EN EL SNS

Transcrito fielmente,

Polidoro Palma Vergara
MINISTRO DE FE

Distribución:
- Depto. Programas sobre el Ambiente (100)
- Directores Regionales
- Direcciones Región Metropolitana
- Oficinas de Higiene y Seguridad Industrial Región Metropolitana.
- Ministerio de Transporte
- Municipalidades de la Región Metropolitana
- Dirección General de Carabineros
- Depto. del Tránsito y Carreteras
- Instituto de Investigaciones Tecnológicas (INTEC-CORFO)
- ODEPAN

JSM/ssa.

Copia para Rodrigo

CONTRALORÍA GENERAL DE LA REPÚBLICA
DIVISIÓN JURÍDICA

N° 000189

Santiago, 17.NOV 97 *037842

Para su conocimiento y demás fines que procedan, me permito remitir a Ud. copia del oficio N° ______, de fecha ________, de esta Contraloría General. 17.NOV 97 *037841

Dios guarde a Ud.,

GASTON ASTORQUIZA ALTANER
Abogado Jefe
División Jurídica

AL SEÑOR
DIRECTOR EJECUTIVO DE LA
COMISION NACIONAL DEL MEDIO AMBIENTE
<u>PRESENTE</u>

CONTRALORÍA GENERAL DE LA REPÚBLICA
DIVISIÓN JURÍDICA

REF.N°s 23.639/96
JCL 26.924/96
28.751/96

SOBRE VIGENCIA DE LA RESOLUCIÓN N° 1.215, DE 1978, DEL DELEGADO DE LA JUNTA DE GOBIERNO ANTE EL SERVICIO NACIONAL DE SALUD.

SANTIAGO, 17.NOV 97*037841

Esta Contraloría General ha estimado necesario emitir un pronunciamiento acerca de la vigencia del acto administrativo de la suma, a raíz de las dudas que se han planteado con motivo de la entrada en vigor de la ley N° 19.300, y de los cuestionamientos que se han formulado a su respecto, en razón de que no fue publicado en el Diario Oficial, ni sometido al control preventivo de legalidad de este Organismo, y porque, además, regularía materias que son propias de ley.

Sobre el particular, es útil tener presente, en primer término, que la indicada resolución N° 1.215 fue dictada el año 1978, y establece, en general, normas sanitarias mínimas destinadas a prevenir y controlar la contaminación atmosférica.

Dicho acto administrativo emanó de la autoridad que a esa data tenía competencia sobre la materia. Así aparece del análisis conjunto de la ley N° 10.383, que creó el Servicio Nacional de Salud, del decreto N° 144, de 1961, del Ministerio de Salud, que establece normas para evitar emanaciones o contaminantes atmosféricos de cualquier naturaleza, y del decreto ley N° 94, de 1973, que creó la institución de los Delegados de la Junta de Gobierno, para administrar diversos servicios públicos, entre los cuales se cuenta al ex-Servicio Nacional de Salud.

AL
HONORABLE DIPUTADO
SEÑOR GUIDO GIRARDI LAVÍN
VALPARAÍSO.

Asimismo, se debe anotar que el 9 de marzo de 1994 entró en vigencia la ley N° 19.300, sobre Bases Generales del Medio Ambiente, que ha establecido un nuevo régimen normativo destinado a salvaguardar el derecho a vivir en un medio ambiente libre de contaminación.

Examinado el contenido de la mencionada resolución N° 1.215, a la luz de las disposiciones de la referida ley N° 19.300, se advierte la necesidad de distinguir entre lo preceptuado en los N°s. 3, 4 y 5 de dicha resolución, y lo dispuesto en el resto de los numerales de la misma, a fin de dilucidar el problema relativo a su vigencia.

En este sentido, cabe precisar que el N° 3 de la resolución que se estudia ha establecido las concentraciones ambientales máximas para las partículas en suspensión, el anhídrido sulfuroso, el monóxido de carbono, los oxidantes fotoquímicos (ozono), y el dióxido de nitrógeno; el N° 4, por su parte, expresa que todas las mediciones de los referidos contaminantes deben ser corregidas en la forma que indica y que el muestreo deberá ser efectuado con la frecuencia mínima que señala; y, finalmente, el N° 5, contempla los métodos de análisis para determinar las concentraciones de los diferentes contaminantes.

Ahora bien, acorde con lo señalado en el artículo 2°, letra n), de la citada ley N° 19.300 -que define lo que debe entenderse por norma primaria de calidad ambiental-, y la denominación de normas de calidad del aire que la resolución N° 1.215, da a las concentraciones máximas a que se ha hecho mención, es posible sostener que los numerales indicados han establecido y regulado las normas primarias de calidad ambiental para cada uno de los elementos recién indicados.

Siendo así, procede aplicar, respecto de la vigencia de esas normas de calidad ambiental, el criterio sustentado por esta Entidad de Control en el dictamen N° 33.256, de 1994, cuya fotocopia se adjunta, y por consiguiente deben entenderse vigentes.

Por otra parte, en lo que concierne al resto de los numerales de la resolución que se examina, cumple manifestar que algunos han perdido su vigencia, por cuanto tratan materias generales relacionadas con la garantía del artículo 19, N° 8, de la Carta Fundamental, y, por consiguiente, deben ser reguladas por disposiciones de rango legal; y otros, no pueden entenderse vigentes ya que establecen prohibiciones y exigencias de carácter general que para ser obligatorios requieren de la correspondiente publicación.

Sobre este último punto, cabe señalar que la circunstancia de que la resolución que se examina no haya sido publicada, no obsta a la conclusión a que se ha arribado en orden a entenderla vigente respecto de los números 3, 4 y 5, de la misma, toda vez que, por su naturaleza, no requería de tal publicación, a lo que cabe añadir que no se advierte precepto alguno, vigente a la época en que fue emitida, que obligara a publicar los actos administrativos que fijaban normas de calidad ambiental, como el de la especie, a diferencia del artículo 49 de la citada ley N° 19.300, que sí contempla dicha obligación.

En lo que concierne al hecho de que la resolución N° 1.215 no fue sometida al control preventivo de legalidad de esta Contraloría General, es del caso señalar que acorde con lo dispuesto en la resolución N° 600, de 1977, de esta Entidad de Control, que estableció reglas sobre exención del trámite de toma de razón, vigente al tiempo de dictarse el acto administrativo de la suma, los actos que fijaban normas de calidad ambiental estaban exentos de dicho trámite.

Por último, es dable destacar que de las disposiciones constitucionales pertinentes no se advierte que la fijación de normas de calidad ambiental sea una materia propia de ley, de lo que se sigue que la citada ley N° 19.300, no ha contemplado en sus preceptos ninguna norma de este tipo, sino que se ha limitado a consignar definiciones de carácter genérico sobre el particular y a señalar los procedimientos y autoridades competentes para dictarlas.

En mérito de lo expresado, cabe concluir que la resolución N° 1.215, de 1978, del Delegado de la Junta de Gobierno ante el ex-Servicio Nacional de Salud, sólo se encuentra vigente en sus números 3, 4 y 5, en cuanto se refieren a normas de calidad ambiental.

Transcríbase al Ministerio Secretaría General de la Presidencia de la República, a la Subsecretaría de Salud, al Servicio de Salud del Ambiente de la región Metropolitana, y a la Comisión Nacional del Medio Ambiente.

Dios guarde a US.

JORGE REYES RIVEROS
CONTRALOR GENERAL DE LA REPUBLICA
SUBROGANTE

CONTRALORIA GENERAL DE LA REPUBLICA
DIVISION JURIDICA

000194

REF. Nº24.440/94
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ATIENDE CONSULTA DEL MINISTERIO SECRETARIA GENERAL DE LA PRESIDENCIA.

33256

SANTIAGO, 27 SET. 1994

Mediante el documento del rubro, esa Secretaría de Estado expresa que en forma previa a la dictación de dos decretos, uno que declara zona saturada la aledaña a la Fundición de Caletones en la VI Región, y otro que aprueba un plan de descontaminación en la Fundición Hernán Videla Lira, en Paipote, III Región, ha estimado necesario solicitar un pronunciamiento a esta Contraloría General acerca de si tales medidas deben adoptarse de acuerdo con las reglas contenidas en el decreto Nº185, de 1991, del Ministerio de Minería o en la ley Nº19.300, de Bases Generales del Medio Ambiente, publicada el 9 de marzo de 1994, y si se encuentran vigentes las normas de calidad ambiental establecidas en el referido decreto.

Sobre el particular, cabe tener presente que la citada ley Nº19.300, que estatuye las Bases Generales del Medio Ambiente, no contempla en sus preceptos ninguna norma de calidad ambiental específica sino que se limita a consignar algunas definiciones de carácter genérico sobre la materia y a señalar los procedimientos y autoridades competentes para dictar tales normas.

Por su parte , el indicado decreto Nº185, que reglamenta el funcionamiento de establecimientos y fuentes emisoras de anhídrido sulfuroso, material particulado o arsénico, junto con establecer disposiciones generales acerca de los diversos aspectos que regula, fijó las concentraciones ambientales máximas permisibles para el material particulado respirable y el anhídrido sulfuroso.

AL SEÑOR
MINISTRO SECRETARIO
GENERAL DE LA PRESIDENCIA
PRESENTE

En efecto, con el fin de proteger la salud humana, el artículo 4º de ese decreto señaló normas de calidad del aire en relación al material particulado respirable y al anhídrido sulfuroso, aplicables en todo el territorio nacional y, con el objeto de preservar los ecosistemas y proteger las explotaciones silvoagropecuarias, el artículo 6º fijó normas sobre concentraciones ambientales máximas permisibles de anhídrido sulfuroso para las áreas geográficas que indica.

Es dable destacar que estas normas de calidad ambiental fueron dictadas en virtud de preceptos legales que actualmente se encuentran vigentes conforme al artículo 1º de la ley Nº19.300, según el cual el derecho a vivir en un medio ambiente libre de contaminación, la protección del medio ambiente, la preservación de la naturaleza y la conservación del patrimonio ambiental se regulan por sus disposiciones, "sin perjuicio de lo que otras normas legales establezcan sobre la materia."

Corrobora lo expresado, el inciso tercero del artículo 32 del citado texto legal al disponer que el reglamento a que se refiere debe contener entre otras materias, "los criterios para revisar las normas vigentes" de calidad ambiental, lo que implica que el legislador reconoce la existencia de normas ambientales en vigor, promulgadas de acuerdo al ordenamiento que regía con anterioridad a la publicación de la Ley de Bases Generales del Medio Ambiente, como ocurre, precisamente, con las fijadas por el citado decreto Nº 185.

En tales condiciones, no cabe sino concluir que las normas de calidad del aire sobre material particulado respirable y anhídrido sulfuroso fijadas por los artículos 4º y 6º del decreto Nº 185, se encuentran vigentes.

Precisado lo anterior, y en lo que concierne a la declaración de zona saturada, esta Entidad Fiscalizadora cumple con manifestar que esa materia ha sido regulada en la aludida ley Nº19.300, por lo que debe entenderse que han quedado sin efecto las disposiciones que al respecto se consignaban en el referido decreto Nº185.

Ahora bien, es menester consignar que acorde con lo dispuesto en el artículo 2º, letra u), de la ley indicada, se entiende por zona saturada "aquella en que una o más normas de calidad ambiental se encuentran sobrepasadas".

Enseguida, es dable anotar que conforme al artículo 43 del mismo texto legal, la declaración de una zona del territorio como saturada se formaliza mediante decreto supremo que debe llevar las firmas del Ministro Secretario General de la Presidencia y la de los demás Secretarios de Estado que corresponda y contener la determinación precisa del área geográfica que abarca.

A continuación, es útil tener en cuenta que de acuerdo a dicho precepto la aludida declaración debe fundarse en mediciones, realizadas o certificadas por los organismos públicos competentes, en las que conste haberse verificado la condición que la hace procedente. Asimismo, corresponde a la Comisión Regional del Medio Ambiente, tomar a su cargo este procedimiento a menos que la zona objeto de la declaración comprenda distintas regiones, en cuyo caso el organismo competente es la Comisión Nacional del Medio Ambiente.

En consecuencia, atendido que, según se indica en la consulta, se ha aprobado la red de monitoreo para medir la calidad del aire en la zona circundante a la Fundición de Caletones, y que la Comisión Regional del Medio Ambiente ha verificado en esa zona la superación de las normas fijadas, resulta procedente que aquella medida se declare mediante decreto supremo con la firma de los Ministros que corresponda.

Finalmente, respecto de la procedencia de aprobar un plan de descontaminación para la Fundición Hernán Videla Lira, de Paipote, es dable tener en cuenta que, según lo manifestado en la consulta, el área circundante a dicha fundición fue declarada zona saturada por el decreto Nº255 de 1993, del Ministerio de Agricultura, y que la Empresa Nacional de Minería, en noviembre de ese año, presentó al Intendente de la Región de Atacama un plan de descontaminación que ha seguido la tramitación contemplada en el título VI del decreto Nº185.

Atendido lo anterior resulta necesario dilucidar si ese procedimiento, llevado a efecto con anterioridad a la entrada en vigencia de la ley Nº19.300, es útil para la aprobación de dicho plan, teniendo en cuenta que el aludido texto legal ha fijado para tal efecto un procedimiento distinto.

En efecto, el artículo 17 del referido decreto Nº 185, imponía a los establecimientos regulados que se localizaban en zonas declaradas como saturadas la obligación de elaborar, en un plazo máximo de seis meses desde la fecha de publicación del decreto que efectuaba tal declaración, planes de descontaminación de acuerdo al Título VI de ese ordenamiento. En éste se indicaba el contenido de los mismos y el procedimiento para su evaluación, etapa que se iniciaba con la presentación del plan al Intendente Regional y culminaba con su aprobación mediante decreto supremo, todo lo cual debía efectuarse en un plazo de 120 días.

Por su parte, la Ley de Bases Generales del Medio Ambiente, en su artículo 44, dispone que a través de decreto supremo del Ministerio Secretaría General de la Presidencia, que debe llevar además la firma del Ministro sectorial que corresponda, se establecen los planes de descontaminación, cuyo cumplimiento es obligatorio en las zonas calificadas como saturadas. Asimismo, señala que la elaboración de estos planes y su proposición a la autoridad competente corresponde a la Comisión Nacional del Medio Ambiente, previo informe de la Comisión Regional respectiva, debiendo seguirse para estos efectos el mismo procedimiento y etapas establecidos en el inciso tercero del artículo 32 de la citada ley, que prevé la dictación de un reglamento que regule tales aspectos.

En tales circunstancias, si bien las nuevas disposiciones de la citada ley Nº19.300, que fijan el procedimiento para la aprobación de los planes de descontaminación, deben aplicarse a contar de su entrada en vigencia, esto es, el 9 de marzo de 1994, las actuaciones y diligencias iniciadas con anterioridad a esa fecha, en armonía con lo establecido en el artículo 24 de la Ley sobre el Efecto Retroactivo de las Leyes, no se rigen por esa normativa sino por los preceptos vigentes al tiempo de su iniciación, criterio que, además, guarda concordancia con la jurisprudencia administrativa contemplada en el dictamen Nº45.905 de 1976, de esta Entidad Fiscalizadora.

En consecuencia, como la etapa de evaluación del plan de la especie se encontraba pendiente ante el Intendente mencionado a la fecha de la entrada en vigencia de la ley Nº 19.300, corresponde a esa autoridad, con arreglo a lo previsto en la letra d) del artículo 27 del referido decreto Nº185, dar cumplimiento a la diligencia de remitir al Presidente de la República dicho plan para su aprobación, la que en todo caso debe efectuarse mediante decreto del Ministerio Secretaría General de la Presidencia, en conformidad a lo dispuesto en el artículo 44 del indicado texto legal.

Atendido lo expuesto, esta Contraloría General cumple con manifestar que ese Ministerio puede declarar zona saturada el área aledaña a la Fundición de Caletones, en la VI Región y aprobar el plan de descontaminación para la Fundición Hernán Videla Lira, de Paipote, III Región, en los términos señalados precedentemente.

Dios guarde a US.

OSVALDO ITURRIAGA RUIZ
Contralor General de la República

República de Chile
Ministerio del Interior
Intendencia Regional Décima Región de los Lagos

CONSTITUYE CONSEJO CONSULTIVO
REGIONAL DEL MEDIO AMBIENTE

RESOLUCIÓN EXENTA Nº 01079 /

Puerto Montt, 24 DIC 1999

VISTOS ESTOS ANTECEDENTES :

1. Lo dispuesto en la Constitución Política del estado; la Ley 19.175 de 1992, según texto refundido por Decreto Nº291 de marzo de 1993, del Ministerio el Interior, la Ley 19.300 de Bases Generales del Medio Ambiente; y el D.S. Nº 86, modificado por D.S. Nº 181, y la resolución 488/97 que modifica la Resolución Nº520 de 1996 de la Contraloría General de la República, que fija texto refundido, coordinado y sistematizado de la Resolución C.G.R. Nº55/92.

TENIENDO PRESENTE:

2. Que el Gobierno de Chile está decidido a impulsar una política ambiental que esta comprometida con el desarrollo y que asuma las funciones reguladoras del Estado.

3. Que la Intendencia Regional y la Comisión Regional del Medio Ambiente han asumido tales objetivos nacionales, buscando regular la sustentabilidad del proceso regional y elevar la calidad de vida de los habitantes de esta Región.

4. Que es necesario lograr una efectiva coordinación y eficacia en la gestión ambiental que realicen las instituciones públicas y privadas de esta Región.

5. Que es necesario avanzar en el cumplimiento de los objetivos perseguidos por la legislación ambiental.

6. Que el D.S. Nº86 modificado por el D.S. 181, instruye sobre la forma y los plazos de constitución del Consejo Consultivo Regional del Medio Ambiente.

RESUELVO:

1. Declárese constituido a contar d esta fecha, en la X Región de los Lagos, el Consejo Consultivo Regional del Medio Ambiente.

2. El Consejo Consultivo Regional del Medio Ambiente estará integrado por las siguientes personas:

- Director Regional de la Comisión nacional del medio ambiente, quien lo presidirá.
- Sr. Carlos Bertrán y Sr. Francisco Magaña, científicos en representación de Universidades e Institutos Profesionales.
- Señor José Arenas y Sr. Waldo Vera, en representación de las Organizaciones No Gubernamentales (ONGs)
- Sr. Osvaldo Cirano y Sr. Daniel Rebolledo, en representación del empresariado.
- Sr. Christian Araus y Sr. Guido Yobanolo, en representación de los trabajadores.
- Sr. Luis Durán Branchi, en representación del Intedente Regional.

3. Los Consejeros durarán en sus funciones un periodo de dos años, el que podrá prorrogarse por una sola vez.

4. Corresponderá al Consejo Consultivo Regional absolver las consultas que formule la comisión regional de medio Ambiente y ejercer todas las atribuciones y desempeñar las demás funciones que le encomiende la Ley.

ANÓTESE, NOTIFÍQUESE Y REGÍSTRESE

INTENDENCIA DECIMA REGION
INTENDENTE REGIONAL

SR. RABINDRANATH QUINTEROS LARA
Intendente Regional
Décima Región de Los Lagos

INTENDENCIA DECIMA REGION
SECRETARIO ABOGADO

SR. BRAULIO SANHUEZA
Asesor Jurídico
Intendencia Regional
Décima Región de Los Lagos

COMISION NACIONAL MEDIO AMBIENTE
Director Regional
DECIMA REGION

SR. RAÚL ARTEAGA MONTESINOS
Director Regional
Comisión Nacional del Medio Ambiente
Décima Región de Los Lagos

REPÚBLICA DE CHILE
MINISTERIO DEL INTERIOR
INTENDENCIA REGIONAL DE AYSÉN

CONSTITUYE CONSEJO CONSULTIVO REGIONAL DEL MEDIO AMBIENTE.

RESOLUCIÓN EXENTA 175 /

COYHAIQUE, 26 OCT 1999

VISTOS:

Lo dispuesto en la Constitución Política del Estado; la Ley 19.175 de 1992, según texto refundido por Decreto N°291 de marzo de 1993, del Ministerio del Interior, la Ley 19.300 de Bases Generales del Medio Ambiente; y el D.S. N°86, modificado por D.S. N°181, y la Resolución 488/97 que modifica la Resolución N°520 de 1996 de la Contraloría General de la República, que fija texto refundido, coordinado y sistematizado de la Resolución C.G.R. N°55/92.

TENIENDO PRESENTE:

Que el Gobierno de Chile está decidido a impulsar una política ambiental que esté comprometida con el desarrollo y que asuma las funciones reguladoras del Estado.

Que esta Intendencia Regional y la Comisión Regional del Medio Ambiente han asumido tales objetivos nacionales, buscando regular la sustentabilidad del proceso Regional y elevar la calidad de vida de los habitantes de esta Región.

Que es necesario lograr una efectiva coordinación y eficacia en la gestión ambiental que realicen las instituciones privadas y públicas de esta Región.

Que es necesario avanzar en el cumplimiento de los objetivos perseguidos por la legislación ambiental.

Que el D.S. N°86 modificado por el D.S. 181, instruye sobre la forma y los plazos de constitución del Consejo Consultivo Regional del Medio Ambiente.

RESUELVO:

1.- Declárese constituido a contar de esta fecha, en la XI Región de Aysén, el Consejo Consultivo Regional del Medio Ambiente.

2.- El Consejo Consultivo Regional del Medio Ambiente estará integrado por las siguientes personas:

Directora Regional de la Comisión Nacional del Medio Ambiente, quién lo presidirá.

Sr. Eduardo Aedo Marchant y Sra. Margarita Oyarce Igor, científicos en representación de las Universidades e Institutos Profesionales.

Sra. Miriam Chible Contreras y Sr. Bernardino Ojeda Barría, en representación de las Organizaciones No Gubernamentales (ONG).

REPÚBLICA DE CHILE
MINISTERIO DEL INTERIOR
INTENDENCIA REGIONAL DE AYSÉN

Sr. Luis Gómez Pizarro y Sr. Eduardo Santelices Puelma, en representación del empresariado.

Sr. Jacinto Tejeda Muñoz y Sr. Víctor Inostroza Flores, en representación de los Trabajadores.

Sra. Lucy Puchi Muñoz en representación del Intendente Regional.

3.- Los Consejeros durarán en sus funciones un periodo de dos años, el que podrá prorrogarse por una sola vez.

4.- Corresponderá al Consejo Consultivo Regional absolver las consultas que le formule la Comisión Regional del Medio Ambiente y ejercer todas las atribuciones y desempeñar las demás funciones que le encomiende la Ley.

ANÓTESE, Y COMUNÍQUESE.

IVÁN MOSCOSO GATICA
Asesor Jurídico
Intendencia Regional de Aysén

CARLOS SACKEL BAHAMONDES
Intendente Regional de Aysén

SERVICIO GOBIERNO REGIONAL
MAGALLANES Y ANTARTICA CHILENA
DEPARTAMENTO JURÍDICO

RESOLUCIÓN EXENTA (G.R.) N° 014 /

MAT.: Renueva Consejo Consultivo Regional del Medio Ambiente.

PUNTA ARENAS, 02 NOV. 1999

Con esta fecha se ha resuelto lo que sigue:

V I S T O S :

1. Los artículos 82 y 83 de la Ley N° 19.300, sobre Bases del Medio Ambiente;
2. El Decreto N° 86, de 1995, del Ministerio Secretaría General de la Presidencia, Reglamentario del Consejo Consultivo de la Comisión Nacional del Medio Ambiente y de los Consejos Consultivos Regionales;
3. La Resolución N° 55, de 24.01.92 de la Contraloría General de la República, cuyo texto refundido, coordinado y sistematizado, se fijó mediante Resolución N° 520, de 15.11.96, del mismo Organismo;
4. La Ley N° 19.175, Orgánica Constitucional sobre Gobierno y Administración Regional,

C O N S I D E R A N D O :

1. Que, de acuerdo con lo establecido en el artículo 15 del Reglamento señalado en el N° de los Vistos del presente documento, corresponde designar el Consejo Consultivo Regional del Medio Ambiente de Magallanes y Antártica Chilena para el período 2000-2002;
2. Que, de conformidad con las proposiciones de sus representantes, formadas por las instituciones y entidades indicadas en la misma disposición esta Autoridad Regional ha procedido a seleccionar como integrantes del referido Consejo para el período 2000-2002 a las personas que se individualizan en la parte resolutiva.

R E S U E L V O :

1. **DESÍGNASE,** como miembros del Consejo Consultivo Regional del Medio Ambiente de Magallanes y Antártica Chilena para el período 2000-2002 a las personas que se indican en representación de las entidades que se señalan:

   a) En representación de la Universidad de Magallanes, los científicos:
   - Señora Maria Soledad Astorga España y
   - Señor Orlando Dollenz Alvarez

   b) En representación de Organizaciones no Gubernamentales:
   - Don Eliecer Bahamonde Mansilla y
   - Don José Luis Oyarzún Barría

c) En representación del empresariado:
   - Don José Jainaga Mallagaray y
   - Don Ivan Nikovic Fernández

d) En representación de Organizaciones y Trabajadores:
   - Don Raúl Hein Bozic y
   - Don Luis Arriaza Henriquez

e) En representación del Intendente Regional:
   - Don José Guzmán V.

2. El Consejo Regional del Medio Ambiente de Magallanes y Antártica Chilena, integrado por los Consejeros designados en la presente resolución, será presidido por el Director Regional de la Comisión Nacional del Medio Ambiente, don Sergio Nitrigual Norambuena.

3. La organización y funcionamiento del Consejo se someterá a las disposiciones pertinentes del Decreto Reglamentario N° 86, de 1995, del Ministerio Secretaría General de la Presidencia de la República, señalando en los Vistos de la presente Resolución.

ANÓTESE, COMUNÍQUESE Y ARCHÍVESE. (Fdo.) Jaime Jelincic Aguilar, Intendente Regional (S) "Magallanes y Antártica Chilena", Juan Poblete Silva Jefe Depto. Jurídico Servicio Gobierno Regional.

Lo que transcribo a Ud. para su conocimiento.

JUAN POBLETE SILVA
JEFE DEPTO. JURÍDICO
SERVICIO GOBIERNO REGIONAL

DISTRIBUCIÓN:
- Integrantes del Consejo
- Archivo Depto. Jurídico
- Archivo

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REPUBLICA DE CHILE
GOBIERNO INTERIOR
INTENDENCIA IX REGION
DE LA ARAUCANIA
DEPARTAMENTO JURIDICO

REF.: Designa Integrantes Consejo Consultivo Regional del Medio Ambiente

Temuco, 25 OCT 1999

Resolución Exenta Nº 421

VISTOS:

1. El Art.82 de la Ley Nº 19.300 sobre Bases Generales del Medio Ambiente.
2. El Art.15 del Decreto Nº86 de 1995 del Ministerio Secretaría General de la Presidencia que aprobó el reglamento que regula el funcionamiento de los Consejos Consultivos Regionales del Medio Ambiente.
3. El ORD. Nº 359 del 15.10.99 de Director Regional IX Región de CONAMA.
4. Art. 2º letra p) de la Ley 19.175 Orgánica Constitucional sobre Gobierno y Administración Regional.
5. Resolución Exenta Nº 582 del 14.10.97 de Intendencia Regional.
6. La Resolución Nº 520 de 1996 de la Contraloría General que fijó el texto refundido, coordinado y sistematizado de la Resolución Nº 55 de 1992.

CONSIDERANDO:

1. Que la Ley 19.300 sobre Bases Generales del Medio Ambiente, Establece los Consejos Consultivos Regionales Como órganos Asesores de las Comisiones Regionales del Medio Ambiente.
2. Que por las normas de los "Vistos 1) y 2), se ha radicado en los Intendentes Regionales la designación de los integrantes de dichos Consejos, conforme al procedimiento establecido en el Reglamento

RESUELVO:

1. DESIGNASE, como integrantes del Consejo Consultivo de la Comisión Regional del Medio Ambiente IX Región, a las siguientes personas:

a) En su calidad de científicos:
- Dr. Carlos Klein Koch
- Dr. Fernando Peña Cortés

b) En representación de las Organizaciones No Gubernamentales sin fines de lucro que tengan por objeto la protección o estudio del Medio Ambiente.

- Sra. Angélica Hernández Moreno
- Sr. Roberto Koch B.

c) En representación del Empresariado

- Sr. Edison Rocha Durán
- Sr. Juan Ojeda Viera

d) En Representación de los Trabajadores

- Sr. Servando Contreras
- Sr. Edgardo Alonqueo M.

e) En representación del Sr. Intendente Regional

- Sr. Sergio Meza Villegas

ANOTESE, COMUNIQUESE Y ARCHIVESE

Oscar Eltit Spielmann
Intendente IX Región
de La Araucanía

INTENDENCIA
IX Región de la Araucanía

Elizabeth V. Brevis Silva
Jefe Departamento Juridico
Intendencia IX Región

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- Sr. Director Regional CONAMA
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ANALISIS DE LA CONSISTENCIA DE LOS ANTECEDENTES PARA LA REVISION DE LAS NORMAS DE CALIDAD DE AIRE CONTENIDAS EN LA RESOLUCION N°1.215/78 DEL MINISTERIO DE SALUD

Este análisis se basa en el estudio del informe final "Antecedentes para la Revisión de las Normas de Calidad de Aire contenidas en la Res. N°1.215 del Ministerio de Salud, 1978", elaborado por la Consultora Sociedad de Gestión Ambiental Ltda. (S.G.A.) en 1998 para la Comisión Nacional del Medio Ambiente. Adicionalmente, se revisaron los antecedentes correspondientes al Plan de Prevención y Descontaminación Atmosférica de la Región Metropolitana (1997), la Resolución N°1.215 de 1978 del Ministerio de Salud y el Reglamento para la Dictación de Normas de Calidad Ambiental y de Emisión, contenido en el Decreto Supremo N°93 de 1995 del Ministerio Secretaría General de la Presidencia.

Antecedentes Generales

El estudio realizado por la consultora SGA comprende, para cada uno de los contaminantes incluidos en la Resolución N°1.215 (en adelante, la Resolución), los siguientes aspectos: (1) efectos del contaminante en la salud: experiencia nacional; (2) efectos del contaminante en la salud: experiencia internacional; (3) niveles del contaminante en la calidad del aire en Chile; (4) cumplimiento y fiscalización de la Resolución; (5) experiencia internacional en normas de calidad del aire; y, (6) proposiciones para la revisión de la norma.

A continuación se presenta un breve resumen de los principales antecedentes contenidos para cada uno de los contaminantes normados:

Material Particulado

Un análisis de consistencia sobre los antecedentes relativos a este contaminante se presentó en el informe del mes de Agosto a CONAMA.

Dióxido de Azufre (SO_2)

La experiencia nacional sobre los efectos de la contaminación por SO_2 muestran que la mortalidad no es estadísticamente significativa. En cuanto a los estudios de morbilidad, se encontró un aumento de las consultas infantiles de urgencia y un efecto en el flujo respiratorio forzado, en asociación con SO_2.

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Por su parte, la Organización Mundial de la Salud (OMS) determinó la existencia de niveles umbrales para los efectos del SO_2 sobre la salud humana tanto para efectos agudos (250 ug/m^3 para niveles de 24 h), traducidos en un aumento de las enfermedades respiratorias agudas en adultos, como para efectos de largo plazo (100 ug/m^3 para niveles anuales de exposición), expresados en un aumento en los síntomas o enfermedades respiratorias.

Adicionalmente, estudios recientes se han enfocado en determinar los efectos en la salud asociados con las exposiciones al dióxido de azufre de más corto plazo. La OMS ha establecido el menor nivel de efecto observado en 1.000 ug/m^3 (10 minutos) y un factor de seguridad igual a 2 para la protección de la salud pública. De ahí que entregue un valor guía máximo de 500 ug/m^3 para exposiciones de 10 minutos.

La Tabla 1 presenta un resumen comparativo entre los niveles normados en Chile y países relevantes respecto a la temática ambiental.

Tabla 1: ***Comparación de las Normas de Calidad del Aire para Dióxido de Azufre (SO_2).***

PAIS	SO_2 (ug/m^3)				
	10 min.	**30 min.**	**1 h**	**24 h**	**Anual**
Chile	-	-	-	365	80
Estados Unidos	-	-	-	365	80
Unión Europea	-	-	350	125	-
OMS	500	-	-	125$^{(1)}$	50$^{(1)}$
Suiza	-	100	-	100	30
Japón	-	-	260	104	-
Alemania	-	400	-	-	140

Nota: (1) Valores guía para exposición combinada de dióxido de azufre y material particulado.

Como se desprende de la tabla anterior, la experiencia internacional conduce a regulaciones más estrictas en cuanto a las concentraciones ambientales diarias y anuales de SO_2, las cuales se fundamentan en los niveles umbrales determinados por la OMS. Asimismo, la tendencia conduce a la regulación de los niveles a más corto plazo de dicho contaminante, ya sea para las concentraciones horarias, de 10 ó 30 minutos.

El nivel de este contaminante en Santiago se encuentra bajo los valores normados. En el resto del país no existen mediciones continuas, con excepción de la ciudad de Copiapó, en la cual los valores han disminuido considerablemente los últimos años, cumpliendo con los niveles establecidos en la Resolución.

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El estudio propone los siguientes valores para las concentraciones máximas de SO_2 permisibles y los períodos asociados:

Tabla 2: Valores de las Concentraciones y Períodos Permisibles Propuestos por el Estudio de SGA.

Concentración máxima permisible (ug/m^3)	Período
(1)	1 h
240	24 h
80	Anual

Nota: (1) Se realizó evaluación técnico-económica para valores entre 700 y 1.300 g/m^3 para la ciudad de Copiapó, la cual presenta valores mayores a los mencionados anteriormente. Los resultados indicaron que los beneficios son menores que los costos, por lo tanto se sugiere no imponer un nivel horario para este contaminante.

En el caso de la disminución de la norma diaria de 365 ug/m^3 a 240 ug/m^3 no se realizó una evaluación económica específica, puesto que en la gran mayoría de las ciudades de Chile se esta cumpliendo este último valor. Sin embargo, según lo establecido en el Artículo 15 del D.S. Nº93/95 del Ministerio Secretaría General de la Presidencia, una vez elaborado un anteproyecto de norma deberá realizarse el análisis general del impacto económico y social de la(s) norma(s) contenidas en dicho anteproyecto. Por lo tanto, dicha evaluación deberá ser efectuada una vez elaborado el anteproyecto para SO_2.

Monóxido de Carbono (CO)

Los estudios nacionales demuestran una relación estadísticamente significativa entre los niveles de CO en el ambiente y el aumento de muertes ante la presencia de este contaminante. Sin embargo, las referencias internacionales no son concluyentes al respecto.

En cuanto a los estudios de morbilidad, los informes nacionales notifican un aumento de tos, ronquera y ausentismo escolar en relación con incrementos del CO. La OMS, por su parte, reporta cuatro tipos de efectos en la salud producidos por la exposición al CO: cardiovasculares, neuroconductuales, fibrinólisis y perinatales. Con respecto a los efectos cardiovasculares, se demuestra que adultos jóvenes y saludables tienen una capacidad de esfuerzo reducida a partir de 5% de carboxihemoglobina (COHb) en la sangre y una menor relación entre tiempo de trabajo y agotamiento en el ejercicio a partir de 2,3% de COHb.

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La acumulación de CO en la sangre es más rápida al comienzo de la exposición y se acerca asintóticamente a un equilibrio dependiendo del nivel de contaminante en el ambiente. Así por ejemplo, a un nivel de exposición de 100 ppm se tiene un nivel de equilibrio aproximado de 22% de COHb en la sangre para una exposición de 17 horas, en tanto que para una duración de exposición de 1 hora se tiene un nivel de COHb en la sangre de 4,1%, aproximadamente.

La Tabla 3 presenta los niveles normados de calidad ambiental para monóxido de carbono, actualmente vigentes en distintos países.

Tabla 3: Comparación de las Normas de Calidad del Aire para Monóxido de Carbono (CO).

PAIS	CO (g/m^3) (1)					
	15 min.	30 min.	1 h	8 h	24 h	Anual
Chile	-	-	40.000	10.000	-	-
Estados Unidos	-	-	40.000	10.000	-	-
Unión Europea	-	-	-	-	-	-
OMS(2)	100.000	60.000	30.000	10.000	-	-
Suiza	-	-	-	-	8.000	-
Japón	-	-	-	22.222	11.111	-
Alemania	-	30.000	-	-	-	10.000

Nota: (1) 1 mg/m^3 = 0,873 ppm.
(2) Los niveles sugeridos permiten que el grupo más sensible se mantenga con niveles de COHb en la sangre menores a 3,0%.

De la tabla anterior se desprende que las normas nacionales son razonables comparadas con las de otros países. La OMS advierte que si se toma como estándar de 1 h un valor de 40.000 g/m^3 (caso de Chile), se deben tomar precauciones para que no se exceda el período de exposición, puesto que el nivel de COHb aumentaría sobre el umbral. Para ello se recomienda el uso de promedios móviles de 8 h, lo cual existe en la normativa nacional.

Por otra parte, sólo en Santiago se realizan mediciones continuas de este contaminante, desde el año 1990 a la fecha. Los niveles identificados se encuentran por sobre la norma horaria y de 8 horas, es así que en 1996 se declaró a la Región Metropolitana saturada por este contaminante.

La propuesta del estudio es mantener los niveles normados en la Resolución. Sin embargo, no se realizó una evaluación técnico-económica de la normativa propuesta. En cuanto a los valores que generan situaciones de emergencia ambiental, la Tabla 4 muestra una comparación entre los niveles que activan alertas y emergencias

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ambientales por monóxido de carbono en algunos países y la propuesta entregada por el estudio de SGA.

Tabla 4: Comparación de los Niveles que generan Situaciones de Emergencia Ambiental por Exposición a Monóxido de Carbono.

PAIS	Nivel de Alerta	Nivel de Preemergencia	Nivel de Emergencia
Chile[1]	17.000	34.000	40.000
Estados Unidos[1]	17.000	34.000	46.000
Alemania[2]	30.000	45.000	60.000

Nota: [1] Concentración 8 horas (g/m^3).
[2] Concentración 3 horas (g/m^3).

Ozono (O_3)

Numerosos estudios internacionales de adultos que practican ejercicios han demostrado disminuciones de la función pulmonar tanto para las exposiciones de 1-3 horas a niveles mayores o iguales a 240 g/m^3 de O_3 como para las exposiciones de 6,6 horas a niveles mayores o iguales que 160 g/m^3. Por su parte, los estudios epidemiológicos que han investigado las posibles asociaciones entre las exposiciones de largo plazo al O_3 y los efectos respiratorios crónicos en seres humanos hasta ahora sólo han entregado evidencia indicativa de tal relación, pero no han identificado niveles específicos a los cuales se produce una relación estadística significativa.

La Tabla 5 muestra un resumen comparativo entre los niveles de O_3 normados, actualmente, en Chile y países relevantes respecto a la temática ambiental.

Tabla 5: Comparación de las Normas de Calidad del Aire para Ozono (O_3).

PAIS	O_3 (g/m^3)		
	30 min.	1 h	8 h
Chile	-	160	-
Estados Unidos	-	240	160
Unión Europea	-	-	-
OMS	-	-	120
Suiza	100	120	-
Japón	-	120	-
Alemania	120	-	-

En cuanto a las concentraciones de ozono en la calidad del aire a nivel nacional, sólo en la ciudad de Santiago se han realizado mediciones continuas desde el año 1992 a la fecha en la red MACAM. Los resultados del monitoreo indican que los valores establecidos en la Resolución son excedidos ampliamente en la Región Metropolitana.

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Es por ello que en 1996 dicha región fuese declarada zona saturada también para este contaminante.
Por su parte, el criterio para el manejo de excedencias de la norma se muestra en la siguiente tabla. Se observa que Chile tiene sustancialmente los mismos niveles que los otros países que cuentan con este mecanismo.

Tabla 6: ***Comparación de los Niveles que generan Situaciones de Emergencia Ambiental por Exposición (g/m³) a 1 h de Ozono.***

PAIS	Nivel de Alerta	Nivel de Emergencia
Chile	470	1.090
Estados Unidos	400	1.000
Alemania	360	-
Japón	480	800

El estudio realizó una evaluación técnico-económica para niveles más restrictivos de la normativa horaria para el ozono (140 y 120 g/m^3). Adicionalmente, se evaluaron los escenarios de extender la norma de 1 hora a 8 horas, basado en que los estudios clínicos en seres humanos demuestran que los efectos preocupantes del O_3 están asociados con niveles de exposición de 240, 200 y 160 g/m^3 por 6 y 8 horas. Los resultados de la evaluación indican que las alternativas de cumplir con normas más estrictas que la actual de 1 h en el año 2011 significa mayores costos que beneficios. Sin embargo, establecer normas de exposición a ozono de 8 horas genera un VPN positivo. Aún así, el estudio propone mantener sólo la norma horaria para el ozono, en el nivel actualmente normado por la Resolución.

<u>Dióxido de Nitrógeno (NO_2)</u>

Los estudios nacionales de mortalidad no mostraron efectos significativos para NO_2. Sin embargo, establecieron un exceso de riesgo para consultas de urgencia infantil asociadas a este contaminante. Por su parte, los estudios internacionales indican evidencia de que una alta exposición al NO_2 (dentro del orden de 376-564 g/m^3), por un período corto de exposición, puede causar un aumento en la reactividad de las vías respiratorias en personas asmáticas.

En cuanto a las exposiciones de largo plazo al NO_2, la OMS las asocia al aumento del riesgo de infecciones respiratorias en los niños. Estudios cuantitativos han examinado estos efectos referidos a concentraciones en interiores, que son elevadas en las casas con cocinas a gas, pero que no pueden extrapolarse directamente a las concentraciones en el exterior. Los efectos, sin embargo, son preocupantes porque las infecciones pulmonares repetidas en la infancia pueden provocar más tarde daños pulmonares.

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En la Tabla 7 se muestran los niveles normados, actualmente, en Chile y otros países de relevancia ambiental.

Tabla 7: Comparación de las Normas de Calidad del Aire para Dióxido de Nitrógeno (NO_2).

PAIS	NO_2 (g/m^3)			
	30 min.	**1 h**	**24 h**	**Anual**
Chile	-	-	-	100
Estados Unidos	-	-	-	100
Unión Europea	-	200	-	40
OMS	-	200	-	40
Suiza	100	-	80	30
Japón	-	-	80-120	-
Alemania	200	-	-	80

Como se desprende de la anterior tabla, el valor anual establecido en Chile, mediante la Resolución N°1.215, es superior al valor guía entregado por la OMS y normado en la Unión Europea y Suiza, pero es asimilable al estándar existente en Estados Unidos y Alemania. Por otra parte, existe la tendencia mundial a establecer niveles máximos permisibles para períodos más cortos de exposición, ya sea diarios, horarios o de 30 minutos. Sin embargo, ni Estados Unidos ni Chile has seguido esta tendencia.

Los niveles de calidad del aire para NO_2 han sido medidos, continuamente, en Santiago desde el año 1990 a la fecha a través de la red MACAM. Los valores indican que las concentraciones son regulares en general, encontrándose entre un 80% y un 100% de la norma, por lo cual en 1996 se declaró a la Región Metropolitana como zona latente por este contaminante.

La Tabla 8 presenta los valores máximos permisibles para exposición de NO_2, propuestos por el estudio de SGA.

Tabla 8: Valores de las Concentraciones y Períodos Permisibles Propuestos por el Estudio de SGA.

Concentración máxima permisible (g/m^3)	Período
400	1 h
100	Anual

El fundamento para esta proposición de norma es que existe evidencia médica y científica que indica la necesidad de restringir las exposiciones horarias a NO_2. Esta evidencia se ve ratificada en la tendencia mundial a normar las exposiciones de corto plazo para este contaminante. Sin embargo, el estudio no presenta un análisis técnico-

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económico que sustente este criterio, así como el de mantener la norma anual en el nivel existente y no disminuirlo según las recomendaciones de la OMS, debido a que "no existen estudios nacionales ni internacionales que contengan información acerca de las funciones dosis-respuesta que permitan valorar los costos evitados en salud (beneficios)". Lo anterior, según lo establecido en el Artículo 15 del D.S. N°93/95, deberá ser resuelto de alguna manera, ya que este Reglamento exige una evaluación de los costos y beneficios para la población derivados del establecimiento de todos los estándares de calidad primario a nivel nacional.

Conclusiones

Sobre la base de lo establecido en el Título III, Párrafo 1°, del D.S. N°93/95 del MINSEGRES, el estudio "Antecedentes para la Revisión de las Normas de Calidad de Aire contenidas en la Res. N°1.215 del Ministerio de Salud, 1978", realizado por SGA, cumple con los siguientes requerimientos:

(1) Describir la distribución del contaminante en el país, identificando el nivel actual, natural o antropogénico, existente en los respectivos medios;
(2) Recopilar la información disponible acerca de los efectos adversos producidos por la exposición en la población, tanto desde el punto de vista epidemiológico como toxicológico del elemento en estudio;
(3) Describir los efectos independientes, aditivos, acumulativos, sinérgicos o inhibidores de los elementos o compuestos;
(4) Proponer, como normas primarias de calidad ambiental, valores de las concentraciones y períodos máximos o mínimos permisibles de elementos o compuestos;
(5) Proponer valores críticos que determinen las situaciones de emergencia ambiental, el plazo para su entrada en vigencia y los organismos públicos con competencia para fiscalizar su cumplimiento;
(6) Señalar las metodologías de medición y control de los parámetros normados;
(7) Realizar una evaluación técnico-económica de las propuestas de norma para los siguientes contaminantes: PM10 (norma diaria y anual), SO_2 (norma horaria y anual) y ozono (norma horaria y de 8 horas).

En general, el estudio presenta una recopilación bastante completa, tanto a nivel nacional como internacional, sobre los efectos adversos en la salud de las personas de cada uno de los contaminantes contenidos en la Resolución N°1.215 y de los métodos de medición de cada uno de ellos en el ambiente. A su vez, presenta una compilación de las normativas actualmente vigentes en varios países (Estados Unidos, Unión Europea, Japón, Alemania, Suiza) y los valores guía entregados por la Organización

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Mundial de la Salud, lo cual permite realizar una adecuada comparación entre los niveles y métodos normados en Chile con respecto a las tendencias mundiales.

Adicionalmente, se identifican los niveles de cada contaminante en la calidad del aire en Chile, según las redes de monitoreo continuas existentes en el ámbito nacional así como sobre la base de monitoreos realizados por proyectos específicos. Cabe señalar que, en estos últimos casos, los métodos de medición no siempre han sido comparables a los establecidos por normativa y que en la mayoría de los casos se refieren sólo a ciertos puntos dentro de las localidades, lo cual no permite establecer conclusiones representativas de las ciudades como un todo.

La principal red de monitoreo que existe en Chile está constituida por las estaciones establecidas en Santiago, en forma permanente, a través de la Red de Monitoreo de Contaminantes Atmosféricos (Red MACAM) que dirige el Servicio de Salud Metropolitano del Ambiente. Sin embargo, como se sabe, la Región Metropolitana fue declarada Zona Saturada para las partículas totales en suspensión (PTS), material particulado respirable (PM10), monóxido de carbono (CO) y ozono (O_3); y Zona Latente para el dióxido de nitrógeno (NO_2). Por lo tanto, los antecedentes sobre la calidad del aire en Chile indican, en general, muy malas condiciones de exposición para la población, pero no permiten identificar adecuadamente zonas geográficas más sensibles que otras.

Finalmente, con respecto a las evaluaciones técnico-económicas realizadas en el estudio, es necesario efectuar un análisis más exhaustivo sobre los supuestos considerados y/o adoptados en la simplificación de algunos escenarios. En el informe entregado a CONAMA el mes de Agosto, se realizó una revisión más detallada sobre la evaluación efectuada para la norma diaria y anual de PM10. En ella, se identificaron algunos criterios de sustentación débiles, por lo que es probable que se encuentren ciertas inconsistencias también en las evaluaciones efectuadas para otros contaminantes.

Lo anterior, hace recomendable profundizar en cada una de las evaluaciones económicas establecidas en el estudio, necesarias para la fundamentación de las normas primarias de calidad ambiental, de manera que no se generen controversias sobre los reales costos y beneficios para la sociedad en su conjunto, y sobre la efectividad de las medidas consideradas, una vez que se presenten los respectivos anteproyectos.

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Santiago, Octubre 15 de 1999.

Doctora
Patricia Matus
Jefe Departamento Planes y Normas
Comisión Nacional del Medio Ambiente
Presente

Estimada Doctora Matus:

De acuerdo a lo solicitado en su fax N°995142, de fecha Octubre 13, adjunto encontrará un resumen conteniendo nuestra opinión en relación a los puntos de especial interés para CONAMA en relación al Estudio "Revisión de las Normas de Calidad de Aire Contenidas en la Resolución N°1215 del Ministerio de Salud".

Sin otro particular, saluda atentamente a usted,

Fernando Muñoz Porras
Director

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Este análisis se basa en el estudio del informe final "Antecedentes para la Revisión de las Normas de Calidad de Aire contenidas en la Res. N°1.215 del Ministerio de Salud, 1978", elaborado por la Consultora Sociedad de Gestión Ambiental Ltda. (S.G.A.) en 1998 para la Comisión Nacional del Medio Ambiente.

1. Niveles de Concentración Máxima Permisible y Período

a. PM10

De acuerdo a la evidencia de los estudios nacionales sobre el efecto de las partículas en suspensión sobre la salud de las personas, se pudo ratificar el hecho de que las normas primarias para material particulado deben expresarse en términos de PM10 y PM2,5 ya que éstas son las fracciones que presentan riesgos a la salud humana y a la que apuntan los estudios epidemiológicos nacionales positivos. Por su parte, los resultados de los estudios internacionales conducen a conclusiones similares a las anteriormente expuestas, entregando mayores antecedentes relativos a los efectos crónicos derivados de la exposición prolongada a partículas en suspensión. En efecto, estudios de cohorte realizados en Estados Unidos mostraron una asociación significativa entre niveles de PM10 y PM2,5 con aumentos en la mortalidad total. A su vez, que estudios prospectivos de morbilidad por exposición crónica, indicaron que existía una relación entre contaminación por PM10 y disminución de la función pulmonar, así como una fuerte relación con bronquitis crónica y tos. Todo lo anterior, sustenta en forma favorable incorporar en la norma primaria para material particulado respirable una restricción de concentración anual de PM10, que conduzca a proteger de efectos respiratorios crónicos a la población.

En cuanto a los niveles establecidos, parecen adecuados en comparación con las concentraciones reguladas a nivel internacional. Sin embargo, es importante señalar que no se ha determinado un nivel umbral de efectos en la salud humana para este contaminante. Por lo tanto, los niveles de exposición permisibles deben estar relacionados a un adecuado análisis costo-beneficio que lo sustente.

b. SO_2

Los niveles de concentración máxima permisible propuestos en el estudio antes referido parecen adecuados en base a los niveles umbrales determinados por la OMS para exposiciones combinadas de dióxido de azufre y material particulado. Así también, se adecuan a la experiencia internacional conducente a regulaciones más estrictas en cuanto a las concentraciones ambientales diarias de SO_2.

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c. CO

Considerando estudios nacionales de mortalidad y estudios internacionales de morbilidad, así como la normativa internacional existente para este contaminante, se desprende que las normas nacionales establecidas en la Resolución N°1.215 son razonables. En efecto, la OMS advierte que si se toma como estándar de 1 h un valor de 40.000 g/m^3 (caso de Chile), se deben tomar precauciones para que no se exceda el período de exposición, puesto que el nivel de COHb aumentaría sobre el umbral; para ello recomienda el uso de promedios móviles de 8 h, lo cual existe en la normativa nacional.
Por lo tanto, parece adecuado la mantención de los niveles de concentración máxima permisible y períodos establecidos para este contaminante en la Resolución N°1.215.

d. O_3

En base a los estudios internacionales y a la comparación con la normativa internacional existente, parece adecuado mantener a lo menos el nivel actualmente establecido en la Resolución N°1.215. Sin embargo, en base a estudios de costo-beneficio más exhaustivos, sería posible justificar niveles de concentración más conservadores y/o períodos adicionales de regulación (tales como promedios móviles de 8 horas).

e. NO_2

El valor anual establecido en Chile mediante la Resolución N°1.215, y propuesto para ser mantenido en el estudio antes referido, es superior al valor guía entregado por la OMS. Este último valor se basa en estudios epidemiológicos de riesgo incrementado de enfermedades respiratorias en niños. Adicionalmente, el estudio de SGA no realiza una evaluación costo-beneficio que sustente la mantención de la actual normativa, pudiendo existir beneficios netos mayores al hacerla más restrictiva. Todo lo anterior, se traduce en que la propuesta para mantener los niveles de concentración anual, actualmente permisibles para NO_2, encuentre débil fundamento en el estudio del consultor.
Por otra parte, existe la tendencia mundial a establecer niveles máximos permisibles para períodos de exposición aguda, ya sea diarios, horarios o de 30 minutos. Es por ello que se considera adecuado el establecer un lineamiento horario para este contaminante. Sin embargo, el nivel propuesto por el consultor aparece bastante elevado en comparación con las normativas internacionales y, por lo mismo, presenta las mismas deficiencias de sustentación que en el caso de la norma anual.

2. Niveles de Concentración de Emergencia

a. PM10

Los valores de emergencia propuestos son consistentes con los niveles existentes y con la evaluación económica que sustenta el D.S. N°59/98 para PM10.

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b. SO_2
Los nuevos valores de emergencia para contaminación por SO_2 no se encuentran bien fundamentados en el estudio de soporte. Se hace referencia a una evaluación económica que no se encuentra claramente identificada. Adicionalmente, se señala que "se establecen los siguientes valores de emergencia para exposición diaria a SO_2" y, posteriormente, la tabla indica "concentración horaria g / m^3" (ver página 5-53 del estudio). Por lo anterior, no es posible sostener una opinión seria a este respecto.

c. CO
Los niveles de concentración de emergencia propuestos para la contaminación por CO no se encuentran suficientemente justificados en el estudio del consultor. La frase asociada al fundamento se encuentra inconclusa en la página 6-28 del estudio de soporte. Sin embargo, los valores establecidos son consistentes con los niveles determinados en la Resolución Exenta Nº369/88 del SESMA y con las concentraciones decretadas internacionalmente.

d. O_3
Los niveles de concentración de emergencia propuestos en el estudio del consultor, parecen adecuados en base a los niveles establecidos en la Resolución Exenta Nº369/88 del SESMA y a los niveles establecidos internacionalmente.

e. NO_2
Los niveles de concentración de emergencia propuestos en el estudio del consultor, parecen adecuados en base a los niveles establecidos en la Resolución Exenta Nº369/88 del SESMA y a los niveles establecidos internacionalmente.

3. Procedimientos de Medición
En general, los procedimientos de medición establecidos en la normativa vigente para todos los contaminantes atmosféricos se corresponden a los permitidos y utilizados a nivel mundial. De esta forma, parece adecuada la propuesta del consultor para mantener, básicamente, las actuales tecnologías de medición.

4. Cumplimiento y Condiciones de Superación de las Normas
Parece adecuada la propuesta de establecer el método de los percentiles (que el percentil 98 de las mediciones se encuentre bajo los niveles normados) para establecer el cumplimiento y las condiciones de superación de norma para los niveles diarios, horarios y promedios móviles de 8 horas de los diferentes contaminantes, según corresponda.

5. Entrada en Vigencia de las Normas Propuestas
Parecen consistentes las fechas de entrada en vigencia propuestas, dado los niveles de concentración máxima permisibles establecidos para los distintos contaminantes, con excepción del plazo de cumplimiento para el nuevo criterio anual de SO_2. En este

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último caso, se debiera analizar con mayor detalle la costo-eficiencia de su aplicación en el plazo establecido (1 de Enero del año 2000), dada la conocida existencia de localidades en las cuales no se cumplirán los nuevos estándares planteados.

6. Justificación de la Propuesta desde el Punto de Vista de los Efectos en Salud, los Costos y Beneficios asociados a su Aplicación

En general, el estudio del consultor presenta una recopilación bastante completa, tanto a nivel nacional como internacional, sobre los efectos adversos en la salud de las personas de cada uno de los contaminantes contenidos en la Resolución N°1.215. A su vez, presenta una compilación de las normativas actualmente vigentes en varios países (Estados Unidos, Unión Europea, Japón, Alemania, Suiza) y los valores guía entregados por la Organización Mundial de la Salud, lo cual permite realizar una adecuada comparación entre los niveles normados en Chile con respecto a las tendencias mundiales.
Con respecto a las evaluaciones de costo-beneficio realizadas por el consultor, se considera necesario efectuar un análisis más exhaustivo sobre los supuestos considerados y/o adoptados en la simplificación de algunos escenarios. En el informe entregado a CONAMA el mes de Agosto, se realizó una revisión más detallada sobre la evaluación costo-beneficio efectuada para la norma diaria y anual de PM10. En ella, se identificaron algunos criterios de sustentación débiles, por lo que es probable que se encuentren ciertas inconsistencias también en las evaluaciones efectuadas para otros contaminantes. Los principales problemas detectados en la evaluación técnico-económica de la normativa propuesta para PM10 fueron los siguientes:

- Es dudoso pensar que la reducción de emisiones establecidas en cada uno de los escenarios para la alternativa N°1 del estudio de soporte (50%, 60% y 70% de reducción en las emisiones, sin considerar el polvo resuspendido) sean realmente efectivas en la reducción de concentraciones ambientales de PM10 y permitan alcanzar los niveles de calidad del aire normados. Esto se debe, principalmente, a la participación del polvo resuspendido dentro de las emisiones totales y a su importancia en la calidad ambiental. Hay que tener presente que las emisiones debidas al polvo resuspendido comprenden alrededor de un 80% de las emisiones totales de PM10 (según el Inventario de Emisiones de 1997 y la Proyección de Emisiones para el año 2005 del PPDA) y representan entre un 25 y 35% de la concentración ambiental de PM10 en la Región Metropolitana. De esta forma, la alternativa N°1 del estudio se hace poco sustentable, puesto que los costos determinados no se relacionan con los beneficios establecidos.

- La alternativa N°2 del estudio de soporte consideró el valor presente del costo medio de remoción de 1 ton de PM10 utilizando medidas de reducción de emisiones que tampoco comprendieron las acciones de disminución del polvo resuspendido, tales como programa de lavado de calles, programa de pavimentación, programas de

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forestación y áreas verdes, etc. De esta manera, también es posible cuestionar la efectividad real de esta alternativa en la reducción de concentraciones ambientales de PM10, para todos los escenarios evaluados. Al ser necesario incluir la evaluación de estas medidas, para lograr la reducción meta de emisiones, sería recomendable realizar nuevamente el análisis costo-beneficio, ya que los beneficios evaluados también se relacionan con los costos asociados a estas medidas.

- En cuanto a este último punto, es necesario mencionar que existen ciertas medidas de planificación que ayudan a disminuir el polvo resuspendido y que son difíciles de evaluar, tales como el desincentivo al uso del automóvil, ordenamiento territorial, promoción y protección de la forestación y áreas verdes, etc. Por lo tanto es muy importante tener especial cuidado en definir con cuáles medidas es suficiente lograr la reducción de emisiones requeridas, considerando todas las actividades que se realizan y aquellas que no es posible evaluarlas.

Todo lo anterior, hace recomendable profundizar en cada una de las evaluaciones económicas establecidas en el estudio, necesarias para la fundamentación de las normas primarias de calidad ambiental, de manera que no se generen controversias sobre los reales costos y beneficios para la sociedad en su conjunto, y sobre la efectividad de las medidas consideradas, una vez que se presenten los respectivos anteproyectos.

GUIDELINES FOR AIR QUALITY

000214

This WHO document on the *Guidelines for Air Quality* is the outcome of the WHO Expert Task Force meeting held in Geneva, Switzerland, in December 1997. It bases on the document entitled "Air Quality Guidelines for Europe" that was prepared by the WHO Regional Office for Europe and regional background papers.

Note to the user:
The electronic form of this document is available on the CD ROM of the Healthy Cities Air Management Information System AMIS and, in part, from the Web site of the World Health Organization (http://www.who.int/).

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Foreword

Achievements in air quality management underlie increased economic and social welfare in many developing countries. Sound air quality management is also a proven way of enhancing public health, since air pollution is associated with increases in outpatient visits due to respiratory and cardiovascular diseases, in hospital admissions and in daily mortality. Recent estimates of the increase in daily mortality show that on a global scale 4-8% of premature deaths are due to exposure to particulate matter in the ambient and indoor environment. Moreover, around 20-30% of all respiratory diseases appear to be caused by ambient and indoor air pollution, with emphasis on the latter. It is suggested that without clean air, a sound economic development becomes virtually impossible and social conflicts inevitable.

Although enormous progress has been made in developing clean air implementation plans for urban areas, especially in developed countries, a substantial number of people living in urban areas - around 1.5 billion, or 25 per cent of the global population - are still exposed to enhanced concentrations of gaseous and particle compounds in the air they breathe. And the use of open fires for indoor cooking and heating currently exposes about 2 billion people to quite substantial concentrations of suspended particulate matter, 10-20 times higher than ambient concentrations according to the limited measurements available. Other sources of air pollution include industrial and vehicular emissions, as well as vegetation fires. Furthermore, the rate of population growth continues to increase and is likely to peak around the year 2000, leading to a doubling of the global population by the middle of the 21st century. Most population growth will occur in low-income countries and will stress already inadequate infrastructures and technical and financial capacities. In parallel, the process of urbanisation will continue, such that the proportion of the global population living in cities will increase from around 45% to around 62% by the year 2025, creating dense centres of anthropogenic emissions.

The primary aim of the WHO *Guidelines for Air Quality* is to protect public health from the effects of air pollution, and to eliminate or minimize exposure to hazardous pollutants. Air quality guidelines are set up to help governments derive legally enforceable air quality standards, and to guide the environmental health authorities and professionals who are trying to protect people from the harmful effects of environmental air pollution.

Agenda 21 states in Chapter 6 on human health and environmental pollution:

Nationally determined action programmes in this area, with international assistance, support and coordination where necessary, should include:

(a) Urban air pollution:

(i) Develop appropriate pollution control technology on the basis of risk assessment and epidemiological research for the introduction of environmentally sound production processes and suitable safe mass transport.

(ii) Develop air pollution control capacities in large cities, emphasizing enforcement programmes and using monitoring networks, as appropriate.

(b) Indoor air pollution:

(i) Support research and develop programmes for applying prevention and control methods to reducing indoor air pollution, including the provision of economic incentives for the installation of appropriate technology.

(ii) Develop and implement health education campaigns, particularly in developing countries, to reduce the health impact of domestic use of biomass and coal.

The WHO *Guidelines for Air Quality* should help to greatly reduce the burden of excess mortality and preventable disability suffered by the poor. It should also help counter potential health threats resulting from economic crises, unhealthy environments and risky behaviour. In this sense, the *Guidelines* contribute to meeting two of the key challenges that were highlighted in the 1999 World Health Report and, thus, they contribute to making health a fundamental human right.

Dr Richard Helmer
Director, Department for Protection of the Environment

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Preface

The risks posed to human health by air pollution have been evaluated since the 1950s and guideline values were derived in 1958. In 1987, the WHO Regional Office for Europe EURO published the *Air Quality Guidelines for Europe.* Since 1993, these guidelines have been revised and updated. In a recent Expert Task Force Meeting convened in December 1997 in Geneva, Switzerland, the Guidelines for Air Quality was extended to provide global coverage and applicability, and the issues of air quality assessment and control were addressed in more detail. The WHO *Guidelines for Air Quality* document is the outcome of the consensus deliberations of the WHO Expert Task Force.

The WHO *Guidelines for Air Quality* provides a basis for protecting public health from the adverse effects of environmental pollutants and for eliminating ,or reducing to a minimum, contaminants that are known or likely hazards to human health and well-being. The *Guidelines* does so by providing background information and guidance to governments for making risk management decisions, particularly in setting standards. It also helps governments carry out local air quality control measures.

The WHO *Guidelines for Air Quality* values are levels of air pollution below which lifetime exposure, or exposure for a given averaging time, does not constitute a significant health risk. If these limits are exceeded in the short-term it does not mean that adverse effects automatically occur; however the risk of such effects increases. Although the *Guidelines for Air Quality* values are health- or environment-based levels, they are not standards *per se*. Air quality standards are air quality guidelines promulgated by governments, for which additional factors may be considered. For example, the prevailing exposure levels, the natural background contamination, environmental conditions such as temperature, humidity and altitude, and socio-economic factors.

When proceeding from the *Guidelines for Air Quality* to standards, policy options include such questions as what proportion of the general population, and which susceptible groups, should be protected. Several additional items must also be considered: the legal aspects; a definition of what constitutes adverse effects; a description of the population at risk; the exposure-response relationship; the characterisation of exposure; an assessment of risks and their acceptability; and the financial costs of air pollution controls and their benefits.

The *Air Quality Guideline* has been prepared as a practical response to the need for action with respect to air pollution at the local level, and for improved legislation, management and guidance at the national and regional levels. WHO will be pleased to see that these *Guidelines* are used widely. Continuing efforts will be made to improve its content and structure. It would be appreciated if users of the *Guidelines* would provide feedback and their own experiences. Please send your comments and suggestions on the WHO *Guidelines for Air Quality – Guideline document* directly to the Department of Protection of the Human Environment, Occupational and Environmental Health, World Health Organization, Geneva, Switzerland (Fax: +41 22-791 4123, e-mail: schwelad@who.int).

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Executive Summary

Introduction

Air pollution is a major environmental health problem, affecting developed and developing countries around the world. Increasing amounts of potentially harmful gases and particles are being emitted into the atmosphere on a global scale, resulting in damage to human health and the environment. It is damaging the resources needed for the long-term sustainable development of the planet.

There are three broad sources of air pollution from human activities: Stationary sources, Mobile sources, and Indoor sources. In developing countries, indoor air pollution from using open fires for cooking and heating may be a serious problem. It has been estimated that about 1.9 million people die annually due to exposure to high concentrations of suspended particulate matter in the indoor air environment, while the excess mortality due to suspended particulate matter and sulphur dioxide in the ambient air amounts to about 500 000 people annually. Although the indoor air database is weak due to the scarcity of monitoring results, these estimates indicate that a serious indoor air problem may exist in developing countries.

Air pollutants are usually classified into suspended particulate matter (dusts, fumes, mists, smokes), gaseous pollutants (gases and vapours) and odours. Current techniques used to measure the mass concentration of particles in air make use of size-specific sampling devices. Thus the mass of particles less than 10 µm diameter may be determined (PM_{10}) as an index of the mass concentration of particles that can penetrate into the human thorax. The mass concentration of particles of less than 2.5 µm diameter ($PM_{2.5}$) is a means of measuring the total gravimetric concentration of several chemically distinct classes of particles that are emitted into, or formed within, the ambient air as very small particles.

Fine and coarse particles generally have distinct sources and formation mechanisms, although there may be some overlap. Biological material such as bacteria, pollen and spores may also be found in the coarse mode. Fine and coarse particles typically exhibit different behaviour in the atmosphere and these differences must be taken into consideration when interpreting central-site monitored values, as well as the behaviour of particles after they penetrate homes and buildings, where people spend most of their time. Fine accumulation-mode particles typically have longer atmospheric lifetimes (days to weeks) than coarse particles, and tend to be more uniformly dispersed across an urban area or large geographic region. Larger particles generally deposit more rapidly than small particles; as a result, total coarse particle mass is less uniform in concentration across a region than that of fine particles.

This publication is focused on those gases and particulate matter that have been accepted as posing a threat to health. The relative health threat of different pollutant gases and particles varies with their concentrations over time and distance, implying that the effects of air pollutants on health may vary from country-to-country. Consequently, careful monitoring of the concentrations of polluting gases, as well as of the particle size distribution, concentration and composition, is needed before an acceptable estimate of the effects can be produced. The picture is further complicated because some pollutant combinations act in an additive manner and some perhaps synergistically.

WHO's air quality guidelines were first published as *Air Quality Guidelines for Europe* in 1987 (WHO 1987). Since 1993 the *Air Quality Guidelines for Europe* has been revised and updated, incorporating a review of the literature published since 1987 (WHO 1999a). Also, the following additional compounds were considered in the review procedure: 1,3 butadiene, environmental tobacco smoke (ETS), fluoride, man-made vitreous fibres and platinum. Parallel to the review of the air quality guidelines for Europe, the Environmental Health Criteria series of the International Programme on Chemical Safety has continued and the health risks of more than 120 chemical compound and mixtures were assessed between 1987 and 1998.

The WHO *Air Quality Guidelines for Europe* (WHO 1987) were based on evidence from the epidemiological and toxicological literature published in Europe and North America. They did not consider the effects of exposure to the different ambient air particle concentrations in developing countries, as well as the different conditions in these countries. However, these guidelines were used intensively throughout the world. In view of the different conditions in developing countries, the literal application of the WHO *Air Quality Guidelines for Europe* could be misleading. Factors such as high and low temperature, humidity, altitude, background concentrations and nutritional status could influence the health outcomes after the population has been exposed to air pollution. To make the WHO *Air Quality Guidelines for Europe* globally applicable, a task force group meeting was convened at WHO Headquarters from 2-5 December 1997. The outcome of that meeting is this publication of globally applicable air quality guidelines.

The objective of WHO's *Guidelines For Air Quality* is to help countries derive their own national air quality standards. The guidelines are technologically feasible and consider socio-economic and cultural constraints. They provide a basis for protecting public health from the adverse effects of air pollution and for eliminating, or reducing to a minimum, those air pollutants that are likely hazardous to human health. Consequently, the instruments of air quality management are also addressed in this publication.

2. Factors affecting the concentrations of air pollutants

Local concentrations of air pollutants depend upon the strength of their sources and the efficiency of their dispersion. Day to day variations in concentrations are more affected by meteorological conditions than by changes in source strengths. Wind is of key importance in dispersing air pollutants and for ground level sources pollutant concentrations are inversely related to wind speed. Turbulence is also important: a "rough" terrain, as produced for example by buildings, tends to lead to increased turbulence and better dispersion of pollutants.

3. Exposure to air pollutants

The total daily exposure of an individual to air pollution is the sum of the separate contacts to air pollution experienced by that individual as he/she passes through a series of environments (also called micro-environments) during the course of the day (e.g. at home, while commuting, in the streets, etc.). Exposures in each of these environments can be estimated as the product of the concentration of the pollutant in question and the time spent in the environment..

There are many factors that can account for the substantial differences between the concentrations of pollutants measured at central sites and those in the breathing zone of residents of the community. Many of these factors can be modelled and such models have been used for estimating dose distributions associated with ambient air concentrations.

4. Health significance of air pollution

A new database of epidemiological studies emerged in the late 1980s and 1990s. This database of time-series studies was developed first in the United States and later in Europe and other areas. In essence the time series approach takes the day as the unit of analysis and relates the daily occurrence of events such as deaths or admissions to hospital to daily average concentrations of pollutants whilst taking careful account of confounding factors such as season, temperature and day of the week. Powerful statistical techniques have been applied and coefficients have been produced that relate the daily average concentrations of pollutants to their effects. Associations have been demonstrated between daily average concentrations of particles, ozone, sulphur dioxide, airborne acidity, nitrogen dioxide, and carbon monoxide. Although the associations for each of these pollutants were not significant in all studies, taking the body of evidence as a whole the consistency is striking. For particles and ozone it has been accepted by many that the studies provide no indication of any threshold of effect.

5. Air pollutant concentrations and factors affecting susceptibility

The concentrations of classical pollutants in ambient air of European countries and of the United States have been extensively discussed in the *Air Quality Guidelines for Europe* (WHO 1999a). In developing countries, by contrast, the concentrations of pollution levels in ambient air are higher by an order of magnitude, according to the main source of information on air pollution in developing countries, the Air Management Information System (AMIS).

Indoor air pollutants usually differ in type and concentration from outdoor air pollutants. Indoor pollutants include environmental tobacco smoke, biological particles, non-biological particles, volatile organic compounds, nitrogen oxides, lead, radon, carbon monoxide, asbestos, various synthetic chemicals and others. Degradation of indoor air quality has been associated with a range of health effects, from discomfort and irritation to chronic pathologies and cancers.

On a global scale, biomass fuels are used daily in about half the world's households as energy for cooking and/or heating. Biomass smoke contains significant amounts of several important pollutants: carbon monoxide, particulate matter, hydrocarbons and to a lesser extent, nitrogen oxides. However, biomass smoke also contains many organic compounds, including PAH that are thought to be toxic, carcinogenic, mutagenic or otherwise of concern. In China, coal burning is a major source of indoor air pollution and coal smoke contains all of these pollutants as well as additional ones, e.g. sulphur oxides and heavy metals such as lead.

An unknown, but significant, proportion of biomass fuel burning takes place in conditions where much of the air-borne effluent is released into poorly ventilated living areas. Therefore, some of the highest concentrations of particulate matter and other pollutants occur in rural, indoor environments in developing countries. Due to the high pollutant concentrations and the large populations involved, the total human exposure to many important air pollutants can be much higher in homes of the poor in developing countries than in the outdoor air of cities in the developed world.

Altitude, temperature and humidity vary significantly across the globe. At increased altitude the partial pressure of oxygen falls and inhalation increases in compensation. For particles, this increased inhalation will lead to an increased intake of airborne particles. On the other hand, for gaseous pollutants no increase in effects over those experienced at sea level would be expected. Temperature has a very significant effect on health, whereas humidity is unlikely to have a significant effect on the toxicity of gaseous pollutants.

The age structure of populations differs markedly from country to country. Old people tend to show increased susceptibility to air pollution. Very young children may also be at increased risk. People with a poor standard of living suffer from nutritional deficiencies, infectious disease due to poor sanitation and overcrowding, and tend to be provided with a poor standard of medical care. Each of these factors may render individuals more susceptible to the effects of air pollution. Diseases which produce narrowing of the airways, a reduction in the area of the gas-exchange surface of the lung and an increased alteration of inhalation-perfusion ratios are likely to make the subject more susceptible to the effects of a range of air pollutants.

6. Role of guidelines and standards

The purpose of the *Guidelines for Air Quality* is to provide a basis for protecting public health from adverse effects of air pollution and for eliminating, or reducing to a minimum, those contaminants that are known to be, or likely to be, hazardous to human health and well being. The *Guidelines* should provide background information for nations engaged in setting air quality standards, although their use is not restricted to this. These *Guidelines* are not intended as standards. In moving from guidelines to standards, prevailing exposure levels and environmental, social, economic and cultural conditions in a nation or region should be taken into account. In certain circumstances there may be valid reasons to pursue policies which will result in pollutant concentrations above or below the guideline values.

In the updated version of the Air Quality Guidelines for Europe, a similar approach to that in the 1987 air quality guidelines was used. However, total tolerable intakes were calculated for multimedia pollutants first, and then adequately partitioned among the different exposure routes. The term "protection factor" used in the 1987 guidelines was abandoned. Instead, uncertainty factors were used to account for the extrapolation from animal to man (alternatively, human equivalent concentrations were calculated), and to account for individual variability. Wherever information on inter- and intraspecies differences in pharmacokinetics was available, data-derived uncertainty factors were employed. Additional uncertainty factors were applied whenever necessary to account for the nature and severity of the observed effects and for the adequacy of the database. For most of the compounds considered, information on the dose/exposure response relationship was provided, to give policymakers clear guidelines on the possible impact of the pollutant at different exposure levels and to permit an informed decision making process to take place. For some compounds, e.g. platinum, a guideline value was considered unnecessary as exposure through ambient air levels was considerably below the lowest level at which effects were seen. For other compounds, for example particulate matter (PM_{10}), no threshold of effect(s) could be found and therefore no guideline value could be derived. Instead, exposure-effect information highlighting the public health impact of different pollutant levels was provided.

In the updating process for carcinogens, a more flexible approach than in the 1987 air quality guidelines was applied. As a default approach, low-dose risk extrapolation was conducted for the IARC groups 1 (proven human carcinogen) and 2A (probable human carcinogen, limited evidence), and an uncertainty factor was applied for agents in IARC groups 2B (probable human carcinogen, inadequate evidence) and 3 (unclassified chemicals). However, the mechanism of action of the carcinogen was the determining factor for the method of assessment. Hence, it was decided that compounds classified under 1 or 2A could be assessed using uncertainty factors, if evidence for a non-threshold mechanism of carcinogenicity existed. By way of contrast, compounds classified under 2B could be assessed by low-dose extrapolation methods, if a non-threshold mechanism of carcinogenicity in animals was proven. Flexibility was also given in the choice of the extrapolation model, depending on the available data (including data for PBPK modelling). The linearized multistage model was used as a default approach. Besides providing unit risk estimates in cases where low dose risk extrapolation was conducted, levels associated with excess cancer risk of 1 : 10000, 1 : 100 000 and 1 : 1000 000 were calculated.

7. Exposure-response relationships

These guidelines place some emphasis on epidemiological data. Epidemiological studies are sometimes preferable to controlled exposure studies in that they provide information on responses in populations and on the effects of real exposures to pollutants and pollutant mixtures. However, the results of epidemiological studies are less easy to use than the results of controlled exposure studies in defining guidelines.

For both particles and ozone an assumption of linearity was made when defining the exposure-response relationships included in the revised guidelines. Extrapolation beyond the available data is dangerous;

however, as there is evidence to suggest that the exposure-response relationship may become less steep as ambient levels of particles rise. For ozone, the relationship at low concentrations may be concave upwards. These are important points to be considered if the guidelines are to be used in countries with levels of pollution different from the range covered by the guidelines.

8. Moving from guidelines to standards

An air quality standard is a description of a level of air quality, adopted by a regulatory authority as enforceable. At its simplest, an air quality standard should be defined in terms of one or more concentrations and averaging times. Further information on the form of exposure (e.g. outdoor), on monitoring to assess compliance with the standard, and on methods of data analysis and Quality Assurance and Quality Control requirements should be added. Other factors to be considered in setting an air quality standard include the nature of the pollution effects and whether they represent adverse health effects; and whether special populations are at risk.

The development of air quality standards is only a part of an adequate air quality management strategy. Legislation, identification of authorities responsible for enforcement of emission standards and penalties for exceeding standards are also necessary. Emission standards may play an important role in the management strategy especially if exceeding air quality standards is used as a trigger for abatement measures. These may be needed at both the national and the local level. Air quality standards are also important in informing the public about air quality. Used in this way they are a double edged weapon as the public commonly assumes that once a standard is exceeded adverse effects on health will occur. This may not be the case.

The transfer of the dose-response relationships to other parts of the world, especially for particulate matter, should be conducted with caution for several reasons. These include:

1. The chemical composition of the particles.
2. The concentration range.
3. The responsiveness of the population.
4. The limitations of the established relationships.

9. Cost-benefit analysis and other factors

Cost-benefit analysis is one way of formally weighing the costs of reducing air pollution against the benefits produced. The concept is that emissions are reduced until the marginal costs and benefits are equal. While the cost of abatement measures may be relatively easy to quantify, this may not be the case when non-technical measures are employed. In any case, it is likely to be more difficult to assign monetary values to the benefits obtained. Some aspects of reduced morbidity, such as the reduced use of hospital facilities and drugs are comparatively easy to cost; others, such as reductions in premature deaths and symptoms, are not. Applying monetary values based on a "willingness to pay" basis has been suggested, and has been accepted as appropriate by many health economists. This approach has been seen as preferable to one based only on such indices as loss of production, earnings or hospital expenses.

Factors other than monetary factors also need to be considered when considering the setting of national air quality standards. These include the technical capacity of a country to achieve and maintain an air quality within the desired standards, the social implications of adopting certain standards to ensure equity of costs and benefits among the population, and environmental costs and benefits.

10. Health-based Guidelines

For the purpose of presenting the health-based air quality guidelines, the key air pollutants, also termed “classical” air pollutants - SO_2, NO_2, CO, O_3, SPM, and lead are briefly described with respect to health risk evaluations and recommended guideline values. Particular emphasis is given to suspended particulate matter <10 µm diameter (PM_{10}) and < 2.5 µm diameter ($PM_{2.5}$). The guidelines are presented in Chapter 3 in tables 3.1 to 3.5 and in figures 3.1 to 3.9. The information available for a number of other air pollutants (including carcinogens and non-carcinogens) is also summarized and presented in synoptic tables.

11. Classical air pollutants: applicability of WHO Air Quality Guidelines for Europe on a world wide scale

In the derivation of the WHO *Air Quality Guidelines for Europe*, assumptions were made for some compounds, which may not be applicable in some parts of the world. For example, the importance of different routes of exposure for some pollutants may vary from country to country. It should be understood that if such factors were to be taken into account then different guidelines could be derived. For a number of pollutants a Unit Risk (UR) assessment has been provided. These assessments are also dependent upon considerations of the comparative importance of different routes of exposure.

It is important that regulatory authorities should evaluate whether local circumstances give cause to doubt the validity of the guideline set out in the WHO *Guidelines for Air Quality* as a basis for setting local guidelines or standards.

12. Indoor Air Quality

Indoor spaces are important microenvironments when assessing risks from air pollution. For many air pollutants most of the daily exposure by inhalation occurs indoors because of the amount of time spent indoors or because of the pollutant concentration levels encountered. The air quality inside buildings is affected by many factors. In an effort to conserve energy, modern building design has favoured tighter structures with lower rates of ventilation. By contrast, in some areas of the world, natural ventilation only is used; in others, mechanical ventilation is common. In modern buildings most of the pollution problems arise from low ventilation rates and the presence of products and materials that emit a large variety of compounds, whereas the inhabitants of many less developed countries face problems related to pollutants generated by human activities, in particular by combustion processes.

If only the health effects of air pollution are being considered, it does not matter if a pollutant is inhaled by breathing outdoor or indoor air. However, there are important differences in the composition of pollutant mixtures in outdoor and indoor air. For example, in outdoor air there are traffic-generated emissions, whereas indoor air pollution is generated from tobacco smoke or from cooking with biomass-fuelled stoves. Not all of these compositions have been taken into account in developing the *Guidelines for Air Quality*, and they may not be applicable under all circumstances, so care should be taken to avoid misinterpretation.

13. Ambient Air Quality Monitoring and Assessment

The three main air quality assessment tools are: i) ambient monitoring; ii) models and iii) emission inventories/measurement.

The ultimate purpose of monitoring is not merely to collect data, but to provide the necessary information required by scientists, policy makers and planners to enable them to make informed decisions on managing and improving the environment. Monitoring fulfils a central role in this process, providing the necessary scientific basis for policy and strategy development, objective setting, compliance measurement against targets and enforcement action. However, the limitations of monitoring should be recognised. No monitoring programme, however well funded and designed, can hope to comprehensively quantify patterns of air pollution in both space and time. In many circumstances, measurements alone may be insufficient or impractical for the purpose of fully defining population exposure in a city or country. Monitoring therefore often needs to be used in conjunction with other objective assessment techniques, including modelling, emission measurement and inventories, interpolation and mapping. At best, monitoring provides an incomplete, but useful, picture of current environmental quality.

Reliance on modelling alone also is not recommended. Although models can provide a powerful tool for interpolation, prediction, and optimisation of control strategies, they are effectively useless unless properly validated by real-world monitoring data. It is important, also, that the models utilised are appropriate to local conditions, sources and topography, as well as being selected for compatibility with available emission and meteorological datasets. Many models depend on the availability of reliable emission data.

A complete emissions inventory for a city or country may need to include emissions from point, area and mobile sources. In some circumstances, assessment of pollutants transported into the area under study may also need to be considered. Inventories will, for the most part, be estimated using emission factors appropriate to the various source sectors (verified by measurement), and used in conjunction with surrogate statistics such as population density, fuel use, vehicle kilometres or industrial throughput. Emission measurements will usually only be available for large industrial point sources or from representative vehicle types under standardised driving conditions.

All three assessment tools are interdependent in scope and application. Accordingly, monitoring, modelling and emission assessments should be regarded as complementary components in any integrated approach to exposure assessment or in determining compliance with air quality criteria.

14. Ambient Air Quality Management

Some basic principles guide international and national policies for the management of all forms of air pollution. An important global initiative occurred in 1983 when the UN General Assembly established the World Commission on Environment and Development, headed by Gro Harlem Brundtland. The report produced by the Commission was entitled *Our Common Future* and it was presented by the UN General Assembly in 1987 and endorsed by it. It has been influential in bringing environmental issues into the global arena, and in expressing some concepts that have been influential in air quality management.

The Brundtland Commission suggested that to meet the legitimate aspirations of the world's population without destroying the environment, sustainable development would be required. It defined **sustainable development** as: *development that meets the needs of the present without compromising the ability of future generations to meet their own needs*. This concept has been embraced as an apparent means of integrating environmental policy and economic development.

Following from the Brundtland Commission, the UN Conference on the Environment and Development was held in Rio in 1992. The aim was to ensure that practical foundations for sustainable development were put into place. The Agenda 21 document and the Rio declaration were the most obvious results of this conference. Agenda 21 is a document covering sustainable development which is not binding on countries, but national implementation is reviewed by the Sustainable Development Commission and the UN General Assembly. Agenda 21 supports a number of environmental management principles on which some government policies including air quality management are based. These include:

- **precautionary principle** - where there is a clear possibility of damaging environmental consequences, action should be taken to protect the environment without awaiting the full scientific proof that the environment will be damaged by the proposal.

- **polluter pays** - the full costs associated with pollution (including monitoring, management, clean-up and supervision) should be met by the organisation responsible for the source of the pollution.

In addition, many countries have adopted the principle of **pollution prevention**, which aims to reduce pollution at sources.

The responsibility of national governments for international reporting on the environment of their country has enabled greater exchange of air quality information around the world.

The foundation for air quality management is the government policy framework. Without a suitable policy framework and adequate legislation it is difficult to maintain an active or successful air quality management programme. A policy framework refers to transport, energy, planning, development, and policy in other areas, as well as environmental policy. Air quality objectives are more readily achieved if these interconnected government policies are compatible, and if mechanisms exist for co-ordinating responses to issues, which cross different areas of government policy. Measures to achieve some integration of air quality policy with health, energy, transport and other policy areas have been adopted in many developed countries.

The goal of air quality management is commonly stated to be to maintain a quality of air that protects human health and welfare. This goal recognises that air quality must be maintained at levels, which protect human health, but it also must provide protection of animals, plants (crops, forests and natural vegetation), ecosystems, materials and aesthetics, such as natural levels of visibility. To achieve an air quality goal requires the development of policies and strategies.

15. Management of indoor air quality

Most human beings spend most of their time in indoor environments, where they can be exposed to poor air quality. Pollution and degradation of indoor air cause illness, increased mortality, loss of productivity and have major economic and social implications. Health effects can include increased rates of cancer, lung disease, allergy and asthma as well as fatal conditions such as carbon monoxide poisoning and legionnaires' disease, as discussed in Section 4.1. The medical and social cost associated with these illnesses, and the related reduction in human productivity, result in staggering economic losses.

Indoor air quality problems affect all types of buildings including homes, schools, offices, health care facilities and other public and commercial buildings. Indoor air problems can be reduced by better urban planning, design and operation, as well as maintenance of buildings, materials and equipment in buildings.

This document considers the management of indoor air quality in developed countries, and in some situations in developing countries, and then focuses on the important and widespread problem of how to manage indoor air quality associated with biomass fuel combustion in developing countries.

16. Priority Setting in Air Quality Management

It is important to give guidance to countries on how to set priorities in rational air quality management. Actual priorities will differ for each country; therefore, each country sets priorities in air quality management according to its policy objectives, needs and capabilities. Priority setting in air quality management refers to prioritising health risks to be avoided, with corresponding prioritisation of air pollutant compounds, and concentrating on the most important sources of the pollutants. Conceptually, prioritising health risks is straightforward. High priority of health risks will be given to those compounds for which "high" toxicity and "high" exposure of the population are entailed. Conversely, low priority health risks involve agents of "low" toxicity and "low" exposure. "Medium" priority risks include compounds in which either toxicity or exposure is "low" while the other is "high".

A framework for a political, regulatory and administrative approach is required to guarantee a consistent and transparent derivation of air quality standards and to ensure a basis for making decisions on risk-reducing measures and abatement strategies. In such a framework the following considerations need to be included:

- The legal aspects.
- The potential of air pollution to cause adverse effects on health, taking into account the populations at risk.
- The exposure-response relationships of pollutants and pollutant mixtures and the actual exposure responsible for related health and/or environmental risks.
- The acceptability of risk.
- The cost-benefit analysis.
- The stakeholder contribution in standard setting.

17. Enforcement of air quality standards: Clean air implementation plans

The enforcement of air quality standards aims to evaluate the need for control action on emission sources to attain compliance with the standards. The instruments used to achieve this goal are the Clean Air Implementation Plans (CAIPs). The outline of such a plan should be defined in regulatory policies and strategies. Clean air implementation plans were developed in several developed countries during the 1970s and 1980s. Air pollution was characterized by a multitude of sources of many different types of air pollutants. Consequently it was extremely difficult to assess the public health risks associated with a single source, or even a group of sources. As a consequence, on the basis of the polluters pay principle (Chapter 6), sophisticated tools were developed which assessed the sources, air pollutant concentrations, health and environmental effects and control measures, and which made a causal link between emission, air pollution and the necessary control measures. A typical clean air implementation plan (CAIP) includes:

A description of the area.
An emissions inventory.
An air pollutant concentrations inventory - monitored and simulated.
A comparison with emissions and air quality standards or guidelines.
An inventory of the effects on public health and the environment.
A causal analysis of the effects and their attribution to individual sources.
Control measures and their costs.
Transportation and land-use planning.
Enforcement procedures.
Resource commitment.
Projections for the future.

In developing countries, the air pollution situation is often characterized by a multitude of sources of few types, or sometimes few sources. Using the experience obtained in developed countries, the control action to be taken is very often obvious. As a consequence, in cases where little useful monitoring data are available, less monitoring could be sufficient, and dispersion models could help to simulate spatial distributions of pollutant concentrations. Much simplified CAIPs would have to be developed for cities of developing countries or countries in transition. At present, the main sources of emissions in many cities of the developing world are old vehicles and some industrial sources such as power plants, brick kilns, cement factories and a few others. Their relative contribution to air pollution could be determined by use of rapid emission inventories. The emission factors used in such inventories are published and a PC programme is available, which enables an estimation of emissions and ambient air concentrations, and evaluates the impact of possible control measures. Projections for the future can also be evaluated by the programme.

1. Introduction

Air pollution is a major environmental health problem affecting developed and developing countries around the world. Increasing amounts of potentially harmful gases and particles are being emitted into the atmosphere on a global scale, resulting in damage to human health and the environment. It is damaging the resources needed for the long-term sustainable development of the planet.

The sources of air pollution resulting from human activities are of three broad types.

- Stationary sources. These can be subdivided into:
  - Rural area sources such as agricultural production, mining and quarrying.
  - Industrial point and area sources such as manufacturing of chemicals, non-metallic mineral products, basic metal industries, power generation.
  - Community sources, e.g. heating of homes and buildings, municipal waste and sewage sludge incinerators, fireplaces, cooking facilities, laundry services and cleaning plants.
- Mobile sources. These comprise of any form of combustion-engine vehicles, e.g. light duty gasoline-powered cars, light and heavy-duty diesel-powered vehicles, motorcycles, aircraft, and including line sources such as fugitive dusts from vehicle traffic.
- Indoor sources. These include: tobacco smoking, biological sources (such as pollen, mites, moulds, insects, micro-organisms, pet allergens etc.), combustion emissions, emissions from indoor materials or substances such as volatile organic compounds, lead, radon, asbestos, various synthetic chemicals and others.

In addition, there are also natural sources of pollution, e.g. eroded areas, volcanoes, certain plants that release great amounts of pollen, sources of bacteria, spores and viruses, etc. These natural physical and biological sources of pollution are not discussed in this publication.

In recent years it has become clear that indoor air pollution from the use of open fires for cooking and heating may be a serious problem in developing countries. It has been estimated that about 2 500 000 people die annually from exposure to high concentrations of suspended particulate matter in the indoor air environment; and the excess mortality due to suspended particulate matter and sulphur dioxide in the ambient air amounts to about 450 000 people annually (Murray and Lopez 1996; Schwela 1996a; WHO 1997a). Although the indoor air database is weak due to the scarcity of monitoring results, these estimates indicate that a serious indoor air problem may exist in developing countries.

Air pollutants are usually classified into suspended particulate matter (dusts, fumes, mists, smokes), gaseous pollutants (gases and vapours) and odours.

Suspended particulate matter (SPM) Particulate matter suspended in air includes total suspended particles (TSP), PM_{10}, (SPM with median aerodynamic diameter less than 10 μm), $PM_{2.5}$ (SPM with median aerodynamic diameter less than 2.5 μm), fine and ultrafine particles, diesel exhaust, coal fly-ash, mineral dusts (e.g. coal, asbestos, limestone, cement), metal dusts and fumes (e.g. zinc, copper, iron, lead), acid mists (e.g. sulphuric acid), fluoride particles, paint pigments, pesticide mists, carbon black, oil smoke and many others. Suspended particulate pollutants provoke respiratory diseases, and can cause cancers, corrosion, destruction to plant life, etc. They can also constitute a nuisance (e.g. accumulation of dirt), interfere with sunlight (e.g. light scattering from smog and haze) and also act as catalytic surfaces for reaction of adsorbed chemicals.

Gaseous pollutants: Gaseous pollutants include sulphur compounds (e.g. sulphur dioxide (SO_2) and sulphur trioxide (SO_3)), carbon monoxide (CO), nitrogen compounds [e.g. nitric oxide (NO), nitrogen dioxide (NO_2), ammonia (NH_3)], organic compounds [e.g. hydrocarbons (HC), volatile organic compounds (VOC), polycyclic aromatic hydrocarbons (PAH) and halogen derivatives, aldehydes, etc.], halogen compounds (HF and HCl) and odourous substances.

Secondary pollutants may be formed by thermal, chemical or photochemical reactions. For example, by thermal action SO_2 can be oxidised to SO_3 which, dissolved in water, gives rise to the formation of sulphuric acid mist (catalysed by manganese and iron oxides). Photochemical reactions between NO_x and reactive hydrocarbons can produce ozone (O_3), formaldehyde (HCHO) and peroxyacetyl nitrate (PAN); reactions between HCl and HCHO can form bis-chloromethyl ether.

Odours: While some odours are known to be caused by specific chemical agents such as hydrogen sulphide (H_2S), carbon disulphide (CS_2) and mercaptans (R-SH, R_1 S R_2), others are difficult to define chemically.

An air pollutant concentrations inventory summarizes the results of monitoring ambient air pollutants. The data are expressed in terms of annual means, percentiles and trends of the parameters measured. In most developed countries compounds measured for such an inventory include SO_2, nitrogen oxides (NO_x), SPM, CO, O_3, heavy metals, PAH, and VOC. In developing countries the "classical" compounds SO_2, NO_x, SPM, CO, O_3 and lead are commonly monitored.

Trends in air pollution exposure are usually shown as annual arithmetic or geometric means and as statistical measures of short-term exposure such as high percentiles, or maximal or second highest values of a sample. The general picture for the "classical" compounds considered in this publication is that SO_2 and SPM concentrations are decreasing in developed countries while NO_x and O_3 concentrations are either constant or increasing (UNEP/WHO 1992). In many countries in transition and in developing countries, SO_2 and SPM concentrations are increasing as a consequence of increasing combustion, as are NO_x and O_3 due to increasing traffic exhaust and emissions of VOC by industrial sources as precursors of O_3.

WHO's air quality guidelines were first published as *Air Quality Guidelines for Europe* in 1987 (WHO 1987). Since 1993 the *Air Quality Guidelines for Europe* has been revised and updated after a review of the literature published since 1987 (WHO 1992a; WHO 1994a; WHO 1995a; WHO 1995b; WHO 1995c; WHO 1996a; WHO 1998a; WHO 1999a). Also, the following additional compounds were considered in the review procedure: 1,3 butadiene, environmental tobacco smoke (ETS), fluoride, man-made-vitreous fibres (MMVF) and platinum. Parallel to the review of the air quality guidelines for Europe, the Environmental Health Criteria series of the International Programme on Chemical Safety has continued and the health risks of more than 120 chemical compound and mixtures were assessed between 1987 and 1998.

Trends of ambient air pollution were assessed in the WHO/UNEP Global Environmental Monitoring System/Air Pollution (GEMS/Air) which operated from 1973 to 1995 (UNEP/WHO 1993). The GEMS/Air programme has been replaced by a new programme under the umbrella of WHO's Healthy Cities Programme: Air Management Information System (AMIS). AMIS is intended as an information turntable which collects information on all issues of air quality management from its participants and distributes this information among them via the information centre at WHO. Several databases have already been developed (WHO 1997b; WHO 1998b). The AMIS core database of ambient air pollutant concentrations contains summary data, including annual means, percentiles and the number of days on which WHO Air Quality Guidelines are exceeded, from more than 100 cities in the world. A database on air quality guidelines and air quality standards contains data from about 60 countries. A database on air pollution management capabilities contains data from 70 cities. A database of the AMIS focal points helps AMIS participants in different countries to communicate with each other. A database on indoor air pollutant concentrations and a noise database have been developed and will be available in the near future.

The WHO Air Quality Guidelines for Europe (WHO 1987) were based on evidence from the epidemiological and toxicological literature published in Europe and North America. They did not consider exposure to ambient air concentrations in developing countries and the different conditions in these countries. However, these guidelines were used intensively throughout the world. In view of the different conditions in developing countries, the literal application of the WHO Air Quality Guidelines for Europe could be misleading. Factors such as high and low temperature, humidity, altitude, background concentrations and nutritional status could influence the health outcome after exposure of the population to air pollution. To make the WHO *Air Quality Guidelines for Europe* globally applicable, a task force group meeting was convened at WHO Headquarters from 2-5 December 1997. The outcome of this meeting is this publication of the globally applicable *Guidelines for Air Quality.*

The objective of WHO's *Guidelines for Air Quality* is to help countries derive their own national air quality standards, to help protect human health from air pollution. The guidelines are technologically feasible and consider socio-economic and cultural constraints. They provide a basis for protecting public health from the adverse effects of air pollution, and for eliminating or reducing to minimum, air pollutants likely to be hazardous to human health. Consequently, the instruments of air quality management are also addressed in this publication.

2. Air Quality and Health

2.1 Basic facts

Pure air comprises oxygen (21%) and nitrogen (78%) and a number of rarer gases, of which argon is the most plentiful. Carbon dioxide (CO_2) is present at a lower percentage concentration (0.03%) than argon (0.93%). Water vapour, up to 4% by volume, is also present. Oxygen is produced by plants as a by-product of photosynthesis and the earth's atmosphere is now described as oxidant, or oxidising, in comparison with the hydrogen-rich reducing atmosphere that was present before life began. The increase in oxygen has led to the development of anti-oxidant defences in many living organisms.

The atmosphere contains a number of gases which, at higher than usual concentrations, are poisonous to humans and animals and damaging to plants. These include O_3, SO_2, NO_2, CO and a wide range of VOC. Some of the latter are carcinogenic, for example benzene and butadiene. All these potentially toxic gases are referred to as air pollutants.

As well as gases, the atmosphere contains a wide variety of particulate matter, both solid and liquid, ranging in size from a few nanometres to about 0.5 mm. Small particles (<2.5 µm) persist in the air for long periods, forming a more or less stable aerosol. Larger particles are more quickly lost as their mass leads to rapid sedimentation.

This publication is focused on gases and particulate materials that have been accepted as posing a threat to health. The relative importance of the different pollutant gases and particles varies with their concentrations over both time and distance. This implies that the extent of the effects of air pollutants on health may vary from country-to-country. Careful monitoring of the concentrations of polluting gases and the particle size distribution, concentration, and composition is thus needed before an acceptable estimate of effects can be produced. The picture is further complicated as some combinations of pollutants act in an additive manner and some perhaps synergistically.

2.1.1 Physico-chemical aspects of air pollution and units used to describe concentrations of air pollutants

A consistent system of units is necessary if concentrations of air pollutants in different countries are to be compared. For both gases and particles WHO has adopted a mass per unit volume system, with concentrations generally expressed as $\mu g/m^3$. The volume of a mass of air varies with ambient temperature and atmospheric pressure and thus these conditions should be specified. In considering pollutants on a global scale this is clearly important.

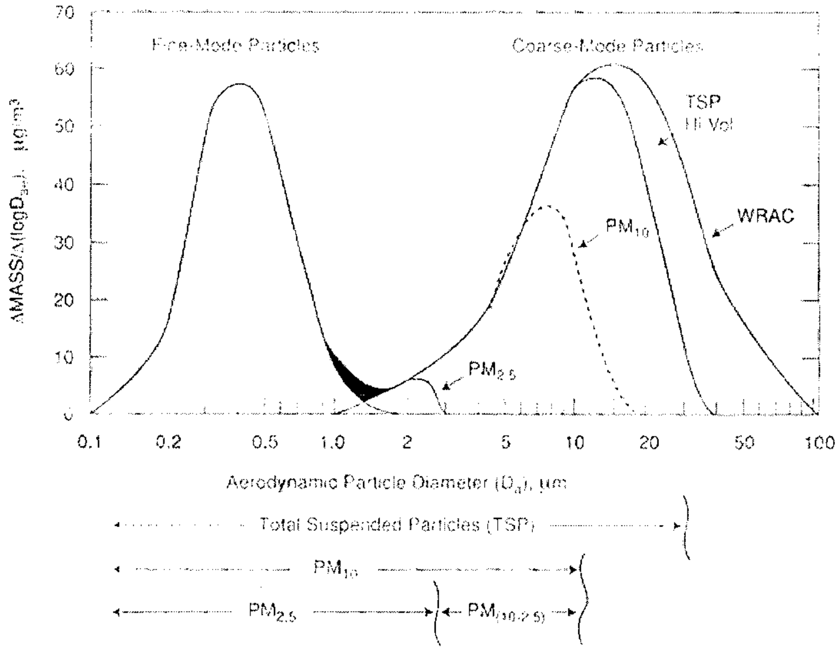
The alternative system, the volume mixing ratio, is applicable only to gases. In this system the concentration of gas is expressed as parts per billion, for example, and assuming ideal gas behaviour, does not depend upon the conditions of sampling because these will affect the air containing the pollutant and the pollutant itself to the same extent. A gas present at one part per million thus occupies 1 cm^3 per m^3 of polluted air; is present as 1 molecule per 1×10^6 molecules and exerts a partial pressure of 1×10^{-6} atmospheres.

The two systems are interconvertible as under ideal conditions, 1 Mole of gas occupies 22.4 litres at 273K and 13mb pressure, dry air Standard Temperature and Pressure Dry (STPD). The interconversion formula is:

$$mg/m^3 = ppm \times (\text{molecular weight/molar volume})$$

molar volume = 22.4 x T x 1013/273 x P
T = absolute temperature (K)
P = atmospheric pressure (mb)

For particles, the mass per unit volume approach is used. Particle deposition in the respiratory tract depends upon the dimensions of the particles (WHO 1979a). Thus, in describing the particle loading of the air, information on the distribution of particle size should be given in addition to the mass concentration. A representative size distribution of urban particulate matter is provided in figure 2.1. It may also be important to specify the number of particles present in each of several specific size ranges per unit volume of air.



Source: USEPA, 1996
Figure 2. 1. Representative example of a mass distribution of ambient PM as function of aerodynamic particle diameter. A wide-ranging aerosol collector (WRAC) provides an estimate of the full coarse mode distribution. Inlet restrictions of the high volume sampler for TSP, the PM_{10} sampler, and the $PM_{2.5}$ sampler reduce the total mass reaching the sampling filter.

The distribution of sizes of particles arising from each source of aerosols has been shown to follow a log-normal distribution: thus the geometric mean (or median) diameter and the geometric standard deviation are often quoted and specify the distribution. In defining the median diameter of the particles of an aerosol it should be specified whether this value reflects the mid-point of the distribution of the mass or number of particles present. Thus the Mass or Count Median Diameter (MMD or CMD) should be specified. An additional refinement involves adjusting for the aerodynamic properties of the particles and so the Mass or

Count Aerodynamic Median Diameters should be quoted. In naturally occurring aerosols the geometric standard deviation tends to vary from about 2 to 4 µm with 84% of the distribution being of size less than that specified by the median diameter multiplied by the geometric standard deviation. It is incorrect to refer to the median diameter of a single particle: the term refers to the distribution of sizes present in an aerosol cloud.

Current techniques used to measure the mass concentration of particles in air make use of size-specific sampling devices and thus the mass of particles of less than 10 µm diameter may be determined (PM_{10}) as an index of the mass concentration of particles that can penetrate into the human thorax. Sampling devices allow a fairly definite separation of particles of greater or less than the specified size. To be precise, the percentage of particle mass in the specified size range accepted by the sampling system, should be specified (e.g. 10 µm in the above example). A PM_{10} sampling head accepts 50% of particles of aerodynamic diameter exactly 10 µm, the acceptance fraction rising rapidly for particles of smaller diameter and declining rapidly for particles of greater diameter.

The mass concentration of particles of less than 2.5 µm diameter ($PM_{2.5}$) is a means of measuring the total gravimetric concentration of several chemically distinctive classes of particles that are emitted into or formed within the ambient air as very small particles. In the former category (emitted) are carbonaceous particles in wood smoke and diesel engine exhaust. In the latter category (formed) are carbonaceous particles formed during the photochemical reaction sequence that also leads to O_3 formation, as well as sulphate and nitrate particles resulting from the oxidation of SO_2 and nitrogen oxide released during fuel combustion and their reaction products.

The coarse particle fraction, i.e., those particles with aerodynamic diameters larger than about 2.5 µm, are largely composed of soil and mineral ash that are mechanically dispersed into the air. Both the fine and coarse fractions are complex mixtures in a chemical sense. To the extent that they are in equilibrium in the ambient air, it is a dynamic equilibrium in which they enter the air at about the same rate as they are removed. In dry weather, the concentrations of coarse particles are balanced between dispersion into the air, mixing with air masses, and gravitational fallout, while the concentrations of fine particles are determined by rates of formation, rates of chemical transformation, and meteorological factors. Concentrations of both fine and coarse particulate matter are effectively depleted through in-cloud and below-cloud scavenging by precipitation. Further elaboration of these distinctions is provided in Table 2.1.

Table 2.1. Comparisons of ambient fine and coarse mode particles

	Fine Mode	Coarse Mode
Formed from:	Gases	Large solids/droplets
Formed by:	Chemical reaction; nucleation; condensation; coagulation; evaporation of fog and cloud droplets in which gases have dissolved and reacted.	Mechanical disruption (e.g. crushing, grinding, abrasion of surfaces); evaporation of sprays; suspension of dusts.
Composed of:	Sulphate, $SO_4^{=}$; nitrate NO_3^-; ammonium, NH_4^+; hydrogen ion, H^+; elemental carbon; organic compounds (e.g., PAHs); metals (e.g. Pb, Cd, V, Ni, Cu, Zn, Mn, Fe); particle-bound water.	Resuspended dusts (e.g., soil dusts, street dust); coal and oil fly ash, metal oxides of crustal elements (Si, Al, Ti, Fe); $CaCO_3$, NaCl, sea salt; pollen, mould spores; plant/animal fragments; tire wear debris
Solubility	Largely soluble, hygroscopic and deliquescent	Largely insoluble and non-hygroscopic
Sources	Combustion of coal, oil, gasoline, diesel, wood; atmospheric transformation products of NO_x, SO_2 and organic compounds including biogenic species (e.g. terpenes) high temperature processes, smelters, steel mills, etc.	Resuspension of industrial dust and soil tracked onto roads; suspension from disturbed soil (e.g. farming, mining, unpaved roads); biological sources; construction and demolition; coal and oil combustion; ocean spray
Lifetimes	Days to weeks	Minutes to hours
Travel Distance	100s to 1000s of kilometres	< 1 to 10s of kilometres

Source: USEPA (1996a, b)

As indicated in Table 2.1, fine and coarse particles generally have distinct sources and formation mechanisms, although there may be some overlap. Primary fine particles are formed from condensation of high temperature vapours during combustion. Secondary fine particles are usually formed from gases in three ways:

1. Nucleation (i.e., gas molecules coming together to form a new particle).
2. Condensation of gases onto existing particles.
3. By reaction of absorbed gases in liquid droplets.

Particles formed from nucleation also coagulate to form relatively larger aggregate particles or droplets with diameters between 0.1 - 1.0 µm, and such particles normally do not grow into the coarse mode. Particles form as a result of chemical reaction of gases in the atmosphere that lead to products that either have a low enough vapour pressure to form a particle, or react further to form a low vapour pressure substance. Some examples include:

1. The conversion of SO_2 to sulphuric acid droplets (H_2SO_4).
2. Reactions of H_2SO_4 with NH_3 to form ammonium bisulphate (NH_4HSO_4) and ammonium sulphate $(NH_4)_2SO_4$.
3. The conversion of NO_2 to nitric acid vapour (HNO_3), which reacts further with NH_3 to form particulate ammonium nitrate (NH_4NO_3).

Although some directly emitted particles are found in the fine fraction, secondary particles formed from gases dominate the fine fraction mass. By contrast, most of the coarse fraction particles are formed directly as particles, and result from mechanical disruption such as crushing, grinding, evaporation of sprays, or suspension of dust from construction and agricultural operations. Basically, most coarse particles are formed by breaking up bigger masses into smaller ones. Energy considerations normally limit coarse particle sizes to greater than 1.0 µm in diameter. Some combustion-generated mineral particles, such as fly ash, are also found in the coarse fraction. Biological material such as bacteria, pollen, and spores may also be found in the coarse mode.

In general, fine and coarse particles exhibit different degrees of solubility and acidity. With the exception of carbon and some organic compounds, fine particles are largely soluble in water and hygroscopic (i.e., fine particles readily take up and retain water). Except under fog conditions, the fine particle mode also contains almost all of the strong acid. By contrast, coarse mineral particles are mostly insoluble, non-hygroscopic, and generally basic.

Fine and coarse particles typically exhibit different behaviour in the atmosphere. These differences affect several exposure considerations including the representativity of central-site monitored values and the behaviour of particles that were formed outdoors after they penetrate into homes and buildings where people spend most of their time.

Fine accumulation mode particles typically have longer atmospheric life times (i.e. days to weeks) than coarse particles, and tend to be more uniformly dispersed across an urban area or large geographic region. Atmospheric transformations can take place locally, during atmospheric stagnation, or during transport over long distances. For example, the formation of sulphates from SO_2 emitted by power plants with tall stacks can occur over distances exceeding 300 kilometres and 12 hours of transport time; therefore, the resulting particles are well mixed in the air shed. Once formed, the very low dry deposition velocities of fine particles contribute to their persistence and uniformity throughout an air mass.

Larger particles generally deposit more rapidly than small particles; as a result, total coarse particle mass is less uniform in concentration across a region than that of fine particles. The larger coarse particles (> 10 µm) tend to fall out of the air rapidly and have atmospheric lifetimes of only minutes to hours depending on their size, wind velocity, and other factors. Their spatial impact is typically limited by a tendency to fall out in the nearby downwind area. The atmospheric behaviour of the small particles within the "coarse fraction" ($PM_{10-2.5}$) is intermediate between that of the larger coarse particles and fine particles. Thus, some of the smaller coarse fraction particles may have lifetimes on the order of days and travel distances of up to 100 km or more. In some locations, source distribution and meteorology affects the relative homogeneity of fine and coarse particles, and in some cases, the greater measurement error in estimating coarse fraction mass precludes clear conclusions about relative homogeneity.

The composition of airborne particles is seldom routinely determined though this can vary significantly from site to site. This is important in interpreting the results of epidemiological studies of the effects of particles on health. Extrapolation from data collected in one country to conditions in another may be unwise unless some comparability of particle composition has been established.

2.1.2 Sources of air pollutants

The sources of air pollutants may be divided into anthropogenic and natural. However, as human activity disturbs natural systems, the distinction may become blurred. Natural sources include dust storms, volcanic action, forest fires and the formation of radioactive particles from gases such as radon. Incursions from the stratosphere increase ground level (tropospheric) concentrations of O_3. For some pollutants, e.g. SO_2, natural sources exceed anthropogenic sources on a global scale. However, when considering the effects of air pollutants on health, especially in urban areas where population densities are high, anthropogenic sources are very important and are those to which attention is usually directed with a view to control.

Most anthropogenic sources of fine particles, i.e. those less than 2.5 µm in aerodynamic diameter, involve combustion of some sort. Materials of biological origin (e.g. wood, coal and oil) burn in air by virtue of their carbon content. If a substance containing only hydrocarbon compounds burns with complete efficiency, only water and CO_2 are produced. Such combustion demands a stoichiometric ratio of oxygen to fuel and, in practice, is never attained. Unburned fragments of combustible material, semi-volatile organic compounds, which vaporise and subsequently recondense as tarry droplets and incombustible matter are usually emitted as components of smoke during and following the combustion process. Improving the mix of air and fuel and pre-removal of volatile compounds may reduce smoke production. Smokeless fuel is prepared and burnt in this way. If the supply of oxygen is inadequate, large increases in CO production occur.

In most countries, motor vehicles, industrial activity and the generation of electricity account for a large percentage of the anthropogenic production of the oxides of nitrogen and sulphur. These, in addition to CO, particles and VOC are described as primary pollutants in that they are produced directly by the combustion process. Reactions taking place in the troposphere generate secondary pollutants: O_3 is a classic example. NO_2 breaks down photochemically under the action of ultra-violet light to generate NO and atomic oxygen. The latter combines with molecular oxygen to produce O_3. The presence of peroxy radicals derived from atmospheric reactions of HC and other organic compounds ensures that NO is oxidized back to NO_2 without loss of O_3. Thus an O_3-generating series of reactions is established. The formation of O_3 typically occurs as polluted air drifts away from sites of production including urban areas; O_3 may thus occur at large distances from sources of NO_2 and HC.

NO_2 is both a primary and a secondary pollutant. Motor vehicles emit both NO and NO_2. In the atmosphere, NO is oxidized to the dioxide, slowly by oxygen but rapidly by O_3. This explains the low concentrations of O_3 generally found close to sources of oxides of nitrogen.

In addition to the above, sulphur in fuel also gives rise to both primary and secondary pollutants. SO_2 is formed by oxidation during combustion. Further oxidation of SO_2 leads to SO_3, which rapidly undergoes hydration to form sulphuric acid and this, in turn, is neutralized by NH_3 to ammonium bisulphate and ammonium sulphate. These compounds make an important contribution to the ambient fine particle aerosol.

The combustion of oil and petrol in internal combustion engines leads to the release of organic compounds, which condense in the air to produce small particles of the order of 1 µm in diameter. These and the freshly formed sulphuric acid droplets of similar size are described as nucleation mode particles. Such particles have a short lifetime (< 1 hour) and aggregate or agglomerate to produce particles in the 0.2-2.0 µm diameter range which are defined as accumulation mode particles. These particles are stable and long-lived, and may be transported many hundreds of kilometres before being eventually lost from the air, generally as a result of below-cloud scavenging by precipitation.

2.1.3 Factors affecting the concentrations of air pollutants

Local concentrations of air pollutants depend upon the strength of their sources and the efficiency of their dispersion. Day to day variations in concentrations are more affected by meteorological conditions than by changes in source strengths. Under some conditions both factors may play a part: in cold, still weather, dispersion is reduced whilst production is increased by the increased use of domestic space heating.

Wind is of key importance in dispersing air pollutants: concentrations being inversely related to wind speed for ground level sources. Turbulence is also important: a "rough" terrain, as produced for example by buildings, tends to lead to increased turbulence and better dispersion of pollutants.

Temperature inversions are of great importance in controlling the depth of the layer of air adjacent to the ground in which pollutants are well mixed (the mixing depth). As a mass of air rises it is exposed to decreasing atmospheric pressure and expands accordingly. This causes the temperature of the air mass to fall. The rate at which temperature falls with height is described as the adiabatic lapse rate: for dry air the rate of decline of temperature is about 1°C for each 100 m of height. Air saturated with water vapour loses heat more slowly than dry air, since the heat capacity of water vapour is twice that of dry air. As temperature falls and the saturated vapour pressure also falls, water condenses out as droplets and latent heat is released. As air containing water vapour, but not saturated, cools on rising it will reach saturation and thereafter the adiabatic lapse rate will be reduced.

As a mass of air rises it cools but as long as its temperature remains greater than that of the surrounding air it will retain buoyancy and continue to rise. Conversely if the actual temperature falls more slowly than that of the mass of air, or even increases, the cooling air will rapidly become heavier than the surrounding air and it will fail to rise. Consequently, a temperature inversion occurs when the air temperature rises with height above the ground.

At night, with low wind speeds and clear skies, rapid cooling of the ground and the adjacent air causes air to be coldest close to the ground and thus air cannot rise. Polluted air will not rise in the layer in which the usual temperature gradient is reversed and thus the concentration of pollutants in this layer will increase, sometimes leading to a thick layer of polluted air close to the ground.

Temperature inversions occur in summer as well as in winter. With strong sunlight and high traffic density, temperature inversions contributed to the high incidence of photochemical smog first described in the early 1950s in Los Angeles and now seen commonly in other large cities surrounded by mountains, such as Mexico City, Sao Paulo, and Caracas.

2.1.4 Exposure to air pollutants

The total daily exposure of an individual to air pollution is the sum of the separate contacts to air pollution experienced by that individual as he/she passes through a series of environments during the course of the day (also called micro-environments, e.g. at home, while commuting, in the streets, etc.). Exposures in each of these environments can be estimated as the product of the concentration of the pollutant in question and the time spent in the environment. In this model, the concentration of pollutants is assumed to be approximately constant during the time a person spends time in it. Exposure should not be confused with dose: i.e., the amount of pollutant absorbed. As the number of micro-environments studied is increased, a better estimate of total daily exposure is produced. The daily average concentration of a pollutant recorded at a single, fixed-site outdoor monitoring point provides only a very approximate guide to actual exposure.

One obvious and important micro-environment is the indoor environment where the types and concentrations of pollutants may be very different from those outdoors. For example, O_3 concentrations are generally much lower indoors in the absence of indoor sources, and O_3 penetrating from outdoors is destroyed by reaction with interior surfaces. By contrast, indoor concentrations of a chemically non-reactive fine particle such as sulphate may reach 90% of those outdoors. For some pollutants, indoor concentrations usually exceed outdoor concentrations.

In some cool climate countries people living in urban areas spend as much as 90% of their time indoors; this should be considered in interpreting the results of epidemiological studies relating outdoor concentrations of pollutants to effects on health. In other countries where climates are warm and many occupational activities are conducted outdoors, the percentage of the day spent indoors may be very much less. In some developing countries, indoor air pollution may be much higher than outdoor air pollution due to use of biomass fuels in open stoves (Section 4.2).

Besides varying temporally, outdoor concentrations of air pollutants vary from place-to-place. For example, concentrations of primary pollutants generated by motor vehicles decline rapidly as one moves away from busy roads. However, concentrations of pollutants generated by motor vehicles may be significantly higher inside motor vehicles than indicated by single site monitors and thus the motor car may itself be a significant micro-environment. Some pollutants are comparatively evenly distributed across large areas: O_3 and fine particles are examples. For such pollutants, monitoring at a limited number of sites may provide an adequate indication of concentrations over wide regions.

Personal monitoring devices have been developed for some pollutants. At their simplest these provide an integrated assessment of personal exposure over a given period. An overview of some aspects of the technology of monitoring devices is provided in Chapter 5.

2.1.5 Health significance of air pollution

Exposure to air pollution is probably as old as human exposure to fire. There is a large amount of archaeological evidence that indoor air pollution must have been troublesome to early humans, who used fire in confined spaces (Brimblecombe 1987). The classical writers record the oppressive fumes of Rome. Attention to effects of air pollution on health was focused during the early and mid 20th Century by a series of air pollution episodes, which produced dramatic effects on health. The Meuse Valley in Belgium (1930), Donora in the USA (1948) and London, England (1952) all experienced air pollution episodes which were investigated in some detail. In the 1952 London air pollution episode it was estimated that 4000 extra deaths occurred as a result of a smog largely consisting of high concentrations of SO_2 and particulate matter (Brimblecombe 1987), and in Donora some 43% of the population were affected by symptoms including headache, eye irritation, dyspnoea and vomiting. Analysis of the London episode showed that the elderly, especially those suffering from pre-existing cardio-respiratory disorders and the very young were at greatest risk. Later studies demonstrated a decline in urban levels of chronic bronchitis as concentrations of air pollutants fell (Chin et al 1981).

Emphasis on severe episodes of pollution may have distracted attention from the effects of long term exposure to pollution. Studies in London in the 1950s and 60s showed that the self-reported state of health of a panel of patients suffering from chronic bronchitis varied with day-to-day levels of air pollution (Waller 1971). It was noted, using simple methods of analysis, that symptoms did not increase unless the concentrations of smoke (measured as Black, or British Smoke) and SO_2 exceeded 250 and 500 $\mu g/m^3$, respectively. It is likely that, had more searching methods of analysis been applied, effects would have been seen at lower concentrations.

Since the 1950s a great body of evidence has accumulated showing that air pollutants have a damaging effect on health. Some of the key studies are reviewed in Chapter 3 of this publication. Two especially important groups of studies will be dealt with briefly here as they have played an important role in the formulation of these guidelines.

When the WHO Air Quality Guidelines for Europe were developed in 1987 (WHO 1987) emphasis was placed on the results of studies of volunteers exposed to air pollutants under controlled conditions. Where such studies demonstrated a Lowest Observed Effect, or Adverse Effect Level this was used as a starting point for deriving the relevant air quality guideline. Epidemiological studies that demonstrated a threshold of effect were used in the same way.

A new database of epidemiological studies emerged in the late 1980s and 1990s. This database of time-series studies was developed first in the United States and later in Europe and other areas (Schwartz et *al* 1996). In essence the time series approach takes the day as the unit of analysis and relates the daily occurrence of events, such as deaths or admissions to hospital, to daily average concentrations of pollutants whilst taking careful account of confounding factors such as season, temperature and day of the week. Powerful statistical techniques have been applied and coefficients relating daily average concentrations of pollutants to effects have been produced. The results of these studies have been remarkably consistent and have withstood critical examination well (Samet et al. 1995). Such methods cannot, of course, be expected to prove the possible or probable causal nature of the associations demonstrated, but detailed examination of the data and application of the usual tests for likelihood of causality have convinced many that it would be unwise to disregard the findings.

Associations have been demonstrated between daily average concentrations of particles, O_3, SO_2, airborne acidity, NO_2, and CO. The associations for each of these pollutants were not significant in all studies though, taking the body of evidence as a whole, the consistency is striking. More remarkable than the consistency of the results was the demonstration of associations at levels of pollution hitherto expected to be quite safe: indeed, below the levels recommended in the 1987 WHO Air Quality Guidelines for Europe.

For particles and O_3 it has been accepted by many that the studies provide no indication of any threshold of effect. This was reflected in the tables relating small differences in daily concentrations of particles and O_3 to effects on health (Chapter 3).

In time - series studies, daily counts of events are related to the daily average concentration of pollutants measured, usually at a single, fixed, monitoring site or predicted from such measurements. In any city it is likely that there will be a distribution of personal exposure across the population. Thus, on days when the measured or predicted level of pollution is low, some individuals may be exposed to greater than the reported concentration. If such exposure exceeded some threshold then effects would be recorded and attributed to occurring as a result of exposure to the recorded or predicted concentration. It might then be asked whether time series studies are capable of discerning a threshold of effect, especially if the threshold is low. This problem is by no means limited to particulate matter and O_3: similar difficulties in identifying a threshold of effect at a population level apply to lead. This is an important point with regard to defining an air quality guideline based on such data: it is unlikely that a single guideline value can be derived from such a database and thus the "guideline" should be accepted to be a relationship relating events to airborne concentrations. This is a significant departure from the concept of a guideline value as a level of exposure at which the great majority of people, even in sensitive groups, would be unlikely to experience any adverse effects. Translation of this new form of guideline into an air quality standard is likely to be difficult. Junker and Schwela further discussed this issue in some detail (Schwela and Junker 1978; Junker and Schwela 1998).

Time-series studies relate the concentrations of air pollutants to their effects on health: in fact they provide the slope of a regression line relating concentrations to health events. There are no grounds for simple extrapolation of the concentration-exposure relationship to high levels of pollution. Several studies have shown that the slope of regression line is reduced when the annual average concentration of pollution is high (Schwartz and Marcus 1990).

Elevations in daily rates for various adverse health outcomes are sometimes referred to as the acute effects of air pollutants. For example, an increase in pollutant concentration might cause an increase in asthma attacks. It is assumed that without an increase in pollution, neither would asthma attacks increase. It is also likely that long-term exposure to air pollution produces chronic effects on health. For example, lifelong exposure to air pollution in England amongst those born in the late 19th Century is likely to have increased their chances of developing chronic bronchitis and dying earlier than expected as a result of the illness. (Chinn et al. 1981). In the United States, cohort studies in a range of towns have demonstrated associations between long term average concentrations of fine particles ($PM_{2.5}$ and sulphates) and the Standardized Mortality Ratios of communities (Dockery *et al* 1993; Pope *et al* 1995). Attempts to estimate the public health impact of air pollution have been made on the basis of both the cohort studies and the time-series studies. On the basis of one of the cohort studies (Pope et al. 1995), Brunekreef (1997) has reported that exposure to current levels of air pollution in the Netherlands may lead to a average reduction in longevity of 1 year. Work reported from the United States reports slightly larger effects: perhaps 2 years are lost in polluted communities compared with unpolluted areas of the United States. Loss of life expectancy may be distributed statistically across the affected population. This is the case amongst cigarette smokers where the average loss of life expectancy is of the order of 3-5 years, though some smoking-related deaths occur among people in their forties.

2.2 Air pollutant concentrations and factors affecting susceptibility

The concentrations of emitted pollutants and population exposures to air pollution vary substantially from country to country. In addition, human responses to air pollutant exposure also vary. Outdoor and indoor concentrations of air pollutants, and a number of examples of factors affecting responses to pollutants, are considered in this section.

2.2.1 Concentrations of classical pollutants in ambient air

There are far more data available on the ambient outdoor concentrations of certain classic air pollutants in many countries around the world than for any of the other pollutants, as monitoring records on black smoke (BS) and SO_2 in particular go back for five decades or more. There are, however, relatively few locations where all of the classical air pollutants have been measured simultaneously, or over extended periods. Additionally, historical data are often of limited value for retrospective or cross-sectoral analyses of air quality and health. Only recently, and only for a limited number of sites, have the specificity of analyses, the validity of calibrations, the identification of site representativity for the specific sampling purpose, the consistency of averaging times and/or sampling intervals, and the frequency and data management procedures been standardized to appropriate quality assurance procedures (see Chapter 5).

Available air pollutant concentration data were reviewed by the Task Group and selected data summaries are presented here to give the reader some general perspectives on recent pollutant levels and trends in the various WHO regions. The presentation is organized into three categories for each of the classical air pollutants.

The first category contains data on air quality in the European region on the basis that these summary data provided key input to the *Air Quality Guidelines for Europe* (WHO 1999a), which in turn provided the basis for the WHO *Guidelines for Air Quality* summarized in this publication. These data underwent a limited peer review by the WHO/EURO Working Group that judged them to be sufficiently representative and reliable for inclusion in the *Air Quality Guidelines for Europe*.

The second category contains data on ambient outdoor air quality in other WHO regions that were collected from countries by representatives from those regions on the WHO Global Air Quality Guidelines Task Group. In most cases, the Task Group was not able to assess data quality. Thus, it was not possible to endorse these data in terms of their accuracy and representativity. Although some data may be of high quality, some of the data were based on intermittent sampling programmes and cannot be reliably used for determining longer-term average concentrations.

Despite these limitations, the Task Group considered that presentation of some of the available summary data would provide a valuable frame of reference for the readers of this report. Accordingly, for each WHO Region other than Europe, a restricted set of data was selected for this report. Wherever possible, they represent: (a) at the one extreme, data for point source monitoring in regions as being representative of high-end human exposures; (b) non-typical levels, selected from data for urban sites not greatly affected by industrial point sources; and (c) at the other extreme, non-urban site data selected as being representative of the low end of concentrations for the country.

Each region was represented by data from a limited number of countries in that region, that differed in size and extent of industrial development, to demonstrate the extent of potential exposure of people in that region. Wherever possible, data that are summarized include available information on the source of the data, averaging times, and the quality assurance procedures followed in producing the data.

The third category of data consists of summaries from the WHO Air Management Information System (AMIS) programme (WHO 1997b, WHO 1998b). Since AMIS collects data from collaborating centres in all WHO regions, there is some overlap in coverage with the data summarized in the regional reports within the second category. The primary justification for including the AMIS data as a separate category is that the procedures used to generate and report these data are more uniform and were subjected to more validation, providing an independent source of data of assured quality.

An examination of the data summaries that follow clearly shows that air quality in large cities in many developing countries is remarkably poor, and that very large numbers of people in those countries are exposed to ambient concentrations of air pollutants well above the WHO *Guidelines for Air Quality.*

AIR QUALITY DATA IN DEVELOPING COUNTRIES

The main source of information on air pollution in developing countries is the Air Management Information System AMIS (WHO 1997b) set up by the WHO as a continuation of GEMS/Air (UNEP/WHO 1993). AMIS is based on voluntary reporting of data by municipalities of the WHO member states. The AMIS core data base collects information on annual (arithmetic) mean and high (95-, 98-) percentiles of daily mean concentrations of SO_2, NO_2, O_3, CO, SPM, lead and other potentially monitored compounds. In principle, data from three types of monitoring stations are stored: "industrial," reflecting levels in areas affected by emissions from industry; "city center / commercial," which will be mostly affected by traffic; and "residential," which should reflect the best basic level of population exposure. Until now the coverage of the system has been limited to 100 cities, but the intention is to acquire current information from some 300 cities by the end of 2000. The analysis of the data and its limitation is discussed by Krzyzanowski and Schwela (1999).

AIR POLLUTION LEVELS AND TRENDS

Sulphur dioxide

In most analysed cities, the annual mean concentrations of SO_2 in residential areas have not exceeded 50 $\mu g/m^3$. Notable exceptions are several cities in China, with the SO_2 concentration of 330 $\mu g/m^3$ in Chongqing and 100 $\mu g/m^3$ in Beijing in 1994. In some Chinese cities, the levels reported from "residential" locations exceed those from "commercial" regions of the city and are comparable with the levels in industrial zones. This may reflect the impact of combustion of sulphur-containing coal for domestic heating and cooking.

High levels of SO_2 may also be seen in other developing countries, especially in those with cold winters, as illustrated by the report from Nepal (Sharma 1997). Daily mean concentration of SO_2 was in the range 273 - 350 $\mu g/m^3$ in residential areas of Kathmandu during September - December 1993. In monitoring sites close to main roads, the reported range is 310-875 $\mu g/m^3$, reflecting the influence of emissions from traffic. More than half of the vehicles registered in the city are equipped with two-stroke engines and many are old and ill maintained.

In most of the cities with data allowing trend assessment a decline in mean annual SO_2 concentration was seen over the 1990s. The most dramatic reduction of air pollution with SO_2 was reported from Mexico City, where the concentration in various residential areas dropped from 100-140 $\mu g/m^3$ in 1990-1991 to 32-37 $\mu g/m^3$ in 1995-1996. In the most polluted Chinese cities an annual means declined between 1% and 10%.

Suspended particulate matter

The most commonly monitored and reported indicator of this type of air pollution is the mass concentration of TSP. In most of the cities, the TSP annual mean concentration exceeds 100 $\mu g/m^3$, with the levels exceeding 300 $\mu g/m^3$ in several cities of China and India. There is no evidence of any overall systematic and significant change in TSP levels: the data from the 1990s show increasing as well as decreasing trends in a similar number of cities. The most visible relative decrease of TSP concentrations is shown by the data from Bangkok, but the progress is not steady there either. More consistent, though with a smaller relative rate, is the decrease in TSP concentration in Mexico City. The opposite tendency can be seen in some Chinese cities, with the most rapid increase of TSP concentration in Guangzhou (from less than 150 $\mu g/m^3$ in 1990-1992 to more than 300 $\mu g/m^3$ in more recent years).

In a limited number of cities reporting data to AMIS levels of PM_{10} are also measured. The most commonly registered annual average PM_{10} levels ranged from 50 - 100 $\mu g/m^3$ in the years 1995-1996. The highest concentrations, exceeding 250 $\mu g/m^3$, were observed in Calcutta and New Delhi. In most towns with high PM_{10} average in the last year, an increase in the pollutant concentration was seen over the 1990s. In most cases, this increase has occurred even when the decrease in TSP was reported. An opposite trend and a decrease in PM_{10} level were seen in the Central and Southern America cities. In Mexico City, the relative decrease in PM_{10} was faster than that of TSP.

This limited information on the size-specific particulate pollution allows a comparison of the mass concentration of TSP and PM_{10}. For most sites and years with data on both indicators, the PM_{10} to TSP ratio was in the range between 0.4-0.8. However, in a few cases, the ratio exceeded 1.0. This fact indicates that the measurements reported to AMIS might not have been done at the same locations and/or periods. In a southeastern part of Mexico City, the ratio remained between 0.25 and 0.32 in all years 1991-1996, while in the southwestern part of the city it was consistently between 0.44 and 0.55. More specific studies of the size distribution of airborne particles, conducted in the northern cities of China in the mid-1980s, indicate that some 70% of the mass concentration of TSP are due to the PM_{10} (Ning et al 1996). During the heating season, particles with diameter less than 2 μm were found to make some 30-50% of TSP. The elemental analysis of the particles confirmed that human activities are the main source of the fine fraction of particulate matter. Similar results were reported from Jakarta, where particles with diameter less than 7.2 μm contributed more than 80% of TSP (Zou et al 1997). Traffic-related compounds contributed significantly to the overall pollution mass, and especially to the fine particle fraction.

Nitrogen dioxide

In most of the cities reporting to AMIS the annual mean concentrations of NO_2 remain moderate or low, not exceeding 40 $\mu g/m^3$. However, in Mexico City and in Cape Town, the annual average of 70 $\mu g/m^3$ has been exceeded regularly in the 1990s. A paper based on data from centrally located monitors in Sao Paulo indicates annual mean of 240 $\mu g/m^3$ in 1990/91 (Saldiva et al. 1995). The trends vary between the cities, but a 5-10% annual increase in concentration of this pollutant was more common than a decrease.

The observed pattern is consistent with the volume of car traffic in each city. The highest pollution levels, and the increasing trends, are observed in the cities with high and increasing car traffic. In Southern Asia or in Latin America, this high NO_2 concentration combined with the intense UV radiation results in photochemical smog with high oxidant concentrations. It is illustrated by the analysis of temporal and spatial patterns of tropospheric O_3 in New Delhi (Singh et al 1997). The build-up of O_3 over the day is faster than scavenging of O_3 by the NO_2. In Mexico City, the mixture of high NO_2 emissions from gasoline combustion and intense UV radiation is the cause of the notorious photochemical smog in that city. According to the data reported to AMIS, the O_3 concentration exceeded a concentration of 120 $\mu g/m^3$ in over 300 days a year in 1994-96, and the 95th percentile of maximum daily 1-hour average O_3 concentration was around 500 $\mu g/m^3$. Some decrease was seen, however, in the annual mean O_3 concentration, indicating slow improvement of air quality in non-extreme days.

2.2.2 Factors affecting susceptibility to indoor air pollution

Indoor air pollutants usually differ in type and concentration from outdoor air pollutants. Indoor pollutants include environmental tobacco smoke, biological particles (such as pollen, mites, moulds, insects, microorganisms, pet allergens etc.), non-biological particles (such as smoke), VOC, NO_x, lead, radon, CO, asbestos, various synthetic chemicals and others. Degradation of indoor air quality has been associated with a range of health effects, including discomfort, irritation, chronic pathologies and various cancers.

With growing public concern about indoor air quality, action has been taken in many developed countries to characterize levels of indoor air pollutants, to improve ventilation and fuel emissions, and to reduce exposure to environmental tobacco smoke, biological contamination and radon among other actions. Even though there is considerable evidence that indoor air quality is a serious and widespread problem in many developing countries, the information and resources to control indoor air quality are often lacking (Ferrari et al. 1995). Management of indoor quality is discussed in section 6.2.

Perhaps the most important factor that causes qualitatively and quantitatively different exposures to air pollutants across different countries is that of indoor heating and cooking by solid fuel burning. This topic deserves special attention. The emissions, concentrations, exposures and health effects are discussed in detail in Chapter 4. On a global scale, biomass fuels (wood, crop residues, dung and grass) are used daily in about half the world's households as energy for cooking and/or heating. In China, for example, it has been estimated that coal burning results in particle concentrations up to 5000 $\mu g/m^3$ in indoor living areas, whereas smoky houses in Nepal and Papua New Guinea have peak levels of 10 000 $\mu g/m^3$ or more (Smith 1996). An unknown, but significant, proportion of this activity takes place in conditions where much of the airborne effluent is released into the living area. Therefore, some of the highest concentrations of particulate matter other pollutants occur in rural, indoor environments in developing countries.

Biomass smoke contains significant amounts of several important pollutants: CO, particles, HC and to a lesser extent, NO_x. However, biomass smoke also contains many organic compounds, including PAH, that are thought to be toxic, carcinogenic, mutagenic or otherwise of concern. Coal smoke contains all of these as well as additional pollutants, e.g. sulphur oxides and heavy metals such as lead. In many parts of the world these pollutants are released from stoves in poorly ventilated homes or in enclosed courtyards. Due to the high concentrations and the large populations involved, the total human exposure to many important air pollutants can be much higher in the homes of the poor in developing countries than in the outdoor air of cities in the developed world.

2.2.3 Meteorological factors

At increased altitude the partial pressure of oxygen falls and inhalation increases in compensation. For gaseous pollutants no increase in effects over those experienced at sea level would be expected as a result of the increased inhalation, as the partial pressures of the pollutant gases will fall in line with that of oxygen. For particles, on the other hand, increased inhalation volumes will lead to increased intake of airborne particles and perhaps changes in patterns of deposition. Differences in effects between those who have always lived at high altitude and those who have recently relocated there might be expected.

Temperature has a very significant effect on health and has been shown to be an important confounding factor when examining the effects of air pollutants. The relationship between ambient temperature and ill health is "U"- or "V"-shaped with excess daily deaths increasing in both cold and hot conditions. Local populations tend to be acclimatised to local conditions and cope better with changes in temperature than do immigrants from other countries. The effect of low temperatures in winter is more marked in countries with temperate climates, than in much colder countries. Inhaled volumes increase under hot conditions, and thus the intake of pollutants also increases. In addition, warm days encourage people to spend more time out-of-doors and so personal exposure patterns to pollutants may change. Of course, living in well-ventilated houses in warm weather, when doors and windows may be open, may decrease exposure to pollutants from indoor sources and increase exposure to outdoor sources.

Humidity is unlikely to have a significant effect on the toxicity of gaseous pollutants, and it may reduce the effects of some particles by permitting hygroscopic growth in particle size prior to inhalation, thus changing the patterns of deposition from smaller to larger airways in the lung.

2.2.4 Demographic factors

The age structure of populations differs markedly from country to country. Old people tend to show increased susceptibility to air pollution as a result of reduced functioning of physiological defence mechanisms, reduced physiological reserves and the increased prevalence of disease. Very young children may also be at increased risk due to incompletely developed defence mechanisms, higher ventilation rates per unit body mass and a tendency to spend more hours out of doors than adults.

2.2.5 Socio-economic factors

People with a poor standard of living suffer from nutritional deficiencies, from infectious diseases due to poor sanitation and overcrowding, and tend to be provided with a poor standard of medical care. Each of these factors may render individuals more susceptible to the effects of air pollution. A dietary lack of anti-oxidant factors may decrease defence mechanisms against oxidant pollutants such as O_3 and NO_2. Delayed clearance of particles in airways already damaged by infection is likely. In developing countries, poor air quality may be closely associated with the incidence of infectious diseases.

2.2.6 Effects of differing levels of disease in the population

Diseases which produce narrowing of the airways, a reduction in the area of the gas-exchange surface of the lung and an increased alteration of inhalation-perfusion ratios are likely to make the subject more susceptible to the effects of a range of air pollutants. Epidemiological studies have shown that patients suffering from asthma or chronic obstructive pulmonary disease suffer an increase in symptoms when levels of pollutants are raised (see Chapter 3). It should be noted that asthma is less common in developing than in developed countries. However, the prevalence of infectious disease in developing countries, including tuberculosis, may militate against the development of the IgE antibody response, which is characteristic of asthma.

2.2.7 Specific differences in prevalence levels of air pollutants

Concentrations of air pollutants vary greatly from country to country. In countries where indoor air pollution is common, due to cooking over open fires with poor ventilation, indoor exposure may be an important cause of damage to health especially among women. In other countries, including those of the Middle East, particle concentrations in outdoor air are high due to wind-blown dust. In desert areas this dust contains a high proportion of silica, and silicotic nodules have been described in the lungs of residents. However, high concentrations of volcanic ash do not seem to be associated with acute effects on health. Specific examples of the levels of ambient urban air quality, and indoor air quality in various countries around the world are provided by the AMIS (WHO 1997b; WHO 1998b).

Countries burning brown coal (or lignite) for domestic heating are likely to experience high concentrations of smoke and SO_2. To these may be added the pollutants produced by motor vehicles. Leaded motor vehicle fuel is in use in many parts of the world and in these areas airborne lead particles make an important contribution to total lead intake both by inhalation and by ingestion.

2.3 Exposure to air pollutants

An ideal characterization of the distribution of human exposures would be based on direct measurements of each pollutant concentration in the breathing zone of each member of a representative cross section of the population of interest. At present, however, such a programme is technically impossible and probably impractical as well. Instead, ambient air quality measurements at central, fixed, air monitoring sites are widely used surrogates for population exposures, and are generally the only widely available quantitative resource that can be related to exposures. Personal monitors for exposure estimates could overcome some of the shortcomings of ambient air monitors, but they can be applied only in a small sample of the population.

There are many factors that can account for the substantial differences between the concentrations of pollutants measured at central sites and those in the breathing zone of residents of the community. Air pollutants emitted into outdoor air can be attenuated during infiltration into indoor air. This attenuation can be expected to be minimal for all pollutants of outdoor origin when barriers such as windows and doors are open or absent. In contrast, attenuation can be very large for tightly sealed buildings during times of maximal heating or cooling needs.

The attenuation of indoor air pollutant concentrations by removal to indoor surfaces is highly dependent on the physico-chemical characteristics of the pollutant. At one extreme is a chemically stable fine particle component such as sulphate ion, where indoor concentrations are typically 90% or more of outdoor concentrations. At the other extreme, indoor concentrations can be low for larger particles deposited by sedimentation in the relatively still air.

For a relatively non-reactive gas, such as CO, the indoor-outdoor concentration ratio is usually near unity in a home without indoor CO sources. However, indoor concentrations can be much higher than outdoor concentrations when there are sources such as burning cigarettes and open flames used for cooking or space heating. By contrast, chemically reactive gases, such as O_3 and SO_2 fairly rapidly diffuse to, and react with, interior surfaces. As a result, indoor-outdoor concentration ratios are typically much lower than unity.

Lead is the only classic air pollutant that can gain access to humans through indirect transport routes. Where leaded motor vehicle fuels are used, fine particle emission from vehicle exhausts can be inhaled. In addition, the particles that deposit on terrestrial surfaces can be ingested, either directly from soil in play yards, or after being carried indoors as a component of house dust. Furthermore, particulate lead deposited on plants or agricultural fields can be retained in food products and add to body burdens. Similar pathway considerations also apply to toxic air pollutants other than lead.

Humans engage in a variety of daily activities, and the concentrations of air contaminants in their breathing zone can vary substantially as they move through various microenvironments, each of which may be affected by different attenuation factors or increments from indoor sources. Furthermore, even a complete knowledge of the concentrations of all relevant pollutants in each microenvironment would not provide an adequate basis for predicting physiological and pathological responses to their exposures. Pollutant uptake could also be greatly affected by ventilation rate and pattern, entry of air via the nose or mouth, airway sizes (which exhibit great individual variability), past and current history of exposure to other toxicants (such as cigarette smoke), and prior disease histories and genetic predispositions. Many of these factors can be modelled and such models have been used for estimating dose distributions associated with ambient air concentrations.

Sulphur dioxide

SO_2 is a colourless pungent, irritating, water-soluble and reactive gas. Concentrations in ambient air in cities of developed countries have mostly decreased in the last two or three decades due to tighter emissions control, increased use of low sulphur fuels and industrial restructuring. Consequently, high ambient concentrations in earlier decades have been replaced by annual mean concentrations of about 20-40 $\mu g/m^3$ in most cities in developed countries and daily means rarely exceed 125 $\mu g/m^3$.

However the situation is more complex in developing countries. In cities, the annual mean concentrations of SO_2 in ambient air may range from very low levels up to 300 $\mu g/m^3$ (WHO 1998b). Peak concentrations measured as ten-minute averages may exceed 2000 $\mu g/m^3$ under conditions of poor atmospheric dispersion such as inversions (Section 2.2.2), or when emissions from a major source are brought to ground levels by certain atmospheric conditions. SO_2 can also reach high concentrations in air in some indoor environments through the use of sulphur containing fuels such as coal for heating and cooking (Section 4.2).

As it is highly reactive, SO_2 has a highly non-uniform dose distribution along the conductive airways of the respiratory tract. For low to moderate tidal volumes and nasal breathing, the penetration into the lungs is negligible. For larger tidal volumes and oral inhalation, doses of interest may extend into segmental bronchi. SO_2 can only reach the gas-exchange region of the lungs after sorption onto fine particles; and the available particle surface is limited except when very large mass concentrations of fine particles are present (WHO 1987; WHO 1994a).

Another special consideration for SO_2 is that there is a great variation in susceptibility to a bronchoconstrictive response. Persons having asthma or atopy can be about 10 times more responsive than healthy subjects.

Nitrogen dioxide

Ambient concentrations of NO_2 in air are variable. Natural background concentrations in ambient air can be less than 1 $\mu g/m^3$ to more than 9 $\mu g/m^3$. In ambient air in cities annual mean concentrations can range from 20-90 $\mu g/m^3$, with hourly maximum concentrations from 75-1000 $\mu g/m^3$ (WHO 1994a). Concentrations of NO_2 in indoor air can reach average concentrations of 200 $\mu g/m^3$ over several days, with hourly maximum concentrations of 2000 $\mu g/m^3$ where there are unvented gas heating appliances and poor ventilation (WHO 1994a).

NO_2 is a relatively water-insoluble gas and appreciable amounts of inhaled NO_2 can penetrate to, and elicit biological responses in, small lung airways. As with SO_2, there is much greater susceptibility to a bronchoconstrictive response in individuals with asthma.

Carbon monoxide

Natural ambient concentrations of CO range between 0.01-0.23 mg/m^3 (WHO 1994a). In urban environments, mean concentrations over eight hours are usually less than 20 mg/m^3, and one-hour peak levels are usually less than 60 mg/m^3. Highest concentrations are usually measured near major roads, as vehicles are the major source of CO. Concentrations of CO can be high in vehicles, underground carparks, road tunnels and in other indoor environments where combustion engines operate with inadequate ventilation. In these circumstances, mean concentrations of CO can reach up to 115 mg/m^3 for several hours. In houses with unflued combustion heaters, peak CO concentrations can reach up to 60 mg/m^3 (WHO 1994a).

CO exerts its toxic effects after binding with hemoglobin in the capillaries of the lungs. It is not removed in larger airways.

Ozone

Background concentrations of O_3 in remote and relatively unpolluted parts of the world are often in the range of 40 to 70 μg/m^3 as a one-hour average. In cities and areas downwind of cities, maximum mean hourly concentrations can be as high as 300 to 400 μg/m^3. High O_3 concentrations can persist for 8 to 12 hours per day for several days, when atmospheric conditions favour O_3 formation and poor dispersion conditions exist (Section 2.2.2). O_3 is normally at higher concentrations in ambient air outdoors than in indoor air.

O_3 is a relatively water-insoluble gas. It reacts and produces toxic effects on small airway surfaces. The dose-delivery is greatest in terminal and respiratory bronchioles. Unlike NO_2 and SO_2, there is very little difference in lung function responsiveness between asthmatics and healthy subjects. There is, however, a great variability in individual responsiveness that is not yet understood.

Particulate matter (PM)

Concentrations of particulate matter in air are highly variable. In some areas very high levels occur naturally due to wind-blown dust from arid soils. Human activities, such as fires, overgrazing, agricultural practices and mining, can increase particle concentrations in air in remote areas. In Western Europe and North America efforts to control emissions of particulate matter have generally resulted in lower levels of particles in ambient air. In many cities the annual average concentrations of PM_{10} are in the range 20 to 50 μg/m^3 for ambient air (WHO 19994a). However, annual average concentrations in some cities in Eastern Europe and in some developing countries can be above 100 μg/m^3. Concentrations of $PM_{2.5}$ are usually about 45 to 65% of the concentrations of PM_{10}.

Concentrations of particulate matter in indoor air can be extremely high when biomass fuels such as wood, crop residues and dung, or coal are used for cooking or heating. Indoor concentrations of up to 2000 to 5000 μg/m^3 of total suspended particulate matter have been measured in some circumstances during cooking with biomass fuels in developing countries (Section 4.2).

Particle size is a critical factor in internal dose distribution. The location of initial deposition in the airways depends on particles size, with coarse particles being deposited in the upper respiratory tract and fine particles being transported to the lower respiratory tract. The rate of deposition in conductive airways also depends on particle size (see Section 2.1).

Lead

Levels of lead found in air, food, water and soil/dust vary widely throughout the world and depend on the degree of industrial development, urbanization and lifestyle factors. Ambient air levels over 10 μg/m^3 have been reported in urban areas near smelters, whereas lead levels below 0.1 μg/m^3 have been found in cities where leaded petrol is no longer used. In cities of developing countries traffic-related lead levels range between 0.3 and 1 μg/m^3 with extreme annual mean values between 1.5-2 μg/m^3.

Lead is inhaled as fine particles and deposited in the lungs. Since lead uptake by blood is dependent on deposition pattern and solubility (which is influenced by chemical form and particle size), total lead content is only a surrogate for the biologically effective dose. Furthermore, as noted in earlier sections, airborne lead can also reach humans indirectly via deposition on soil and vegetation, and through food chains.

Other air pollutants

In nearly all countries routine air quality monitoring programmes are concentrated almost exclusively on selected classic pollutants. Relatively few of the other air pollutants (considered in detail in Section 3.2) are routinely monitored, except in a few occupational environments. Data are sometimes collected on personal exposures to classic and other air pollutants, but seldom are there standardised protocols for sample collection and analysis, and data processing and storage. As a result, estimates for personal exposures are generally based on highly uncertain models and the assumptions built into them. In general, the situation with respect to ambient concentrations of other air pollutants considered in section 3.2 is characterized as described in the second columns ofTables 3.2 and 3.3 in that section.

2.4 Role of guidelines and standards

The purpose of these guidelines is to provide a basis for protecting public health from the adverse effects of air pollution and for eliminating, or reducing to a minimum, those air contaminants that are known to be, or are likely to be, hazardous to human health and well being (WHO 1987).

These *Guidelines* should provide background information for nations engaged in setting air quality standards, although their use is not restricted to this. The *Guidelines* are not intended to be standards. In moving from guidelines to standards, prevailing exposure levels and environmental, social, economic and cultural conditions in a nation or region should be taken into account (see Section 2.4.4). In certain circumstances there may be valid reasons to pursue policies, which will result in pollutant concentrations above or below the guideline values (WHO 1987).

2.4.1 The 1987 WHO *Air Quality Guidelines for Europe*

Already in 1958, WHO recognized that air pollution was a threat to the health and well-being of peoples throughout the world. As a consequence, WHO has taken its first steps to marshal the facts and to suggest procedures by which preventive and remedial action may be taken by its member countries, before serious harm is done to the health of their people (WHO 1958). In a forthcoming Technical Report, criteria for guidelines for air quality are described as tests, which permit the nature and magnitude of air pollution on man and the environment to be determined. Guidelines were defined as sets of concentrations and exposure times that are associated with specific effects of varying degrees of air pollution on man, animals, vegetation and on the environment in general (WHO 1964). In 1972, guidance as to the levels of ambient air pollutants that constitute hazards to health were first formulated for the "classic" compounds SO_2, SPM, CO and photochemical oxidants (WHO 1972). These attempts culminated in 1987 in the publication of the *Air Quality Guidelines for Europe* for a much extended set of air pollutants (WHO 1987).

In the *Air Quality Guidelines for Europe* (WHO 1987), relevant information on the pollutants was carefully considered during the process of establishing guideline values. It was noted that ideally, guideline values should represent concentrations of chemical compounds in air that would not pose any hazard to the human population. However, the realistic assessment of human health hazards necessitated a distinction between absolute safety and acceptable risk. To aim at achieving absolute safety, one would need to know the complete dose-response relationships in individuals in relation to all sources of exposure. Moreover, the type of toxic effect elicited by specific pollutants or their mixtures; the existence (or not) of "thresholds" for specified toxic effects; the significance of interactions; and the variation in sensitivity and exposure levels within the human population would all have to be known. However, such comprehensive and conclusive data on environmental contaminants are not always available. Scientific judgement and consensus, therefore, play an important role in establishing acceptable levels of population exposure.

Criteria for endpoints other than carcinogenicity

For compounds reportedly without carcinogenic effects, or for which data on carcinogenicity were lacking or insufficient, the starting-point for the derivation of guideline values was to define the lowest concentration at which effects are observed in humans, animals and plants. The difference between the lowest level at which an effect is observed. and the level, at which no effect is observed, is among the factors included in judgements concerning the appropriate margin of protection. In the case of irritant and sensory effects on human, it was considered desirable where possible to determine the no-effect level.

Criteria for selection of a lowest-observed adverse-effect level (LOAEL)

The distinction between adverse and non-adverse effects was stated to pose considerable difficulty. The definition of an adverse effect was given as "any effect resulting in functional impairment and/or pathological lesions that may affect the performance of the whole organism, or which contributes to a reduced ability to respond to an additional challenge". Even with such a definition, a significant degree of subjectivity and uncertainty was found to be present. To resolve this difficulty, data were ranked in three categories: (i) Single observations, even of potential health concern, were not readily used as a basis for guideline values; (ii) A lowest-observed-effect level might result in pathological change, and therefore was considered a higher degree of health concern; (iii) A substantial change in the direction of pathological effects has had a major influence on guideline considerations.

Criteria for selection of uncertainty factors

The toxicology of pollutants, including the type of metabolites formed, variability in metabolism, or response in humans suggesting hypersusceptible groups, and the likelihood that the compound or its metabolites will accumulate in the body, was taken into account by uncertainty factors. Uncertainty factors were essentially determined through scientific judgement in consensus.

Criteria for selection of averaging times

As a chemical may cause acute, minor, reversible effects after brief exposure, and irreversible or incapacitating effects after prolonged exposure, expert judgement had to be applied, based on the weight of the evidence available. Generally, when short-term exposures lead to adverse effects, short-term averaging times were recommended. In other cases, exposure-response knowledge was sufficient to recommend a long-term average.

Criteria for consideration of sensory effects

Some of the substances selected for evaluation have malodorous properties at concentrations far below those at which toxic effects occur. Although odour annoyance cannot be regarded as an adverse health effect in a strict sense, it affects the quality of life. Therefore, odour threshold levels (detection threshold, recognition threshold, and nuisance threshold) for such chemicals have been indicated where relevant and used as a basis for separate guideline values.

Criteria for Carcinogenic Endpoint

Cancer risk assessment involves a qualitative assessment of how likely it is that an agent is a human carcinogen, and a quantitative assessment of the cancer rate the agent is likely to cause at given level and duration of exposure.

Quantitative assessment of carcinogenicity

The decision to consider a substance as a carcinogen is based on the classification criteria of the International Agency for Research on Cancer:

Group 1 – Proven human carcinogens.
Group 2 – Probable human carcinogens. This category is divided into two subgroups according to higher (Group 2A) and lower (Group 2B) degrees of evidence.
Group 3 – Unclassified chemicals

It was decided that for all chemicals not categorized in Groups 1 and 2A guidelines values based on non-carcinogenic health endpoints were to be given.

Quantitative assessment of carcinogenic potency

Quantitative risk assessment was found to include the extrapolation of risk from relatively high dose levels to relatively low dose levels. High dose levels are characteristic of animal experiments or occupational exposures, where cancer responses can be measured. Low dose levels are of concern in environmental protection, where such risks are too small to be measured directly, either in animal or epidemiological studies.

In the 1987 guidelines, the risk associated with lifetime exposure to a certain concentration of a carcinogen in the air has generally been estimated by linear extrapolation. The carcinogenic potency has been expressed as the incremental unit risk estimate. The incremental unit risk estimate of an air pollutant was defined as "the additional lifetime cancer risk occurring in a hypothetical population in which all individuals are exposed continuously from birth throughout their lifetimes to a concentration of 1 $\mu g/m^3$ of the agent in the air they breathe".

Necessary assumptions for the average relative risk method were: (i) the response (measured as relative risk) is some function of cumulative dose or exposure; (ii) there is no threshold dose for carcinogens; (iii) the linear extrapolation of the dose-response curve towards zero gives an upper-bound conservative estimate of the true risk function, if the unknown (true) dose-response curve has a sigmoidal shape; (iv) there is constancy of the relative risk in the specific study situation.

Advantages and limitations of the method used in the 1987 guidelines were extensively discussed.

2.4.2 The development of the guideline setting process

During the development of the 1987 WHO *Guidelines*, emphasis was placed on specifying the guidelines in terms of a concentration and averaging time, which would define an exposure unlikely to produce adverse effects, even in the majority of those members of groups with increased sensitivity to the pollutant in question. Small changes, or so called physiological changes, for example in indices of lung function, were agreed to fall outside the definition of "adverse effects".

For many of the classic air pollutants the guidelines were based on controlled exposure studies, or on epidemiological studies which demonstrated a threshold of effect. Uncertainty factors, or protection factors, were applied to the published data to allow for more sensitive individuals who might not have been adequately represented in the studies. The guidelines were statements of levels of exposure at which, or below which, no adverse effects can be expected. This does not imply that as soon as a guideline is exceeded adverse effects occur, but rather that the likelihood of such effects occurring would be increased. The guidelines have sometimes been misinterpreted as Lowest-Observed-Adverse-Effect Levels (LOAEL), which they are not.

Genotoxic carcinogens were treated differently: a Unit Risk was estimated from calculating the additional risk from a lifetime exposure to a unit concentration of the carcinogen. For a few pollutants, including O_3, the guideline was specified as a range of concentrations.

During the period between the publication of the 1987 *Guidelines* and their revision, a number of meetings were held to consider how the guidelines might be updated (WHO 1992a; WHO 1994a; WHO 1995a; WHO 1995b; WHO 1995c; WHO 1996a). A number of important decisions were made and these are detailed in the reports of the meetings. Among these, the desirability of providing guidance on the exposure-response relationship for as many pollutants as possible was stressed. This has been an important feature of the revised guidelines.

In the updated version of the *Air Quality Guidelines for Europe*, a similar approach was applied as in the 1987 air quality guidelines. However, total tolerable intakes were calculated for multimedia pollutants first, and then adequately partitioned among the different exposure routes. The term "protection" factor used in the 1987 guidelines was abandoned. Instead, uncertainty factors to account for the extrapolation from animal to man (alternatively, human equivalent concentrations were calculated), and to account for individual variability. Wherever information on inter- and intraspecies differences in pharmacokinetics was available, data-derived uncertainty factors were employed. Additional uncertainty factors were applied whenever necessary to account for the nature and severity of the observed effects and for the adequacy of the database. For most of the compounds considered, information on the dose/exposure-response relationship was provided, both to give policy makers clear guidelines on the possible impact of the pollutant at different exposure levels, and to permit an informed decision making process to take place. For some compounds, e.g. platinum, a guideline value was considered unnecessary as exposure through ambient air levels was considerably below the lowest level at which effects were seen. For other compounds, for example PM_{10}, no threshold of effect could be found and therefore no guideline value could be derived. Instead, exposure-effect information highlighting the public health impact of different pollutant levels was provided.

In the updating process for carcinogens, a more flexible approach than in the 1987 *Air Quality Guidelines* was applied. Although, as a default approach, low-dose risk extrapolation was conducted for groups 1 and 2A, and an uncertainty factor approach applied in the case of agents in groups 2B and 3, the mechanism of action was the determining factor for the method of assessment. Hence, it was decided that compounds classified under 1 or 2A could be assessed using uncertainty factors, if evidence for a non-threshold mechanism of carcinogenicity existed. By way of contrast, compounds classified under 2B could be assessed by low-dose extrapolation methods, if a non-threshold mechanism of carcinogenicity in animals was proven. Flexibility was also given in terms of the choice of the extrapolation model, depending on the available data (including data for PBPK modelling). The linearized multistage model was used as a default approach. Besides providing unit-risk estimates in cases where low-dose risk extrapolation was conducted, levels associated with excess cancer risk of 1:10 000, 1:100 000 and 1:1 000 000 were calculated.

In evaluating ecotoxic effects of major air pollutants, the effects of O_3, nitrogen-containing compounds and SO_2 on vegetation (crops, forests) were evaluated. Besides the deposition effects of nitrogen compounds, those of sulphates and total acidity were also evaluated. The principles applied were those developed by the Working Group on Effects under the Convention on Transboundary Air Pollution of the UNECE, and the evaluations were carried out jointly with that group. Critical levels and critical loads were derived. Critical levels are concentrations of pollutants in the atmosphere above which direct adverse effects on receptors such as plants, ecosystems or materials may occur. Critical loads represent quantitative estimates of an exposure, in the form of deposition, to one or more pollutants, below which significant harmful effects on specified sensitive elements of the environment will not occur.

2.4.3 Exposure-response relationships

These guidelines place some emphasis on epidemiological data. Epidemiological studies are sometimes preferable to controlled exposure studies in that they provide information on responses in populations and on the effects of real exposures to pollutants and pollutant mixtures. However, the results of epidemiological studies are less easy to use than the results of controlled exposure studies in defining guidelines.

Most epidemiological studies relate responses to concentrations of pollutants, often measured at single fixed site monitors. These data tell us little about the exposure-response relationships of individuals but, rather, tell us about the concentration-response relationship of the population studied. This relationship depends upon the pattern of exposure of the population considered and thus the relationship may vary from country-to-country. When the results of time-series studies on the effects of particles in the USA and Europe were compared, only small differences were seen (Wilson and Spengler 1996). But whether the differences were, in fact, due to differences in exposure patterns, or to differences in the toxicity of the ambient particle aerosol, or differences in the particle indices that were measured, remains unknown. Differences in response to air pollution may occur between developed and developing countries.

For both particles and O_3 an assumption of linearity was made when defining the exposure-response relationships included in the revised guidelines. Extrapolation beyond the available data is unwise, since there is evidence to suggest the exposure-response relationship may become less steep as ambient levels of particles rise (Schwartz and Marcus 1990; Lippmann and Ito 1995). For O_3, the relationship at low concentrations may be concave upwards. These are important points to be considered if the guidelines are to be used in countries with levels of pollution different from the range covered by the guidelines.

2.4.4 Moving from guidelines to standards

An air quality standard is a description of a level of air quality that is adopted by a regulatory authority as enforceable. At its simplest, an air quality standard should be defined in terms of one or more concentrations and averaging times. In addition, other data should be added, including information on the form of exposure (e.g. outdoor), on monitoring which is relevant in assessing compliance with the standard, and on methods of data analysis, quality assurance and quality control.

In some countries the standard is further qualified by defining an acceptable level of attainment or compliance. Levels of attainment may be defined in terms of the fundamental units that define the standard. For example, if the unit defined by the standard is the day, then a requirement for 99% compliance allows the standard to be exceeded by three days a year. The cost of meeting any standard is likely to depend on the degree of compliance required. Consequently, it may be sensible to consider carefully the costs and benefits of different levels of compliance when deciding on the standard.

It is important to remember that the development of air quality standards is only a part of an adequate air quality management strategy (see Chapter 6). Legislation, identification of authorities responsible for enforcement of emission standards and penalties for exceedances are all also necessary. Emission standards may play an important role in the management strategy, especially if exceedance of air quality standards is used as a trigger for abatement measures. These may be needed at both the national and the local level.

Air quality standards are also important in informing the public about air quality. Used in this way they are a double-edged weapon as the public commonly assumes that once a standard is exceeded adverse effects on health will occur. This may not be the case, as discussed in Section 2.4.2.

2.4.5 Factors to be considered in setting an air quality standard

The process of setting standards is simplified when the WHO *Guidelines* provide a guideline value. In general, local review of the health effects database may be unnecessary. However, when published studies on associations between air pollutants and health effects in the local region are available, it is prudent for the authorities responsible for setting national standards to give them due consideration in their evaluation of the applicability of the WHO *Guidelines for Air Quality*. If no single value is offered but rather a Unit Risk estimate, or a concentration-response relationship is defined, then the following should be considered in setting standards:

a. The nature of the effects indicated should be examined and decisions made as to whether they represent adverse health effects.
b. Special populations at risk should be considered.

Sensitive populations or groups are defined here as those impaired by concurrent disease or other physiological limitations and those with specific characteristics that make the health consequences of exposure more significant (e.g. developmental phase in children). In addition, other groups may be judged to be at special risk because of their exposure patterns and because the effective dose for a given exposure may be increased, as in the case of children for example. The sensitive populations may vary between countries due to differences in the number of people with inadequate access to medical care, in the prevalence of certain endemic diseases, in the prevailing genetic factors, or in the prevalence of debilitating diseases or nutritional deficiencies. The regulator needs to decide which specific groups at risk should be protected by the standards.

These factors have been considered in the development of these guidelines and have been included when a guideline value has been offered.

The WHO Guideline for SPM was developed to address the health effects associated with exposures to particulate matter released into the ambient outdoor environment, as well as the secondary ambient particulate matter found in the atmosphere from gaseous precursors (e.g. sulphate, nitrate, and the organic products of photochemical reaction sequences). The exposures take place in the outdoor air and in indoor microenvironments following infiltration of the particles into occupied indoor spaces. The numerical effects relationships described in the *Guideline* were based on size-selective mass concentration data that were obtained from numerous, and generally consistent, study results for urban population in North and South America and Europe. However, the transfer of these relationships to other parts of the world should be conducted with caution for several reasons. These include:

1. The chemical composition of the particles may be substantially different in the nation developing the air quality standard, when compared with the regions in which the community studies were conducted and which contributed to the development of the guideline.
Mass concentration in selected particle size ranges (i.e. PM_{10} and/or $PM_{2.5}$) is, at best, a surrogate index for the biologically active components in the mixture. The mixture in the communities studied in the development of the guideline was dominated by primary and secondary effluents from motor vehicles, central station power generation, and space heating by natural gas and light oil combustion. The mixtures in communities in less developed countries may be different. They may be dominated by the effluents of inefficient combustion units and wind-blown soil, with quite different toxic properties from those in the studies used by WHO.

2. The particle concentration range may be substantially different.
The WHO response-concentration relationships for particulate matter are based on a linear model of response, which is a suitable approximation within the range of particle concentrations typically found in the studies used by WHO. However, it is well established that the coefficient tends to decrease toward the upper end of the concentration range. In addition, the slope

established for the lower concentrations cannot reliably be used to predict responses at the higher mass concentration levels that may be observed in urban areas in less developed countries.

3. The responsiveness of the population may be substantially different.
The WHO response-concentration relationships were based on responses of populations that were mostly well nourished and who had access to modern health services. By contrast, the populations exposed to higher concentrations of particles in less developed countries are likely to have lower quality nutrition and health care. Alternatively, they may well be a hardy survivor population with fewer people in a fragile condition of health. It is currently unclear whether the responsiveness of the populations in other parts of the world differ from those studies in North and South America and Europe.

For these reasons, the WHO response-concentration relationships should be used with caution as predictors of health impacts in less developed countries. In particular, the relationships should not be extrapolated to concentrations beyond the ranges given in Figures 3.6 to 3.8.

2.4.6 Uncertainty factors

In development of these guidelines, the size of uncertainty factors applied to published data in deriving a guideline was considered to be a matter for expert judgement, rather than prescription (WHO 1987). Where the database was strong, smaller uncertainty factors were used than where the database was weak. Database strength depends upon the availability of published studies relevant to the circumstances of a country for which the guidelines are intended. In moving from guidelines to country-specific standards, the size of the uncertainty factors may require revision.

Impact assessment or risk assessment plays an important part in setting standards. This will depend on exposure and an assessment of population exposure will be required. In considering the appropriate form of exposure assessment needed attention should be paid to the database from which the guideline was derived.

Acceptability of risk varies from country to country and is in part dependent on social conditions, priorities and on the other risks to which a population is exposed. In some countries a risk that would be unacceptable elsewhere might be considered small.

2.4.7 Cost-benefit analysis and other factors

The costs of reducing levels of air pollution should be weighed against the benefits produced. Cost-benefit analysis is one way of formally setting out this process, and it uses money as a common currency for costs and benefits.

The concept is that pollutant concentrations are reduced at least until the associated costs and benefits are balanced: more strictly, emissions are reduced until the marginal costs and benefits are equal. While the cost of abatement measures may be relatively easy to quantify, this may not be the case when non-technical measures are employed. In any case, it is likely to be more difficult to assign monetary values to the benefits obtained. Some aspects of reduced morbidity, such as a reduction in the use of hospital facilities and drugs, are comparatively easy to cost; others such as reductions in premature deaths and symptoms are not. Applying monetary values based on a "willingness to pay" basis has been suggested, and has been accepted as appropriate by many health economists. This approach has been seen as preferable to one based only on such indices as loss of production, earnings or hospital expenses. Cost-benefit analysis is discussed in detail in Section 7.9.

In practice the strict theoretical precepts of cost-benefit analysis should be supplemented by broader social and economic considerations. This process is sometimes described as "Stakeholder Input". Stakeholders are defined as those who have an interest in the outcome of a decision making process. The aim is to ensure as far as possible social equity and fairness to all involved parties. An adequate and early involvement of all concerned stakeholders will increase the transparency of the process and is likely to increase the acceptability of the outcome.

Factors other than monetary concerns also need to be evaluated when considering the setting of national air quality standards. These include the technical capacity of a country to achieve and maintain an air quality within the desired standards; the social implications of adopting certain standards to ensure an equity of costs and benefits among the population; and environmental costs and benefits.

3. Health-based Guidelines

In this chapter the key air pollutants, also termed "classic" air pollutants - SO_2, NO_2, CO, O_3, SPM and lead - are briefly described with respect to health risk evaluations and recommended guideline values. Particular emphasis is given to PM_{10} and $PM_{2.5}$. The information available for a number of other air pollutants (including inorganic compounds, organic volatile components and certain indoor air pollutants such as radon) is also summarized and presented in a synoptic table. These sections are based upon papers prepared for the updating of the *Air Quality Guidelines for Europe* (WHO 1999a) and exposure information obtained from various regions. A third section considers factors, such as altitude, humidity, temperature, nutritional status, health status, vulnerability etc., that affect the actual health impact of air pollutants on the individual and vulnerable groups.

3.1 Key air pollutants

Sulphur dioxide

Short-period exposures (less than 24 hours)

Most information on the acute effects of SO_2 comes from controlled chamber experiments on volunteers exposed to SO_2 for periods ranging from a few minutes up to one hour (WHO 1999a). Acute responses occur within the first few minutes after commencement of inhalation. Further exposure does not increase effects. Effects include reductions in the mean forced expiratory volume over one second (FEV_1), increases in specific airway resistance (sRAW), and symptoms such as wheezing or shortness of breath. These effects are enhanced by exercise that increases the volume of air inspired, as it allows SO_2 to penetrate further into the respiratory tract.

A wide range of sensitivity has been demonstrated, both among normal subjects and among those with asthma. People with asthma are the most sensitive group in the community. Continuous exposure-response relationships, without any clearly defined threshold, are evident. To develop a guideline value, the minimum concentrations associated with adverse effects in asthmatic patients exercising in chambers have been considered. An example of an exposure-response relationship for asthmatic patients is shown in Figure 3.1, expressed in terms of change in FEV_1 after a 15-minute exposure.

Exposure over a 24-hour period

Information on the effects of exposure averaged over a 24-hour period is derived mainly from epidemiological studies in which the effects of SO_2, SPM and other associated pollutants are considered. Exacerbation of symptoms among panels of selected sensitive patients seems to arise in a consistent manner when the concentration of SO_2 exceeds 250 $\mu g/m^3$ in the presence of SPM. Several more recent studies in Europe have involved mixed industrial and vehicular emissions now common in ambient air. At low levels of exposure (mean annual levels below 50 $\mu g/m^3$; daily levels usually not exceeding 125 $\mu g/m^3$) effects on mortality (total, cardiovascular and respiratory) and on hospital emergency admissions for total respiratory causes and chronic obstructive pulmonary disease (COPD), have been consistently demonstrated. These results have been shown, in some instances, to persist when black smoke and SPM levels were controlled for, while in others no attempts have been made to separate the pollutant effects. In these studies no obvious threshold levels for SO_2 has been identified.

Long-term exposure

Earlier assessments examined findings on the prevalence of respiratory symptoms, respiratory illness frequencies, or differences in lung function values in localities with contrasting concentrations of SO_2 and SPM, using data from the coal-burning era in Europe. The lowest-observed-adverse-effect level of SO_2

was judged to be at an annual average of 100 $\mu g/m^3$, when present with SPM. More recent studies related to industrial sources of SO_2, or to the changed urban mixture of air pollutants, have shown adverse effects below this level. But a major difficulty in interpretation is that long-term effects are liable to be affected not only by current conditions, but also by the qualitatively and quantitatively different pollution of earlier years. However, cohort studies on differences in mortality between areas with contrasting pollution levels indicate that mortality is more closely associated with SPM, than with SO_2.

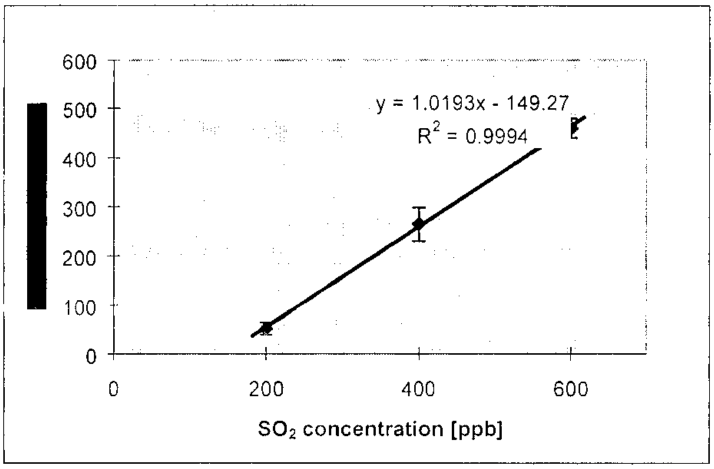


Figure 3.1 Mean change of FEV_1 in asthmatics with changing SO_2 concentrations

Guidelines

Based upon controlled studies with asthmatics exposed to SO_2 for short periods, it is recommended that a value of 500 $\mu g/m^3$ (0.175 ppm) should not be exceeded over averaging periods of 10 minutes. Because exposure to sharp peaks depends on the nature of local sources, no single factor can be applied to estimate corresponding guideline values over longer periods, such as an hour. Day-to-day changes in mortality, morbidity, or lung function related to 24-hour average concentrations of SO_2 are necessarily based on epidemiological studies, in which people are in general exposed to a mixture of pollutants; and guideline values for SO_2 have previously been linked with corresponding values for SPM. This approach led to a previous guideline 24-hour average value of 125 $\mu g/m^3$ (0.04 ppm) for SO_2, after applying an uncertainty factor of two to the lowest-observed-adverse-effect level. In more recent studies, adverse effects with significant public health importance have been observed at much lower levels of exposure. However, there is still uncertainty as to whether SO_2 is the pollutant responsible for the observed adverse effects, or whether it is a surrogate for SPM with diameters below 10 μm or 2.5μm, or even for some other correlated substance. There is no basis for numerical changes of the 1987 guideline values for SO_2 and thus 125 $\mu g/m^3$ for an averaging time of 24 hours and 50 $\mu g/m^3$ as an annual mean are recommended. However, the current guideline values are no longer linked with SPM.

Nitrogen dioxide

Short-term exposure effects

Available data from animal toxicology experiments indicate that acute exposure to NO_2 concentrations of less than 1880 $\mu g/m^3$ (1 ppm) rarely produce observable effects. Normal healthy humans, exposed at rest or with light exercise for less than two hours to concentrations above 4700 $\mu g/m^3$ (2.5 ppm), experience pronounced decreases in pulmonary function; generally, normal subjects are not affected by concentrations less than 1880 $\mu g/m^3$ (1.0 ppm). One study showed that the lung function of subjects with chronic obstructive pulmonary disease is slightly affected by a 3.75-hour exposure to 560 $\mu g/m^3$ (0.3 ppm).

A wide range of findings in asthmatics has been reported. Asthmatics are likely to be the most sensitive subjects, although uncertainties exist in the health database. The lowest concentration causing effects on pulmonary function was reported from two laboratories that exposed mild asthmatics for 30-110 minutes to 565 $\mu g/m^3$ (0.3ppm) NO_2 during intermittent exercise. However, neither of these laboratories was able to replicate these responses with a larger group of asthmatic subjects. One of these studies indicated that NO_2 can increase airway reactivity to cold air in asthmatic subjects. At lower concentrations, the pulmonary function of asthmatics was not changed significantly.

NO_2 increases bronchial reactivity, as measured by the response of normal and asthmatic subjects following exposure to pharmacological bronchoconstrictor agents, even at levels that do not affect pulmonary function directly in the absence of a bronchoconstrictor. Some, but not all, studies show increased responsiveness to bronchoconstrictors at NO_2 levels as low as 376-565 $\mu g/m^3$ (0.2 to 0.3 ppm); in other studies, higher levels had no such effect. Because the actual mechanisms of effect are not fully defined and NO_2 studies with allergen challenges showed no effects at the lowest concentration tested (188 $\mu g/m^3$; 0.1 ppm), full evaluation of the health consequences of the increased responsiveness to bronchoconstrictors is not yet possible. Recent studies have shown an increased reactivity to natural allergens in the same concentration range. The results of repetitive exposures of such individuals, or the impact of single exposures on more severe asthmatics, are not known.

Long-term exposure effects

Studies with animals have clearly shown that several weeks to months of exposure to NO_2 concentrations of less than 1880 $\mu g/m^3$ (1ppm) causes a range of effects, primarily in the lung, but also in other organs such as the spleen and liver, and in blood. Both reversible and irreversible lung effects have been observed. Structural changes range from a change in cell type in the tracheobronchial and pulmonary regions (at a lowest reported level of 640 $\mu g/m^3$), to emphysema-like effects. Biochemical changes often reflect cellular alterations, with the lowest effective NO_2 concentrations in several studies ranging from 380-750$\mu g/m^3$.

NO_2 levels of about 940 $\mu g/m^3$ (0.5ppm) also increase susceptibility to bacterial and viral infection of the lung. There are no epidemiological studies that can be confidently used to quantify a long-term NO_2 exposure or concentration likely to be associated with the induction of unacceptable health risks in children or adults. Homes with gas cooking appliances have peak levels of NO_2 in the same range as levels causing effects in some animal and human clinical studies. Epidemiological studies evaluating the effects of NO_2 exposures in such homes have been conducted. In general, epidemiological studies of adults and infants (less than 2years old) show no significant effect of the use of gas cooking appliances on respiratory illness; nor do the few available studies of infants and adults show any associations between pulmonary function changes and gas stove use. However, children 5-12 years old are estimated to have a 20% increased risk for respiratory symptoms and disease for each increase of 28 $\mu g/m^3$ NO_2 (2-week average), where the weekly average concentrations are in the range of 15-128 $\mu g/m^3$ or possibly higher. However, the observed effects cannot clearly be attributed to either the repeated short-term high level peak, or to long-term exposures in the range of the stated weekly averages (or possibly both).

The results of outdoor studies consistently indicate that children with long-term ambient NO_2 exposures exhibit increased respiratory symptoms that are of longer duration, and show a decrease in lung function. However, outdoor NO_2 epidemiological studies, as with indoor studies, provide little evidence that long-term ambient NO_2 exposures are associated with health effects in adults. None of the available studies yields confident estimates of long-term exposure-effect levels, but available results most clearly suggest respiratory effects in children at annual average NO_2 concentrations in the range of 50-75 $\mu g/m^3$ or higher.

Guidelines

Despite the large number of acute controlled exposure studies in humans, several which used multiple concentrations, there is no evidence for a clearly defined concentration-response relationship for NO_2 exposure. For acute exposures, only very high concentrations (>1,000 ppb; 1,990 $\mu g/m^3$) affect healthy people. Based on small changes in lung function, often less than a 5% drop in FEV_1 with NO_2 exposure, and changes in airway responsiveness in studies on asthmatics and patients with chronic obstructive pulmonary disease, a range of 365-565 $\mu g/m^3$ (0.20 to 0.30 ppm) is a clear lowest-observed-effect-level. A 50% margin of safety is proposed because of the reported statistically significant increase in response to a bronchoconstrictor with exposure to 188 $\mu g/m^3$, and because of a meta-analysis suggesting changes in airway responsiveness below 365 $\mu g/m^3$. However, the significance of the response at 188 $\mu g/m^3$ has been questioned on the basis of an inappropriate statistical analysis and a failure to replicate the findings. Based on these human clinical data, a one-hour guideline of 200 $\mu g/m^3$ is proposed. At double this recommended guideline (400 $\mu g/m^3$), there is evidence to suggest possible small effects in pulmonary function of asthmatics. Should the asthmatic be exposed either simultaneously or sequentially to NO_2 and an aero-allergen, the risk of an exaggerated response to the allergen is increased.

Although there is no particular study or set of studies that clearly supports selection of a specific numerical value for an annual average guideline, there is need to protect the public from chronic NO_2 exposures. Based on the studies reviewed, it is not currently possible to select a well-supported value; but a previous review on NO_2 recommended an annual value of 40 $\mu g/m^3$ (WHO 1997c). In the absence of support for an alternative value, this figure is recognized as an air quality guideline.

Carbon monoxide

CO diffuses rapidly across alveolar, capillary and placental membranes. Approximately 80-90 % of the absorbed CO binds with hemoglobin to form carboxyhemoglobin (COHb), which is a specific biomarker of exposure in blood. The affinity of hemoglobin for CO is 200-250 times that for oxygen. During exposure to a fixed concentration of CO, the COHb concentration increases rapidly at the onset of exposure, starts to level off after 3 hours, and reaches a steady-state after 6-8 hours of exposure. It is noted that the elimination half-life in the fetus is much longer than in the pregnant mother.

The binding of CO with hemoglobin to form COHb reduces the oxygen-carrying capacity of the blood and impairs the release of oxygen from hemoglobin. These are the main causes of tissue hypoxia produced by CO at low exposure levels. At higher concentrations, the rest of the absorbed CO binds with other heme proteins such as myoglobin and with cytochrome oxidase and cytochrome P-450. The toxic effects of CO first become evident in organs and tissues with high oxygen consumption, such as the brain, heart, exercising skeletal muscle and the developing fetus.

Severe hypoxia due to acute CO poisoning may cause both reversible, short-lasting, neurological deficits and severe, often delayed, neurological damage. The neurobehavioural effects include impaired coordination, tracking, driving ability, vigilance and cognitive performance at COHb levels as low as 5.1-8.2%.

In apparently healthy subjects, the maximal exercise performance decreases at COHb levels as low as 5%. The regression between the percentage decrease in maximal oxygen consumption and the percentage increase in COHb concentration appears to be linear, with a fall in oxygen consumption of approximately 1% for each 1% rise in COHb level above 4%.

In controlled studies involving patients with documented coronary artery disease, mean pre-exposure COHb levels of 2.9-5.9% (corresponding to post-exercise COHb levels of 2.0-5.2%) have been associated with a significant shortening in the time to onset of angina, with increased electrocardiographic changes and with impaired left ventricular function during exercise. In addition, ventricular arhythmias may be increased significantly at the higher range of mean post-exercise COHb levels. Epidemiological and clinical data indicate that CO from smoking and environmental or occupational exposures may contribute to cardiovascular mortality and to the early course of myocardial infarction. Current data from epidemiological studies and experimental animal studies indicate that common environmental exposures to CO in the developed world would not have atherogenic effects on humans (WHO 1999a).

During pregnancy, endogenous production of CO is increased so that maternal COHb levels are usually about 20% higher than the non-pregnant values. At steady-state, the fetal COHb levels are as much as 10-15% higher than the maternal COHb levels. There is a well-established and probably causal relationship between maternal smoking and low birth weight at fetal COHb levels of 2-10%. In addition, maternal smoking seems to be associated with a dose-dependent increase in perinatal deaths and with behavioural effects in infants and young children.

Guidelines

Endogenous production of CO results in COHb levels of 0.4-0.7% in healthy subjects. During pregnancy, elevated maternal COHb levels of 0.7-2.5% have been reported, mainly due to increased endogenous production. The COHb levels in non-smoking general populations are usually 0.5-1.5% due to endogenous production and environmental exposures. Non-smoking people in certain occupations (car drivers, policemen, traffic wardens, garage and tunnel workers, firemen etc.) can have long-term COHb levels up to 5%, and heavy cigarette smokers have COHb levels up to 10% (WHO 1999a). Well-trained subjects engaging in heavy exercise in polluted indoor environments can increase their COHb levels quickly up to 10-20%. Epidemic CO poisonings in indoor ice arenas have been reported.

To protect non-smoking, middle-aged and elderly population groups with documented or latent coronary artery disease from acute ischemic heart attacks, and to protect fetuses of non-smoking pregnant mothers from untoward hypoxic effects, a COHb level of 2.5% should not be exceeded.

The guideline values (ppm values rounded), and periods of time-weighted average exposures, have been determined in such a way that the COHb level of 2.5% is not exceeded, even when a normal subject engages in light or moderate exercise. The guideline values for CO are 100 mg/m^3 (90 ppm) for 15 minutes, 60 mg/m^3 (50 ppm) for 30 minutes, 30 mg/m^3 (25 ppm) for 1 hour, and 10 mg/m^3 (10 ppm) for 8 hours.

Ozone and other photochemical oxidants

O_3 toxicity occurs in a continuum in which higher concentrations, longer exposure duration, and greater activity levels during exposure cause greater effects. Short-term acute effects include pulmonary function changes, increased airway responsiveness and airway inflammation, and other symptoms. These health effects are statistically significant at 160 µg/m^3 (0.08 ppm) for 6.6 hour exposures in a group of healthy exercising adults, with the most sensitive subjects experiencing a more than 10% functional decrease within 4-5 hours. Controlled exposure of heavily exercising adults, or children to an O_3 concentration of 240 µg/m^3 (0.12 ppm) for 2 hours, also produced decreases in pulmonary function. There is no question that substantial acute adverse effects occur during exercise with one hour exposure to concentrations of 500 µg/m^3 or higher, particularly in susceptible individuals or subgroups.

Field studies in children, adolescents, and young adults have indicated that pulmonary function decrease can occur as a result of short term exposure to O_3 concentrations in the range 120-240 µg/m^3 and higher. Mobile laboratory studies have observed changes in pulmonary function in children or asthmatics exposed to O_3 concentrations of 280-340 µg/m^3 (0.14-0.17 ppm) for several hours. Respiratory symptoms, especially coughing, have been associated with O_3 concentrations as low as 300 µg/m^3 (0.15

ppm). O_3 exposure has also been reported to be associated with increased respiratory hospital admissions and exacerbation of asthma. The effects are observed with exposures to ambient O_3 (and co-pollutants) and with controlled exposures to O_3 alone. This demonstrates that the functional and symptomatic responses can be attributed primarily to O_3.

A number of studies evaluating animals (rats and monkeys) exposed to O_3 for a few hours or days have shown alterations in the respiratory tract, in which the lowest-observed-effect levels were in the range of 160-400 μg/m^3 (0.08-0.2 ppm). These included the potentiation of bacterial lung infections, inflammation, morphological alterations in the lung, increases in the function of lung enzymes active in oxidant defenses, and increases in collagen content. Long-term exposure to O_3 in the range of 240-500 μg/m^3 (0.12 to 0.25 ppm) causes morphological changes in the epithelium and interstitium of the centri-acinar region of the lung, including fibrotic changes.

Guidelines

Establishing guidelines for ambient O_3 concentrations is complicated by the fact that detectable responses occur at, or close to, the upper bounds of background concentrations. Thus it is not possible to base the guidelines on a no-observed-adverse-effect level (NOAEL) or LOAEL. At O_3 levels of 200 μg/m^3 and lower (for 1-8 hour exposure periods), there are statistically significant decreases in lung function, airway inflammatory changes, exacerbation of respiratory symptoms, and symptomatic and functional exacerbation of asthma in susceptible people during exercise. Functional changes and symptoms, as well as increased hospital admissions for respiratory causes, are also observed in population studies.

To select a guideline, one must accept the premise that some detectable functional responses are of little or no health concern, and that too few people may respond to the effects of O_3 exposure to warrant designation as a group needing protection from exposure to ambient O_3. In the case of respiratory function responses, a judgement could be made that O_3-related reductions of FEV_1 at, for example, less than 10% were of no clinical concern. The balance of evidence indicates that reductions of FEV_1 of more than 10% occurred at O_3 levels of 160 μg/m^3 and higher. It is generally accepted that the exposure duration to O_3 is important in controlling the response and that exposures to raised concentrations for periods of eight hours are not unlikely. On this basis, a guideline value for ambient air of 120 μg/m^3 for a maximum period of eight hours per day has been established as a level at which acute effects on public health are likely to be small.

For those public health authorities that cannot accept such levels of health risk, an alternative is to explicitly select some other level of acceptable exposure and associated risk using the dose response relationships given in Figures 3.2-3.5. These figures, which are based on corresponding tables in the *Air Quality Guidelines for Europe* (WHO 1999a), summarize the ambient O_3 concentrations that are associated with levels of responses among population subgroups. Although chronic exposure to O_3 may cause effects, quantitative information from humans is inadequate for estimating the degree of protection from chronic effects offered by these *Guidelines*. In any case, the O_3 concentration at which any adverse health outcome is expected will vary with the duration of the exposure and with the volume of air inhaled during the exposure. As there is a strong correlation in field studies between the one-hour and eight-hour O_3 concentration and hospital admissions (Figure 3.5), the reduction in health risk associated with decreasing one-hour or eight-hour O_3 levels should be very similar.

Thus, the amount of time spent outdoors and the typical level of activity are factors which should be considered in risk evaluation. Figures 3.2 and 3.5 summarize the O_3 levels at which two representative adverse health outcomes, based on controlled exposure experiments, may be expected. The dose-response relationships in these figures represent expert judgment based on the collective evidence from numerous studies and linear extrapolation in a few cases where data were limited. Interestingly, these dose-response relationships appear to be non linear.

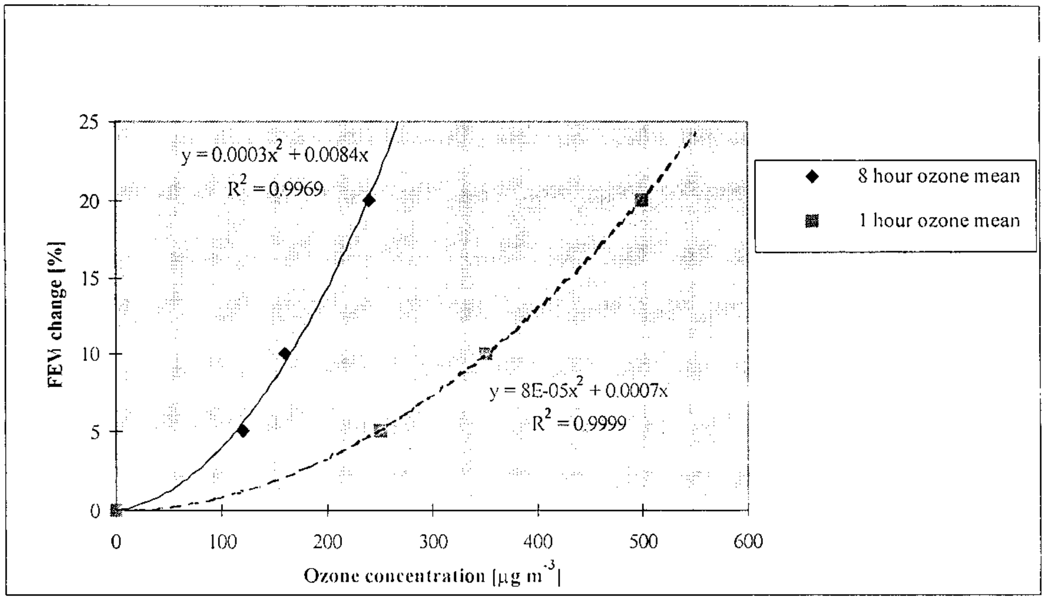


Figure 3.2. Change in FEV_1 as a function of O_3 concentration in the most sensitive 10% of active young adults and children.

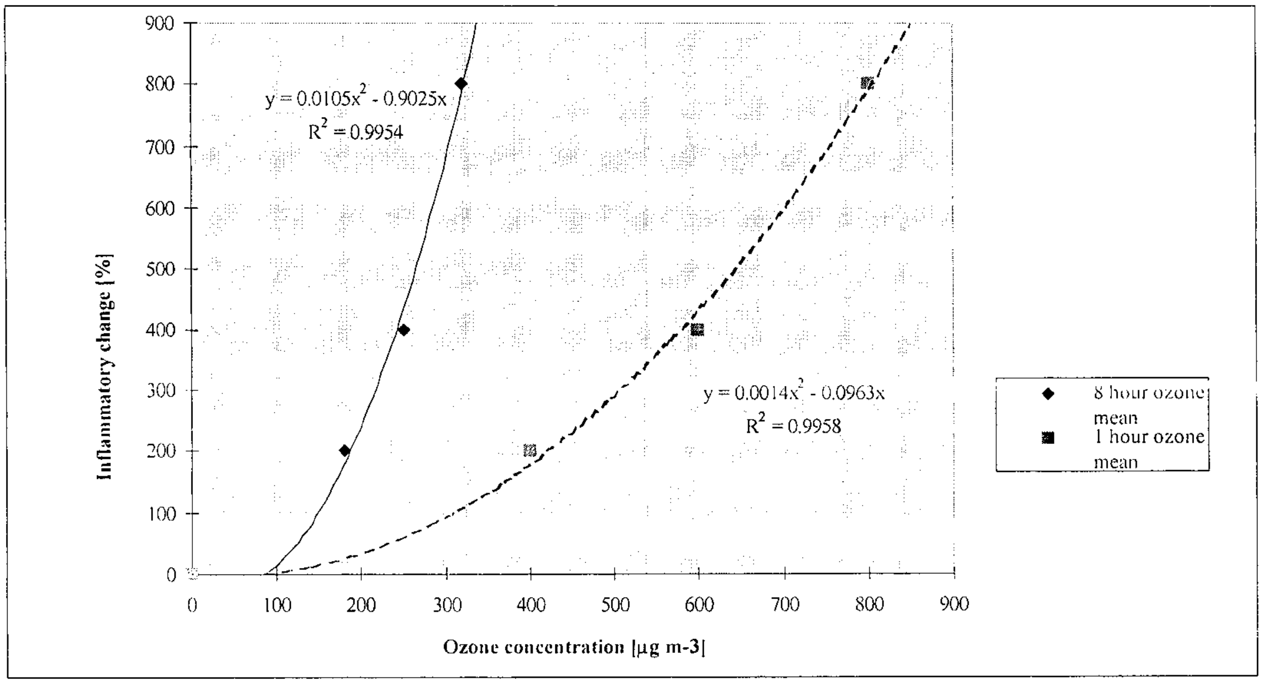


Figure 3.3. Inflammatory change (neutrophil influx in lungs of healthy young adults exercising outdoors at more than 40l/min expiratory volume in the lung) as a function of O_3 concentration.

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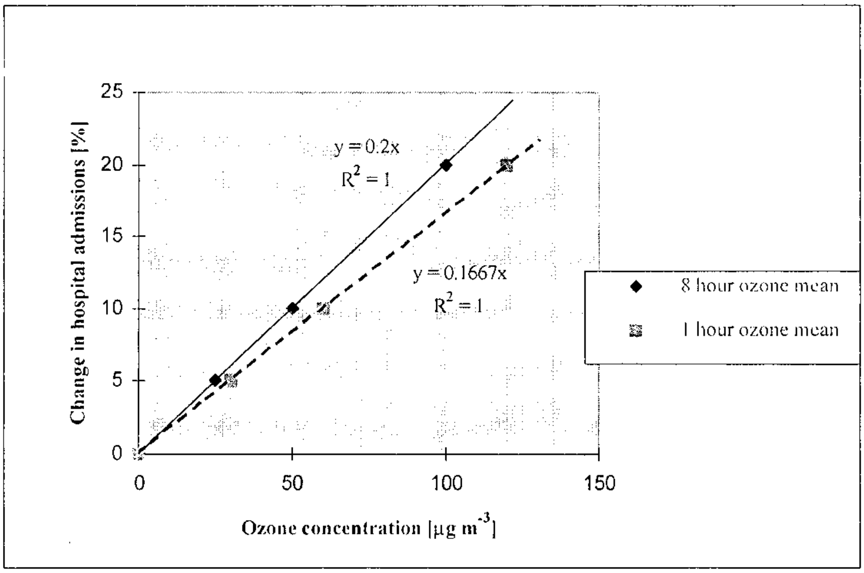

Figure 3.4. Increase in hospital admissions for respiratory conditions as a function of O_3 concentration.

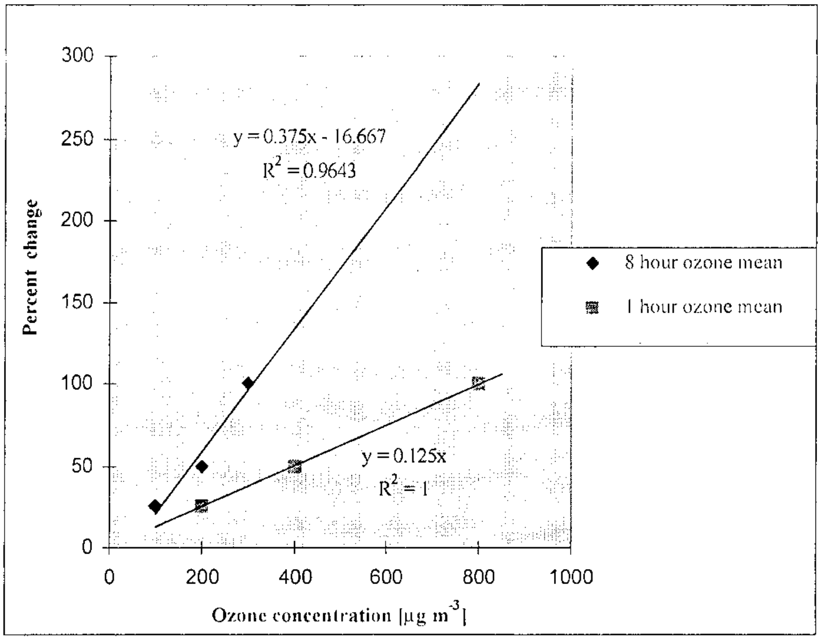

Figure 3.5. Change in symptom exacerbation among adults and asthmatics as a function of O_3 concentration.

Epidemiological data show relationships between changes in various health outcomes and changes in the peak daily ambient O_3 concentration. Two examples of such relationships are shown in Figures 3.4 and 3.5. Short-term increases in levels of ambient O_3 are associated both with increased hospital admissions with a respiratory diagnosis, and with respiratory symptom exacerbation in healthy people and asthmatics. These observations may be used to quantify the expected improvements in health outcomes that may be associated with a lower ambient O_3 concentration. The dose-response relationships presented in Figures 3.4 and 3.5 assume a linear relationship between O_3 concentration and health outcome. However, uncertainties exist concerning the forms of these relationships and it is unclear whether similar response slopes can be expected at widely different ambient O_3 levels. In the event that such relationships are curvilinear (i.e., concave upwards), the benefits of lowering the O_3 concentration are likely to be greater when the average ambient level is higher. Conversely, if the ambient O_3 concentration is already low, the benefits of lowering the concentration may be less than would be suggested by these figures. Another important area of uncertainty is the degree to which other pollutants influence these relationships.

The previous WHO guidelines (WHO 1987) included a one-hour guideline value of 150-200 $\mu g/m^3$ for O_3. Although recent research does not indicate that this guideline would necessarily be erroneous, the 8-hour guideline would protect against acute one-hour exposures in this range and thus it is concluded that a one-hour guideline value would not be necessary. The health problems of greatest concern are increased hospital admissions, exacerbation of asthma, inflammatory changes in the lung and structural alterations in the lung. These are more appropriately addressed by a guideline value which limits average daily exposure, and consequently inhaled dose and dose rate, rather than addressing the rare short duration deterioration of air quality that may be associated with unusual meteorological conditions.

A guideline for PAN is not warranted at present, as it does not seem to pose a significant health problem at levels that are observed in the environment.

Suspended particulate matter

Health effects of SPM in humans depend on particle size and concentration, and can fluctuate with daily fluctuations in PM_{10} or $PM_{2.5}$ levels. They include acute effects such as increased daily mortality, increased rates of hospital admissions for exacerbation of respiratory disease, fluctuations in the prevalence of bronchodilator use and cough and peak flow reductions. Long-term effects of SPM refer also to mortality and respiratory morbidity, but only few studies on the long-term effects of SPM exist. Air pollution by particulate matter has been considered to be primarily an urban phenomenon, but it is now clear that in many areas of developed countries, urban-rural differences in PM_{10} are small or even absent, indicating that PM exposure is widespread. This is not to imply that exposure to primary, combustion-related PM may not be higher in urban areas.

A variety of methods exist to measure different fractions of particulate matter in air, with different health significance (see Section 2.1.1). This evaluation has tended to focus on studies in which PM exposure was expressed as PM_{10} and $PM_{2.5}$. Health effect studies conducted with various TSP and BS as exposure indicators have provided valuable additional information. However, they are less suitable for deriving exposure-response relationships for PM because TSP includes particles that are too large to be inhaled, or because the health significance of particle opacity as measured by the Black Smoke method is uncertain. Methods for measuring particle concentrations are discussed in section 5.7.

The current time-series epidemiological studies are unable to define a threshold below which no effects occur. Recent studies suggest that even at low levels of PM (less than 100 $\mu g/m^3$), short-term exposure is associated with health effects. At low levels of PM_{10} (0 - 100 $\mu g/m^3$), the short-term exposure-response curve fits a straight line reasonably well (Figures 3.6 to 3.8). However, there are indications from several studies that at higher levels of exposure (several hundreds of $\mu g/m^3$ of PM_{10}), at least for effects on mortality, the curve is flatter than at low levels of exposure. This is discussed later in this section.

Although many studies have obtained acute effect estimates for PM_{10} that are reasonably consistent, this does not imply that particle composition or size distribution within the PM_{10} fraction is unimportant. Limited evidence from studies on dust storms indicates that such PM_{10} particles are much less toxic than those associated with combustion sources. Recent studies in which PM_{10} size fractions and/or constituents have been measured suggest that the observed effects of PM_{10} are largely associated with fine particles and not with the coarse fraction (PM_{10} minus $PM_{2.5}$). In some areas strong aerosol acidity or sulphate may be the cause of the effects associated with $PM_{2.5}$.

Evidence is also emerging that long-term exposure to low concentrations of PM in air is associated with mortality and other chronic effects, such as increased rates of bronchitis and reduced lung function. Two cohort studies conducted in the U.S.A. suggest that life expectancy may be 2-3 years shorter in communities with high PM than in communities with low PM. This is consistent with earlier cross-sectional studies, which compared age-adjusted mortality rates across a range of long-term average PM concentrations. The results showed that long-term average exposures to low PM levels, starting at about 10 $\mu g/m^3$ of fine particulate matter, were associated with a reduction in life expectancy. Whilst such observations require further corroboration, preferably also from other areas in the world, these new studies suggest that the public health implications of PM exposure may be large.

Figures 3.6-3.8 show summary estimates of the relative increase in various health parameters as a function of PM concentration. These figures are based on data reported in studies in which PM_{10} and/or $PM_{2.5}$ have been measured. They were not inferred from other measures such as Coefficient of Haze, Black Smoke or SPM. The database for parameters other than PM_{10} is still limited, so the evaluation of health effects, especially the short-term effects, is largely expressed in terms of PM_{10}. However, future regulations and monitoring activities should give emphasis to the ultrafine and fine fractions in addition to, or even instead of, PM_{10}.

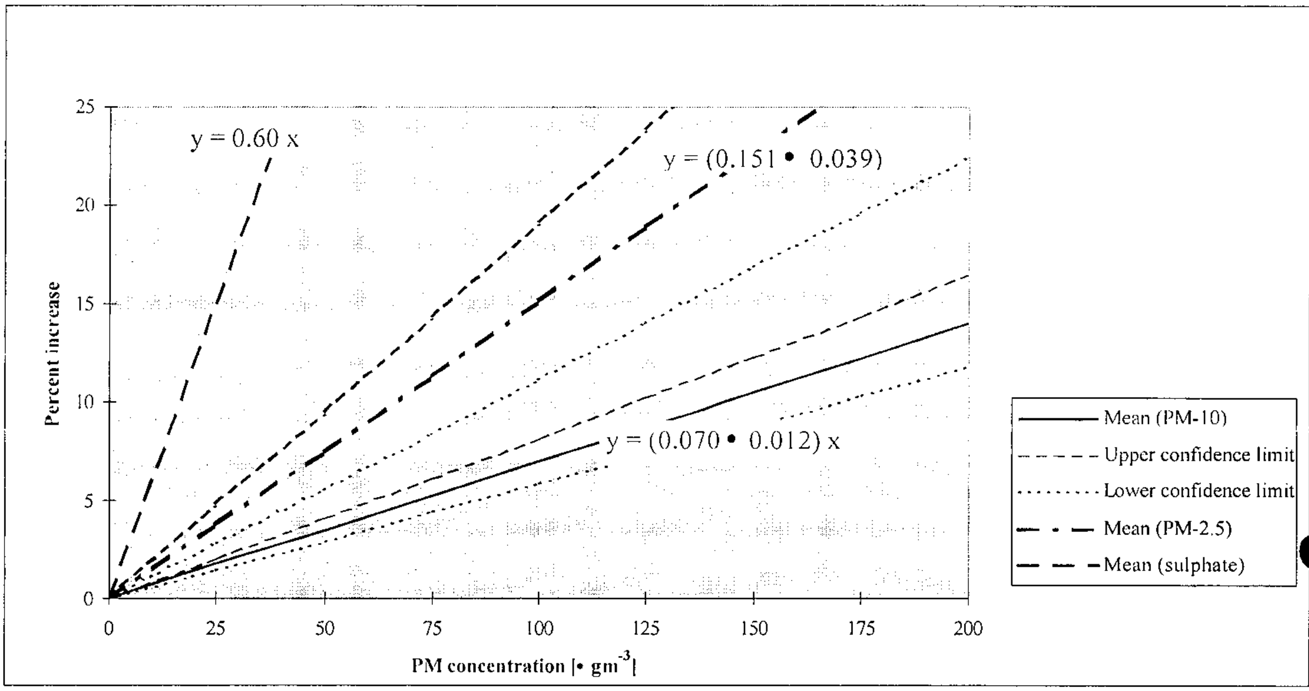

Figure 3.6. Increase in daily mortality as a function of PM concentration.

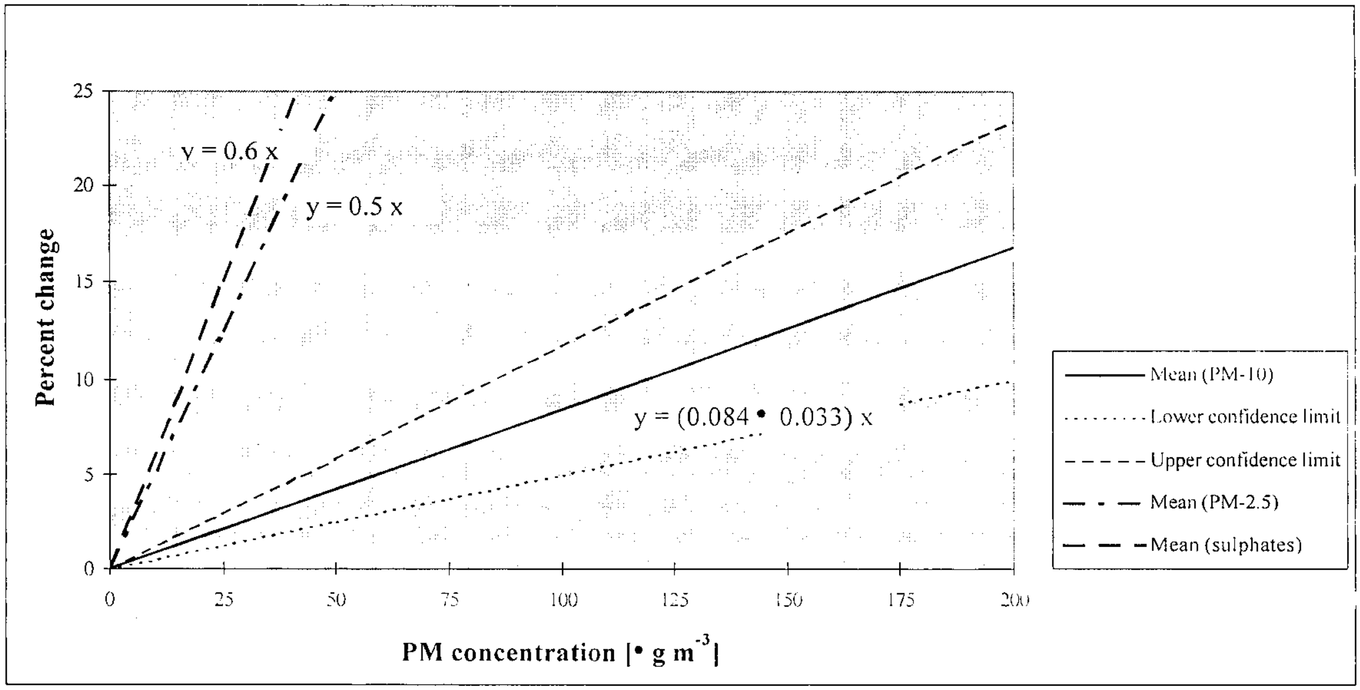

Figure 3.7. Percent change in hospital admissions assigned to PM_{10}, $PM_{2.5}$ and sulphates.

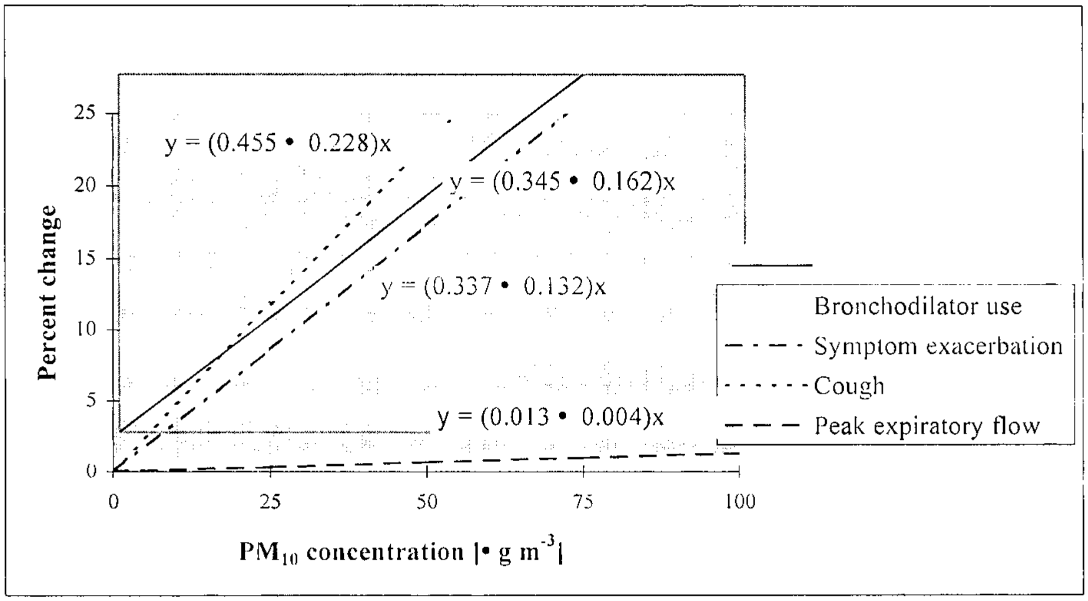

Figure 3.8. Change in health endpoints as a function of PM_{10} concentration.

The following issues should be considered when using these graphs:

(1) The graphs should not be used for PM_{10} concentrations below 20 μg/m^3, or above 200 μg/m^3; or for $PM_{2.5}$ concentrations below 10 μg/m^3, or above 100 μg/m^3. This caution is required as mean 24-hour concentrations outside of the quoted ranges were not used for the risk assessment, and extrapolations beyond them would be invalid.

(2) The areas close to the straight lines in Figures 3.6–3.8 should be considered as 'shaded' areas representing uncertainty, indicated by the 95% confidence intervals (CI).

(3) There is a fundamental difference between the guidelines for PM_{10} or $PM_{2.5}$ and the guideline values for respirable particulate matter derived in the WHO *Air Quality Guidelines for Europe* (WHO 1987). The guidelines for PM_{10} and $PM_{2.5}$ are relationships between a health endpoint and the PM concentration. The percent change is related to the risk of health effects occurring. In consequence, when deriving an air quality standard for PM_{10} or $PM_{2.5}$ using these relationships, it has to be decided which curve should be used and the risk has to be fixed. This is a new situation with respect to the derivation of air quality standard from an air quality guideline value, in which a risk is assumed without it being explicitly stated.

(4) Figures 3.6-3.8 can be used with caution to estimate how many subjects would be affected over a short period of time with increased PM levels, for a population of a given size, mortality and morbidity characteristics. There is need for caution because of variation in results between studies for some effects.

(5) With information on the average number of deaths and the average number of hospital admissions due to respiratory illness in a particular population, the trendlines in Figures 3.6 and 3.7 allow an estimation of the number of subjects that would be affected by an episode of PM_{10}, or $PM_{2.5}$. Similarly, with information on the number of asthmatics using bronchodilators, or experiencing asthma symptoms on a particular day, the trendlines in Figure 3.8 allow an estimate of the expected number of affected subjects. An instructive example is explained in the *Air Quality Guidelines for Europe* (WHO 1999a).

(6) There is little current information to quantify the reduction in life expectancy associated with daily mortality increases related to PM exposure. If effects are restricted to subjects in poor health, effects on age at death may be relatively small.

Guidelines

Evidence from epidemiological studies consistently points to associations between short-term exposure to PM and adverse effects on human health, even at low levels of PM commonly encountered in developed countries. The database does not, however, enable the derivation of specific guideline values at present. Most of the information currently available comes from studies in which particles in air have been measured as PM_{10}. There is now also an increasing body of information on $PM_{2.5}$, and the most recent studies show that, in general, $PM_{2.5}$ is a better predictor of health effects than PM_{10}. Evidence is also emerging that constituents of $PM_{2.5}$, such as sulphates and strongly acidic particles, are sometimes better predictors of health effects than $PM_{2.5}$.

Many studies relate day-to-day variations in PM to day-to-day variations in health parameters. They provide quantitative estimates of effects of PM that are generally consistent. The available information does not allow a judgement to be made of concentrations below which no effects would be expected. For this reason, no guideline value for short-term average concentrations is recommended. Risk managers are referred to the risk estimates provided in the Figures 3.6-3.8 for guidance in setting standards for PM.

There is less information on the long-term effects of PM on health. Some studies have suggested that long-term exposure to PM is associated with reduced survival, and a reduction of life expectancy in the order of 2-3 years. Other recent studies have shown that the prevalence of bronchitis symptoms in children, and of reduced lung function in both children and adults, are associated with PM exposure. For this reason, no guideline value for long-term average concentrations is recommended. Risk managers are referred to the risk estimates provided in Figures 3.6-3.8 for guidance regarding standards for PM.

Lead

The level of lead in blood is the best available indicator of current and recent past environmental exposure and, with stable exposures, may also be a reasonably good indicator of lead body-burden. The biological effects of lead can therefore be related to blood lead levels as an indicator of internal exposure. The relationship between blood lead concentrations and exposure to lead in air exhibits downward curvilinearity where the range of exposures is sufficiently large. At low levels of exposure the deviation from linearity is negligible and linear models of the relationship between intake and blood lead levels are satisfactory approximations.

The LOAEL for hematological and neurological effects of lead in adults and children can be summarized as follows. Frank anemia is exhibited in adults at blood lead levels above 800 μg/l, and in children above about 700 μg/l. Hemoglobin production is reduced in adults at blood lead levels above 500 μg/l and in children above 250-300 μg/l. The presence of lead in the blood also inhibits delta-aminolaevulinic acid dehydrase (ALAD), an enzyme involved in heme biosynthesis, resulting in an accumulation of its substrate, ALA, in blood, plasma and urine (WHO 1987). Urinary ALA and coproporyphyrin are elevated in both adults and children above blood lead levels of about 400 μg/l. Erythrocyte protoporphyrin is found to increase in male adults at blood lead levels above 200-300μg/l, and in female adults and children above 150-200 μg/l. A reduction in vitamin D3 occurs in children at blood lead levels above 100-150 μg/l. Consequently, inhibition of ALAD in adults and children is likely to occur at blood lead levels of about 100 μg/l. However, because of its uncertain biological significance for the functional reserve capacity of the heme biosynthetic system, ALAD inhibition is not treated as an adverse effect here. Encephalopathic signs and symptoms appear not to occur in adults at lead concentrations in blood below 1000-1200 μg/l, and in children below 800-1000 μg/l.

Cognitive effects in lead workers have not been observed at blood lead levels below 500 μg/l, although reductions in nerve conduction velocity were found at concentrations as low as 300 μg/l. Elevation of free erythrocyte protoporphyrin has been observed at blood lead levels of 200-300 μg/l. Central nervous system effects, as assessed by neurobehavioural endpoints, appear to occur in children at levels below 200 μg/l. Consistent effects have been reported for global measures of cognitive functioning, such as the psychometric intelligence quotient, at blood lead levels between 100-150 μg/l. Some epidemiological studies have indicated effects such as hearing impairment at blood lead levels below 100 μg/l. Animal studies provide qualitative support for the claim that lead is a causative agent for hearing impairment.

Guidelines

The guidelines for lead in air are based on the effects of lead in blood. Critical effects to be considered in the adult organism include elevation of free erythrocyte protoporphyrin, whereas for children cognitive deficits, hearing impairment and disturbed vitamin D metabolism are taken as the decisive effects. All of these effects are considered adverse. A critical level of lead in blood is 100 μg/l. It should be stressed that all of these values are based on population studies yielding group averages, and apply to the individual child only in a probabilistic manner.

For the derivation of a guideline value the following arguments have been considered:

1. Currently measured "baseline" blood lead levels of minimal anthropogenic origin are probably between 10-30 μg/l.
2. Various international expert groups have determined that the earliest adverse effects of lead in populations of young children begin at 100-150 μg/l. Although it cannot be excluded that population

effects may occur below this range, it is prudent to derive a guideline value based on the lowest value of this range (100 μg/l).

3. It can be assumed that inhalation of airborne lead is a significant route of exposure for adults (including pregnant women), but it is of less significance for young children, for whom other pathways of exposure such as ingestion are generally more important than inhalation.
4. It appears that 1 μg Pb/m^3 of air directly contributes approximately 19 μg Pb/l of blood in children and about 16 μg Pb/l of blood in adults, although it is accepted that the relative contribution of lead in air is less significant in children than in adults. These values are approximations, recognizing that the relationships are curvilinear in nature and will apply principally at lower blood lead levels.
5. It must be taken into account that in typical situations an increase of lead in air also contributes to increased lead uptake by indirect environmental pathways. To correct for uptake by other routes, it is assumed that 1 μg Pb/m^3 in air would contribute to 50 μg Pb/l in blood.
6. It is recommended that efforts should be undertaken to ensure that at least 98% of an exposed population, including pre-school children, should have blood lead levels that do not exceed 100 μg/l. In this case, the median level of lead in blood would not exceed 54 μg/l. On this basis, the annual average concentration of lead in air should not exceed 0.5 μg/m^3, corresponding to 25 μg/l of lead in blood. This proposal is based on the assumption that the upper limit of nonanthropogenic blood lead is 30 μg/l. These estimates are assumed to also protect adults.
7. To prevent further increases of lead in soils, and the consequent increases in exposure of future generations, the levels of lead in air should be kept as low as possible.

As both direct and indirect exposure of young children to lead in air occurs, the guidelines for lead in air should be accompanied by other preventive measures. These should specifically take the form of monitoring the lead content of dust and soils arising from the fallout of lead in air. The normal hand-to-mouth behaviour of children necessitates that dust and soil be defined as potentially serious sources of exposure. A specific monitoring value is not recommended. Some data indicate that lead fallout in excess of 250 μg m^{-2}/day will increase blood lead levels.

In summary, the WHO guideline values for the "classic" air pollutants are provided in Table 3.1.

Table 3.1. WHO guideline values for the "classical" air pollutants (WHO 1999a)

Compound	Annual ambient air concentration [µg/m³]	Health endpoint	Observed effect level [µg/m³]	Uncertainty factor	Guideline Value [µg/m³]	Averaging time
Carbon monoxide	500-7000	Critical level of COHb < 2.5%	n.a	n.a.	100 000	15 minutes
					60 000	30 minutes
					30 000	1 hour
					10 000	8 hours
Lead	0.01-2	Critical level of Pb in blood < 25 µg Pb/l	n.a.	n.a.	0.5	1 year
Nitrogen dioxide	10-150	Slight changes in lung function in asthmatics	365-565	0.5	200	1 hour
					40	1 year
Ozone	10-100	Respiratory function responses	n.a.	n.a.	120	8 hours
Sulphur dioxide	5-400	Changes in lung function in asthmatics	1000	2	500	10 minutes
		Exacerbations of respiratory symptoms	250	2	125	24 hours
		in sensitive individuals	100	2	50	1 year

n.a. not applicable

3.2 Other air pollutants

This section briefly describes the health-based guidelines for airborne inorganic and organic compounds for non-carcinogenic and carcinogenic health endpoints. Also some compounds relevant for indoor air pollution will be covered. In the process of revising and updating the WHO *Air Quality Guidelines for Europe* and the *Environmental Health Criteria* series, no guideline value and no risk-concentration relationship could be derived for several compounds. The compounds are fluorides and platinum for non-carcinogenic endpoints and 1,3 butadiene and cadmium^{VI} for carcinogenic health endpoints.

Guidelines based on noncarcinogenic health endpoints

In the updated and revised document of the WHO *Air Quality Guidelines for Europe* (WHO 1999a) the following compounds with noncarcinogenic endpoints were considered: cadmium, dichloromethane, fluorides, HCHO, manganese, mercury, styrene, tetrachloroethylene, and toluene.

Data for CS_2 and H_2S were not revised, and the original guidelines (WHO 1987) are still applicable.

In addition, some compounds were not considered in the process of updating and revising the *Air Quality Guidelines for Europe*. The guidelines for these compounds were taken from the published documents of the *Environmental Health Criteria* series (EHC) of the International Programme for Chemical Safety and the Concise International Chemical Assessment Documents (CICAD) of the Inter-Organization programme for the sound Management of Chemicals. For non-carcinogenic health endpoints these include the compounds: acetaldehyde (EHC 167, WHO 1995d); acetone (EHC 207, WHO 1998c); acrolein (EHC 127, WHO 1992b); acrylic acid (EHC 191, WHO 1997d); 2-butoxyethanol (CICAD 10, WHO1998d); carbon tetrachloride (EHC 208, WHO 1999b); chloroform (EHC 163, WHO 1994b); cresol (EHC 128, WHO 1995e); 1,4-dichlorobenzene, monochlorobenzene, and trichlorobenzene (EHC 128, WHO 1991a); di-n-butyl phthalate (EHC 189, WHO 1997e); diesel exhaust (EHC 171, WHO 1996b); 2-ethoxyethanol, 2-ethoxyethanolacetate, and methoxyethanol (EHC 115, WHO 1990a); ethylbenzene (EHC 186, WHO 1996c); hexachlorocyclopentadiene (EHC 120, WHO 1991b); isophorone (EHC 174, WHO 1995f); methanol (EHC 196; WHO 1997f); methyl bromide (EHC 166, WHO 1995g); methylmethacrylate (CICAD 4, WHO 1998e); propanols (EHC 102, WHO 1990b; EHC 103, WHO 1990c); 1,1,1,2-tetrafluoroethane (CICAD 11, WHO 1998f); and xylenes (EHC 190, WHO 1997g).

The starting point for the air quality guidelines for non-carcinogenic air pollutants from the Environmental Health Criteria documents were the concepts of NOEL, NOAEL, LOEL and LOAEL (WHO 1987; WHO 1994c. Uncertainty factors were applied to these values to derive the guidelines. These uncertainty factors take into account intraspecies variation, interspecies variation, quality of data, and extrapolations from LOAEL to NOAEL and from subchronic to chronic effects. Examples for such factors and their application in deriving the guidelines are given in EHC 170 (WHO 1994c). For interspecies (extrapolation from animal to human) variation, usually a factor of 10 was applied. For intraspecies variation a factor of 5–10 was used. For use of an effect level rather than a no-effect level a factor of 2-10 was also applied, depending on the quality of the data. It was usually assumed that an uncertainty factor of 1000, based on interspecies variation (factor of 10), intraspecies variation (factor of 10) and LOAEL to NOAEL extrapolation (factor of 10), also accounted for variations in exposure time and the limitations of the database. If occupational data were the basis of a guideline derivation, a factor accounting for the number of hours per week divided by the number of working hours was applied. The choice of uncertainty factors was subject to individual expertise and judgement.

Some general considerations have to be considered in deriving guideline values in the Environmental Health Criteria (EHC) documents and in their interpretation and use:
A consistent methodology has been used in the derivation of quantitative guideline values for human exposures to chemical substances present in food, drinking-water, air and other media by *ad hoc* IPCS Task Groups (of varying membership) reviewing and evaluating data and finalizing EHC monographs on various chemicals. This approach embodies the concept that, to the extent possible, guidance values for the protection of human health should reflect consideration of total exposure to the substance whether present in air, water, soil, food or other media. Guideline values should be derived for a clearly defined exposure scenario, based on the data for the reference man (as defined in Appendix 4 of WHO 1994c), and therefore might not represent national or local circumstances.

The precision of the guidance values is dependent upon the validity and reliability of the available data. Frequently, there are sources of uncertainty in the derivation of TIs and in their allocation as a basis for guideline values, so that the resulting values represent a best estimate based on the available data at the time. The description of the derivation of guideline values clearly indicates the nature and sources of uncertainty and the manner in which they have been taken into account in the derivation. The numerical values of guideline values should reflect the precision present in their derivation; usually guideline values are given to only one significant figure.

Establishing tolerable intakes (TIs comprising tolerable daily intakes (TDIs) or acceptable daily intakes (ADIs), in units mg/(kg bw d) or µg/(kg bw d), bw bodyweight) is central to the determination of guidance values. A TDI or ADI is defined as an estimate of the intake of a substance over a lifetime that is considered to be without appreciable health risk. It may have

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different units depending upon the route of administration upon which it is based and is generally expressed on a daily or weekly basis. Though not strictly an "intake", TIs for inhalation are generally expressed as airborne concentrations (i.e. µg or mg per m^3).

Two areas are critical in the methodology for the derivation of guidance values for human exposures to chemical substances in the environment:

Development of a tolerable intake on the basis of interpretation of the available data on toxicity. For practical purposes, toxic effects are considered to be of two types, threshold and non-threshold. For substances where the critical effect is considered to have a threshold (including non-genotoxic carcinogenesis for which there is adequate mechanistic data), a TI is developed usually on the basis of a NOAEL.

Allocation of the proportions of the tolerable intake to various media. Development on available information, the development of guidance values for compounds present in more than one environmental medium will require the allocation of proportions of the TI to various media (for example, air, food and water). For the derivation of guidance values, the allocation will be based on information on relative exposure via different routes.

Media exposure allocations of TIs for the derivation of guidance values in EHC monographs are based on relative exposure by different routes for a given scenario. Though this is suggested as a practical approach, the use of allocations based on exposure in different media does not preclude the development of more stringent limits. It is also important to recognize that the proportions of total intake from media may vary, based on circumstances. Site- or context-specific guideline values better suited to local circumstances and conditions could be developed from TIs presented in the EHC in situations where relevant data on exposure are available, and particularly where there are other significant sources of exposure to a chemical substance (e.g., in the vicinity of a waste site). Regulatory authorities may also take control to develop risk management strategies appropriate for local circumstances, although the ultimate objective of control should be reduction of exposure from all sources to less than the TIs. In addition, where data on organoleptic thresholds are included in EHC monographs, these can also be considered by relevant authorities in the development of limits.

Polychlorinated dibenzodioxins (PCDDs), polychlorinated dibenzofurans (PCDFs) and polychlorinated biphenyls (PCBs) constitute a group of persistent environmental chemicals. A number of dioxin or furan congeners, as well as some co-planar PCBs have been shown to exert a number of toxic responses similar to those of 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD), the most toxic dioxin. These effects include dermal toxicity, immunotoxicity, reproductive effects and teratogenicity, endocrine disruption and carcinogenicity. For dioxin-like compounds a TDI was derived in units of toxicity equivalent (TEQ) uptakes (WHO 1998k), which is supposed to represent a tolerable daily intake for life-time exposure. Occasional short-term excursions above the TDI would have no health consequences provided that the averaged intake over long periods is not exceeded. It was stressed that the upper range of the TDI of 4 pg TEQ/kg bw should be considered a maximal tolerable intake on a provisional basis and that the ultimate goal is to reduce human intake levels below 1 pg TEQ/kg bw/day.

The air quality guidelines for non-carcinogenic pollutants can only be applied if the averaging times are specified. The averaging time associated with a guideline value depends on the type of effects that are caused by short-term exposure producing acute effects, or long-term exposure producing chronic effects. Typical averaging times are 30 minutes for odorous pollutants, 24 hours to 1 week for acute exposures and 1 year for chronic health effects. The decision on the averaging time for a guideline needs careful screening of the toxicological and epidemiological findings and expertise in judging the results. As a consequence, the choice of an averaging time can be subjective, as is the choice of an uncertainty factor.

The air quality guidelines for compounds with non-carcinogenic health endpoints are summarized in Table 3.2.

Table 3.2. Guidelines for air quality: compounds with non-carcinogenic health endpoints

Compound	Average ambient air concentration [• g/m^3]	Health endpoint	Observed effect level [mg/m^3]	Uncertainty factor	Guideline Value (GV) or Tolerable Concentr-ation (TC) [• g/m^3]	Averaging time	Source	
Acetaldehyde	5	Irritancy in humans	45 (NOEL)	20	2 000 (TC)	24 hours	WHO 1995d	EHC 167
		Carcinogenicity related irritation in rats	275 (NOEL)	1000	50 (TC)	1 year		
Acetone	0.5-125	Odour annoyance	240 (OT)	n.a.	n.p.	-	WHO 1998c	EHC 207
Acrolein	15	Eye irritation in humans	0.13	n.p.	50 (GV)	30 min	WHO 1992b	EHC 127
		Odour annoyance (Odour threshold)	0.07	n.a.	-	30 min	WHO 1992b	EHC 127
Acrylic acid	No data	Nasal lesions in mice	15 (LOAEL)	50	54 (GV)	1 year	WHO 1997d	EHC 191
2-Butoxyethanol	0.1-15	Haematoxicity in rats	242 (NOAEL)	10	13100 (TC)	1 week	WHO 1998d	CICAD 10
Cadmium	(0.1-20) . 10^{-3}	Renal effects in the population	n.a.	n.a.	5 x 10^{-3} (GV)	1 year	WHO 1999a	
Carbon disulphide	10-1500	Functional CNS changes in workers	10 (LOAEL)	100	100 (GV)	24 hours	WHO 1987	
		Odour annoyance	0.2 (OT)	n.a.	20 (GV)	30 min	WHO 1987	
Carbon Tetrachloride	0.5-1	Hepatotoxicity in rats	6.1(NOAEL)	1000	6.1 (TC)	1 year	WHO 1999b	EHC 208
1,4 Dichlorobenzene	0.2-3.5	Increase in organ weight and urinary proteins	450 (NOEL)	500	134 (TC)	1 year	WHO 1991a	EHC 128
Dichloromethane	< 5	COHb formation in normal subjects		n.a.	3000 (GV)	24 hours	WHO 1999a	
Diesel exhaust	1.0 - 10.0	Chronic alveolar inflammation in humans	0.139 (NOAEL)*	25	5.6 (GV)	1 year	WHO 1996b	EHC 171
		Chronic alveolar inflammation in rats	0.23 (NOAEL)*	100	2.3 (GV)	1 year		

* For diesel exhaust two approaches were applied, which based on a NOAEL of 0.41 mg/m3 in rats. The corresponding levels were converted to a continuous exposure scenario.
n.a. not applicable; n.p. not provided.

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Table 3.2 Guidelines for air quality: compounds with non-carcinogenic health endpoints (cont.)

Compound	Average Concentration [• g/m^3]	Health endpoint	Observed effect level [mg/m^3]	Uncertainty factor	Guideline Value (GV) or Tolerance Concentration (TC) [• g/m^3]	Averaging time	Source	
2-Ethoxyethanol	No data	Developmental effects in rats	37 (NOEL)	n.p.	n.p.	1 year	WHO 1990a	EHC 115
2-Ethoxyethylacetate	No data	Developmental effects in rats	170 (NOEL)	n.p.	n.p.		WHO 1990a	EHC 115
Ethylbenzene	1-100	Increase of organ weight	2150 (NOEL)	100	22 000 (GV)	1 year	WHO 1996c	EHC 186
Fluorides	0.5 - 3	Effects on livestocks	n.a.	n.a.	1 (GV)	1 year	WHO 1999a	
Formaldehyde	(1-20) . 10^{-3}	Nose, throat irritation in humans	0.1 (NOAEL)	n.a.	100 (GV)	30 min	WHO 1999a	
Hexachlorocyclopentadiene	No data	Inhalation effects in rats	0.45 (NOEL)	n.p.	n.p.	1 year	WHO 1991b	EHC 120
Hydrogen sulphide	0.15	Eye irritation in humans Odour annoyance	15 (LOAEL) (0.2-2.0) x 10^{-3} (OT)	100 n.a.	150 (GV) 7 (GV)	24 hrs 30 min	WHO 1987 WHO 1987	
Isophorone	No data	Odour annoyance	1.14 (OT)	n.a.	-	30 min	WHO 1995f	EHC 174
Manganese	0.01 - 0.07	Neurotoxic effects in workers	0.03 (NOAEL)	200	0.15 (GV)	1 year	WHO 1999a	
Mercury, inorganic	(2-10) . 10^{-3}	Renal tubular effects in humans	0.020 (LOAEL)	20	1 (GV)	1 year	WHO 1999a	
2-Methoxyethanol	No data	Developmental toxicity in rats	31 (NOEL)	n.p.	n.p.		WHO 1990a	EHC 115
Methyl bromide	0.05-0.8	Reduction in fertility index in rats	12 (NOEL)	n.p.	n.p.		WHO 1995g	EHC 166
Methyl Methacrylate	2.4 x 10^{-4}	Degenerate changes in olfactory epithelium in rodents	102.5 (NOEL)	100	200 (TC)	1 year	WHO 1998e	CICAI
Monochlorobenzene	0.2-3.5	Decreased food intake, increased organ weight, lesions and changes in blood parameters	341 (LOAEL)	1000	71 (TC)	1 year	WHO 1991a	EHC 128

n.a. not applicable; n.p. not provided.

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Table 3.2 Guidelines for air quality: compounds with non-carcinogenic health endpoints (cont.)

Compound	Average ambient air concentration [• g/m³]	Health endpoint	Observed effect level [mg/m³]	Uncertainty factor	Guideline Value (GV) or Tolerance concentration (TC) [• g/m³]	Averaging time	Source	
1-Propanol	0.05	Reproduction in pregnant rats	9001 (NOEL)	n.p.	n.p.		WHO 1990b	EHC 102
2-Propanol	1500-35000	Developmental toxicity in rats	9001 (LOEL)	n.p.	n.p.		WHO 1990c	EHC 103
Styrene	1.0 -20.0	Neurological effects in workers Odour annoyance	107 (LOAEL) 0.07 (OT)	40 n.a.	260 (GV) 7 GV)	1 week 30 minutes	WHO 1999a WHO 1987	
Tetrachloroethylene	`1 - 5	Kidney effects in workers Odour annoyance	102 (LOAEL) 8	400 n.a.	250 (GV) 8000 (GV)	24 hours 30 minutes	WHO 1999a WHO 1987	
1,1,1,2-Tetrafluoroethane	No data	Development toxicity in animals	41700 (NOAEL)	n.p.	n.p.		WHO 1998f	CICAD 11
Toluene	5 - 150	Effects on CNS in workers Odour annoyance	332 (LOAEL) 1 (OT)	1260 n.a.	260 (GV) 1000 (GV)	1 week 30 minutes	WHO 1999a WHO 1987	
1,3,5 Trichlorobenzene	0.5-0.8	Metaplasia and hyzperplasia of respiratory epithelium in rats	100 (NOEL)	500	36 (TC)	1 year	WHO 1991a	EHC 128
1,2,4 Trichlorobenzene	0.02-0.05	Increae in urinary porphyrins in rats	22.3 (NOAEL)	500	8 (TC)	1 year	WHO 1991a	EHC 128
Vanadium	0.05 - 0.2	Respiratory effects in workers	0.02 (LOAEL)	20	1 (GV)	24 hours	WHO 1987	
Xylenes	1 - 100	CNS effects in human volunteers Neurotoxicity in rats Odour annoyance	304 (NOAEL) 870 (LOAEL) 4.35 (OT)	60 1000 n.a.	4800 (GV) 870 (GV) -	24 hours 1 year 30 minutes	WHO 1997g WHO 1997g WHO 1997g	EHC 190 EHC 190 EHC 190

n.a. not applicable; n.p. not provided.

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Table 3.2 Guidelines for air quality: compounds with non-carcinogenic health endpoints (cont.)

Compound	Average ambient air concentration [• g/m^3]	Health endpoint	Observed effect level [mg/kg bw d]	Uncertainty factor	Tolerable Daily intake (TDI or ADI) [• g/kg bw d]	Averaging Time (over lifetime)	Source	
Chloroform	0.3-10	Hepatoxicity in beagles	15 (LOEL)	1000	15 (TDI)	24 hours	WHO 1994b	EHC 163
Cresol	1-'10	Reduced body weight and tremors in mice	50 (LOAEL)	300	170 (ADI)	24 hours	WHO 1995e	EHC 168
Di-n-butyl Phthalate	(3-80) . 10^{-3}	Developmental/Reproductive toxicity	66 (LOAEL)	1000	66 (ADI)	24 hours	WHO 1997e	EHC 189
			Estimated human daily intake [pg/kg bw d]		[TEQ/kg bw d]			
Dioxin-like compounds	n.p.	Neurobehavioural effects/ Endometriosis in monkey offspring Decreased sperm count/immune suppression/increase genital malformations in rat offspring	14-37 (LOAEL)*	10	1-4 (TDI)	24 hours	WHO 1998k	

* Estimated from the maternal body burden of exposed rats and monkeys by applying a factor of 2.

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Additional air pollutants were considered for which it was not possible to derive guideline values. For non-carcinogenic health endpoints these compounds include dioxins, fluorides, platinum and other compounds, for which the existing information can be extracted from the EHC series compiled in Appendix 4.

Guidelines based on carcinogenic health endpoints

In the revision of the WHO *Air Quality Guidelines for Europe* (WHO 1999a) the following compounds with carcinogenic endpoints were considered: arsenic, benzene, chromium (VI), man-made vitreous fibres, nickel, PAH, radon, trichloroethylene, and toluene. The data for acrylonitrile and vinylchloride were not revised and updated and the original guidelines are still applicable (WHO 1987). Additional carcinogenic compounds, for which unit risks could be derived from the EHC series publications, are included in the guidelines. These include acetaldehyde (EHC 167, WHO 1995d); bis(chloromethyl)ether (EHC 201, WHO 1998h); 1,2-dichloroethane (CICAD 1, WHO 1998g); diesel exhaust (EHC 171, WHO 1996b); selected non-heterocyclic PAH (EHC 202, WHO 1998i); and 1,1,2,2-tetrachloroethane (CICAD 3, WHO 1998j).

In addition, for some carcinogenic compounds, such as 1,3 butadiene and cadmium, guidelines could not be derived. Existing information on these compounds can be taken from WHO 1999a and, for other compounds, from the published documents of the *Environmental Health Criteria* series compiled in Appendix 4.

Table 3.3 **Guidelines for air pollutants with carcinogenic health endpoints**

Compound	Average ambient air concentration [$\mu g/m^3$]	Health endpoint	Unit risk [$\mu g/m^3$]$^{-1}$	IARC classification	Source	
Acetaldehyde	5	Nasal tumours in rats	$(1.5\text{-}9) \times 10^{-7}$	2B	WHO 1995d	EHC 167
Acrylonitrile	0.01 - 10	Lung cancer in workers	2×10^{-5}	2A	WHO 1987	
Arsenic	$(1 - 30) . 10^{-3}$	Lung cancer in exposed humans	1.5×10^{-3}	1	WHO 1999a	
Benzene	5.0 - 20.0	Leukemia in exposed workers	$(4.4\text{-}7.5) \times 10^{-6}$	1	WHO 1999a	
Benzo[a]pyrene		Lung cancer in humans	8.7×10^{-2}	1	WHO 1999a	
Bis(chloromethyl)ether	No data	Epitheliomas in rats	8.3×10^{-3}	1	WHO 1998h	EHC 201
Chloroform	0.3-10	Kidney tumours in rats	4.2 x 10-7	2B	WHO 1994b	EHC 163
Chromium^{VI}	$(5\text{-}200) . 10^{-3}$	Lung cancer in exposed workers	$(1.1\text{-}13) \times 10^{-2}$	1	WHO 1999a	
1,2-Dichloroethane	0.07 - 4	Tumour formation in rodents	$(0.5\text{-}2.8) \times 10^{-6}$	2B	WHO 1998g	CICAD 1
Diesel exhaust	1.0 - 10.0	Lung cancer in rats	$(1.6\text{-}7.1) \times 10^{-5}$	2A	WHO 1996b	EHC 171

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Table 3.3 Guidelines for air pollutants with carcinogenic health endpoints (cont.)

Compound	Average ambient air concentration [μg/m^3]	Health endpoint	Unit risk [μg/m^3]$^{-1}$	IARC classification	Source
ETS	1-10	Lung cancer in exposed humans	10^{-3}		WHO 1999a
Nickel	1-180	Lung cancer in exposed humans	3.8×10^{-4}	1	WHO 1999a
PAH (BaP)	(1-10) . 10^{-3}	Lung cancer in exposed humans	8.7×10^{-2}	1	WHO 1999a
1,1,2,2-Tetrachloroethane	0.1 - 0.7	Hepatocellular carcinomas in mice	$(0.6\text{-}3.0) \times 10^{-6}$	3	WHO 1998j
Trichloroethylene	1 -10	Cell tumours in testes of rats	4.3×10^{-7}	2A	WHO 1999a
Vinychloride	0.1 - 10	Hemangiosarkoma in exposed workers Liver cancer in exposed workers	1×10^{-6}	1	WHO 1987

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For the compounds noted inTable 3.3 estimation of the unit risks is described in the references quoted. Unit risks for mixtures such as petrol exhaust, roofing tar, smokeless and smoky coal, and wood smoke can, in principle, be estimated from the potencies of these mixtures and the unit risk of benzo[a]pyrene (BaP) by use of the formula:

$UR_{mixture}$ = (potency of mixture)/(potency of "coke oven top") x UR_{BaP} x (content of BaP in mixture).

In this relationship the potencies of the mixture and the potency of "coke oven top" are taken fromTable A.I.17 of EHC 202 (WHO 1998i); $UR_{mixture}$ denotes the unit risk of the mixture and UR_{BaP} that of BaP; the unit of the content of BaP in the mixture is microgram per gram of mixture. Table 3.4 reflects the relative potencies of the mixtures. which defined as the potencies of the mixtures divided by the potency of "coke oven top" (see EHC 202, WHO 1998i).

Table 3.4. Relative potencies of certain mixtures

Mixture	Relative potency of mixture
Petrol exhaust	0.736
Roofing tar	0.145
Smokeless coal	0.368
Smoky coal	1.026
Wood smoke	0.759

For example, the BaP content of wood smoke has been estimated to range between 1 and 29 [mg BaP/g of mixture] (Ward 1999). Inserting all quantities into the above equation leads to a unit risk for wood smoke in the range of $(0.07\text{-}1.9) \times 10^{-7}$ $[\mu g/m^3]^{-1}$. If the BaP content of other mixtures are known the unit risk can be estimated in a similar way.

Using the potencies of other non-heterocyclic polycyclic hydrocarbons relative to BaP (see Table AI.9 of EHC 202. WHO 1998i), unit risks can also be given as a rough estimate for these compounds by using of the formula (results are given in Table 3.5)

$UR_{compound}$ = (potency of compound)/(potency of BaP) x UR_{BaP}

Table 3.5. Estimate of unit risks for several polycyclic aromatic hydrocarbons

Compound	Relative potency range compared to BaP	Unit risk $[\mu g/m^3]^{-1}$
Anthanthrene	0.28 - 0.32	$(2.4 - 2.8) \times 10^{-2}$
Benz[a]anthracene	0.014 - 0.145	$(1.2 - 13) \times 10^{-4}$
Benzo[a]pyrene	1	8.7×10^{-2}
Benzo[b]fluoranthene	0.1 - 0.141	$(0.87 - 1.2) \times 10^{-2}$
Benzo[j]fluoranthene	0.045 - 0.1	$(0.4 - 0.87) \times 10^{-2}$
Benzo[k]fluoranthene	0.01 - 0.1	$(8.7 - 87) \times 10^{-4}$

Chrysene	0.001 - 0.1	$(8.7 - 870) \times 10^{-5}$
Cyclopenta[*cd*]pyrene	0.012 - 0.1	$(1 - 8.7) \times 10^{-3}$
Dibenzo[a,e]pyrene	1	8.7×10^{-2}
Dibenz[a,c]anthracene	0.1	8.7×10^{-3}
Dibenz[a,h]anthracene	0.89 - 5	$(7.7 - 43.5) \times 10^{-2}$
Dibenzo[a,l]pyrene	100	8.7×10^{-0}
Dibenzo[a,e]fluoranthene	1	8.7×10^{-2}
Dibenzo[a,h]pyrene	1 - 1.2	$(8.7 - 10.4) \times 10^{-2}$
Dibenzo[a,i]pyrene	0.1	8.7×10^{-3}
Fluoranthene	0.001 - 0.01	$(8.7 - 87) \times 10^{-5}$
Indeno[1,2,3,-*cd*]pyrene	0.067 - 0.232	$(5.8 - 20.2) \times 10^{-3}$

Air quality guidelines for man-made vitreous fibres and radon were also revised Man-made vitreous fibre (MMVF) concentrations have been measured in only a few studies and have been found to average about 340 fibres per cubic metre (F/m^3) in ambient air and 570 F/m^3 in indoor air. Maximum values were 2400 F/m^3 in ambient air and 5600 F/m^3 in indoor air. Several types of refractory ceramic fibres were found to be carcinogenic in inhalation studies in animals. The IARC classified ceramic fibres as possibly carcinogenic to humans (Group 2B). From inhalation studies in animals, the unit risk for lung tumours for a lifetime exposure to 1000 F/m^3 was estimated to be 10^{-6} per fibre/m^3 for fibres of length below 5 μm.

Radon is another indoor air pollutant known to cause lung cancer in humans. Average indoor concentrations range between 20 and 200 Bq/m^3. A study of lung cancer in workers showed a linear increase in lung cancer in response to increases in estimated radon exposure (Pershagen et al. 1994). Figure 3.9 shows the estimated proportion of lung cancers that can be attributed to residential radon. This figure can be used to assess the risk of radon exposure.

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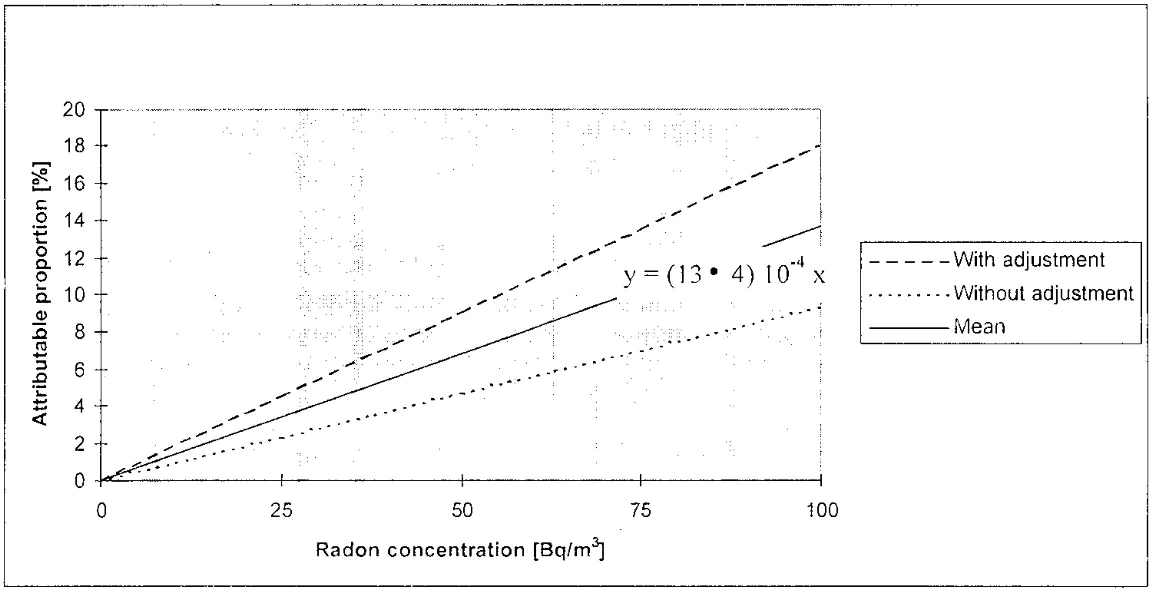

Figure 3.9. The proportion of lung cancers attributable to radon exposure.

3.3 Classical air pollutants: applicability of WHO *Air Quality Guidelines for Europe* on a world-wide scale

In the derivation of the WHO *Air Quality Guidelines for Europe*, assumptions were made for some compounds, which may not be applicable in some parts of the world. For some, but not all, pollutants the importance of different routes of exposure may vary from country to country. It should be understood that if such factors were to be taken into account then different guidelines could be derived. It is important that regulatory authorities should answer the following question before adapting for local use a guideline from the *Air Quality Guidelines for Europe*: Do local circumstances give cause to doubt the likely validity of the guideline set out in the WHO *Air Quality Guidelines* as a basis for setting local guidelines or standards? For a number of pollutants a unit risk assessment has been provided. These assessments are also dependent upon considerations of the comparative importance of different routes of exposure.

3.4 Studies of Effects of Air Pollutants on Health in WHO Regions

As discussed above, the effects of air pollutants on health vary depending on several factors. These include the level of exposure and the susceptibility of the exposed population. The susceptibility of the population is affected by factors such as the numbers of young children and older people, as well as the proportion of people suffering from asthma and other chronic respiratory conditions. Epidemiological studies reflect this variation in sensitivity by showing different associations between levels of exposure and health effects for different subpopulations. In addition, sources and patterns of exposure, e.g. indoor and outdoor exposures, are likely to differ substantially from region to region. In part this is dependent upon weather conditions.

These factors and the variation in response-concentration relationships are powerful arguments for health studies being undertaken in the different WHO Regions on the effects of air pollutants. It could be a mistake to simply adopt response-concentration relationships derived from Western European or North American studies for general use.

No general review drawing together the results of epidemiological studies on air pollution across the WHO Regions has been published. Regions differ significantly in terms of the number of studies undertaken and in the quality of those studies. Many, perhaps most, studies are done with the intention of characterising the local problem and quantifying the effects of air pollution on health. Preliminary studies to assess whether there is a problem are common.

Recent developments in our understanding of the effects of air pollutants on health suggest that, at least for particulate matter and O_3, all levels of exposure above zero are associated with effects on health. That pollutants such as sulphur and NO_2 should be regarded as no-threshold compounds seems toxicologically implausible, although such a conclusion is difficult to avoid given the current time-series data.

Sulphur dioxide

Latin America

Few epidemiological studies conducted in Latin America have investigated the effect of SO_2 on health. In a study conducted in Chile close to an industrial area where SO_2 annual means ranged from 101-145 $\mu g/m^3$, and maximum daily averages from 405-1230 $\mu g/m^3$, an increase of 50 $\mu g/m^3$ in the SO_2 daily mean value was related to a 4% increase in cough frequency (95% CI: 1-7%), a 3% increase in phlegm production (95% CI: 0-6%) and a 4% increase in wheeze occurrence (95% CI: 0-11%), with a one-day lag among children with chronic respiratory symptoms (Sanchez-Cortez 1997). A significant change in evening peak flow measurements was also observed. No effects were observed in children without chronic respiratory symptoms. In this study, health effects were observed at levels lower than 125 $\mu g/m^3$ (the WHO guideline) among susceptible children. However, SO_2 may have interacted with PM_{10} levels, which ranged from 5 to 125 $\mu g/m^3$ in this study.

In the same study, when areas with different long-term ambient levels of SO_2 were compared (70 $\mu g/m^3$ vs. 130 $\mu g/m^3$ annual mean over 3 years), the prevalence of chronic respiratory symptoms was higher in the area with the higher SO_2 annual means (30% vs. 14% for chronic cough and 14.3% vs. 6.1% for wheezing). The differences were statistically significant (Sanchez-Cortez 1997). PM_{10} annual means were low in both areas.

Mediterranean Region

Few studies have investigated the effects of air pollution on health in the Eastern Mediterranean region. In one study of residents of the Shoubra El-Kheima industrial area of Egypt results showed that 37.4% of the examined sample (4730 subjects) suffered from chronic obstructive pulmonary diseases (COPD) and the prevalence increased with age (El-Samara et al. 1984). This study found that 1478 students (out of the studied group of 6380 students) were suffering from COPD. A strong positive correlation was recorded between PM_{10} level and incidence of asthma.

Western Pacific Region

Japan

An epidemiological survey in Japan from 1981 to 1983 involved schoolchildren aged 6-12 years (Nitta et al. 1993; Ono et al. 1990; Nakai et al. 1995). Annual mean concentrations in urban areas ranged from 26.8-30.9 $\mu g/m^3$ SO_2. Suburban area levels ranged from 20.5-23.9 $\mu g/m^3$ and background levels from 13.3-22.9 $\mu g/m^3$. Comparison of the effect of SO_2 on human health in the different areas showed that the prevalence of asthmatic symptoms, of chest congestion and of phlegm significantly correlated with annual mean levels of SO_2.

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China

Epidemiological investigations in China show short-term exposure to 280 μg/m^3 SO_2 was correlated with apparent effects on the health of traffic police, whose respiratory function was reduced by 29-64%, and whose incidence of chronic rhinitis and pharyngitis was raised by 30-90%, compared with the control group (BMEPB 1980). Where the annual average air concentration of SO_2 was 260 μg/m^3, secondary and elementary school students had a much higher incidence of chronic respiratory diseases than in less polluted areas. For example, the incidence of tonsil suppuration was increased 5.1-fold, simple rhinitis by 1.1-fold and nose engorgement by 0.9-fold (BMEPB 1980). Under long exposure to an annual average of 175 μg/m^3 SO_2 (with 550 μg/m^3 particulate matter also present), the three-year average mortality from pulmonary heart disease and respiratory diseases in the community was twice that of the control group (GMEPB 1980).

A study was conducted on the influence of SO_2 pollution on lung function of children and women (Chen et al. 1993). It found that at annual average concentration of 140 μg/m^3 (with 150 μg/m^3 particulate matter), SO_2 is associated with lower levels of lung function in children at the ages of 10-12, with major decreases in FVC and FEV_1. For each 60 μg/m^3 increment in annual average concentration of SO_2, there was an average 99 ml drop in the children's FVC and a 70 ml drop in FEV_1. The FVC of women was decreased by 57 ml under the same conditions. In addition, it was found that SO_2 can affect women's non-specific immunity in parts of their respiratory passages, lowering their average concentration of saliva lysozyme by 5.6 μg/ml and specific immuneglobuline by 32 μg/ml (Chen et al. 1995).

South East Asia

The results of epidemiological studies in India indicate that adverse health effects can be associated with ambient air SO_2 at an annual average concentration of 40 μg/m^3. Interpretation of these findings is complicated by the high co-existing particle levels, as well as by a number of additional local factors. These include high indoor and occupational exposure to air pollutants, below average health conditions and poor nutritional status, unsafe water supply, poor general hygiene etc.

A study of 4129 community residents of three areas of Bombay, representing three grades of air pollution conditions (based on secondary data), and a fourth area 40 km away towards the south-east as a control, found:

i. Higher morbidity in the two more polluted areas for breathing problems, cough and common colds. The city's residents in the polluted zone were the healthiest, even in comparison to rural populations. Other symptoms related to pollution were headache, eye irritation, chest pain, skin lesions and intermittent cough.

ii. In the urban low pollution area there was a larger prevalence of cardiac complaints.

Table 3.6. Standardised prevalence of selected diseases in Bombay (after Kamat and Doshi 1987)

Disease	Urban SO_2 levels			
	Low (<50 μg/m^3)	Intermediate (51-100 μg/m^3)	High (>100 μg/m^3)	Rural (control)
Dyspnea	3.2	6.0	7.3	5.5
Chronic cough	1.7	2.7	5.1	3.3
Intermittent cough	0.4	5.8	15.6	3.7
Frequent colds	12.1	20.8	18.0	11.0
Chronic bronchitis	2.3	4.5	4.5	5.0
Cardiac disorders	8.2	4.3	6.8	2.7

000291

A study (Kamat et al. 1992) of 4 comparable communities in central and north-eastern Bombay (2 each) among randomly matched 349 subjects in 1988-1989, along with ambient SO_2, NO_2 and SPM air monitoring was carried out in Parel, Maravali, Deonar and Dadar. Air pollutant levels in winter were higher particularly for SO_2 in Parel (up to 584 $\mu g/m^3$) and Maravali; Deonar showed lower pollution. Clinical respiratory symptoms were higher in Parel and Maravali (cough 12% and 11.2%, dyspnea 17% and 13.3% respectively). Cardiac problems were commoner in Parel (11.0%). Maravali had a high prevalence for headache and eye irritation (9.5%). Those using kerosene suffered more than those using gas (22.2% as compared to 9.2%) Lung functions (FVC, FEV_1) were lowest in Parel for males and in Maravali for females. Expiratory flow rates were lower at Dadar, followed by Maravali. Despite lower SO_2 pollution, symptoms in Maravali residents were comparable to those in Parel. It was conjectured that this may be due to added effect of diesel exhausts (NO_2, SPM) or other unmeasured chemicals.

Nitrogen dioxide

Latin

There are few data from Latin America on the impact of outdoor sources of NO_2 exposure on health. As in many Latin American cities, NO_2 levels are usually low (WHO 1998b). However, in a preliminary study conducted in Sao Paulo, Brazil (Saldiva et al. 1995), a 75 $\mu g/m^3$ increase in NO_2 was related to a 30% increase in mortality for respiratory illness among children less than five years old.

In Mexico City, a time-series study of hospital emergency visits among children less than 15 years of age found NO_2 daily levels correlated with upper respiratory illnesses (Tellez-Rojo et al. 1999). Stronger associations were observed during the winter months, when NO_2 levels ranged from 40-160 $\mu g/m^3$ (mean 90 $\mu g/m^3$), and O_3 levels from 82-740 $\mu g/m^3$ (mean 368 $\mu g/m^3$). The correlation coefficient between pollutants and illness was 0.44. The highest indicated effect of NO_2 was observed with a two-day lag. A 56 $\mu g/m^3$ increase in daily NO_2 ambient concentration was associated with a 39% increase in upper respiratory illnesses (95% CI: 28-51%). However, given the mixture of contaminants, and the general low NO_2 levels observed in this study, it is not possible to ascertain that NO_2 is the contaminant responsible for the observed effects.

Western Pacific Region

Japan

From 1992 to 1995, the Japanese Environment Agency surveyed the health effects of air pollutants in about 15 000 schoolchildren (EA 1997). The results showed that the prevalence of asthmatic symptoms was higher at NO_2 levels above 37.6 $\mu g/m^3$ than below this level. In general, however, the levels of NO_2 in Japan are not high enough to demonstrate a clear cause-effect relationship between the prevalence of asthmatic symptoms and NO_2 concentration. But neither are they low enough to rule out a causal relationship.

A survey of respiratory symptoms as a function of distance from roads with heavy traffic showed that the prevalence rate of respiratory symptoms, such as chronic cough and wheezing, was higher in residents nearer roads (Nitta et al. 1993; Ono et al. 1990). When there were no indoor NO_2 sources except for gas cooking stoves, both indoor and individual levels of NO_2 were attributable primarily to automobile exhaust (Nakai et al. 1995).

It has been reported that an interaction between air pollution, especially NO_2, and high temperature, may synergistically increase lung cancer mortality rates, since regional differences in age-adjusted lung cancer rates were explained by an interaction between NO_2 and temperature (Choi et al. 1997).

000292

China

In recent years, epidemiological studies examined NO_2 concentrations in kitchens of 160 city dwellers, as well as urine hydroxyproline (HOP) levels of individuals after 24-hour exposures. The results showed that in liquid petroleum gas (LPG) -fuelled kitchens, NO_2 peak concentrations can reach 990-1,809 $\mu g/m^3$ at the moment of ignition, 17-37.5 -fold higher than the daily average concentration of 50 $\mu g/m^3$ (background concentration). Also, the urine HOP levels of individuals cooking in LPG-fuelled kitchens were higher than those cooking in coal fuelled kitchens (Zhang Jinhiang et al. 1996). In contrast, NO_2 exposures produced by burning coal was significantly higher than those resulting from the burning of LPG.

A survey in four cities showed that the daily average value of indoor NO_2 concentration was 53 $\mu g/m^3$, and elevated levels of SO_2, CO and TSP were recorded. Studies of primary school students aged 10-15 years residing in this environment showed 30-70% suffer from coughing, and 7-40% suffer from phlegm; and the incidence of tonsillitis and hyperplasia of retropharyngeal lymph folliculi are 7-17% and 15-16%, respectively. In addition, effects on immunity indices (such as PHA skin test and saliva lysozyme) were also observed (Wang Jin et al. 1989; Qin Yuhui et al. 1990).

Studies on 60 healthy Beijing children aged 9-11 years, and exposed to NO_2 at a daily average level of 70-110 $\mu g/m^3$, with the peak values of 150-260 $\mu g/m^3$ for two months, reported a negative correlation between NO_2 concentration and peak expiratory flow rates (PEFR). The results indicate that increased NO_2 level could affect children's respiratory function, aggravate air duct blocking and subsequently reduce PEFR (Wang Lihua et al. 1994). Long-term exposure to 50-100 $\mu g/m^3$ NO_2 may significantly affect children's respiratory and immunity systems; and it may have similar effects on sensitive adults.

Australia

Morgan et al. (1998) examined the effects of outdoor air pollutants on daily hospital admissions in Sydney, Australia. A time-series analysis of counts of daily hospital admissions and outdoor air pollutants (1990-1994) showed that an increase in the daily maximum 1-hour concentration of NO_2 from the 10th to the 90th percentile was associated with an increase of 5.29% (95% CI: 1.07% to 9.68%) in childhood asthma admissions and 4.60% (95% CI: -0.17% to 9.61%) in COPD admissions. A similar increase in daily maximum 1-hour particle concentration was associated with an increase of 3.01% (95% CI: -0.38% to 6.52%) in COPD admissions. An increase from the 10th to the 90th percentile in daily maximum 1-hour NO_2 was associated with an increase of 6.71% (95% CI: 4.25% to 9.23%) in heart disease admissions among those 65 years and older. Increases in heart disease, COPD and childhood asthma were associated with increased NO_2 levels.

Carbon monoxide

Mediterranean Region

In Cairo, CO concentrations greater than the WHO *Guidelines for Air Quality* values were recorded in streets having moderate-to-heavy traffic densities in residential areas and in the city centre (Nasralla 1997). These concentrations resulted in high levels of COHb in the blood of traffic policemen, sometimes reaching more than 10%. This study also found a significant direct relationship between ischemic heart disease and COHb level in Cairo traffic policemen (Salem 1990).

Western Pacific Region

China

Chinese middle-school students residing in a relatively low-pollution district of Shenyang, and undergraduate students studying at a relatively low-pollution district of Beijing, had average blood COHb concentrations of 0.8 % and 0.5 % respectively. Research on the effect of indoor CO on children aged 8-13 years showed that for rooms with individual heating the average CO content was 12.4 mg/m^3 and the COHb blood levels in these children was 4.17%. In rooms with central heating, the CO concentration was 6.4 mg/m^3 and the COHb levels in was 1.79% (Liu Jifang et al. 1992). This study also showed that in individually heated rooms the children's saliva lysozyme exhibited lower activity than that in centrally heated rooms; and immunoglobulin G content of the former is less than that of the latter. This phenomenon suggests that CO pollution could result in hypoimmunity for children (Liu Jifang et al. 1992).

Ozone and other photochemical oxidants

Latin

Several studies conducted in Mexico City have illustrated the association of acute peak daily O_3 concentration with respiratory health. A study conducted among children reported both acute and subacute effects of O_3 on lung functions (Castillejos et al. 1992). A 106 µg/m^3 rise in the mean 48-hour O_3 levels was associated with a decrease of 2% in FEV_1, and a 7.4% decrease in the forced expiratory flow FEF_{25-75}. A greater decrease in these parameters was observed in children with chronic cough, chronic phlegm or wheeze. In another study, conducted among school children from Mexico City, that compared quintiles of O_3 concentration, a decrease of 1.43% in FVC and 2.85% in FEV_1 was reported in the highest quintile of O_3 concentration (364-730 µg/m^3) (Castillejos et al.1995). This change in FEV_1 is less than that predicted by Figure 3.2.

In a study conducted among pre-school children, an increase in school absenteeism for respiratory illnesses was observed among children exposed to higher O_3 concentrations (Romieu et al. 1992). Children exposed for two consecutive days to peak daily O_3 levels above 260 µg/m^3 had a 20% increase in risk of respiratory illness. For children exposed for 2 consecutive days to high O_3 levels (above 260 µg/m^3) and the previous day were exposed to low temperature, the risk of respiratory illness reached 40%. It is important to note that in Mexico City, and in some areas of Sao Paulo, levels of 260 µg/m^3 are frequently reached on several consecutive days.

O_3 exposure has also been related to emergency department visits for acute upper respiratory illness among children in Mexico City. An increase of 100 µg/m^3 in the 1-hour daily maximum was related to a 10% increase (95% CI: 7-13%) in upper respiratory illnesses during winter time. An increase of 100 µg/m^3 in the 1-hour daily maximum during 5 consecutive days was related to a 30% increase in upper respiratory illnesses (95% CI: 23-37%) (Tellez-Rojo et al. 1997). In this study a non-linear effect was observed in relation to O_3 levels. The upper respiratory illnesses increased linearly from 160-300 µg/m^3 and then tended to level off. A further increase in risk was observed at levels close to 440 µg/m^3. Effects at low concentrations of O_3 could not be studied.

Asthmatic children may be more susceptible than others to the effects of O_3 exposure. Studies conducted in Mexico City have shown that asthma-related emergency department visits increased 43% (95% CI: 24-66%) for an increase of 50 ppb in the daily 1-hour maximum O_3 level, with a 1-day lag (Romieu et al. 1995). In this study, peak O_3 concentrations ranged from 20-500 µg/m^3, with a mean of 180 µg/m^3.

In panels of asthmatic children, O_3 exposure has been related to a decrease in peak expiratory flow rate and an increase in respiratory symptoms (Romieu et al. 1996; Romieu et al. 1997). In general an increase of 100 $\mu g/m^3$ of daily peak O_3 concentrations led to an 11% increase (95% CI: 5-19%) of lower respiratory symptoms and a significant decrease in peak expiratory flow rate.

The decreased respiratory function observed among children exposed to O_3 in Mexico City seems to be smaller than that observed in children who are not chronically exposed to high levels of O_3, suggesting the existence of a phenomenon of "tolerance". This finding supports studies showing that repetitive exposures tend to produce smaller responses (Hackney et al. 1997; Folinsbee 1991). The potential adverse effect of such "tolerance", or functional adaptation, is not known, but the absence of a protective response to O_3 exposure (bronchoconstriction) could lead to a higher exposure of children and therefore a more severe long-term effect. Experimental studies in animals and humans have shown that O_3 increases airway permeability and particle clearance, causes airway inflammation and a decrease in bacterial capacity, causes structural alteration in the lung and accelerate ageing of the lung (Lippmann 1989; and Section 3.1).

Western Pacific Region

China

An investigation has been conducted in China on the effect of short-term O_3 exposure on lung function for male non-smokers. During the test, volunteers undertook a moderate amount of exercise at intervals; and parameters of vital capacity were monitored. The study data showed that under the condition of short-term exposure 180 ± 40 $\mu g/m^3$ is the threshold concentration for acute lung dysfunction; and $100 \mu g/m^3$ is the threshold concentration for general malaise (Fang Qisheng et al. 1991).

Australia

A time-series analysis of counts of daily hospital admissions and outdoor air pollutants in Sydney (Morgan et al. 1998) found that an increase in the daily maximum 1-hour O_3 concentration was associated with a 2.45% (95% CI: -0.37, 5.35) increase in heart disease admissions among those 65 years and older.

A study of daily mortality in the Brisbane region (Simpson et al. 1997) indicated that O_3 levels (maximum daily O_3 levels were about 240 $\mu g/m^3$) were significantly associated with total daily mortality. There was little evidence of interaction between the O_3 effects (mainly in summer) and particles or with SO_2 and NO_2. The associations between O_3 and daily mortality were significant only for individuals who were older than 65 years of age. Positive associations were also found with cardiovascular disease categories and the regression coefficients, when significant, were higher than those for total mortality. The results indicated a possible threshold for O_3 levels.

Suspended Particulate Matter

Latin America

Evaluation of the effects of short-term exposure on morbidity and mortality

Various studies in Latin America have assessed the effect of particulate matter pollution on health. These included mortality studies, and studies of the health effects of particulate matter on respiratory symptoms and functions among children and adults. Studies related to the effects of particulate matter pollution on mortality have been conducted in Brazil, Chile and Mexico. An increase of 10 $\mu g/m^3$ PM_{10} in Sao Paulo was related to an increase in daily mortality of 3% among adults older than 65 years of age (Saldiva et al. 1995). In Chile, a 0.8% increase (95% CI: 0.6-1.2%) in daily mortality was reported for an increase of 10 $\mu g/m^3$ PM_{10} (Ostro et al. 1999). In Mexico, a 0.5% increase (95% CI: 0.3-0.7%) in daily mortality was found for a similar increase in daily TSP (Borja-Aburto et al. 1997). These results are concordant with similar studies conducted in other parts of the world (Pope et al. 1995).

Studies conducted to determine the impact of particulate matter pollution on respiratory emergencies and medical visits have also suggested a positive association (Molina Esquivel et al. 1989; Ara-Seebla 1990; Arranda et al. 1994). In a study conducted in Santiago, Chile, respiratory-related emergency visits were related to ambient levels of PM_{10} and $PM_{2.5}$ during the winter months. In this study, PM_{10} levels ranged from 16-270 $\mu g/m^3$ and $PM_{2.5}$ levels from 10-156 $\mu g/m^3$. It was observed that an increase of 63.5 $\mu g/m^3$ in PM_{10} (1 quartile of the distribution) was related to a 2% increase (95% CI: 0.5-3.4%) in respiratory-related emergency department visits, with a 2-day lag during the winter months. A 36.5 $\mu g/m^3$ in $PM_{2.5}$ was related to a 2.2% increase in the number of emergency department visits for acute respiratory illnesses (95% CI: 0.9-3.6%) with a 2-day lag. A similar increase in $PM_{2.5}$ was related to a 5.4% increase in the risk of acute pneumonia (95% CI: 1.9-5.6%) with a 3-day lag, and to a 3.7% increase in the risk of upper respiratory illnesses (95% CI: 1.9-5.6%) with a 2-day lag during winter (Ilabaca Marileo 1996). In this study, the $PM_{2.5}$ daily mean ranged from 10-156 $\mu g/m^3$, and the relation appeared to be linear over the range of concentration studied.

The dose-response curves of this study, for emergency department visits of patients with severe and not-so-severe respiratory diseases related to PM_{10} and $PM_{2.5}$, had smaller slopes than those provided in the WHO *Guidelines* (Figure 3.7). In fact, for PM_{10} the slope fell below the lower confidence limit provided. For $PM_{2.5}$, the slope was considerably smaller than that shown in the WHO *Guidelines*. However, when the relationship of $PM_{2.5}$ with pneumonia-related emergency department visits, a severe respiratory illness, was considered, the slope was larger and above the upper limit of the PM_{10} effect predicted by the WHO *Guidelines*.

Results from a panel study conducted in Punchucavi, Chile, indicated an increase of 5% in cough (95% CI: 1-10%) among children with chronic respiratory symptoms was associated with an increase of 30 $\mu g/m^3$ in the 24-hour average levels of PM_{10} (Sanchez-Cortez 1997).

Studies conducted in Mexico among asthmatic children have documented an increase in respiratory symptoms and a decrease in lung function related to exposure to PM_{10}. During the study, daily PM_{10} ambient levels ranged from 29-363 $\mu g/m^3$, with a mean of 167 $\mu g/m^3$, and daily $PM_{2.5}$ levels ranged from 23-177 $\mu g/m^3$, with a mean of 86 $\mu g/m^3$. The results suggested that an increase of 10 $\mu g/m^3$ in PM_{10} levels was associated with a 4% increase in minor respiratory symptoms, and a 0.35% decrease in peak expiratory flow rate (Romieu et al. 1996). In the same study, an increase of 10 $\mu g/m^3$ in the $PM_{2.5}$ daily mean level was associated with an 8% increase (95% CI: 3-14%) in the incidence of symptoms in the lower respiratory tract. It is important to note that results of this study suggest a synergistic effect of PM_{10} and O_3 exposure on the incidence of symptoms in the lower respiratory tract among these children.

Evaluation of the effects of long-term exposure on mortality and morbidity.

Few studies have investigated the long-term health effects of particulate matter in Latin America. In a study conducted in Rio de Janeiro , an association was found between the annual average TSP levels in different districts of the city and mortality for pneumonia among infants (Penna and Duchiade 1991). For each 10 $\mu g/m^3$ increase in TSP, the infant mortality from pneumonia was estimated to increase by 2.2 per 10,000 population.

Studies conducted in Cubatao, Brazil, have documented the decrease in pulmonary functions among children chronically exposed to high particle levels (Hofmeister 1987; Spektor et al. 1991). Children residing in the most polluted areas had lower pulmonary functions. Studies conducted in Chile (SERPLAC 1989; Arranda et al. 1993) reported a higher incidence of respiratory symptoms and lower pulmonary functions in children resident in Santiago than in a control city. The results suggested an association between cough, nocturnal respiratory symptoms and hoarseness, and PM_{10} levels. However, these studies do not provide sufficient data to quantitatively evaluate the risk.

Mediterranean Region

A study showed a significant increase of chest diseases occurred in schoolchildren living in Kafr El-Elwe (a residential settlement close to a cement company) and Helwan City, as compared with those living in Shebin El-Kom, a more rural area (Hussein 1988; Nasralla 1992). It was found that 29.2% of schoolchildren in the first two settlements have obstructive lung diseases compared to only 9% in Shebin El-Kom. Furthermore, the high rate of mortality due to chest and cardiovascular diseases among the population of Helwan and Maadi was related to the prevalence of high concentrations of suspended particles and SO_2 in the atmosphere (Hussein 1988; Nasralla 1992).

Western Pacific Region

Japan

An epidemiological survey of schoolchildren in Japan showed that the prevalence of asthmatic symptoms, and congestion in chest and phlegm, was significantly correlated with levels of SPM (Nitta et al. 1993; Ono et al. 1990; Nakai et al. 1995). The annual mean concentrations of SPM in urban, suburban and background areas were 45.1-52.7 $\mu g/m^3$, 36.5-43.3 $\mu g/m^3$ and 27.8-32.4 $\mu g/m^3$, respectively. The Japanese Environment Agency surveyed the health effects of air pollutants in about 15,000 schoolchildren (EA 1997). The results revealed a correlation between the prevalence of asthmatic symptoms and SPM at annual mean levels of 25-57 $\mu g/m^3$ SPM. An epidemiological study in 185 schoolchildren (Shima and Adachi 1996) has shown that children with high IgE levels appear to be particularly susceptible to the effects of automobile exhaust at annual average concentrations of SPM of about 34 $\mu g/m^3$.

A study of the morbidity of allergic rhinitis based on Japan National Health Insurance records showed a three-fold increase in the rate of allergic rhinitis (AR) over 10 years (Miyao et al. 1993). Additionally, results suggested possible correlations between the morbidity of AR and the mean yearly levels of the pollutant components SPM and NO_2.

China

Epidemiological studies in China show that under long-term exposure, there is a correlation between particle concentrations and mortality from lung cancer. An investigation based on data for 50 million people in 26 cities showed that the average PM_{10} pollution in urban districts and in control districts were 460 $\mu g/m^3$ and 220 $\mu g/m^3$, respectively, and the corresponding average mortality from lung cancer was 14.0% and 7.0% (He Xingzhou et al. 1984; Fang Qisheng et al. 1991). The incidence of respiratory diseases, mainly chronic broncho-pneumonia and emphysema, with symptoms of coughing and dyspnea, increased with increasing particle level. Every 100 $\mu g/m^3$ increase in TSP concentration led to a 6.75% increase in the incidence of chronic broncho-pneumonia in this coal-burning area. The results showed that exposure to 200 $\mu g/m^3$ of TSP can cause upper-respiratory diseases in children; and that 290-470 $\mu g/m^3$ of TSP significantly depressed immune functions in children. TSP concentrations less than 160 $\mu g/m^3$ had no obvious effect on the incidence of respiratory tract diseases. Another study found that organic extracts from TSP of different sizes had different strengths of mutagenic effects. The smaller the particle, the stronger its mutagenic effects (Li Xiuyun et al. 1992).

Exposure to TSP (with the daily-average concentration below 150 $\mu g/m^3$) produced an increased frequency of attacks of asthma in some asthma patients. The lung function of children was reduced after short-term exposure to TSP concentrations over 250 $\mu g/m^3$. When TSP concentration were higher than

750 µg/m^3, middle-aged and old people, people with respiratory disease, and cardiovascular patients exhibited higher mortality (Li Xiuyun et al. 1992).

Australia

In Sydney, a time-series analysis of counts of daily hospital admissions and outdoor air pollutants (Morgan et al. 1998) showed that an increase in daily maximum 1-hour particle concentration was associated with an increase of 3.01% (95% CI: -0.38% to 6.52%) in hospital admissions for chronic obstructive pulmonary disease. An increase from the 10th to the 90th percentile in daily mean particle concentrations was associated with an increase in heart disease admissions among those 65 years and older of 2.82% (95% CI: 0.90 to 4.77), respectively.

A study of daily mortality in the Brisbane region (Simpson et al. 1997) indicated that the associations between total daily mortality and particle levels that were found in the United States and other countries might also be applicable in Brisbane. The associations between particulate matter and daily mortality were significant only for individuals who were older than 65 years of age; positive associations were also found with cardiovascular disease categories. And the regression coefficients, when significant, were higher than those for total mortality. The results did not indicate a threshold for particle levels.

Africa

A paucity of data exists in Africa about health effects associated with exposure to specific air pollutants. However, numerous studies in South Africa have indicated associations between a variety of respiratory symptoms and air pollution in urban, industrial and informal settlement areas. For example, high prevalence rates for respiratory illness were found in a residential suburb within an industrial area, relative to a suburb further away. Similarly, when compared with areas using cleaner fuel, raised levels of respiratory effects have been identified in informal settlements, where coal and wood were commonly used for domestic purposes (Opperman et al. 1993; Terblanche et al. 1992; Terblanche et al. 1993).

Lead

Latin America

Lead is transported to the fetus across the placenta since there is no metabolic barrier to fetal lead uptake. Parental exposure to lead produces toxic effects on the human fetus including reductions in gestational age, birthweight and mental development. A study conducted in Mexico has shown that the concentration of lead in the bone of a mother was significantly related to low birthweight (Gonzalez-Cossio et al. 1997).

The central nervous system is the primary target organ for lead toxicity in children (Needleman and Galsonis 1990), as discussed in Section 3.3. In agreement with these findings a study, conducted in Mexico City among schoolchildren from low-to-medium social status and aged 9-12 years, showed a strong negative correlation between blood lead level, and intellectual coefficients and teacher grading. There was no evidence of a threshold level (Muñoz et al. 1993).

The intensity of vehicular traffic, as a surrogate for exposure to ambient air lead, has been related to blood lead levels. In a study conducted in Mexico, children residing near a road with high traffic volumes had significantly higher levels of lead in blood than did children residing in a residential neighbourhood with smaller traffic volumes (Romieu et al. 1992). In another study conducted in Mexico among two hundred children younger than five years of age, the concentration of lead in ambient air was a significant predictor of blood lead levels (Romieu et al. 1995). The concentration of lead in ambient air (24-hour average) ranged from 0.20-0.52 $\mu g/m^3$. The correlation coefficient between lead in the blood and lead in ambient air was 0.30. It was estimated that for each increase of 1.5 $\mu g/m^3$ of lead in ambient air, the concentration of lead in blood would increase by 1 $\mu g/dl$.

Africa

Studies conducted in Johannesburg indicated that approximately 60% of children have blood lead levels exceeding 10 $\mu g/dl$. Children from an informal settlement group, where coal was largely used for cooking purposes, had significantly higher blood lead levels than their inner city and suburban counterparts. In Cape Town, about 13% of coloured pre-school and first-grade children had blood lead levels above 25 $\mu g/dl$ (Deveaux et al. 1986; von Schirnding 1989; von Schirnding et al. 1991).

4. Indoor Air Quality

Most people spend a large of their time indoors, which makes indoor spaces important microenvironments when addressing risks from air pollution. Most of a person's daily exposure to many air pollutants comes through inhalation of indoor air, both because of the amount of time spent indoors and because of the higher pollution levels indoors. The air quality inside buildings is affected by many factors. In an effort to conserve energy, modern building design has favoured tighter structures with lower rates of ventilation. By contrast, in some areas of the world only natural ventilation is used; in other areas mechanical ventilation is common. Factors that can have a negative effect on health and comfort in buildings range from chemical and biological pollutants, to occupant perceptions of specific stresses such as temperature, humidity, artificial light, noise and vibration.

Although there is a tendency to use similar types of construction all over the world, especially for office buildings, indoor problems are often different in developed countries when compared with less developed countries. While in the former most of the problems arise from low ventilation rates and the presence of products and materials that emit a large variety of compounds, the inhabitants of many less developed countries face problems related to pollutants generated by human activities, in particular by combustion processes.

If health effects of air pollution are being considered, it does not matter if a pollutant is inhaled by breathing outdoor or indoor air. However, outdoor air has a different pollutant composition than that found in indoor air. Traffic-generated emissions are an example of outdoor air pollution; indoors, pollution sources include tobacco smoke and combustion products generated with biomass-fuelled stoves. Not all of these compositions have been taken into account in developing the air quality guidelines, and they may not be applicable under **all** circumstances, so care should be taken to avoid misinterpretation.

4.1 Indoor air pollution in developed countries

4.1.1 Important indoor air pollutants and their sources

Important sources of chemical indoor pollutants include outdoor air, the human body and human activities; emissions from building materials, furnishings and appliances and use of consumer products. Microbial contamination is mostly related to the presence of humidity. The heating, ventilating and air conditioning system can also act as a pollutant source, especially when it is not properly maintained. For example, improper care of filters can lead to re-emission of particulate contaminants. Biological contamination can proliferate in moist components of the system and be distributed throughout the building.

Indoor air pollutants can be classified in different ways. One approach is to divide them into chemical, physical and biological agents. Another approach is to classify them according to their origin. The origin of a particle has an important impact on its composition, which may include chemical and biological agents besides the physical nature of the particle itself. For example, combustion-generated tobacco smoke contains a complex mixture of pollutants.

The sources of indoor air pollution and the principal pollutants, grouped by outdoor and indoor origin, are summarized in Table 4.1. This is not a complete listing of all sources of indoor air pollutants, as there is continuous air exchange between indoors and outdoors, and most pollutants present in the outdoor air are also found indoors. Moreover, indoor sources may lead to an accumulation of some compounds that are rarely present in the ambient air. The most important compounds in indoor air environments include SPM, SO_2, NO_x, CO, photochemical oxidants and lead. In developed countries, pollutant concentrations indoors are similar to those outdoors, with the ratio of indoor to outdoor concentration falling in the range 0.7-1.3. Concentrations of combustion products in indoor air can be substantially higher than those outdoors when heating and cooking appliances are used. This is particularly true in developing countries where ovens and braziers are used with imperfect kitchen and stove designs.

Table 4.1. - Principal pollutants and sources of indoor air pollution, grouped by origin

Principal pollutants	**Sources, predominantly outdoor**
SO_2, SPM/RSP	Fuel combustion, smelters
O_3	Photochemical reactions
Pollens	Trees, grass, weeds, plants
Pb, Mn	Automobiles
Pb, Cd	Industrial emissions
VOC, PAH	Petrochemical solvents, vaporization of unburned fuels
Principal pollutants	**Sources both indoor and outdoor**
NO_x, CO	Fuel burning
CO_2	Fuel burning, metabolic activity
SPM & RSP	Environmental tobacco smoke, resuspension, condensation of vapours and combustion products
Water vapour	Biological activity, combustion, evaporation
VOC	Volatilization, fuel burning, paint, metabolic action, pesticides, insecticides, fungicides
Spore	Fungi, moulds
Principal pollutants	**Sources, predominantly indoor**
Radon	Soil, building construction materials, water
HCHO	Insulation, furnishing, environmental tobacco smoke
Asbestos	Fire-retardant, insulation
NH_3	Cleaning products, metabolic activity
PAH, Arsenic, Nicotine, Acrolein	Environmental tobacco smoke
VOC	Adhesives, solvents, cooking, cosmetics
Mercury	Fungicides, paints, spills or breakage of mercury-containing products
Aerosols	Consumer products, house dust
Allergens	House dust, animal dander
Viable organisms	Infections

Adapted from Suess 1992; WHO 1995i.

4.1.2 Concentrations of indoor air pollutants

Indoor concentrations of air pollutants are influenced by outdoor levels, indoor sources, the rate of exchange between indoor and outdoor air, and the characteristics and furnishings of buildings. Indoor concentrations of air pollutants are subject to geographical, seasonal and diurnal variations.

In developed countries indoor levels of NO_2, for example, are affected by gas heaters and cooking ranges (used in 20-80% of houses in some countries). In five European countries, the average NO_2 concentrations (over 2-7 days) were in the range of 20-40 $\mu g/m^3$ in living rooms and 40-70 $\mu g/m^3$ in kitchens, for dwellings with gas equipment and 10-20 $\mu g/m^3$ in dwellings without gas equipment. These values may be doubled in rooms facing streets with heavy motor traffic. These exposure levels may have an effect on respiratory function, as discussed in Chapter 3. People may be exposed to higher NO_2 levels under certain circumstances, such as in dwellings equipped with unvented cooking ranges. In addition, short-term measurements reveal NO_2 concentrations that may be five-fold higher than those averaged over several days. Peak values of up to 3800 $\mu g/m^3$ for 1 minute have been measured in the Netherlands in kitchens with unvented gas cooking ranges (ECA 1989; Seifert 1993).

In general, average short-term CO concentrations at kerbside locations in developed countries are about 60 mg/m^3 for 30 minutes or 30 mg/m^3 for 1 hour. In kitchens with gas stoves, short-term values of up to 15 mg/m^3 have been measured. High values were also measured in bars and pubs, where smoking is common, with average concentrations of 10-20 mg/m^3 and peak levels up to 30 mg/m^3 (Seifert 1993).

In five developed European countries HCHO concentrations in indoor air were reported to range from 9-70 $\mu g/m^3$. Higher values are occasionally encountered, especially in dwellings with urea-formaldehyde foam insulation (ECA 1990).

In general, average indoor levels of radon are 20-70 Bq/m^3 (ECA 1995), although they may be ten times higher in certain areas.

Exposure to environmental tobacco smoke is an important factor in indoor air quality assessment. The particle and vapour phases of environmental tobacco smoke are complex mixtures of several thousand chemicals, including known carcinogens such as nitrosamines and benzene. One of the most commonly used indicators of environmental pollution by tobacco smoke is the concentration of PM_{10}. This is 2-3 times higher in houses with smokers than in other houses (Schwartz and Zeger 1990). Nicotine is present in the vapour phase, with concentrations of up to 10 $\mu g/m^3$ in houses with smokers. Data from nine European countries revealed that 33-66% of households had at least one smoker. The proportion of children with mothers smoking at home varied from 20-50%, and the proportion of children with fathers smoking at home ranged from 41-57%. Tobacco smoke, and particularly the exposure of children, is therefore a major problem for indoor air quality and environmental health.

4.1.3 Health effects and symptoms

Most indoor air pollutants directly affect the respiratory and cardiovascular systems, and have been discussed in detail in Chapter 3. In this section, health effects of indoor air pollutants not discussed in Chapter 3 will be summarized.

The direct human health effects of indoor air pollution on the respiratory system vary according to both the intensity and the duration of exposure, and also with the health status of the population exposed. Certain parts of the population may be greater risk, for example, the very young and elderly, those already suffering from respiratory disease, hyper-responders and people exercising.

The active and passive inhalation of tobacco smoke can lead to reduced pulmonary function, to an increased incidence of respiratory symptoms and infections, and to an increased incidence of lung cancer.

Inhalation of infectious microorganisms discharged by people and animals is a primary mechanism of contagion for most acute respiratory infections. In indoor environments characterized by reduced ventilation and increased use of untreated recirculated air concentrations of microorganisms may increase.

Outdoor allergens, house dust mites, and moulds in indoor environments of high humidity can cause allergic asthma (reversible narrowing of lower airways), allergic rhinoconjunctivitis in children and young adults, and recurrent bouts of pneumonitis or milder attacks of breathlessness.

The main acute effects of HCHO include odour perception and irritation of eyes, nose and throat. Discomfort, lacrimation, sneezing, coughing, nausea and dyspnea have also been observed, depending on the HCHO concentration.

Health effects reported for VOC range from sensory irritation to behavioural, neurotoxic, hepatoxic and genotoxic effects. Concentrations at which identified health effects occur are usually much greater than those measured in indoor air. Exposure to mixtures of VOC may be an important cause of Sick Building Syndrome (SBS).

Asbestos and other mineral fibres may be a cause of an increased incidence of lung cancer. Acute exposure to asbestos and glass fibres can cause severe skin irritation.

More complex health effects are SBS and Building Related Illnesses (BRI). SBS is the occurrence of specific symptoms with unspecified aetiology, and are experienced by people while working or living in a particular building, but which disappear after they leave it. Symptoms include mucous membrane, skin and eye irritation, chest tightness, fatigue, headache, malaise, lethargy, lack of concentration, odour annoyance and influenza symptoms. SBS usually cannot be attributed to excessive exposure to known contaminant or to a defective ventilation system. A number of factors may be involved:

- Physical factors, including temperature, relative humidity, ventilation rate, artificial light, noise and vibration,
- Chemical factors, including environmental tobacco smoke, HCHO, VOC, pesticides, odorous compounds, CO, CO_2, NO_2 and O_3.
- Biological and psychological factors.

It is assumed that the interaction of several factors, involving different reaction mechanisms, cause the syndrome, but there is yet no clear evidence of any exposure-effect relationship.

BRI is an illness related to indoor exposures to biological and chemical substances (e.g. fungi, bacteria, endotoxins, mycotoxins, radon, CO, HCHO). It is experienced by some people working or living in a particular building and it does not disappear after leaving it. Illnesses include respiratory tract infections and diseases, legionnaires' disease, cardiovascular diseases and lung cancer.

4.2 Indoor Air Quality in Less-Developed Countries

Air quality in buildings in developing countries can have similar problems to those found in developed countries, particularly in the large modern urban areas in developing countries. As smoking rates in developing countries increase, exposure to environmental tobacco smoke can also be expected to increase. In addition, some hazardous materials, particularly pesticides, are becoming so widely used in developing countries that there may be higher indoor exposures than in developed countries.

There can be significant and widespread indoor exposures to many of the classical air pollutants, specifically sulphur dioxide, particulate matter, carbon monoxide, and nitrogen dioxide, in developing countries. A particular issue for developing countries is exposure to emissions from cooking and heating which may produce the highest air pollution exposures to many pollutants. Today about half the population of the world continues to rely for cooking and associated space heating on simple household stoves using unprocessed solid fuels that have high emission factors for a range of health-damaging air pollutants. This section briefly summarizes what is known about the emissions, exposures, and health effects. Possible ways of managing the problems are discussed in Chapter 6.

4.2.1 Emissions

Although part of human experience since the first controlled use of fire, air pollution from simple open combustion of biomass has been scientifically characterized only in the last two decades, largely due to rising concerns about woodsmoke pollution in developed countries. Studies have shown high emission factors for many important pollutants, including respirable particulate matter, carbon monoxide, polycylic aromatic hydrocarbons, such as benzo-a-pyrene, and volatile organic compounds, such as formaldehyde and benzene. Biomass fuels emit hundreds of chemicals during small-scale combustion, such as in household cooking or heating stoves (Smith 1987).

By comparison to modern cooking fuels, such as kerosene and gas, unprocessed solid fuels produce 10-100 times more respirable particulate matter per meal as the result of low (combustion and heat-transfer) efficiencies. Although biomass makes up only 10-15% of total human fuel use, compared to modern fuels a much larger fraction is burned indoors, since nearly one-half of humanity cooks and/or heats with simple stoves burning traditional biomass fuels (WHO 1997a).

Household use of coal is common in China and Eastern Europe. In Eastern Europe, coal is used mainly for heating in devices and emissions are vented outdoors, a process usually resulting in less human exposure than from using coal for cooking.

4.2.2 Concentrations

It is not known what fraction of biomass-burning households cook indoors on unvented stoves, although it is clear that many hundreds of millions do so during some or all seasons of the year. There is also little information about the ventilation rates in the many thousands of housing types in developing countries or countries in transition.

Unfortunately, relatively little monitoring has been done in these indoor environments and none of it has been done in a way to provide statistically valid samples of large populations. The results that have been obtained, nevertheless, are striking. Table 4.1, for example, lists results for particulate matter in indoor air obtained in a number of indoor air quality studies. Other classical pollutants also reach significant levels in these circumstances.

Important non-classical pollutants, such as formaldehyde, polycylic aromatic hydrocarbons, benzene, and 1,3-butadiene also have been found to reach levels much higher than any but occupational settings in developing countries. In some areas of China and India, household coal use leads to high indoor concentrations of fluorine and arsenic with consequent health effects.

4.2.3 Exposures

Population exposure to an air pollutant is defined here as the simple combination of the concentration of the pollutant in air being inhaled, the duration of time over which it is inhaled, and the number of people exposed. As half the households in the world use solid fuels on a daily basis and it is activities such as cooking that generate most indoor emissions, there is a confluence of emissions, people, and time in places which may have relatively little ventilation. Consequently, globally there are high levels of indoor exposure to emissions from solid fuels (Smith 1993).

These high exposures are suggested by the data on personal exposure concentrations experienced by women during cooking over solid fuel stoves listed in Table 4.2.

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4.2.4 Health Effects

Relatively few studies have been conducted to determine the health effects of indoor exposures to air pollutants in developing countries. Enough data has become available in recent years, however, to obtain some preliminary information on the type and very approximate magnitude of effects (Chen et al. 1990).

The following categorizes some major categories of effects where there is reasonable evidence from smoking studies, urban air studies, and multiple studies of solid-fuel use in developing countries. Also listed, where known, are the apparent odds ratios comparing the risk of these diseases between people living in houses using unvented biomass fuel and similar households not using such fuels. All the odds ratios reported here are statistically significant results, mostly of multivariate analyses in which a number of potentially confounding variables were included:

> Acute respiratory infections in children: This is the chief cause of ill-health in the world and strongly associated with indoor use of solid fuels for cooking in a number of studies in Asia and Africa (OR = 2 - 6) (e.g., Pandey et al. 1989; Collings et al. 1990; Mtango et al. 1992; O'Dempsey et al. 1996).
>
> Chronic obstructive pulmonary disease: This has been shown to be strongly associated with use of solid fuels in non-smoking women often along with *cor pulmonale* in studies from Latin America, South Asia and Saudi Arabia (OR = 3.4-15) (e.g., Dennis 1996; Dossing et al. 1994; Pandey 1984; Sandoval et al. 1993; Albalak et al. 1999)
>
> Lung cancer: Lung cancer has been shown in many Chinese studies to be statistically associated with use of coal for cooking and heating, but not biomass fuels (OR = 3-9) (Smith and Liu 1994; Shields et al. 1995).

There is some evidence from studies of solid-fuel use in developing countries indicating a relationship between adverse pregnancy outcomes, the third most important category of ill-health in the world, and smoke exposure. After multivariate analyses, stillbirth has been associated with biomass fuel use by pregnant women in one Indian study (OR = 1.5) (Mavalankar et al. 1991) and with low birth-weight in Guatemala (Boy et al. 1999). After multivariate analyses, TB and blindness (cataracts) have been shown to be related to use of biomass fuels in two national and two local studies in India (Mishra et al. 1999a; Gupta et al. 1997; Mishra et al. 1999b; Mohan et al. 1989). Unfortunately all these studies relied on the type of stove or fuel as the indicator of pollution. More studies are needed that measure concentrations and exposures to indoor air pollutants so that exposure-response relationships can be more firmly determined.

4.2.5 Application of Air Quality Guidelines to Indoor Air Pollutant Exposure

The magnitude and population distribution of indoor air pollution exposure from unvented solid fuel use tends to differ from the outdoor urban air pollution exposures that have been the basis of most of the health effects research cited in Chapter 3. In many situations, for example, exposure levels may be high during cooking periods, with relatively low exposures between cooking periods.

Classical Gaseous Pollutants

All of the classical gaseous pollutants except ozone can be found in indoor solid fuel smoke and these can be a health concern in households with poor ventilation. Although there have been relatively few measurements of gaseous pollutants in developing countries, emissions estimates from solid fuel burning suggest that levels exceeding the air quality guidelines may be widespread in developing countries (WHO 1992c; WHO 1997a).

Particulate matter

The WHO air quality guidelines and most other particulate matter standards do not specify the chemical composition of particles. However, the health effects may vary with differences in particle compositions (see Section 2.4). Most of the epidemiological studies used to derive the air quality guidelines for particulate matter were conducted in cities where fossil-fuel particulate matter dominated and some even had significant contributions from coal burning, sometimes at household scale. Thus, it is important to consider the chemical composition of indoor air particulate matter when considering health effects of emissions from solid fuel combustion.

Very high concentrations of particles in indoor air can occur, sometimes for short duration, such as during cooking over solid fuel fires in rooms with poor ventilation. As discussed in Section 2.4, extrapolations of the air quality guidelines health impacts slope for particulate matter beyond 150 $\mu g/m^3$ PM_{10} must be done with extreme care because there may be a flattening of the exposure/response slope at higher exposure concentrations.

Although some epidemiological studies of particle air pollution were conducted in cities with significant emissions from woodsmoke during some seasons, there is insufficient information to consider the applicability of the new air quality guideline for particulate matter to biomass smoke. Many researchers believe that he chemical composition of fresh biomass smoke from open fires is too different from the aged fossil-fuel particulate matter upon which most of the epidemiological studies have been based to make such an extrapolation with current knowledge. At this stage, no judgment can be made about whether biomass particulate matter is less or more unhealthy than the same exposure concentration of urban outdoor particulate matter, but only that they may induce a different response because of their different composition. Thus, even though it is clear from the existing epidemiological literature that significant ill-effects do occur, it is not possible at this point to be confident about the precise exposure-response relationships.

Tobacco smoke is a fresh biomass smoke, which has been studied far more than any other pollutant mixture. In the form of ETS, it is associated with adverse health impacts in adults and children at particle concentrations similar to those at which the epidemiological studies of health effects of outdoor particulate matter have been conducted (Section 3.4). Even though it is not clear whether particulate matter is the best single measure by which to characterize ETS, the large health impact at concentrations commonly found leads to the conclusion that no level above zero could be considered acceptable (see Section 3.4). It should also be kept in mind that exposure to ETS and other air pollutants can act synergistically to produce adverse health effects (WHO 1999c).

There are similarities between ETS and biomass smoke from stoves, as hundreds of the organic compounds they both contain are similar. This supports evidence that exposure to biomass smoke from open stoves causes considerable human ill-health world wide. Nevertheless, until more evidence becomes available from studies done in biomass-using households, it is considered prudent not to extrapolate the guidelines described for particulate matter in section 3.1 to higher PM concentrations but rather use a conservative approach or alternatively apply the 1987 Air Quality Guidelines for particulate matter (WHO 1987).

Table 4.1. Indoor particle air pollution from biomass combustion in developing countries: partial list of studies measuring area concentrations (Smith 1996).

Country	Year of publication	Description of sample	Concentration [μg/m3]
Papua New Guinea	1968	n=9, overnight, floor level	5200
	1974	n=6, overnight, sitting level	
			1300
Kenya	1971/2	n=8, overnight, highlands/lowlands	4000/800
		1988	n=64, 24 h,
thatched/iron roof		1300/1500 (R)	
India	1982	n=64, 30 min, wood/dung/charcoal	15,800/18,300/5500
	1988	n=390, cooking, 0.7m/ceiling	4000/21,000
	1992	n=145, cooking/non-cooking/living	5600/820/630
	1994	n=61, 24 h, ag-resid/wood	2800/2000 (I)
	1995	n=50, breakfast/lunch/dinner	850/1250/1460 (I)
	1996	n=136, urban, cooking/sleeping	2860/880 (I)
Nepal	1986	n=17, 2 h	4400 (I)
China	1986	n=64	2570
	1987	n=4, 8 h	10,900 (I)
	1988	n=9, 2 houses, 12 h	2900
	1988	n=12, 4 houses, dung	3000 (I)
	1990	15 houses, dung, winter/summer	1670/830 (I)
	1991	straw, avg summer-winter, kitchen/living room/dung	1650/610/1570 (I)
	1991	1-story/2-story houses	80/170
	1993	4 kitchens	1060 (I)
Gambia	1988	n=36, 24 h, dry/wet season	2000/2100 (I)
Zimbabwe	1990	n=40, 2 h	
			1300 (I)
Brazil	1992	n=11, 2-3 h, trad/impr	1100/90 (I)
Guatemala	1993	n=44, 24 h, trad/impr	1200/530 (I)
	1996	n=18, 24 h, trad/impr	720/190 (I), 520/90 (R)
	1996	n=43, 24 h, trad/impr	870/150 (R)
South Africa	1993	n=20, 12 h, kitchen/bedroom	1720/1020
Mexico	1995	n=31, 9 h	335 (R)/439 (I)

(Woodfuel, rural, and TSP unless otherwise stated; I=inhalable=cutoff at approx. 10mm; R=respirable=cutoff at 5mm or smaller; Trad/impr=traditional open stove compared to improved stove with flue)

Table 4.2. Indoor particle air pollution from biomass combustion in developing countries: partial list of studies of individual breathing area concentrations (women during cooking, unless otherwise stated) (Smith 1996).

Country	Year of publication	Description of sample	Concentration [µg/m3]
India	1983	n=65, 4 villages	6800
	1987	n=165, 8 villages	3700
	1987	n=44, 2 villages	3600
	1988	n=129. 5 villages	4700
	1991	n=95, winter/summer/monsoon	6800/5400/4800
	1996	n=40, two urban slums, infants, 24 h	400/520 (I)
Nepal	1986	n=49, 2 villages	2000
	1990	n=40, trad/impr	8200/3000
Zambia	1992	n=184, 4 h, urban, wood/charcoal	470/210 (R)
Ghana	1993	n=143, 3 h, urban, wood/charcoal	590/340 (R)
South Africa	1993	n=15, 12 h, children, winter/summer	2370/290

(Woodfuel, rural, and TSP unless otherwise stated; I=inhalable=cutoff at approx. 10mm; R=respirable=cutoff at 5mm or smaller; Trad/impr=traditional open stove compared to improved stove with flue)

Table 4.3. Particle concentrations and exposures in the eight major global microenvironments (Smith 1996).

	Concentrations			Exposures		
Region	Indoor ($\mu g/m^3$)	Outdoor ($\mu g/m^3$)		Indoor (%)	Outdoor (%)	TOTAL (%)
Developed						
Urban	100	70		7	1	7
Rural	80	40		2	0	2
Developing						
Urban	250	280		25	9	34
Rural	400	70		52	5	57
		TOTAL (%)	==	86	14	100

Note: Population exposures expressed as a percentage of the world total. Here exposure is defined to equal to the number of people exposed multiplied by the duration of exposure and the concentration breathed during that time.

5. Ambient Air Quality Monitoring and Assessment

5.1 Assessment tools and functions

This chapter reviews some of the methodologies and systems used for the assessment of ambient air quality, with particular reference to the requirement for population exposure assessment and for determining compliance with standards or guidelines. The pollutants considered in detail are, SO_2, NO_2, CO, O_3, SPM and lead. These have a variety of potentially acute and chronic population health impacts, discussed in Chapter 3. Accordingly, the evaluation of air quality against guidelines may need to consider a range of time scales for effects, ranging from 10 minutes (SO_2) to one year (NO_2, SO_2, lead).

The three main air quality assessment tools are:

- ambient monitoring
- models
- emission inventories/measurement

The ultimate purpose of monitoring is not merely to collect data, but to provide the information necessary for scientists, policy makers and planners to make informed decisions on managing and improving the environment. Monitoring fulfils a central role in this process, providing the necessary sound scientific basis for policy and strategy development, objective setting, compliance measurement against targets and enforcement action (Figure 5.1).

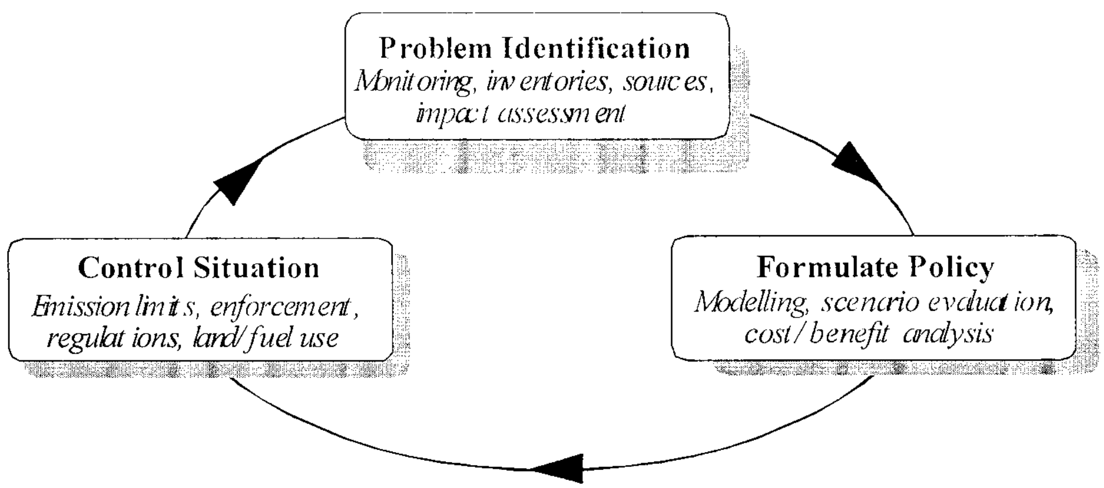


Figure 5.1. The Role of Monitoring in Air Quality Management

However, the limitations of monitoring should be recognized. In many circumstances, measurements alone may be insufficient -or impractical- for the purpose of fully defining population exposure in a city or country. No monitoring programme, however well funded and designed, can hope to comprehensively quantify patterns of air pollution in both space and time. At best, monitoring provides an incomplete - but useful - picture of current environmental quality. Monitoring therefore often needs to be used in conjunction with other objective assessment techniques, including modelling, emission measurement and inventories, interpolation and mapping. These are discussed in greater detail in Chapter 6.

Conversely, reliance on modelling alone is not recommended. Although models can provide a powerful tool for interpolation, prediction, and optimization of control strategies, they depend on the availability of reliable emission data. A complete inventory for a city or country may need to include emissions from point, area and mobile sources; in some circumstances, assessment of pollutants transported into the area under study may also need to be considered. It is important, also, that the models utilized are appropriate to local conditions, sources and topography, as well as being selected for compatibility with available emission and meteorological datasets.

Inventories will, for the most part, be estimated using emission factors appropriate to the various source sectors (verified by measurement), and used in conjunction with surrogate statistics such as population density, fuel use, vehicle kilometres or industrial throughput. Emission measurements will usually only be available for large industrial point sources, or from representative vehicle types under standardized driving conditions.

All three assessment tools are interdependent in scope and application. Accordingly, monitoring, modelling and emission assessments should be regarded as complementary components in any integrated approach to exposure assessment or determining compliance against air quality criteria. Thus, for a reasonably complete picture of population exposure, ambient monitoring data will need to be supplemented by corresponding information from microenvironment and individual exposure surveys. This chapter focuses on ambient monitoring techniques and systems. Historically, these have provided most of the data used for exposure assessment. Recent publications have dealt in some detail with microenvironment and individual exposure monitoring (WHO 1999a). These issues are discussed in Chapter 4.

5.2 Monitoring objectives

The first step in designing or implementing any monitoring system is to define its overall objectives. Setting diffuse, overly restrictive or ambitious monitoring objectives will result in cost-ineffective programmes with poor data utility. In such circumstances, it will not be possible to make optimal use of the available manpower and resources. Thus it is vital that clear, realistic and achievable monitoring objectives be set. This enables appropriate Data Quality Objectives (DQOs) to be defined (Box 5.2). In turn, this makes it possible for a targeted and cost-effective Quality Assurance Programme (QAP) to be developed. Overall requirements for such a programme are addressed in outline in section 5.3. A clear definition of overall monitoring objectives and DQOs is therefore essential to enable networks to be optimally designed, priority pollutants and measurement methods to be selected, and data management/reporting requirements to be identified (Figure 5. 2).

The relationships between the data collected and the information to be derived from it must be taken into account when a monitoring programme is planned. This emphasizes the need for users and potential users of the data to be involved in the planning of surveys, not only to ensure that they are appropriate to their needs, but also to justify the resource commitment. It should be recognized that monitoring networks are invariably designed for a variety of functions. These may include policy and strategy development, local or national planning, measurement against international standards, identification/quantification of risk and public awareness. Typical monitoring functions are summarized in Box 5.1. Every monitoring survey or network is therefore different, being influenced by a unique mix of local/national issues and objectives.

Box 5.1 - Key Monitoring Objectives

- Determining population exposure and health impact assessment.
- Informing the public about air quality and raising awareness.
- Identifying threats to natural ecosystems.
- Determining compliance with national or international standards.
- Providing objective inputs to Air Quality Management, traffic and land-use planning.
- Source apportionment and identification.
- Policy development and prioritisation of management actions.
- Development/validation of management tools (models, Geographical Information Systems etc.).
- Assessing point or area source impacts.
- Trend qualification, to identify future problems or progress against management/control targets.

Box 5.2 - Data Quality Objectives

The essential requirements to be met by measurements, if overall monitoring objectives are to be achieved.

- Measurement accuracy and precision.
- Traceability to metrology standards.
- Temporal completeness (data capture).
- Spatial representativeness and coverage.
- Consistency - from site to site and over time.
- International comparability/harmonization.

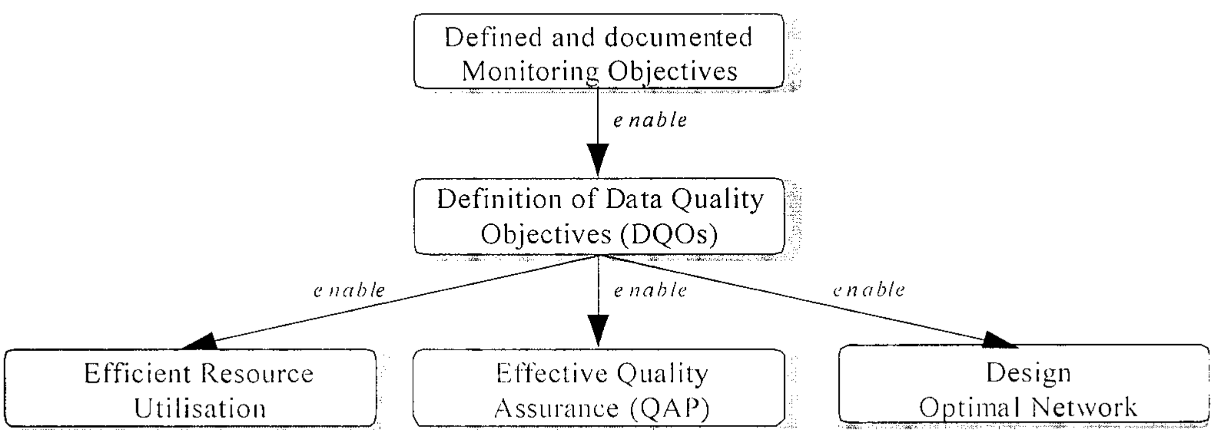


Figure 5.2 The Importance of Objective Setting

5.3 Quality assurance and quality control (QA/QC)

Quality assurance and control (QA/QC) is an essential part of any air monitoring system. It is a programme of activities that ensures that measurements meet defined and appropriate standards of quality, with a stated level of confidence. It should be emphasized that the function of QA/QC is not to achieve the highest possible data quality. This is an unrealistic objective, which cannot be achieved under practical resource constraints. Rather, it is a set of activities, which ensures that measurements comply with the specific DQOs for the monitoring programme. In other words, QA/QC ensures that data are fit for the purpose. Major QA/QC objectives are summarized in Box 5.3, whilst the functional components of a QA/QC programme are identified in Box 5.4.

Quality assurance activities cover all pre-measurement phases of monitoring, including determining monitoring and data quality objectives, system design, site selection, equipment evaluation and operator training. Quality control functions affect directly measurement-related activities such as site operation, calibration, data management, field audits and training. The successful implementation of each component of a QA/QC scheme is necessary to ensure the success of the complete programme. QA/QC may be regarded as a chain of activities designed to deliver credible and accurate data, but a chain is only as strong as its weakest link!

Box 5.3 - QA/QC for Air Monitoring: overall objectives

- Measurements accurate, precise and credible.
- Data representative of ambient or exposure conditions.
- Results comparable and traceable.
- Measurements consistent over time.
- High data capture, evenly distributed.
- Optimal use of resources.

Box 5.4 - QA/QC for Air Monitoring: the major components

	• Definition of monitoring and data quality objectives.
Quality Assurance	• Network design, management and training systems.
	• Site selection and establishment.
	• Equipment evaluation and selection.
	• Routine site operations.
Quality Control	• Establishment of calibration/traceability chain.
	• Network audits and inter-calibrations.
	• System maintenance and support.
	• Data review and management.

Although the main principles of QA/QC system design apply to most network or instrumentation types, there are often characteristic differences in their emphasis and practical implementation. It is a common oversight to place too much emphasis on laboratory-based quality assurance activities, as these are often easier to control and monitor.

Although such QA/QC tasks are vital, particularly for sampler-based measurement programmes involving substantial laboratory analysis, considerable emphasis in any network quality system needs to be focused on the point of measurement. Mistakes or problems at the start of the measurement chain cannot be readily corrected afterwards. Sample system design and maintenance (see Section 5.4.3), regular site visits, audits and inter-calibrations therefore play an important role in network quality assurance.

Another unifying feature of network quality systems is the need for effective data screening and validation. In any measurement programme -however well designed or operated- equipment malfunction, human error, power failures, interference and a variety of other disturbances may result in the collection of spurious data. To maximize data integrity and utility, therefore, these must be identified and removed before a final, definitive dataset can be generated or used.

The design of an effective and targeted QA/QC programme is only the first step in the process of quality management. The programme needs to be fully documented, and compliance with its procedures and requirements actively monitored. Monitoring programmes often evolve over time as objectives, legislation, resources or air pollution problems change. Quality assurance programmes therefore also need to be regularly reviewed, to ensure that they remain properly targeted and fit for purpose.

A step-by-step model for the development and implementation of QA/QC programmes for air monitoring is depicted in Figure 5.3. QA/QC systems are considered in greater detail elsewhere (UNEP/WHO 1994a; Bower 1997).

5.4 Network design

There are no universal rules for network design, since any decisions will be determined ultimately by the overall monitoring objectives and resource availability. Although monitoring systems can have just a single, specific objective, it is more common for them to have a broad range of targeted programme functions. No survey design can hope to completely address all the possible monitoring objectives listed in Box 5.1. However, the design of surveys to meet these individual requirements often has common features, and can use common data (to avoid duplication of effort) and overlapping data to verify the credibility of results and conclusions. The overall design goal is to ensure that the maximum information can be derived from the minimum effort. In some countries, networks may be operated by a variety of organisations, including different Government Departments. In such a circumstance, harmonization of the programmes and sharing of data is vital to avoid unnecessary effort and to maximize overall cost-effectiveness.

5.4.1 Resource constraints and issues

A key issue, which needs to be addressed at a very early stage of the network design process, is that of resource availability (Box 5.5). In practice, this is usually the major determinant in network design, which will exert a particularly strong influence on the choice of site numbers, pollutants to be monitored and instrumentation selected.

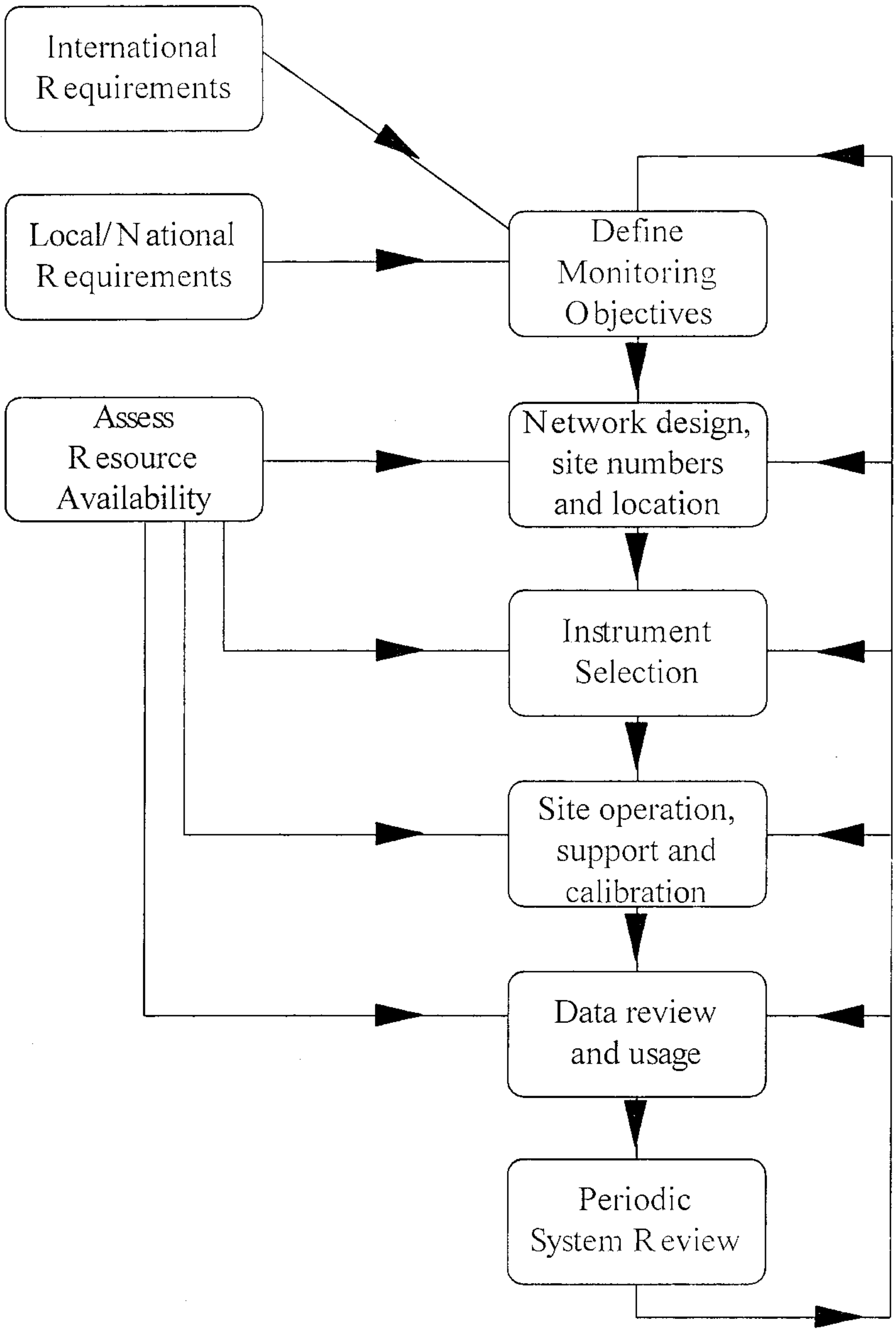


Figure 5.3. QA/QC for Air Monitoring: a Step-by-step Approach

A wide range of commitments and costs is likely to be incurred in any air monitoring programme. Some of these are listed in Box 5.6. Before any firm capital or resource commitment, it is therefore essential to plan the survey, assess resource availability, select the most appropriate equipment and choose monitoring sites.

Box 5.5 - Network Design: important resource constraints
\$ money (capital and ongoing). ☺ skilled manpower. 🕑 time.

When any equipment purchase must be made, consideration is needed of its long-term operational or financial sustainability. Local sustainability requires the continuing availability of agents (or an in-house capability) for repair and maintenance, together with the necessary skill-base for routine equipment operation and calibration. Financial sustainability requires an ongoing budget for equipment operation, typically amounting to about 10% per annum of the initial capital expenditure.

Box 5.6 - Costs of Air Monitoring
• Capital purchase of analysers, samplers, site and laboratory infrastructure. • Equipment service, maintenance and repair. • Staff and subcontractor costs - operational and management. • QA/QC audits, intercalibrations, training, data management. • Running costs - site rental, electricity, consumables, spare parts, calibration gases, telephone, lab analysis, transport etc.

An ongoing resource commitment to QA/QC is also required in any monitoring survey or network, to ensure that its measurement quality and availability are fully consistent with overall programme objectives. Typically, a budget of between 20-40% of the total annual operating costs may be appropriate for this purpose, depending on the complexity of the programme and the stringency of its DQOs.

5.4.2 Site numbers and selection

For the purposes of designing a network to assess population exposure and compliance with health guidelines, a number of basic issues need to be addressed (Box 5.7).

Box 5.7 - Compliance Monitoring- basic issues
• Where is the population? • What pollutant concentrations are they exposed to? • ... and for how long? • In what areas and micro-environments is exposure important?

In practice, the number and distribution of air quality monitoring stations required in any network, or the number of samplers used in a survey, also depend on the area to be covered, the spatial variability of the pollutants being measured and the required data usage (Box 5.8).

Box 5.8 - Network Design: Site Numbers
Will depend on: • required data use/objectives. • area to be covered. • spatial variability of pollutants. • resource availability. • instruments deployed.

There are a number of approaches to network design and site selection. Exposure assessment, in particular, will often need to target both source-oriented monitoring sites (often synonymous with worst-case or 'hot-spot' environments) and background locations optimized for quantifying general population exposure. Depending on the pollutants under assessment, data from a wide variety of location types may therefore be necessary to build up a reasonably complete picture of exposure patterns (Box 5.9).

Although the overall requirement of any network or survey is to maximize spatial coverage and representativeness, in practice this goal is only approached by grid-based monitoring strategies: these can be optimized to provide detailed information on spatial variability and exposure patterns for priority pollutants. However, this approach is highly resource-intensive and not, in consequence, widely used. To reduce resource requirements, a grid approach can be utilized in conjunction with intermittent or mobile sampling, although use of this technique is not consistent with the need to maximize temporal representativeness as well as spatial coverage (see section 5.4.3).

A more flexible approach to network design, appropriate over city-wide or national scale, involves siting monitoring stations or sampling points at carefully selected representative locations, chosen on the basis of required data and known emission/dispersion patterns of the pollutants under study. This approach to network design requires considerably fewer sites than grid strategies and is, in consequence, cheaper to implement. However, sites must be carefully selected if measured data are to be useful. Moreover, modelling and other objective assessment techniques may need to be utilized to 'fill in the gaps' in any such monitoring strategy.

Box 5.9 – Possible Monitoring Locations Relevant to Exposure Assessment	
Site Classification	**Description**
• city/urban centre	An urban location representative of general population exposure in towns or city centres, e.g. pedestrian precincts and shopping areas
• urban background	An urban location distanced from sources and therefore broadly representative of city-wide background conditions
• suburban/residential	A location type situated in a residential area on the outskirts of a town or city
• kerbside/near road	A site sampling within 1-5 metres of a busy road
• industrial	An area where industrial sources make an important contribution to long-term or peak concentrations
• rural	An open countryside location distanced as far as possible from roads, populated and industrial areas.
• source/target-oriented	Any special source-orientated or micro-environment site. For example, garages, car parks or tunnels, or a site located at a targeted receptor point such as schools or hospitals
• indoor	Will include domestic and office environments (excluding occupational), together with in-car and commuting environments- see Chapter 6.

Some general points to consider when selecting a site location are:

- **Overall monitoring objectives.** These usually determine the target areas for study, the priority pollutants and the number of sites required.

- **Sources and emissions**. Compilations of emission data can assist substantially in site selection. These will help to identify the most polluted areas, as well as other location types where population exposure may be significant. If a full emission inventory is not available, then surrogate statistics such as population density, traffic flows and fuel consumption may be of use in estimating likely pollution 'hot spots', where target receptor exposure may be maximized.

- **Meteorology and topography**. The prevailing weather conditions and local topography will strongly influence the dispersion of air pollutants or, in the case of secondary pollutants, affect their production in the atmosphere.

- **Model simulations**. The results of dispersion modelling, if available, can be used to predict pollutant dispersion and deposition patterns, thereby helping to identify areas where exposure may be maximized. To be of real use, reliable emissions and meteorological data are needed, together with an appropriate and validated model.

- **Existing air quality data**. If monitoring has already been carried out in the area of interest, the data from previous studies may prove useful in targeting problem areas. If no such studies have been carried out, special screening surveys may be designed to provide area-wide or local information on pollution problems. These often involve passive samplers and/or mobile monitoring laboratories.

- **Other information** such as demographic, health, population and land-use information are invaluable in targeting locations representative of both baseline and worst-case exposure. The use of Geographical Information Systems (GIS), in particular, allow both ambient measurements and other geo-co-ordinated datasets to be used for exposure assessment, epidemiological studies and a range of air quality management activities.

The site-selection process must also take into account the spatial distribution and variability of criteria pollutants within urban environments. For example, concentrations of primary traffic pollutants such as CO are highest at roadside locations, whereas O_3 levels have higher spatial uniformity but will be lowest in near-road locations due to scavenging by vehicle NO_x emissions. For this reason, it is usually not possible to optimize measurements for all pollutants at any one site location. In such circumstances, some degree of compromise will often be required. In general, the spatial variability of secondary pollutants, such as NO_2 and O_3, tends to be more homogeneous than for primary pollutants such as CO and SO_2. This greater variability of primary pollutants, in particular in proximity to sources, will have obvious implications for monitoring site density and numbers required in any survey.

Micro-scale siting considerations are also important in ensuring that meaningful and representative measurements are made. If baseline concentrations are to be assessed, then monitoring sites should be adequately separated from local pollutant sources (for example, roads or small boilers) or sinks (such as dense vegetation). Probe aerodynamics and site sheltering will also often be important. Free airflow around the sampling inlet will be necessary to ensure representative sampling; for this reason, sampling in a stagnant or sheltered micro-environment should be avoided.

A variety of practical considerations also apply when selecting monitoring sites. They must be accessible for site visits, but the potential for public interference or vandalism must also be recognized. Electricity for pollutant analysers and station infrastructure must be available, together with a telephone linkage for data telemetry, if utilized (Box 5.10).

Box 5.10 - Network Design: Micro-Scale

Need to consider -

- public safety.
- visual intrusiveness/aesthetics of site.
- security/vandalism.
- access to utilities and maintenance.
- planning permission.
- local sources/sinks.
- aerodynamic clearance/sheltering.

5.4.3 Sampling strategies and systems

Monitoring involves assessing pollutant behaviour in both space and time. A good network design should therefore seek to optimize both spatial and temporal coverage, within available resource constraints (UNEP/WHO 1994a; Bower 1997). The previous section dealt with maximizing spatial coverage and obtaining representative measurements. Achieving good time-domain performances is not a problem for most commonly-used air monitoring methodologies (see Section 5.5). However, once priority pollutants are identified, the measurement technologies selected must be capable of a time resolution consistent with the pollutant averaging times specified in guidelines.

Continuously operating automatic analysers may be used to assess compliance with short- or long-term guidelines. Well-recognized semi-automatic methods such as acidimetric SO_2 samplers (see Section 5.7.1) will be perfectly adequate for measurement against daily standards or criteria. For automatic analysers or samplers to reliably measure ambient pollutant concentrations, it is essential that these pollutants are transferred unchanged to the instrument reaction cell. The sampling manifold is a crucial and often overlooked component of any monitoring system, which strongly influences the overall accuracy and credibility of all the measurements made.

Integrating measurement methods such as passive samplers, although fundamentally limited in their time resolution, are useful for the assessment of long-term exposure, as well as being invaluable for a variety of area-screening, mapping and network design functions (UNEP/WHO 1994b). Problems can arise, however, when using manual sampling methods in an intermittent, mobile or random deployment strategy. Such an approach is usually adopted for operational or instrumentation reasons, or simply because it would not be possible to analyse the sample numbers or data produced by continuous operation. Intermittent sampling is still widely used world-wide. However, this sampling strategy may be of limited utility in assessing diurnal, seasonal or annual pollutant patterns or, indeed, for a reliable assessment of population exposure patterns.

When auditing monitoring sites world-wide, sampling system deficiencies are by far the most commonly encountered problem. Usually, these result from inappropriate designs or inadequate cleaning of the sampling system. Some design requirements, common to all gas sampling systems for analysers or samplers, are summarized in Box 5.11. Corresponding requirements for SPM are complex, and these are discussed in detail elsewhere (UNEP/WHO 1994c).

Box 5.11 - Key Air Sampling System Requirements
• Inertness to pollutants being sampled. • Minimized air-residence time. • Low airstream/sample line interaction. • Excess flow above total analyser demand. • Minimized pressure drop. • Removal of interferences such as water vapour/pollutants. • Avoidance of thermal "shock" (when hot, humid, ambient air is sampled into an air-conditioned enclosure). • ease of cleaning and maintenance... • ...which must be done regularly!

5.5 Instrument issues

The capabilities of air monitoring methodologies, as well as their inevitable resource implications, exert a strong influence on network design. This section reviews some of these issues. Specific monitoring methods applicable to individual criteria pollutants are reviewed in Section 5.7.

Air monitoring methodologies can be divided into four main generic types, covering a wide range of costs and performance levels. These are passive samplers, active samplers, automatic analysers and remote sensors. The main advantages and characteristics of these monitoring technologies are summarized in Box 5.12.

Box 5.12 - Air Monitoring Techniques

Method	Advantages	Disadvantages	Capital Cost
Passive Samplers	• Very low cost. • Very simple. • No dependence on mains electricity. • Can be deployed in very large numbers • Useful for screening, mapping and baseline studies.	• Unproven for some pollutants. • In general only provide monthly and weekly averages. • Labour-intensive deployment/analysis. • Slow data throughput.	US$10-70 per sample.
Active Samplers	• Low cost. • Easy to operate. • Reliable operation/ • performance. • Historical dataset.	• Provide daily averages. • Labour-intensive sample collection and analysis. • Laboratory analysis required.	US$1000-3000 per unit.
Automatic Analysers	• Proven. • High performance. • Hourly data. • On-line information.	• Complex. • Expensive. • High skill requirement. • High recurrent costs.	US$10 000-15 000 per analyser.
Remote sensors	• Provide path or range-resolved data. • Useful near sources. • Multi-component measurements.	• Very complex and expensive. • Difficult to support, operate, calibrate and validate. • Not readily comparable with point data. • Atmospheric visibility and interferences.	US$70 000 - 150 000 per sensor, or more.

Passive samplers

These offer a simple and cost-effective method of screening air quality in an area. A sample integrated over a defined exposure time (typically a week to a month) is collected by molecular diffusion to a pollutant-specific absorbent material. The low unit costs permit sampling at a number of points in the area of interest. This is useful in highlighting "hot-spots" of high pollutant concentrations, such as major roads or emission sources, where more detailed studies may be needed. Careful survey design and attention to laboratory-based QA/QC of the sample analysis process is necessary to make best use of this technique.

Active samplers

Pollutants samples are collected either by physical or chemical means for subsequent analysis in a laboratory. Typically, a known volume of air is pumped through a collector such as a filter or chemical solution for a known period of time, which is then removed for analysis. There is a long history of active sampler measurements in many parts of the world, providing valuable baseline data for trend analyses and comparison. Sampling systems (for gases), sample conditioning, weighing systems (for SPM) and laboratory procedures are key factors influencing the quality of the final data.

Automatic analysers

These can provide high-resolution measurements (typically hourly averages or better) at a single point for most of the criteria pollutants (SO_2, NO_2, CO and SPM), as well as for other important species such as VOC. The sample is analysed on-line and in real-time, usually by electro-optic methods: UV or IR absorption, fluorescence or chemiluminescence are common detection principles. To ensure the data from automatic analysers are accurate and reliable, a high standard of maintenance, operational and quality assurance/control procedures is invariably required.

Remote sensors

These are recently developed instruments which use long-path spectroscopic techniques to make real-time concentration measurements of a range of pollutants. The data are obtained by integrating along a path between a light source and a detector. Long-path monitoring systems can have an important role to play in a number of monitoring situations, particularly in proximity to sources. A high standard of operational, calibration and data screening/management practice is essential if meaningful data are to be produced by such systems.

General advice on instrument selection

It is advisable to always choose the simplest technique that will do the job. Inappropriate, too complex or failure-prone equipment can result in poor network performance, limited data utility and - worst of all - a waste of money. Although monitoring objectives are the major factor to consider, resource constraints and the availability of skilled manpower must also be considered. There is a clear trade-off between equipment cost, complexity, reliability and performance. More advanced systems can provide increasingly refined data, but are usually more complex and difficult to handle.

Sampler methods are not necessarily less accurate than automatic analysers. For instance, data from co-located chemiluminescence NO_x analysers and diffusion tubes can show excellent agreement, to within plus or minus 10%, providing both techniques are subject to high standards of quality assurance and operational practice (Smith et al. 1997). In practice, the combined use of samplers and automatic analysers in a 'hybrid' monitoring programme can offer a versatile and cost-effective approach to network design over a municipal or national scale. Such a network design will use passive or active samplers to provide good spatial coverage and area-resolution of measurements. Automatic analysers, deployed at carefully selected locations, can provide more detailed time-resolved data for assessing peak concentrations or comparison with short-term standards.

In some circumstances, additional use may be made of passive or active samplers. Reasonably robust statistical relationships can often be derived between peak, upper percentile and long-term average pollutant concentrations (Carless et al. 1994). Although these semi-empirical relationships may differ from pollutant to pollutant, as well as with generic site type, they may enable long-term datasets from sampler surveys to be used to assess broad compliance with short-term guidelines; or at least to identify areas where exceedances are likely. This indirect assessment technique should, however, always be used with caution.

Deducing the levels of one pollutant from measurements of another may be possible when the local air pollution climate is dominated by emissions from one source sector, and where robust and well-established emission ratios exist for the species in question. For example, traffic-related benzene and lead levels may in some circumstances be estimated from corresponding CO concentrations. However, surrogate measurements of this kind must always be used with caution.

5.6 Turning data into information

As emphasised in the introduction to this chapter, the purpose of monitoring is not merely to collect data, but to produce useful information for planning, health professional, regulatory and public end-users (Figure 5.4). Raw data by themselves are of very limited utility. These first need to be screened (by validation) and collated to produce a reliable and credible dataset (UNEP/WHO 1994a; Bower 1997). In effective Air Quality Management Information Systems, the validated measurements will be archived together with corresponding emission datasets, model predictions and other input relevant to decision-making.

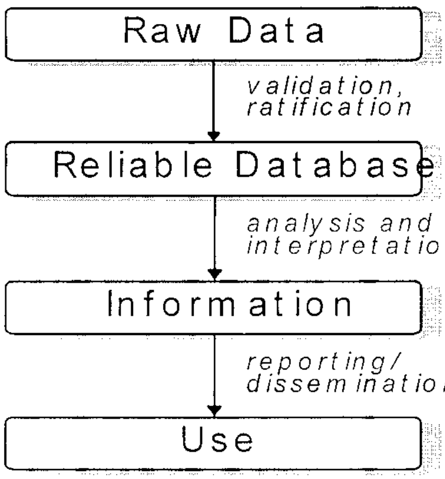


Figure 5.4 Data throughput from a monitoring programme

The next stage in data management is analysis and interpretation, designed to provide useful information in an appropriate format for end-users. A variety of proven analytical methodologies are available for air quality datasets. However, the appropriate level and method of data treatment will be determined by the ultimate end-use. A minimum level of data management could be the production of daily, monthly and annual summaries, involving simple statistical and graphical analyses that show both time and frequency distributions of the monitoring data. The use of Geographical Information Systems (GIS) should be considered, particularly when the intention is to combine pollution data with those from epidemiological and other geo-co-ordinated social, economic or demographic sources.

The information derived from measured data must be reported or otherwise disseminated in a timely manner to end-users. This can be in the form of complete datasets, processed summaries, peak or average statistics, exceedances of standards or targets, analytical results, graphs or maps. Formats for information transfer should be designed which are both appropriate to the capabilities of the network and to the requirements of the users. Communicating data or information may involve a number of transmission methods, including paper reports, CD-ROMs, electronic, broadcast and INTERNET media. Public information systems, often exploiting innovative broadcast and world wide web media, play an increasingly important role in many countries in raising awareness, warning of pollution episodes and advising susceptible population subgroups.

5.7 Key pollutants and measurement methods

This section summarizes the measurement techniques available for determining ambient concentrations of the main "classic" pollutants, SO_2, NO_2, CO, O_3, SPM and lead. There is some overlap between these techniques and corresponding methodologies used for individual exposure and micro-environment surveys. At extreme ambient concentrations, moreover, some occupational exposure measurement systems, such as detector tubes, may be used in a semi-quantitative manner (Saltzman and Caplan 1995).

Sulphur dioxide

As the main source of this pollutant is the combustion of fossil fuels containing sulphur, either in power stations or domestic/commercial space heating, the major local source types strongly influences monitoring and assessment strategies. Automatic analyzers need to be used if compliance against a short-term guideline is to be determined; a variety of active samplers are suitable for comparison with daily or annual guidelines. Passive samplers may be used to provide data for comparison with the long-term annual guideline.

Passive samplers

There are currently no national or international standards governing the application of SO_2 diffusion tubes to ambient air monitoring, nor for their laboratory preparation and analysis. Protocols for sample preparation and analysis by spectrophotometry and ion exchange chromatography have, however, been published in scientific literature (Bennett et al. 1992; Downing et al. 1994: Hargreaves and Atkins 1988).

A variety of passive sampling techniques are available (UNEP/WHO 1994b). The most widely used include:

- The triethanolamine (TEA)/glycol/spectrophotometry method (Hangartner et al. 1989).
- The potassium hydroxyde (KOH)/glycerol/spectrophotometry method (Hargreaves and Atkins 1988).
- The sodium carbonate (Na_2CO_3)/glycerine/ion-exchange chromatography method (Ferm 1991).

Hybridization of these techniques is widespread. In the UK, for instance, KOH or NaOH is used as absorbent, but with the tube membrane proposed by Ferm (1991) and using ion-exchange chromatography as the analysis method. In practice, the ion-exchange chromatographic technique has been informally accepted as the standard method for SO_2 diffusion tube analysis. The typical sensitivity of this hybrid technique is $\pm 8.5\ \mu g/m^3$: some under-reading against automatic analysers has been observed (about 30%), although agreement with active samplers is better (Downing et al. 1994).

Active samplers

The equipment required for sampling gaseous sulphur compounds in ambient air is described in full in International Standard ISO 4219 (ISO 1979). This standard gives details of the equipment necessary to sample gaseous pollutants by absorption in a liquid bubbler. The standard also includes guidance for siting and installation of the apparatus. The principle of active-sampling methodologies is to draw ambient air through a collecting medium (typically a liquid bubbler), for a specified time, typically 24 hours. The volume of air is metered. The collecting medium is subsequently analysed and the concentration of pollutant in the sampled air determined. This proven method is well established, and has been used in many monitoring networks worldwide for a number of years. In consequence, there is a long history of active sampler SO_2 measurements available for trend assessment.

There are several methods of SO_2 monitoring based on this principle, which can be carried out using the apparatus specified in ISO 4219. They differ with respect to the solutions used in the bubblers for SO_2 absorption and the method of analysis. The four most widely used methods are described below.

Acidimetric (total acidity) method. This method, given in ISO 4220 (ISO 1983), is used to determine a gaseous acid air pollution index. Although this method measures total acidity, and is not specific for SO_2, it is adequate for general use. The simplicity of the method, and the fact that the reagents are relatively safe, makes it a popular choice for routine monitoring (AEA 1997). An accuracy of ±10% has been estimated for SO_2 measurements using the total acidity method, taking account of all contributory factors. A precision of ±4 $\mu g/m^3$ is achievable for this widely-used method (AEA 1997).

Ion-exchange chromatography. A variation on the above technique. The exposed peroxide solutions are analysed for sulphate ions by means of ion-exchange chromatography, rather than titration. This has the advantage of being sulphate-specific, but requires the use of an expensive ion-exchange chromatograph.

Tetrachloromercurate (TCM) method. This is also known as the Pararosaniline method ISO 6767 (ISO 1990). This is the reference method specified in the EC Directive on SO_2 and suspended particulate matter(EC 1980). However, the reagents used are very toxic, and for this reason the method is not widely used.

Thorin method. This method is given in ISO 4221 (ISO 1980). The reagents used include perchloric acid, barium perchlorate, dioxane and thorin. These are hazardous and must be handled and disposed of with care. Accordingly, this method is not commonly used world-wide.

Automatic analysers

The measurement of SO_2 in ambient air using automatic analysers is covered by ISO/DIS 10498 (ISO/DIS 1999). Well-established automatic monitoring techniques are available. The most widely used method for automatic SO_2 measurement is ultraviolet fluorescence (UVF). SO_2 molecules in the sample airstream are excited to higher, unstable energy states by UV radiation at 212 nm. These energy states decay, causing an emission of secondary fluorescent radiation with an intensity proportional to the concentration of SO_2 in the sample.

The accuracy of data from automatic SO_2 analysers depends on a range of factors encompassing the entire measurement chain. These include accuracy of calibration standards, analyser stability and sample losses in the measurement system. An accuracy of ±10% has been estimated for SO_2 measurements in UK national automatic networks, taking account of all contributory factors. The precision of SO_2 measurements, determined from long-term variations in baseline response of in-service analysers, is estimated to be ±3 $\mu g/m^3$ (AEA 1996).

Remote sensors

Remote optical sensor systems, such as the Differential Optical Absorption System (DOAS), use a long-path spectroscopic technique to make real-time measurements of the pollutant concentration by integrating readings along a path between a light source and a detector. Long-path monitoring systems can be used to measure SO_2, but the methodology is less well established than that for automatic point monitors. The accuracy and precision of the data from these instruments are, therefore, much more difficult to determine. The method does not conform to ISO 7996 (ISO 1985b). Particularly careful attention needs to be paid to instrument calibration and quality assurance to obtain meaningful data from remote sensing instruments.

Nitrogen dioxide

Automatic analysers must be used for the direct determination of compliance against the hourly guideline, although much useful information can be inferred using passive samplers (see section 4.5). Either technique is applicable for comparing ambient levels against the annual guideline.

Passive samplers

Monitoring ambient NO_2 concentrations using passive diffusion tube samplers is now well established. This method provides an integrated, average concentration for the pollutant over the exposure period (typically 2-4 weeks) and is particularly well suited to baseline and screening studies for assessing the spatial distribution of NO_2 concentrations in an urban environment. The most widely used techniques are variants on the Palmes-type sampler, originally developed for the assessment of occupational exposure. This uses a tube sampler, employing TEA as absorbent. Sample analysis, after thermal desorption, is by spectrophotometry or ion-exchange chromatography (Palmes et al. 1976). Very large scale mapping surveys are possible using diffusion tubes, but careful attention both to the harmonization of analytical procedures and to the outputs from different analytical laboratories is essential for the success of large-scale passive sampler surveys.

Although extensively used throughout the UK and Europe there are, at present, no national or international standards governing the application of diffusion tubes for ambient air quality monitoring, nor for the laboratory preparation and analysis of diffusion tubes. Protocols for sampler preparation and analysis by spectrophotometry have, however, been published in the scientific literature (Palmes et al. 1976; Atkins et al. 1986); these have been informally accepted as standard procedures for NO_2 diffusion tube preparation and analysis.

Recent comparisons of NO_2 diffusion tube measurements with co-located chemiluminescent NO_x analysers show good agreement (Smith et al. 1997; Gerboles and Amantini 1993). Over the range of concentrations generally encountered in urban areas (20-80 $\mu g/m^3$), it was found that on average NO_2 diffusion tubes, exposed for one month, tended to overestimate ambient NO_2 by approximately 10% compared with a chemiluminescent NO_x analyser. Precision estimates of the diffusion tube technique have been quoted as 5-8% in similar studies.

Active samplers

A variety of active sampler technologies are available (UNEP/WHO 1994b). The best known of these is the Griess-Saltzman method, covered by ISO 6768 (ISO 1985a). Although this method is sensitive and requires a relatively simple, inexpensive sampling apparatus, there are a number of disadvantages. It is a relatively skilled and labour-intensive technique, uses corrosive chemicals and is not readily applicable to sampling periods longer than 1-2 hours. There also remain doubts about calibration methods, collection efficiency and possible side-reactions. In consequence, this method cannot be recommended for general baseline monitoring applications.

Automatic analysers

The reference method for automatic measurement of nitrogen oxide concentrations, as defined for compliance with EC Directive 85/203/EEC (EC 1985), is the automatic chemiluminescence method described in ISO standard 7996 (ISO 1985b). This method is widely used world wide. The method is based on the chemiluminescence energy emitted when NO in the sample airstream reacts with O_3 in an evacuated chamber to form an excited energy state of NO_2. The chemiluminescent reaction is:

$$NO + O_3 = NO_2^* + O_2$$

Emitted light from the excited NO_2^* is converted to an output voltage by a photomultiplier tube and amplifier.

Automatic NO_2 analysers based on liquid-phase chemiluminescence, produced by reacting NO_2 with a chemical solution, are also available. These highly sensitive but relatively fragile instruments are mostly employed for research applications and are not generally regarded as being suitable for routine baseline monitoring purposes.

The accuracy of data from automatic NO_2 analysers depends on a range of factors encompassing the entire measurement chain. These include the accuracy of calibration standards, analyser stability and sample losses in the measurement system. Final accuracy can therefore vary from network to network. An accuracy of ± 8% has been estimated for NO_2 measurements in well-run automatic networks, taking account of all contributory factors (AEA 1996). The precision of NO_2 measurements is estimated to be ±6.5 $\mu g/m^3$, determined from long-term variations in the baseline responses of in-service analysers.

Remote sensors

Long-path monitoring systems are available for the measurement of NO_2, but the methodology is less well established than that for automatic point monitors. The accuracy and precision of the data from these instruments are, therefore, much more difficult to determine. The method does not conform to ISO 7996 (ISO 1995b) and, as noted previously, careful attention needs to be given to instrument calibration and quality assurance to obtain meaningful data.

Carbon monoxide

CO in urban areas results almost entirely (typically ~90%) from road traffic emissions. Since CO is a primary pollutant, its ambient concentrations closely follow emissions. In urban areas, concentrations are therefore highest at the kerbside and decrease rapidly with increasing distance from the road. Mostly automatic analysers are being used for the direct assessment of ambient levels against guidelines.

Passive samplers

A passive sampler has been developed for CO, utilizing a zeolite absorber and a narrow filamental diffusion passage to optimize uptake, and involving GC/FID analysis after thermal desorption (Lee et al. 1992). This technique may be useful for screening, mapping and 'hot-spot' identification. Its use does not, however, appear to be widespread at the present time.

Active samplers

Grab samples may be collected for subsequent laboratory analysis. However, this technique is not known to be widely used.

Automatic analysers

The measurement of CO in ambient air is covered by international standards ISO/FDIS 4224 (ISO/FDIS 1999a) and ISO 8186. (ISO 1989)

Baseline ambient CO monitoring is normally carried out using IR analysers. A number of electrochemical CO analysers are available, but these are generally of low sensitivity and not suitable for routine ambient monitoring. However, they may have application in areas of high concentrations. A version of this sensor is incorporated in a commercially available roadside pollution monitoring system.

CO analysis is based on the absorption of IR radiation at wavelengths of 4.5-4.9 micrometres. Since other gases and particles can also absorb IR, the analyser must distinguish between absorption by CO and absorption by interferences. In the most common analyser type, this is done using a gas filter correlation wheel containing a cell of pure nitrogen and a cell of nitrogen plus CO. The cell containing CO removes the CO-sensitive wavelengths before the IR signal enters the absorption chamber, whilst all wavelengths are transmitted by the other cell. The difference in the intensity of the two absorption signals, divided by the intensity of the IR source, provides a measure of the ambient CO concentration.

The accuracy of data from automatic CO analysers depends on a range of factors encompassing the entire measurement chain. These include accuracy of calibration standards, analyser stability and sample losses in the measurement system. An accuracy of ± 8% and a precision of ±0.5 mg/m^3 may be achieved using this technique in well-managed and quality-assured programmes.

Ozone

O_3 is not emitted directly from man-made sources in any significant quantities, but is formed in the atmosphere by sunlight-driven chemical reactions involving NO_x and VOC (see Section 2.1.2). These reactions are not immediate, but may take from hours to days to complete. O_3 is chemically scavenged by primary NO_x emissions from traffic, and is also removed from the atmosphere by deposition to the ground.

Both spatial and temporal distributions of O_3 differ markedly from those of other pollutants. In particular, significant impacts may occur in areas up to hundreds of kilometres downwind of the original precursor emissions, as a result of long-range as a result of long-range transport. Ambient concentrations and population exposure may often be maximized in suburban and rural areas. This has important implications for monitoring system design.

Passive samplers

A variety of techniques are available (UNEP/WHO 1994b). These include:

- 1,2,di-(4-pyridyl) ethylene absorbent- spectrophotometry (Monn and Hangartner 1990).
- KI –spectrophotometry (Grosjean and Hisham 1992).
- $NaNO_2/Na_2CO_3$/glycerine -ion chromatography (Koutrakis et al. 1990).
- Indigo carmine-reflectance (Alexander et al. 1991).

These methods are not as widely used or validated as corresponding samplers for NO_2 and no clear consensus as to a standard technique has yet emerged.

Active samplers

The most widely used active sampler technique was the Neutral Buffered Potassium Iodide (NKBI) method. Although relatively simple and inexpensive, there are practical problems with deterioration of the iodine complex and interference (most notably from NO_2 and SO_2). These issues have reduced its use to the extent that the technique may now be regarded as obsolete.

Automatic analysers

ISO 10313 (ISO 1993a) is not of real relevance, as the chemiluminescence detection technique it describes is no longer widely used. The most commonly used technology is now that of UV absorption; this is specified as the reference method for the purposes of EC Directive 92/72/EEC (EC 1992). An ISO standard is being developed for the UV method.

UV absorption is a robust, well-developed technique. Ambient O_3 concentrations are calculated from the absorption of UV light at 254 nm wavelength. The sample passes through a detection cell of known length (l). An O_3-removing scrubber is used to provide a zero reference light intensity, I_0. The analyser alternately measures the absorption of air in the cell with no O_3 present and the absorption in the experimental sample cell, I_s. The ambient O_3 concentration, c, may be simply calculated using the Beer-Lambert equation:

$$I_s = I_0 e^{-alc}$$

where a is the relevant absorption coefficient at 254 nm.

Given appropriate attention to system design, calibration and equipment support a typical measurement accuracy of ±11% and a precision of ±4 $\mu g/m^3$ should be readily achievable in well-run automatic networks.

Remote sensors

Open-path optical remote sensing techniques such as DOAS are available for O_3, although the associated practical issues noted in previous sections are applicable.

Suspended particulate matter

SPM is a generic term embracing all airborne particulate matter. This therefore encompasses a wide range of size fractions, morphologies and chemical compositions, as discussed in Chapter 2. Although coarse particle size ranges may cause significant local nuisance or soiling, it is the finer fractions, such as $PM_{2.5}$, that are capable of deep lung/airway penetration. Concern about the potential health impacts of fine particulate matter has increased rapidly over recent years.

SPM monitoring is fundamentally different from the measurement of gaseous pollutants, and the methods are generally less precise. A wide variety of different sampling and detection methodologies is available, including the Tapered Element Oscillating Microbalance (TEOM), β-ray analysis, gravimetric sampling (low or high-volume) and a number of indirect optical, particle counting and light-scattering methods. The sampling system strongly affects the measurement process and appropriate aerodynamically designed inlets are essential for proper sample-fractionated determinations (UNEP/WHO 1994c).

Active samplers

Gravimetric samplers collect particulate matter onto a filter using high-volume (about 100 m^3/hour) or low-volume (about 1 m^3/hour) pumped sample flows. The weight of particulate matter deposited on the filter is used to calculate a 24-hour average mass concentration. No ISO or CEN standards have yet been promulgated for ambient measurement of PM_{10} particulate matter using gravimetric samplers, although these are under development at the present time. An ISO standard for evaluating PM_{10} inlet heads is, however, available (EN 1999). A United States Environmental Protection Agency procedure for PM_{10}

using the high-volume sampler is given in Federal Register 40 CFR Part 50 (CFR 1993). However, compliance with this procedure does not ensure consistency with the anticipated CEN standards.

The various SPM monitoring techniques may not necessarily produce comparable measurements. Different sampling systems, operating temperature, filter media and filter history may also potentially affect measurement equivalence. The accuracy and precision of any measured mass concentration is, therefore, liable to a wide margin of error. A target accuracy of <10 $\mu g/m^3$ and a precision of <5 $\mu g/m^3$ (for daily average concentrations <100 $\mu g/m^3$) are given for PM_{10} measurements by EN 12341 (EN 1999).

Medium- or low-volume gravimetric samplers are more portable and less noisy than high-volume samplers, making them more suitable for use in urban areas. However, the mass of particles collected is far less than with high-volume samplers, giving a greater potential for errors due to filter weighing. According to a recent large-scale instrument comparison, a number of commercially available high- and medium-volume samplers are equivalent to a reference Wide Ranging Aerosol Collector (WRAC) (EN 1999).

Correct filter handling, documentation and analysis is fundamental for obtaining valid data. The filters must be conditioned in a temperature- and humidity-controlled environment, typically 20 °C and 50% relative humidity, for at least 24 hours before and after exposure. The filters must be accurately weighed using a suitable balance, that has been calibrated using an accredited method.

Automatic analysers

Instruments are commercially available using the following techniques:

- Tapered Element Oscillating Microbalance (TEOM).
- Beta-ray absorption analysers (ISO/FDIS 1999b).
- Light scattering systems.

Of the automatic instrument types available, the TEOM and β-ray systems have been operated widely for many years and are well tested in the field. The light scattering type of instrument has been developed more recently, and is therefore less well proven in service. Operating experience and co-located measurement campaigns indicate that measurements from the different instruments are not always equivalent or comparable

For traceable and robust measurements, samplers must be fitted with a tested PM_{10} inlet head and an accurate flow control system. The PM_{10} sampling inlet should be tested to ISO Standard 7708 (ISO 1995) to ensure accurate size fractionation at the point of sampling. A target accuracy figure of <10$\mu g/m^3$ and precision of <5$\mu g/m^3$ (for daily average concentrations <100 $\mu g/m^3$) are given in EN 12341 (EN 1999). Tests on in-service TEOM analysers deployed in UK networks demonstrate these figures to be realistic and achievable.

Lead

The main sources of lead in air are the combustion of petrol containing lead-based additives and industrial emissions.

Active samplers

These are based on pumped sampling of large quantities of ambient air, capturing fine ambient particulate matter on a filter for subsequent analysis. Analysis of filters for lead is covered by ISO 9855 (E), which specifies atomic absorption spectroscopy as the standard analytical method (ISO 1993b). There is no standard sampling method, although the EC Directive does specify some relevant sampling and filter criteria (EC 1982).

A variety of sampling methods are used, including high-, medium-, and low-volume samplers. There is no standard or reference sampling method. The UK method is broadly typical: this utilises an "M Type" sampler designed specifically for this purpose. Its flow rate is controlled to 5.4-7.1 m^3/day, and Millipore Aerosol Field Monitor filters are exposed and changed weekly.

Passive sampling methods are not applicable.

6. Air Quality Management

Introduction

Basic principles guide international and national policies for the management of all forms of air pollution. An important global initiative occurred in 1983 when the UN General Assembly established the World Commission on Environment and Development, headed by Gro Harlem Brundtland. The report produced by the Commission, *Our Common Future*, was presented to the UN General Assembly in 1987 and endorsed by it. It has been influential in bringing environmental issues into the global arena, and in expressing some concepts that have been influential in air quality management (WCEDC 1987).

The Brundtland Commission suggested that sustainable development would be required to meet the legitimate aspirations of the world population without destroying the environment. It defined **sustainable development** as: "development that meets the needs of the present without compromising the ability of future generations to meet their own needs." This concept has been embraced as an apparent means of integrating environmental policy and economic development.

Following the Brundtland Commission, the UN Conference on the Environment and Development was held in Rio, in 1992 (UNCED 1992). The aim was to ensure that practical foundations for sustainable development were put in place. The Agenda 21 document and the Rio declaration were the most obvious results of this conference. Agenda 21 is a document covering sustainable development, which is not binding on countries. However, national implementation is reviewed by the Sustainable Development Commission and the UN General Assembly. Agenda 21 supports a number of environmental management principles on which some government policies are based, including air quality management. These include:

precautionary principle - where it is clear that a proposal will damage the environment, action should be taken to protect the environment without awaiting scientific proof of damage.

polluter pays - the full costs associated with pollution (including monitoring, management, clean-up and supervision) should be met by the organization responsible for the source of the pollution.

In addition, many countries have adopted the principle of **pollution prevention**, which aims to reduce pollution at sources.

The responsibility of national governments for international reporting on the environment of their country has enabled greater exchange of air quality information around the world.

Strategy for air quality management

The goal of air quality management is to maintain a quality of air that protects human health and welfare. This goal recognizes that air quality must be maintained at levels that protect human health, but must also provide protection of animals, plants (crops, forests and natural vegetation), ecosystems, materials and aesthetics, such as natural levels of visibility (Murray 1997). And to achieve this air quality goal, it is necessary to develop policies and strategies.

Government policy is the foundation for air quality management. Without a suitable policy framework and adequate legislation it is difficult to maintain an active or successful air quality management programme. A policy framework refers to policies in several areas, including transport, energy, planning, development and the environment. Air quality objectives are more readily achieved if these interconnected government policies are compatible, and if mechanisms exist for co-ordinating responses to issues which cross different areas of government policy. Measures that have been adopted in many developed countries for integrating air quality policy with health, energy, transport and other areas are summarized in a report of the United Nations Economic Commission for Europe (UNECE 1995; UNECE 1999).

This following section (6.1) will discuss management of ambient air, and section 6.2 the management of indoor air.

6.1 Strategies for ambient air quality management

This section reviews the development of an air quality strategy, including some basic principles of ambient air quality management, ambient air quality standards, source emission inventories, emissions control for point, mobile and area sources, management of "non-classic" pollutants, communication and international air quality management.

Ambient air quality management has a long history. Complaints of air pollution led to studies of air pollutants and their effects. However, a substantial excess mortality rate during the economic expansion after the Second World War resulted in the initiation of pollution control. High air pollution levels in cities in the US and Europe resulted in excess deaths, including more than 4000 excess deaths in London from a stagnant atmosphere of fog, smoke and SO_2 during five days in December 1952 (Brimblecombe 1987). As a consequence of this disaster, there was increased public pressure for better air quality in cities in developed countries around the world. With the availability of relatively cheap and clean fuels, and in an environment of strong economic growth and increasing incomes, governments in developed countries slowly introduced measures to improve air quality in cities. Particular emphasis in the early stages was on reducing particle and SO_2 concentrations in cities.

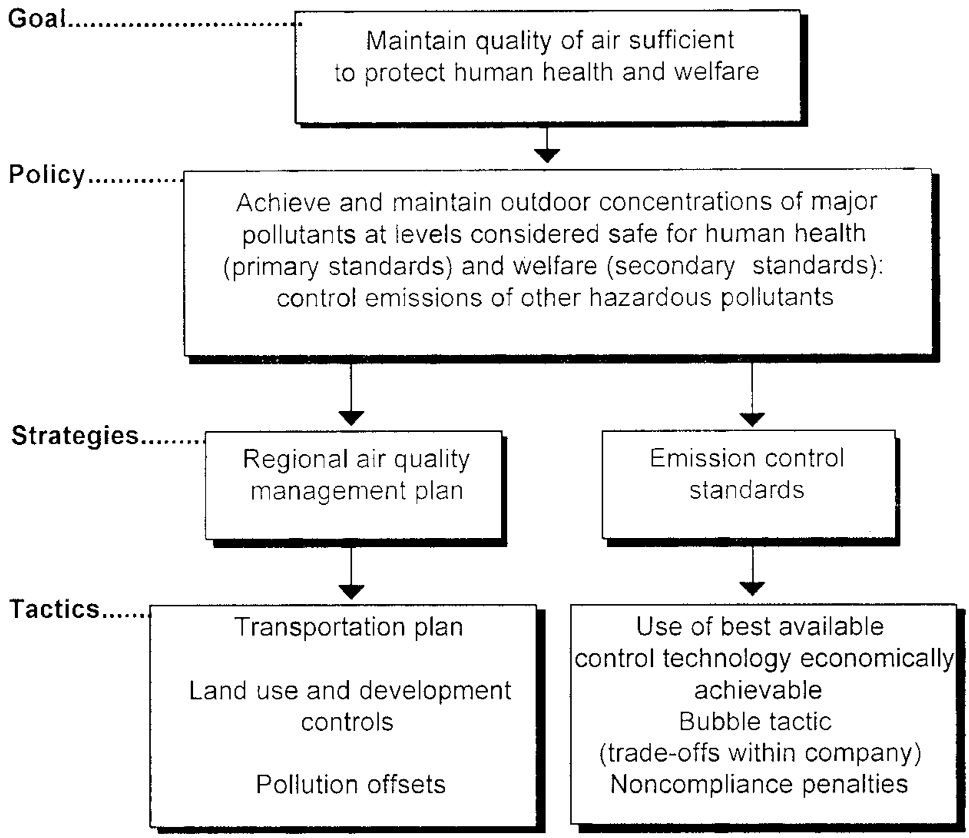
In the last two or three decades, air quality management in the cities of developed countries has broadened in scope. However, the emphasis and success of management activities has been varied. Although considerable progress to improve air quality has been achieved in some large cities of developing countries, many large cities face very significant challenges to implementing effective action. Also, it is now recognized that urban air pollution can travel long distances, affecting areas outside the local and national boundaries in which the polluting event occurs. Polluted air crosses regional and national boundaries, affecting health and environments in rural areas and in other countries.

In response, more effective international action has been implemented. International guidelines on ambient air quality have been produced by organisations such as WHO (WHO 1987), and international policies are being co-ordinated under conventions such as the Convention on Long-Range Transboundary Air Pollution (UNECE 1995; UNECE 1999).

6.1.1 Stages in the development of ambient air quality management

A legal framework is needed to provide a context for ambient air quality management. While there are many possible models, one example is illustrated by Figure 6.1.

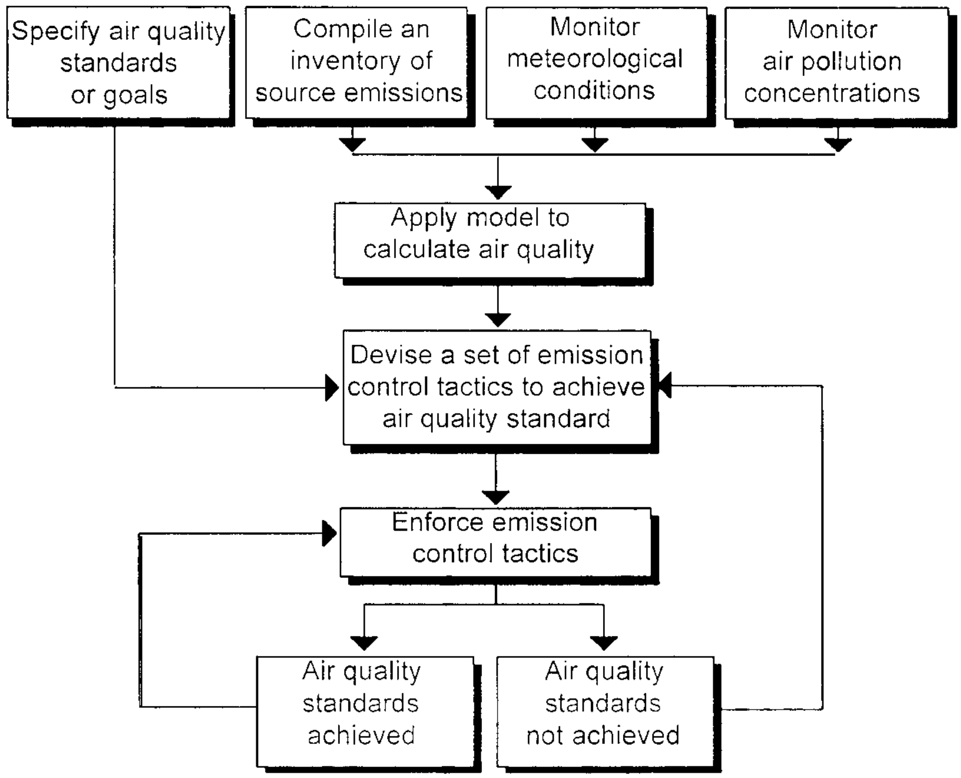
Figure 6.1. The Structure of the U.S. ambient air quality legislation as established by the Clean Air Act 1970, and amendments (after Westman 1985).



When goals and policies have been developed, the next stage is the development of a strategy or plan. Figure 6.2 summarizes the stages involved in the development of an air quality management strategy and can start with the development of ambient air quality standards or guidelines. It may also involve the development of an emissions inventory. The monitoring of both meteorological conditions and air pollutant concentrations would also normally occur, as these data are required by models used to estimate air quality, and to validate the model output. Air quality standards and model outputs or measurements may be considered in devising emission control tactics aimed at achieving the air quality standards. The tactics need to be enforced, and if the standards are achieved, they need continued enforcement. If the standards are not achieved after a reasonable period of time, the emission control tactics may need to be revised.

National air quality standards are usually based on a consideration of international guidelines, such as the WHO *Guidelines for Air Quality*, as well as national criteria documents that consider dose-response relations for the effects of each pollutant on human health, livestock, wildlife, crops, forests, natural ecosystems, materials, aesthetics etc. In some cases, studies of combinations of pollutants may be required. National standards take into account the technical, social, economic and political factors within the nation. National approaches to the establishment of air quality standards in some developed countries have been summarized by the Economic Commission for Europe (UNECE 1995; UNECE 1999).

Figure 6.2. Stages involved in the development of an air quality management strategy (Elsom 1992).



In some cases, monitoring may show that ambient air pollutant concentrations are considerably higher than some options for standards. An issue for those developing standards is whether national standards should reflect the need to protect human health and the environment, when this objective is unlikely to be achieved in the short- to medium-term with the available resources. In some countries, the standards are set at realistically attainable levels, given the prevailing national technical, social, economic and political conditions, even though they may not be fully consistent with the levels needed to fully protect human health and the environment. Over time, air quality standards may also change, after review, as conditions within a nation change, and as the scientific relationship between air quality, the health of the population and the quality of the environment becomes better understood.

As discussed in Chapter 3, there are considerable differences between the "classic" air pollutants such as SO_2, particles, NO_2, CO, O_3, and the "non-classic" air pollutants (Table 6.1). Different approaches may be needed to develop standards for the two types of air pollutants. Air quality monitoring (Chapter 5) is used to assess whether air quality at particular locations is in compliance with the standards selected.

Table 6.1. A comparison of the "classic" and "non-classic" air pollutants

"CLASSIC" POLLUTANTS	"NON-CLASSIC" POLLUTANTS
Few	Numerous
Not bioaccumulated (except Pb)	Some bioaccumulate
Lung is primary target (except CO and Pb)	There may be many target organs
Human health effects are generally well known (except NOx)	Human dose-response data rarely available
Effects occur from minutes (acute) to years later (chronic)	Effects occur from minutes (acute) to years later (chronic)

6.1.2 Source emission inventories

A crucial component of an air quality management plan is a reasonable quantitative knowledge of the sources of the various emissions (Figure 6.2). An emissions inventory is essential. In some cases, emissions are described in source groups. These may be:

- Point sources such as major industrial sites.
- Mobile sources such as motor vehicles.
- Area sources such as domestic emissions and emissions from light industry and commercial areas.
- Biogenic or natural sources.

For some components of an emissions inventory accurate data may be available. For example, accurate emissions data may be available for some industrial sites from measurements of stack emissions. In other cases, emissions can be calculated from estimates of process inputs. For example, the emissions of SO_2 from coal-fired electricity generation plants can often be calculated with reasonable accuracy from the knowledge of the throughput and sulphur content of the fuels and other information.

While estimates of emissions are needed to develop emission inventories, measurements to confirm the veracity of the estimates are highly desirable. Surveys may be used for point sources such as large industrial facilities to provide data on their emissions. However, reporting by companies is not always complete, particularly for fugitive emissions (such as leaks of volatile substances, equipment leaks and loss of fine particles from stockpiles), and for combustion products such as PAH for which sufficient data may not be available.

When source data are missing, it is common to use general emission factors for both point and diffuse sources. Emissions from diffuse sources include emissions from motor vehicles and off-road mobile sources, and area sources such as light industry, domestic and wood burning, as well as biogenic emissions from natural sources such as vegetation. Emission factors for diffuse sources are usually calculated using data specific for each source type. For example motor vehicle emissions may be estimated by calculations involving the distance traveled by vehicles, the number of vehicles, temperature, fuel consumption and the composition and properties of the fuels used. General emission factors for various industrial processes are available from published sources (such as EEA (undated); USEPA 1985; USEPA 1987; USEPA 1995 and more recent supplements and updates). However, these emission factors need to be used with care, as adjustments in emission factors may be needed to take into account differences in operating conditions. fuels and feed materials.

It should be noted that emissions inventories must also manage those pollutants, which form in the air from reactions among other pollutants. O_3 and some other components of the photochemical smog complex are not directly emitted into the atmosphere, but form from reactions among NO_x and reactive organic compounds. The control of photochemical smog requires, among other things, an understanding of the sources and emissions of NO_x and reactive organic compounds.

In some developing countries, reliable statistical information for producing accurate emissions estimates is lacking. However, where action is needed to improve air quality, the absence of this information should not prevent the development of preliminary emissions estimates. Basic information about the population, transportation, industry, fuels and other information can be used to calculate preliminary emissions estimates (Kato and Akimoto 1992), which can then be used to develop and implement air quality management plans. The preliminary emissions estimates can be revised as more accurate information becomes available. Sources of information on how to prepare rapid emissions inventories include WHO 1993a; WHO 1993b; WHO 1995h; WHO 1997b.

6.1.3 Meteorology and mathematical models

A knowledge of meteorological conditions in an area is useful when applying mathematical models to calculate air quality. As indicated in Chapter 4, modelling is a powerful tool for the interpolation, prediction and optimization of control strategies. Models allow the consequences of various options for improving air quality to be compared. However, models need to be validated by monitoring data. Their accuracy depends on many factors, including the accuracy of the source emissions data, the quality of knowledge of meteorological conditions in the area, and the assumptions about physical and chemical processes in the atmosphere involving the transport and transformation of pollutants.

6.1.4 Emissions control approaches

Command and control

Laws and regulations are at the heart of air quality management strategies. The traditional approach for developing and implementing air quality management strategies has been the "command and control" approach. This approach has several major features centred around the regulation of emissions. The command and control approach usually involves the development and regulation in law of emissions standards, the licensing of emissions sources, the monitoring and reporting of emissions, and penalties for exceeding license conditions. Under this system, the techniques to be used in areas such as pollution control are prescribed by government, and compliance with conditions is checked by government inspectors. Licences are issued, standards are set, compliance with standards are checked, non-compliance cases commonly go to court, mitigating circumstances are considered by the court, and penalties are imposed. New developments or major changes to sources are usually subject to environmental impact assessment, and new sources may be subject to tighter performance standards than existing operations.

The "command and control" approach is the most widely used technique around the world as it has many strengths. This system has some public confidence, and provides a degree of certainty to industry and the public. However, it is also time consuming, expensive and legalistic. As the penalties imposed by the courts may be light, the outcomes may be unsatisfactory for all involved. The command and control approach is also rigid. with the potential for arbitrary decisions and a focus on end-of-pipe solutions, instead of more comprehensive pollution prevention approaches. While it may establish a minimum condition, it provides no incentive to minimize emissions. It usually ignores equity, often requiring highly expensive best-available technology for new sources, while existing sources with a lower level of technology and performance continue to pollute. However, in some situations the command and control approach has worked extremely well, and many countries have reduced emissions of SO_2, coarse particles and reduced or eliminated lead emissions from petrol.

In many countries the reform of regulations in the last 10-15 years has reduced dependence on the traditional command and control approach. In recent years, the trend in most developed countries has been towards increased use of other forms of regulatory control. One such approach is self-regulation (Table 6.2). It is argued that some industry groups, for example the chemical industry or the petroleum industry, are familiar with current best practice within their own industry, and can set codes of practice, industry standards and targets. Individual companies conduct self-monitoring of compliance and are subject to audit. However, self-regulation measures can provide less certainty to industry and may inspire less public confidence than regulatory control by government.

Table 6.2. Types of environmental regulation (after Bradfield et al. 1996)

Type	Description	Example
Command and control	Issue of licences, setting of standards, checking for compliance with standards, sanctions for non-compliance	Air pollution control Government audits Emission standards
Economic instruments	Use of pricing, subsidies, taxes, and charges to alter production and consumption patterns of organisations and the public	Load-based emission charges Tradeable emission permits Differential taxes True cost pricing of resources
Co-regulation	Formulation and adoption of rules, regulations and guidelines in consultation with stakeholders, negotiated within prescribed boundaries	National registers of pollution emission inventories
Self-regulation	Self-imposition of regulations and guidelines and environmental audits by industry groups. Voluntary adoption of environmental management measures.	Voluntary codes of practice Self-audit Emission reduction targets Environmental management systems

Economic instruments

Another approach adopted in many countries involves the use of economic instruments (UNECE 1995; UNECE 1999). This approach decreases the operating costs for pollution prevention. Examples include load-based emission charges, which increase operating costs for industry if pollution discharge increases; higher tax charges for leaded petrol compared with unleaded petrol; product charges and environmental taxes on fertilisers, batteries, pesticides, etc.; reducing subsidies for energy use; and subsidising zero emissions products. Pricing policies are a powerful economic instrument for air quality improvements. It has been estimated that direct energy subsidies in developing countries total nearly US$230 billion each year (El-Ashry 1993). Reducing subsidies for energy use encourages energy conservation, reduces emissions from power stations, and frees investment to be used for other purposes, such as less polluting technologies (Hall 1995).

Another market-oriented approach is a system of tradeable emission permits. In this system, the regulating authority quantifies the total mass of emissions permitted in an area and issues an equivalent number of tradeable emissions entitlements. These tradeable permits can be freely bought and sold. They have the potential to achieve government policy objectives at the lowest cost to industry, and in some cases to government. A comparison of command-and-control and market-based incentives in Santiago, Chile, found that flexible market-based incentives enabled substantially higher reductions in emissions to be achieved for the same expenditure (O'Ryan 1996).

An Emissions Trading Policy has been adopted in the US, in particular in the 1990 revision of the US Clean Air Act, which enables some trading of emissions permits. The US has established a national cap on SO_2 emissions of 8.9 million tonnes per year, beginning in year 2000. Sources may not emit more SO_2 emissions than their marketable emission allowance. These emissions allowances can be purchased, sold or banked for later use. New or expanding sources must arrange to transfer allowances from existing sources, using pollution control or closure of existing sources to provide the required emissions allowances. Existing industries can reduce or cease emissions from one source within the organization to enable expansion of emissions elsewhere. It is considered that this system provides maximum flexibility to industry to pursue the lowest-cost options, while meeting government policy objectives (Portney 1990).

Systems have been proposed which replace the requirement that every new model of vehicle produced meets a uniform emissions standard. It has been proposed that as the costs of achieving various levels of emission control vary among vehicle types, manufacturers should be required to achieve a weighted emissions level over their fleet (Kling 1994). It was argued that manufacturers who better the standard should be permitted to sell their emissions reduction credits to manufacturers unable to meet the standard. Some limited application of an incentive-based system has been incorporated into the Low Emission Vehicle Program adopted in California.

Emissions trading may be considered to be a government regulated, but private market in tradeable emission permits. While sufficiently developed markets may be a pre-requisite for an emissions trading system in developing countries, some principles of emissions trading may be applied without well-developed markets (Smith 1993).

Co-regulation

As part of the process of regulatory reform, companies and their industry organisations have been included in discussions of options for regulation reform, and in the review of these options. This pro-active approach by industry organisations has led to a degree of co-regulation in some areas. It has resulted in the adoption of regulations and guidelines considered to be practical and realistic by those affected, and have simplified and reduced the costs of compliance for national governments. The process has resulted in the voluntary adoption of environmental management measures in a collaborative manner.

Corporate environmental management is a combination of public policy and social responsiveness. In the public policy area, the enactment of legislation and regulations has enforced socially responsible behaviour. The role of government has increasingly been to provide guidelines to environmental managers in industry, so that corporate behaviour can be shaped to meet social expectations. The aim is that guidelines should prescribe industrial emissions outcomes, but not the means to achieve these outcomes, and to avoid being too prescriptive, as this can encourage a legalistic approach.

Self regulation

There is a growing worldwide adoption of environmental management systems. These include the British Standard 7750, the European Union Eco-Management and Audit Scheme, and the environmental management system of the International Organization for Standardization, the ISO 14000 series (ISO 1996a; ISO 1996b; Sheldon 1997). The adoption of environmental management systems has also influenced the process by which governments define industrial emissions outcomes, while not prescribing to industry how these outcomes should be achieved.

Governments are also using public education strategies to improve the actions of the public that can lead to air pollution. In many cities, area sources of air pollution and vehicle sources together comprise the largest component of emissions, and it is the actions of individuals that decide the scale of these emissions. While technical strategies have a major role, education and public information programmes can also contribute to reducing the magnitude of these sources.

Another recent approach to non-classic air pollutants involves risk assessment. In many cases there is no "safe" level for these air pollutants. They do not follow a threshold-type response, as health and ecological risk can increase with increasing exposure. Consequently, this approach requires an evaluation of health risks for the general or sensitive population, and establishes acceptable levels of health risk for these populations. Sources are required by regulation to implement techniques for reducing the levels of health risk to those prescribed.

Emissions control options can involve broad strategic approaches, such as land use, transportation, energy and industrial development planning. Unless air quality planning has a consistency with these other areas, substantial progress is difficult. Complex models have been developed to assess the interaction and consequences of changes in these areas for air quality. However, changes in land use, transportation, energy, and industrial development planning may take decades to substantially improve air quality, so more specific tactics to control emissions are needed. A decision support system for industrial air pollution control is available which aims to support policy makers and managers in analysing and formulating policy options and control measures (WHO 1995h).

6.1.5 Evaluation of control options

Unless legal constraints in a country prescribe a particular control option, the evaluation of control options must take into account technical, financial, social, health and environmental factors, as well as the speed with which they can be implemented and whether they are enforceable. Although considerable improvements in air quality have been achieved in some developed countries, the financial costs have been high, and the resource demands of some approaches make them unsuitable for poorer developing countries. Methodologies for evaluating air pollution control strategies have been developed for use in metropolitan areas, both in developed and developing countries, such as the methodology for evaluating options for improving air quality in Mexico City (Hardie et al. 1995).

Technical

There needs to be confidence that the selected options are technically practical within the resources of the region. It must be possible to bring a selected option into operation, and maintain the expected level of performance in the long term with the resources available. For some control options in certain regions, this may require regular staff training and other programmes.

Financial

The selected options must be financially viable in the long term. This may require comparative cost-benefit assessments of options. These assessments must include not only the capital costs of bringing an option into operation, but also the costs of maintaining the expected level of performance in the long term.

Social

The costs and benefits of each option should be assessed for social equity in its effects on people's lifestyles, community structures and cultural traditions. Considerations may include, disruption or displacement of residents or land uses, impacts on community, culture, and recreation. Some impacts can be managed and resources substituted.

Health and environment

The costs and benefits of each option should be assessed for health and environmental factors. This may involve use of dose-response relations, or risk assessment techniques.

Effect-oriented and source-oriented principles

Some countries determine air pollution control requirements on the basis of an assessment of the effects of the pollutants on health and the environment (effect-oriented). Increased emissions may be permitted where the assessment suggests there will be no health or environmental impacts, or ambient air quality standards will not be exceeded. Action may be taken to reduce ambient concentrations where impacts or exceedances are shown to occur. Other countries base their air quality management policies on the requirement for best available technology, or best available techniques not entailing excessive cost (source-oriented). Most developed countries apply a combination of both source-oriented and effect-oriented principles (UNECE 1995; UNECE 1999).

6.1.6 Control of point sources

Siting and planning

The most powerful and cost-effective air quality management options occur during the planning stages of a new facility, whereas options involving changes in existing production processes or pollution control technology are more limited in scope. Planning options involve careful site selection, to maximize dispersion, and location of the proposed facility away from sensitive receptors, such as residential areas or areas of natural or commercial sensitivity.

Source emissions reduction

The most cost-effective approaches to controlling existing air pollution sources are those that entail source emissions reduction (Griffin 1994). There are four major approaches, each of which require an understanding of the processes and activities that give rise to the emissions. These source reduction approaches are: management and operational changes; process optimization; combustion modifications; and fuel modifications.

Each approach has a different level of effectiveness on the various air pollutants. For example, process optimization may considerably reduce emissions of volatile and hazardous compounds, but can have little effect on NO_x and SO_2 emissions. In contrast, fuel modifications can decrease NO_x and SO_2 emissions but they may have little effect on volatile and hazardous compounds.

Management and operational changes

Management audits of emissions, sources, and source strength, and subsequent changes in operation to reduce emissions, offer a cost-effective way of reducing emissions. It requires the implementation of good practices in housekeeping and maintenance, to ensure that systems are in place to check that equipment is maintained, and that staff are trained and properly supervised. It aims to minimize fugitive emissions, and losses from stored liquids and solids, by changing the composition of materials used, provided this can reduce emissions while maintaining product quality.

Process optimization

This approach seeks to achieve emissions reductions by altering the production process without loss of product quality or production volume. It usually involves conducting a series of changes in which a factor involved in the manufacturing process is altered, such as temperature, ventilation or line speed.

Combustion modifications

Changes to the way in which combustion occurs can substantially reduce emissions. Increasing fuel flow in burners, by taking some burners out of service and increasing fuel flow to those remaining, can substantially reduce emissions of NO_x. Changes to the geometry of the combustion chamber can reduce emissions of NO_x without requiring changes to the boiler or fuel. Other techniques that can be applied to reduce nitrogen oxide emissions include tight control over the oxygen feed into a burner, lowering the flame temperature, staged combustion and reburning.

Fuel modifications

Another alternative for reducing emissions is to reduce the amount of fuel used or to change the type of fuel. The simplest approach is to change the fuel from a relatively dirty fuel, such as coal, to a cleaner fuel such as natural gas. This is usually a cheaper means of reducing emissions than scrubbing SO_2 from emissions. Blending of fuels is also used, such as the blending of low-sulphur coal with high-sulphur coal, and coal/oil blends to reduce emissions of SO_2. Emissions from processes using coal as a fuel can also be reduced by coal washing, which reduces the proportion of contaminants in coal. In recent years there have been many moves to improve the use of waste flue gases for secondary process such as heating, drying or power. This can reduce the overall requirement for fuel, and consequently reduce emissions.

In Hong Kong a ban on high-sulphur fuel was the best option for reducing SO_2 emissions. The cost of compliance monitoring made the costs of flue gas desulphurization and market-based measures more expensive than a ban on high-sulphur fuels (Barron et al. 1995). Others also doubt the value of flue gas desulphurization and consider that converting to the use of low-polluting fuels and energy conservation are less costly options for Eastern Europe and developing countries (Pearce 1996).

Emissions control

Tall stacks have traditionally been used to reduce ground-level concentrations of air pollutants at minimum cost to the producer. Their effectiveness depends on height, the velocity and temperature of the stack gases, and atmospheric conditions such as windspeed and direction, atmospheric stability, local topography and air quality. Stacks of 200-400 metres in height are reasonably effective at reducing ground-levels concentrations of air pollutants when they are suitably sited. However, tall stacks do not reduce emissions. They distribute them over a wide area. Where the magnitude of emissions within a region is substantial, or the receiving environment is sensitive, serious environmental effects such as acid deposition and forest decline can occur in remote locations (Wellburn 1988).

Before a system for collecting emissions can be planned, some information is needed to identify, quantify and characterize the chemical and physical properties of the emissions, both under average and extreme conditions. This enables the optimum type and capacity of collection system to be designed. There are many forms of emissions control systems available. Factors involved in the selection of control equipment are discussed by Holmes et al. (1993) and Griffin (1994). Different approaches are usually used for gaseous and particle emissions. The techniques listed in Table 6.3 and 6.4 are not comprehensive and represent only some of the more commonly used methods.

Table 6.3. Techniques commonly used to control particle emissions

Particle collection system	Action
Cyclone collectors	The waste gas swirls in a vessel and particles are removed by inertial impaction on the walls of a cylindrical vessel.
Filters	The waste gas is forced through a fabric bag or filter beds on which particles are physically collected.
Electrostatic precipitation	A negative charge is imparted to particles in the waste gas, which are attracted to positively charged collection plates.
Wet scrubbers	Liquids are brought into contact with particles to form agglomerates, which are removed from the waste stream by impaction on plates or on the walls of vessels.

Table 6.4. Techniques commonly used to control gaseous emissions

Technique	Action
Combustion	Incineration is used to oxidize combustible air pollutants. It may involve open-ended combustion units such as flares, high-temperature thermal incineration involving specific retention times, and catalytic incineration.
Adsorption	Solid collecting media with large surface-to-volume ratios, such as activated charcoal, are used to remove contaminants from waste gas streams.
Absorption	This involves the use of liquids (commonly water with additives) to scrub contaminants from waste gas streams.
Condensation	Condensers operate by removing heat from the gas stream, enabling the condensation of volatile liquids.

While these control techniques can be very effective, some are expensive in capital and maintenance infrastructure, and may be beyond the resources of some developed and developing countries. However, not all approaches need be expensive. Source reduction techniques are often the most cost-effective and suitable measures for many developing countries. These include fuel modifications, such as the preparation and use of low-sulphur and low-ash fuels, combined with management and operational approaches to reducing emissions.

Another key factor in pollution control and prevention is the designation of responsibility for controlling point source emissions in each facility (Hashimoto 1989). It is a legal requirement in Japan for each factory to designate an individual to be responsible for pollution control. The action of courts in strictly applying concepts of negligence and joint liability has led to an increased focus on due diligence and the application of best practices for controlling emissions. The decisions concerning air quality necessarily take place within the context of each nation, and effective action requires political support assisted by public awareness and demand for change (Hashimoto 1989).

6.1.7 Control of mobile sources

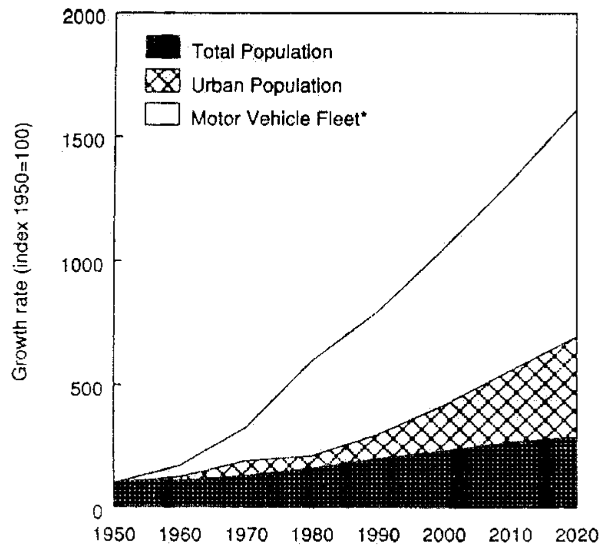
There is considerable variation in the pattern of vehicle emissions at different locations and in different regions of the world. However, considering anthropogenic emissions on a global basis, it has been estimated that motor vehicles can account for about 25-30% of emissions of NO_x, 50% of HC, 60% of lead and as much as 60% of CO (Faiz and de Larderer 1993). In city centres, vehicles may be responsible for 90-95% of CO and lead and 60-70% of NO_x and HC. As vehicle emissions usually occur near to the breathing zone of people, exposures can be high and they can represent substantial health risks.

While most of the vehicle population is in developed countries, motor vehicle pollution in developing countries is rapidly worsening due to increasing vehicle fleet growth (Figure 6.3), increasing distances travelled, and high rates of emissions from the vehicle fleets. The causes of the high emissions rates include high proportions of polluting two-stroke engine vehicles, road congestion which increases emissions per kilometre travelled, poor fuel quality including high lead content, inadequate emissions controls, poor maintenance and high average age of the vehicle fleet (Faiz and de Larderer 1993).

Many countries have acted to regulate and enforce emissions reductions, so ambient concentrations of vehicle-related air pollutants over the last two decades have declined in most developed countries. For example, the decreases in ambient concentrations in the US from 1985 to 1994 were 28% for CO, 86% for lead, and 9% for NO_x (USEPA 1995). With pressure to improve engine design and operating conditions, and improved tailpipe control technologies, vehicle emissions in many countries have decreased despite increasing number of vehicles and kilometres travelled. For example, while emissions of CO in the period 1980-1990 increased in France from 9216 000 to 10 268 000 tonnes, they decreased subsequently to 8 850 000 in 1996 (UNECE 1999). In the period 1980-1996 CO emissions in Germany decreased from 15 046 000 to 6 717 000 tonnes, and in the European part of the Russian Federation from 13 520 000 to 9 312 000 tonnes (UNECE 1999). Although in the most wealthy of the developing countries significant improvements in air quality are occurring, in most other developing countries for which data are available, both vehicle emissions and ambient concentrations of vehicle-related air pollutants have increased (WHO 1997a). For example it is estimated that emissions of CO in Delhi increased from 140 to 265 tonnes in the period 1980-1990, and are projected to be 400 tonnes in the year 2000 (UNEP/WHO 1992).

As the options for controlling vehicle emissions must be considered within the technical, financial, social, health and environmental context of each nation, the challenges and response options in developed and developing countries are different. In some developing countries, financial and regulatory measures to control vehicle emissions impose major economic and social costs, and there may be an uneven distribution of costs and benefits in the community. For example, there may be increased costs but few benefits for people living in rural areas. Capital may be required to alter local vehicle manufacturing and fuel refining processes, and operating costs may increase. This could divert resources from other priority areas, or make local industry uncompetitive.

Figure 6.3. Estimated and projected increases in the total population, urban population, and vehicle numbers 1950-2020, excluding motorized two- and three-wheeled vehicles (after Faiz et al. 1990).



The experience with vehicle inspection programmes in developing countries has been reported to be generally poor (Faiz et al. 1990), and the use of sophisticated vehicle control technologies is expected to have greatest utility in only the most advanced of the developing countries. Consequently, the most promising approaches for controlling vehicle emissions in developing countries is likely to be through the use of cleaner fuels, traffic management and administratively simple policies (Faiz et al. 1990). However, many developing countries have found that improving fuel economy and emission standards, as well as encouraging use of fuel-efficient vehicles and clean fuels, have the effect of both reducing costs and contributing to an improvement in air quality. In addition the strengthening of traffic management programmes, improvements in public transport, restrictions on motorized traffic and encouragement of the use of gas-fuelled vehicles in fleets are also cost-effective means of reducing vehicle emissions (Faiz and de Larderer 1993).

Many middle-income countries have introduced most of the above measures. Some have implemented additional measures, including approval standards and testing of new vehicles, exhaust emission controls, fuel improvements, roadside emission checks, replacement of two-stroke engines with four-stroke engines, and use of low- or zero-emission fuels (such as electric light-rail) for public transport.

Most developed countries apply regulations for vehicle emissions as part of an international process, under which vehicles and their component parts are required to be approved before marketing. Some countries also require regular in-service inspection and maintenance for emissions and safety, as a condition for continued operation of vehicles. This includes retrofitting or scrapping of non-conforming vehicles. Technology requirements for new vehicles in most developed countries include three-way catalytic converters, with closed loop and charcoal canister for petrol-fuelled passenger cars. There are also requirements that apply to diesel, light- and heavy-duty trucks and buses. Conventional two-stroke motorcycles are usually prohibited. There are programmes to control fuels losses during refuelling. Most developed countries require use of unleaded fuels for new cars, and encourage their use by economic instruments. In some countries, leaded petrol is banned (UNECE 1995; UNECE 1999). Advanced area-wide traffic management systems may be employed to facilitate vehicle flow and to minimize emissions.

Policy measures to control vehicle ownership and use, and to encourage other forms of transport, are also commonly employed to support vehicle emissions programmes. For example, tight control over vehicle ownership and use in Singapore, especially within the central business district during the day, has contributed to reducing air pollution from motor vehicles (Chin 1996). Coercive programmes such as no-drive days are normally used as a last resort on days when air quality reaches extreme levels, as they are politically unpopular, and they create social costs and enforcement problems. More socially acceptable measures include incentives to develop and use public transportation, such as buses, light rail and bicycles. Land-use planning approaches that encourage public transport and provide disincentives for use of private vehicles are attractive and cost-effective long-term measures.

6.1.8 Control of area sources

The control of area sources of air pollutants involves a number of strategies, as the characteristics of area sources are highly variable. The sources are often small, such as domestic and light-industry sources. Area sources include open burning of waste materials from agriculture, forestry and land clearance. Other sources are forest fires, emissions from vehicle refuelling, off-road vehicles and marine craft, and commercial and domestic fuel combustion. Surface mining and overgrazing of land in semi-arid areas can also act as sources of particles.

The options for controlling area sources can be classified as technical, regulatory, educational and market-based strategies. Technical strategies involve investigating alternatives to existing polluting activities, and implementing cleaner production and pollution prevention technologies and best practices. They encourage the replacement of existing technologies with lower- or zero-emission technologies.

Regulatory strategies involve legal enforcement of regulations at local and national government levels. This could involve banning of some emissions, banning of some open burning, or burning of materials during certain periods, increasing penalties, control of fuel quality, and restrictions on the types of combustion equipment available.

Educational strategies involve informing the community about sources of emissions and the impact of air pollution on health and the environment, and informing them about practices such as open burning, use of poor quality fuels etc, which lead to pollution.

Market-based strategies may involve polluter pays concepts. They include changes in cost structures to provide financial incentives for using clean fuels. They also involve reducing the costs of emissions licenses for adopting best practices, load-based emission charges and true cost pricing of resources (Table 6.2).

6.1.9 Non-classic air pollutants

While most attention is given to the relatively small number of well-recognized and often ubiquitous classic air pollutants (Table 6.1), there are thought to be several tens of thousands of synthetic chemicals in use, some of which are known or thought to be highly toxic air pollutants. The US Congress has identified 189 toxic air substances. Although the acute effects of the most common non-classic chemicals are relatively well-known, much less is known about the chronic, long-term or indirect effects of exposure at ambient concentration levels. In addition, exposure to many non-classic air pollutants may occur in small commercial operations, such as in agricultural enterprises where staff may not be well trained, and accidental exposure or release can occur. Some of these air pollutants are emitted at low concentrations from common sources such as vehicle emissions, and from wood fires. Some non-classic air pollutants can be very persistent in the environment, with exposure occurring many years after release.

As many of these chemicals, such as agricultural chemicals, are often traded, international approaches have been developed to maintain registers of their known toxic effects and their legal status. While techniques to manage them have been developed, the effect of increasing the regulation of non-classic air pollutants has been to exert pressure on industry to manage their production, using pollution prevention approaches. This can involve, but not be limited to, replacing them with safer compounds, changing the production process to prevent them from being produced in side reactions, and recycling or destroying them (such as by high temperature incineration) to prevent release into the environment.

6.1.10 Education and communication

Effective education and communication are important tools in raising public awareness of air quality issues. The successes of air quality management strategies have often involved action at all levels in the community. In many cases, central government action is triggered by local complaints from citizens. Actions to control air pollution have sometimes been possible only by establishing communications between local communities, local government and the national government agency responsible for air quality issues (e.g. Hashimoto 1989). Two-way communication between local communities and those responsible for air quality management is essential, and it requires use of many techniques to be successful.

Reporting air quality information in a form that is generally understandable by the public is a difficult problem. One approach is the use of the pollutant standard index, an example of which is explained by Griffin (1994). This system enables a wide range of air quality components, concentrations and averaging times to be reported to the public as one simple normalized figure. Although a pollution index provides a relatively simple and easy way to disseminate information on the level of air pollution, there are difficulties associated with the setting of these indices. Most of these difficulties arise from the fact that the composition of the pollutant mixture varies in both time and space, and that the components of the mixture have different health impacts. Despite these difficulties, they have been successfully used in some countries. In particular, they were used in communicating complex air quality information to the public during the 1997 haze periods that affected several major South East Asian cities.

6.1.11 International air quality management

The recognition that air pollution does not respect national frontiers has led to considerable action to develop international approaches to the management of air quality. Initially, action to control air pollution was conducted only at a national level, ignoring the import or export of air pollution across national frontiers. Acid deposition, photochemical oxidants, and accidental releases of ionising radiation and toxic chemicals first became international issues only during the 1970's. The development of international environmental law to guide air quality management in the area of transboundary air quality matters is still at an early stage of development, although some principles, international agreements and treaties have been formulated.

The Organization for Economic Co-operation and Development (OECD) provided the first multinational co-operative assessments of the long-range transport of sulphur pollutants in Western Europe. It urged member countries to reduce emissions and pressed for the principle of "polluter pays" to be applied internationally (Elsom 1992). Following this, members of the United Nations Economic Commission for Europe adopted the Convention and Resolution on Long Range Transboundary Air Pollution. This convention commits signatories in North America, Western Europe and Eastern Europe to reduce and prevent air pollution and to use the best available technology that is economically feasible. Many nations agreed to cut emissions of SO_2 by thirty percent by 1993, and fifty percent by 1995, based on 1980 emissions levels.

The European Union has also agreed on directives to reduce emissions of SO_2 and NO_x, has established air quality standards and has limited the sulphur content of some fuels. It has also agreed to apply the "best available technology not entailing excessive costs" and agreed to limits on emissions from power stations. In other parts of the world there has been action to increase the information flow among nations for air quality management by introducing international reporting of emissions, ambient concentrations, policy directives and tools for strengthening air quality management. This has largely involved UN agencies such as WHO and UNEP

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(UNEP/WHO 1992; UNEP/WHO 1996; WHO 1997a), the World Bank and Regional Banks (World Bank 1992), OECD (OECD 1991) and the international development agencies.

6.2 Management of indoor air quality

Most human beings spend most of their time in indoor environments, where they can be exposed to poor air quality. Pollution and degradation of indoor air cause illness, increased mortality, loss of productivity and have major economic and social implications. Indoor air problems can be reduced by better urban planning, by better design, operation and maintenance of buildings, and through the use of less-polluting materials and equipment in buildings. Indoor air quality problems affect all types of buildings, including homes, schools, offices, health care facilities and other public and commercial buildings. Health effects can include increased rates of cancer, lung disease, allergy and asthma, as well as fatal conditions such as CO poisoning and legionnaires' disease (discussed in Section 4.1). The medical and social costs associated with these illnesses, and the related reduction in human productivity, result in staggering economic losses.

This section considers management of indoor air quality in developed countries, and in some situations in developing countries, and then focuses on the important and widespread problems of indoor air quality management associated with biomass fuel combustion in developing countries.

6.2.1 Management of indoor air quality in developed countries

6.2.1.1 Strategies for indoor air quality management

Control and improvement of indoor air quality can be achieved by combining the three main strategies: proper design and construction of buildings; control of indoor air pollution; and adequate management of problems associated with indoor air quality.

6.2.1.2 Design considerations

Site

Site investigation. Potential sites of buildings need to be evaluated to determine whether they may be prone to indoor air quality problems, or may be in a high-risk area for radon. Assessment of sites includes a consideration of past uses and identification of any contaminants that might remain as a result of previous use. The use of adjacent sites should also be noted, to evaluate the potential for outdoor pollutants being carried to the proposed building.

Site preparation. Accumulation of moisture favours the growth of biological agents and can be prevented by choosing dry and well-drained building sites and properly grading the property.

Building Envelope Design

Tightness. Buildings should be designed to conserve energy and with good control over infiltration of air and movement of pollutants. This requires that adequate outside air be effectively delivered to occupants through the high volume air conditioning system (HVAC). Natural ventilation should be encouraged whenever possible and convenient. Energy conservation can also be achieved by controlling internal loads (e.g. through increased use of natural light).

Ventilation

Outside air-flow rates. Outdoor air-flow requirements are calculated as part of the mechanical design process. Guidelines based on occupancy and space usage are important; however, outdoor air-exchange rates should also take into consideration the total indoor pollution load and the desired quality of air. Adequate outdoor air flows are important in residential as well as commercial properties.

Breathing space. A consideration in HVAC design should be the amount of supply air and outside air that actually reaches the occupants of a building. This involves examining the method and efficiency of air distribution. The effectiveness of the HVAC system to dilute and remove indoor pollutants, and to properly distribute outside air throughout the building, is an important aspect of the design. Ventilation rates should be re-evaluated when interior spaces are renovated.

Mechanical ventilation in houses. Some houses are designed airtight with insufficient outside air entering through passive infiltration. As a result, mechanical ventilation is necessary to introduce a satisfactory flow of outside air and to provide adequate dilution and removal of pollutants. This enables heat recovery from the ventilation air.

Commissioning

New buildings should be commissioned before occupancy. Commissioning should include testing and balancing of the HVAC system, and documentation that the system meets needs both during operations and during potential renovations. Commissioning should also establish responsibilities for maintaining and operating the system, and for training the staff responsible for operating and maintaining the system. In addition, commissioning should include ventilation specifications for use while the building is new, to control levels of VOC.

Material selection

Designers should specify building materials that are minimal sources of indoor emissions. These materials include low-emitting products and materials, which do not generate or store dust particles. In addition, the design should minimize horizontal surfaces on interior finishes and furnishings to reduce the particle levels in buildings.

Combustion appliances

Designers and builders should specify and install combustion appliances according to manufacturers' specifications, paying special attention to requirements for combustion and for exhaust ventilation.

6.2.1.3 Indoor air pollution control

Management of pollutant sources

Biological contaminants. Biological contaminants will flourish wherever there is adequate moisture because adequate nourishment is always available on building surfaces. Because so many building materials can serve as a nutrient source for moulds and other biological contaminants, the most practical means for controlling biological contamination is to avoid excess moisture wherever possible. Moisture control can be accomplished by dehumidification, ventilation, and increasing the temperature at the building surfaces to prevent condensation. Dehumidification is most important in humid climates, and ventilation can aid in moisture control by increasing air movement. These techniques may be used individually or in combination.

Biological contamination can be avoided both by sustaining high-quality maintenance and by monitoring the materials and procedures used in operating and maintaining the building components, including the air-conditioning system. Proper maintenance of air-conditioning equipment is critical for preventing microbiological growth and the entry of undesirable micro-organisms into the indoor air. These components include drainage pans, coils, cooling towers, ductwork and humidifiers. Poor filter maintenance is a common problem and a poorly maintained filter can act as a source of fungal spores, and bacterial and other biological particles that can be distributed in air within the building. Routine maintenance schedules are required that include filter checking and replacement and drain pan clearing.

Volatile Organic Compounds. The concentration of VOC within the air of a building can be controlled through careful selection of building materials and products. Building managers should become familiar with the VOC found in the building components and products. Designers and building managers should attempt to select the safest, least toxic materials, when they can be identified, or those with the lowest emission rates. Information regarding VOC may be found by reviewing product labels, Material Safety Data Sheets (MSDS), and available compendia (e.g. the American Institute of Architects Environmental Resource Guide).

For building materials, off-gassing is greatest immediately after the installation of VOC sources, when they are new. This off-gassing decreases with age of the VOC sources. To minimize occupant exposure to VOC, areas that have newly-installed VOC-emitting materials, or that have undergone renovation, should receive increased outdoor air ventilation and/or local exhaust. In the initial months after building completion, the ventilation should operate 24 hrs/day and 7 days/week. Installation of new products or renovation work should preferably occur when the space is unoccupied and remain unoccupied until the strongest VOC off-gassing has occurred.

Air clearing is not recommended as a substitute for source control and adequate ventilation for removing VOC. Although VOC can be removed by air cleaners relying on adsorption and absorption methods, care must be taken to avoid re-emission of the collected VOC from the filter medium.

Radon. To prevent the migration of radon gas into a structure, any cracks or openings in the foundation of the lowest level of that structure should be tightly sealed. Ventilation can be introduced to the lowest level in a building to dilute and remove the gas. Exhaust fans and piping can create sub-slab depressurization to remove radon and deter it from accumulating in the building.

Combustion Gases. Combustion gases should normally be exhausted to the outdoor air, and prevented from entering occupied spaces. Outdoor air intakes for a building should not be located near exhaust systems or other sources of combustion gases, such as highways. Combustion appliances are a source of combustion gases within a building and should be used and vented in accordance with the manufacturers' recommendations. Adequate general ventilation, as well as exhausts for the appliances, should be provided to minimize the exposure of occupants.

Particles. Particles, including asbestos, tobacco smoke particles, dust and pollen are hazardous or troublesome to occupants when they become airborne. Materials that generate high loads of particles need to be avoided. Proper housekeeping practices should be followed to keep dust levels low. Cleaning activities should be conducted during the off-peak hours to minimize effects of fine particles on sensitive occupants. High-efficiency filtration in the air handling system can also help reduce airborne particle levels.

Asbestos Asbestos products must be avoided. When asbestos products are identified in existing buildings, the general recommendation is to minimize disturbance of those materials, which are non-friable or friable, yet in good condition. This also involves training staff on emergency maintenance handling procedures.

Environmental tobacco smoke. To eliminate exposure of non-smokers to ETS, organisations should prohibit smoking in buildings. If this is not possible, organisations should provide enclosed, separately-ventilated, negatively-pressurized smoking rooms, with direct external exhaust. These smoking rooms should provide a high volume of outdoor air per smoker.

Operation and maintenance of ventilation systems

Building maintenance personnel should be trained to understand the indoor air quality aspects of their work. Many maintenance activities directly affect indoor air quality , and some may reveal indicators of potential problems. The staff should be made aware of indoor air quality considerations and how their work can directly impact the health and comfort of occupants.

Preventive maintenance of an HVAC system is essential for it to operate correctly and provide suitable comfort conditions and good indoor air quality. Detailed maintenance logs should be kept for all equipment, including controls and filters. A scheduled program should be developed for a routine check of equipment, calibration of control system components, and necessary filter replacements.

Space is often used for purposes other than those originally intended, especially in older buildings. Changes such as increased occupant density, or altered function of the space, can affect both the required outdoor air supply to the space and the necessary exhaust from the space, and consequently can reduce indoor air quality. When space is reallocated, renovated, or changed from the original design, the use of the space should be re-examined to determine if adjustments to the HVAC system are warranted. The same procedure is required when new sources of contaminants are introduced.

Air cleaning

Depending on the pollutants of interest, four technologies can be considered for removing contaminants from the air: particle filtration, electrostatic precipitation, negative ion generation and gas sorption. The first three are devised for the removal of particulate matter, while the fourth is designed to remove gases. Air cleaning is most effective when used in conjunction with source control and adequate ventilation. Most air cleaning in large buildings is directed primarily at preventing contaminant accumulation in HVAC equipment and enhancing equipment efficiency.

Filtration is effective only when properly installed and maintained. It is important that filters be changed or cleaned on a regular basis and that leakage around the filters is minimized. High-efficiency filtration is most effective at improving indoor air quality.

6.2.1.4 Resolving indoor air quality problems

Addressing occupant complaints and symptoms

When complaints are received from occupants of a building, the building management needs to be responsive to these complaints. The initial investigation into the cause of the complaint may be conducted by the in-house building management staff. Building management should continue an investigation as far as it can, and be responsible for hiring an outside consultant if needed.

Building diagnostic procedures

Investigation protocol. After receiving complaints related to indoor air quality, experienced staff or consultants should investigate the cause of the problem through an iterative process of information collection and hypothesis testing. To begin, a walkthrough inspection of the building is required, including the affected areas and the mechanical systems serving these spaces. A walkthrough can provide information on the occupants, HVAC system, pollutant pathways and contaminant sources. Visual indicators of possible contaminant sources or HVAC system malfunctions should be evaluated first. Measurements of temperature, relative humidity, and air flow should be taken if a walkthrough alone does not provide a solution. Symptom logs and schedules of building activities may provide enough additional information to resolve the problem. When visual inspection and data gathered from the occupants do not identify a possible cause, it may be necessary to sample for suspected contaminants, or compare indoor and ambient levels of pollutants, to ascertain the source of the problem. Whenever a problem is discovered during the investigation, a remedy should be attempted and then a determination made as to whether the complaint has been resolved.

Sampling for contaminants. As part of the evaluation of the HVAC system, samples should be collected for temperature, relative humidity, CO_2 levels and airflow. More sophisticated sampling can be conducted for mould, bacteria, VOC etc. at a later date, if it becomes necessary to confirm a hypothesis, or to provide proof to a building owner or other responsible party.

Other potential stressors. Several building-related factors can cause symptoms similar to those of indoor air pollution - headaches and eye irritation are examples. These other stressors include ergonomics, lighting, noise, vibration and psychosocial factors. An investigation should therefore also evaluate non-indoor air quality factors.

6.2.1.5 Government policy

Many of the problems associated with poor air quality can be prevented at low cost and without compromising energy efficiency if governments develop and implement integrated strategies for the indoor environment, in concert with all social and economic partners.

Guidance/education

Understanding indoor air quality issues enables a government to focus public education. Both general information, as well as technical training, can be provided for minimizing indoor air pollution. Special focus needs to be given to the design process, so that buildings meet acceptable indoor air standards. Targeted technical guidance and training can be provided for audiences that influence building air quality or occupant health. These include architects; mechanical designers; building owners; facility managers; homebuilders; diagnosis and mitigation professionals; and physicians.

Research support

Pollutant source characterization. Research on indoor air quality can be used to characterize pollutant sources and provide protocols for reducing exposures; it can also provide information on the relationship between health effects and indoor pollutants.

Health effects. There are three areas where research can significantly improve our understanding of the health effects of indoor pollution. These are: low-level chemical exposure and pollutant mixtures; allergy/hypersensitivity; and multiple chemical sensitivity, also known as environmental illness.

The effects of low-level exposure to the mixtures of pollutants found in non-industrial environments need to be characterized, since they can induce different health effects from those produced by higher pollutant levels, such as those identified in occupational exposure limits.

Research can be used to better understand the mechanisms causing the health effects, and the different responses of individuals, or groups of individuals. For example, an improved understanding of hypersensitivity associated with allergy and other conditions would help find medical solutions to hypersensitive reactions.

Research to characterize and determine the causes of, and solutions to multiple chemical sensitivity is also needed. Identifying the physiological nature of multiple chemical sensitivity is the first step in understanding whether and how indoor air quality contributes to the syndrome.

Technology development. The development of better technologies in diagnosis, mitigation, and control would help to improve indoor air quality. Mitigation and control studies are needed to provide economical and practical alternatives to current technologies. Better means of measuring the effectiveness of ventilation systems are also needed. While the ability to measure individual pollutants often exceeds our knowledge of their health effects at the measured levels, progress is still needed in measurement of pollutant mixtures. There is a need for the development of diagnostic tools that are inexpensive and easy to use.

There is a particular need for improving methods for assessing airborne biological contamination, including both viable and total microorganisms. Research needs to be directed towards the development of immunological and other methods for reliably detecting and quantifying specific organisms, or their allergens. Techniques are also needed for assessing mycotoxins and microbial metabolites that may affect health via non-allergic mechanisms.

Sick Building Syndrome and Building Related Illnesses. Efforts to identify causes and solutions to SBS and BRI are required (for definitions of these terms see chapter 4). Research in health effects and building diagnostics, combined with analyses of data compiled from building investigations, are important for gaining a better understanding of indoor air quality problems.

Problem assessment and surveys

There is a need to assess the extent of indoor air quality problems, to provide accurate information when setting priorities for public health problems.

Building surveys/Epidemiology. Building surveys are necessary to identify building types in which problems occur more frequently. The results of these studies support effective risk reduction programs. Epidemiological studies are needed to characterize indoor air quality-related symptoms, and to distinguish the effects of air pollution from those due to other causes. Epidemiological studies also help to quantify the risk for indoor air pollutants.

Economics. Economic studies are needed to measure the costs of indoor air pollution and indoor air quality control strategies to individuals, businesses and society. This research includes developing measures of productivity loss and health cost increases, as well as costing various control strategies, including increasing ventilation, controlling pollutant sources and air cleaning.

Standard/protocol development

Exposure guidelines for indoor air quality. When the health effects of exposure to pollutants are known, it is important to ensure the protection of workers by setting reasonable exposure limits. In cases where research or risk assessment activities have yet to determine precise dose-response relationships, but where health effects are generally recognized, exposure limits should be set conservatively, weighing risk, economic impact and feasibility. In addition, efforts should be made to develop exposure limits that recognize non-carcinogenic effects.

Building codes. Building codes provide an opportunity to incorporate indoor air quality considerations into the design process. There is a need to develop codes for ventilation design, building envelope design, site preparation, materials selection and commissioning.

Ventilation standards. Adequate ventilation of occupied spaces with outside air is necessary to ensure good indoor air quality. Research and development is needed for a health-based ventilation standard. Encouraging code-setting bodies to adopt ventilation standards, set by consensus organisations or governmental bodies, will help improve indoor air quality in buildings.

Maintenance protocols. Easily implementable guidelines are needed for maintaining HVAC systems and other maintenance activities that affect indoor air quality.

Product labelling. As an incentive to industries to develop and market products that emit less pollution, improved product labelling programmes should be implemented. The intent is to provide information to consumers and building designers; it is not intended as a sign of safety approval. Labelling would serve to achieve general reductions in emissions, rather than requiring manufacturers to meet specific guidelines, except for those cases where undesirable chemicals can be identified.

Accreditation. By instituting a system of accreditation that recognizes and highlights areas of expertise, consumers can be provided with information to make better informed choices when procuring indoor air quality services.

Emission Standards. Guidelines for product VOC emissions would provide useful information for manufacturers, architects, design engineers, building managers and others who play a role in selecting products used indoors. However, development of such guidelines is dependent upon additional research establishing a health basis for them.

6.2.2 Management of Indoor Air Quality in Developing Countries

The management of indoor air pollution in developing countries is a very important task of the building occupants if adverse impacts from e.g. open stove cooking and heating are to be avoided. Decisions of the building occupants, however, will often be driven by the household economy, convenience or habits rather than by minimal health risk considerations with respect to activities, facilities, and materials used indoors. Legislative and economic mechanisms should encourage individuals to manage the indoor environment in a health promoting way by means of technical and behavioural interventions. WHO has summarized technical and social-behavioural interventions in a publication on indoor air pollution from the use of biomass fuels (WHO 1992). Both types of interventions are depicted in figures 6.4 and 6.5.

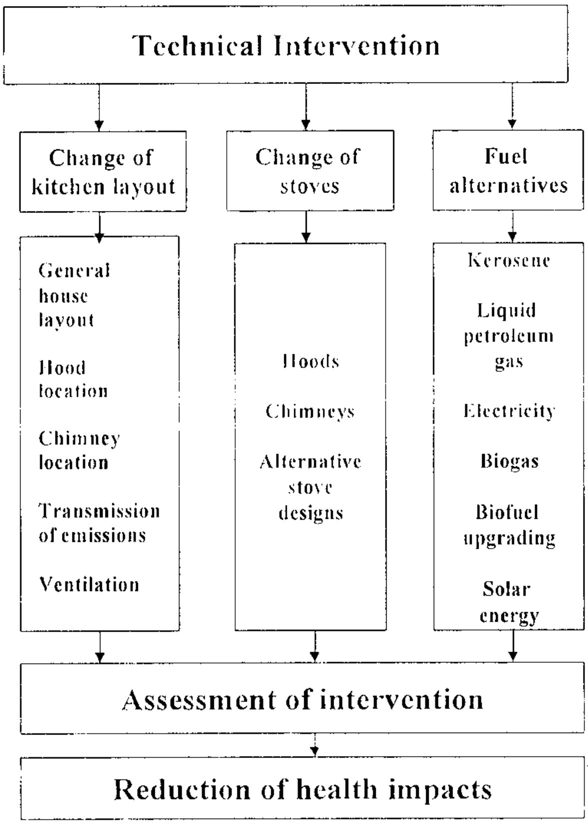

Figure 6.4 Technical interventions for reducing health impacts from use of biomass fuel in households

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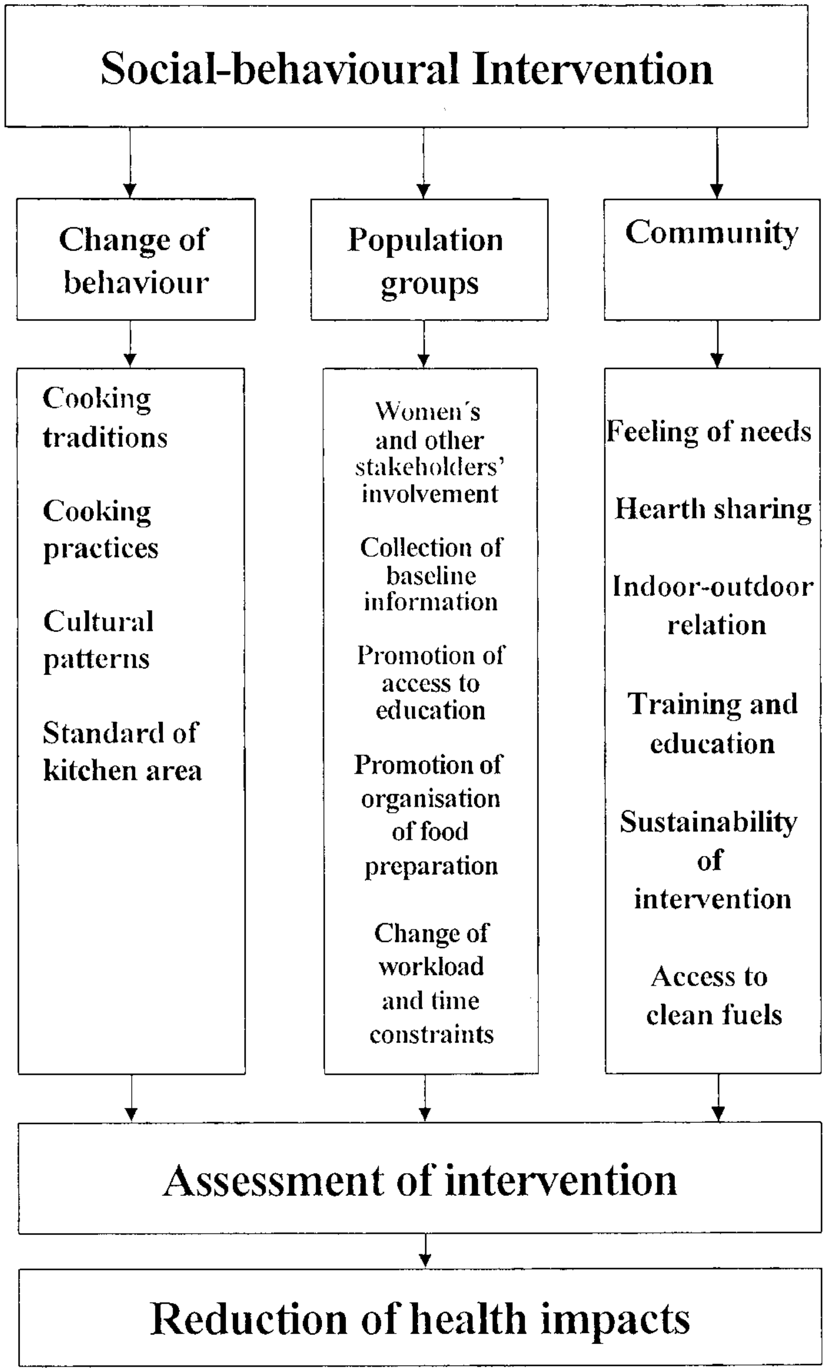
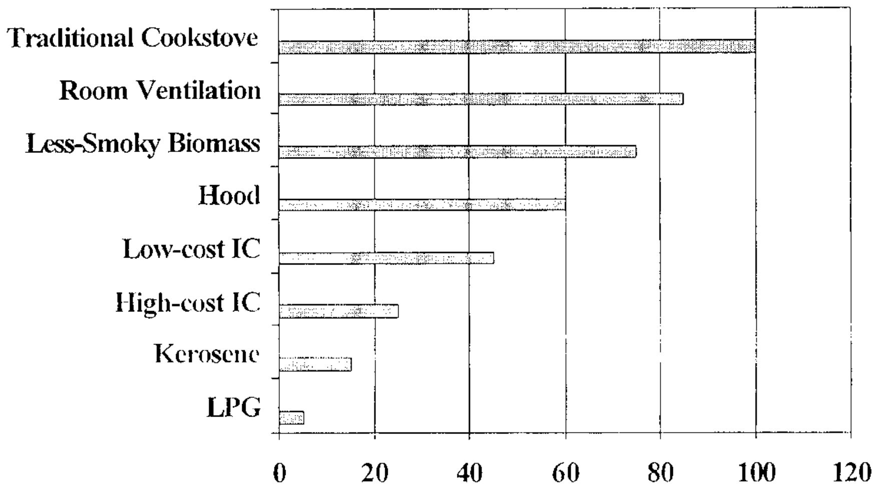
Figure 6.5 Social-behavioural interventions for reducing health impacts from use of biomass fuels in households



An overview of the effectiveness of major technical interventions for reducing ill-health from the use of household solid fuel is shown in Figure 6.6. This section concentrates in the following on only the major technical options and provides a brief outline of the issues involved.



IC = Improved cookstove with flue (chimney)

Figure 6.6 Effectiveness of potential exposure interventions: Percent of exposure compared to using traditional cookstove without flue – typical values.

6.2.2.1 Improved Ventilation

An obvious solution when observing a village kitchen containing an unvented woodstove is better ventilation - i.e. more windows or other openings. In practice, however, there are often severe constraints because of weather, security or architecture. Thus, while better ventilation can clearly help in many circumstances, it is not a solution applicable to all situations.

6.2.2.2 Improved Stoves - Chimneys

Standard industrial hygiene suggests that general ventilation is not always sufficient as a means of exposure control, and that ventilation at the individual workplace is needed. Improved stoves utilizing flues or hoods can reduce indoor exposures substantially, particularly in the vicinity of the stove. Studies in developing countries show that pollution levels in homes can be lowered by nearly a factor of ten in ideal circumstances when well-constructed and maintained improved stoves are used.

Unfortunately, however, such circumstances do not seem to prevail in a large percentage of households. Inexpensive stoves tend to deteriorate through use of poor quality materials, poor construction and poor maintenance, leading at best to a factor of three improvement in exposures over long periods. In a large number of studies, no statistically significant difference was found between the indoor concentrations of particles in homes using these improved stoves, and those in homes of their neighbours, who used open fires.

Another factor reducing the health benefit of even well-operating chimney stoves is that they exhaust emissions outdoors. In a built-up areas, such as exists in most urban slums and many villages, outdoor levels of air pollutants around the houses can significantly affect indoor levels. This "neighborhood effect" is not well-characterized, but it can limit practical exposure reduction.

If not carefully designed, chimney stoves can decrease fuel efficiency. The natural draft of the flue can so reduce the heat transfer to the cooking pots that overall efficiency is reduced. Perversely, in an attempt to prevent this effect, improved chimney stoves often have dampers to reduce the airflow. While overall efficiency may increase due to increased heat transfer efficiency, combustion efficiency can be impaired by poor air supply. The result, therefore, is paradoxically an increase in both fuel efficiency and emissions, although perhaps also lower exposures since the emissions are released outdoors.

In spite of these problems, chimney stoves seem to offer a short-term solution in many situations, but they probably need to be considered as only a first step in managing indoor emissions from fuel combustion.

6.2.2.3 Improved Stoves - Combustion

Wood and most other biomass fuels have few intrinsic contaminants, so that in ideal circumstances, virtually complete combustion can almost eliminate health-damaging emissions. In many developed countries, wood-burning stoves are subject to severe restrictions on emissions. By application of good engineering, remarkable improvements in emission performance has been achieved in such devices. This includes not only the use of catalytic converters, but also clever designs incorporating fluidized beds or secondary combustion.

Unfortunately, it can be difficult to design inexpensive devices that can reliably achieve high combustion efficiency and low emissions. A "low cost" low-emissions metal heating stove in the USA might cost $500. More typically, costs are twice this or more. Improved stove programmes in many developing countries attempt to keep costs well under $20. The technical potential seems high for filling this gap and inexpensive devices utilizing downdraft designs, for example, have achieved remarkable combustion efficiency in experimental situations. Much work remains to be done before such devices are practical on a global scale.

6.2.2.4 Fuel

Although the potential of truly low-emission stoves is alluring, improved fuels are the only proven long-term approach to the indoor air quality problem in developing countries. History has shown that people generally move to higher-quality fuels given access and affordability. This observation has led to the concept of the "energy ladder." At its bottom rung are the lowest-quality biomass fuels, grass, shrubs and roots; next come agricultural residues of dung and crop wastes; and then the highest-quality unprocessed biomass fuel, wood.

Although improved stoves have important roles, the long-term approach to the indoor air quality problem in developing countries is probably to accelerate the natural movement up the energy ladder to liquid and gaseous fuels. These fuels can be made from biomass itself, for example in the forms of alcohol and biogas. Promoting movement up the energy ladder in some cases can be accomplished by changing government policies that restrict access to certain petroleum fuels because of concerns about balance of payments. In many cities, even at international prices, such fuels are often cheaper than buying wood or charcoal when all costs are considered. Here the constraint is often the up-front cost of the stove and storage system (pressurized tank), which could be provided by low-interest loans or other subsidies.

Subsidizing kerosene and bottled gas directly, however, has many problems. When this has been done, usually as a means to reduce the pressure on biomass resources, the poor often do not benefit much, while others benefit by using the fuels for unintended purposes, e.g., irrigation pumps and vehicles. The result is high cost to the society and little shifting of household fuel use. Creative new approaches using vouchers or other types of incentives are needed in this area, to confine the benefits of subsidies to those who need them and are the intended beneficiaries. In addition, much enhanced research is needed on conversion of biomass into liquid and gaseous fuels that are compatible with high-quality household environments.

Other renewable fuels, such as solar energy, have the potential to provide clean fuels at an affordable economic cost, and in some areas to wholly or partially replace those household fuels that create substantial indoor air quality problems.

6.2.2.5 Conclusion: Simple Exposure Indicators

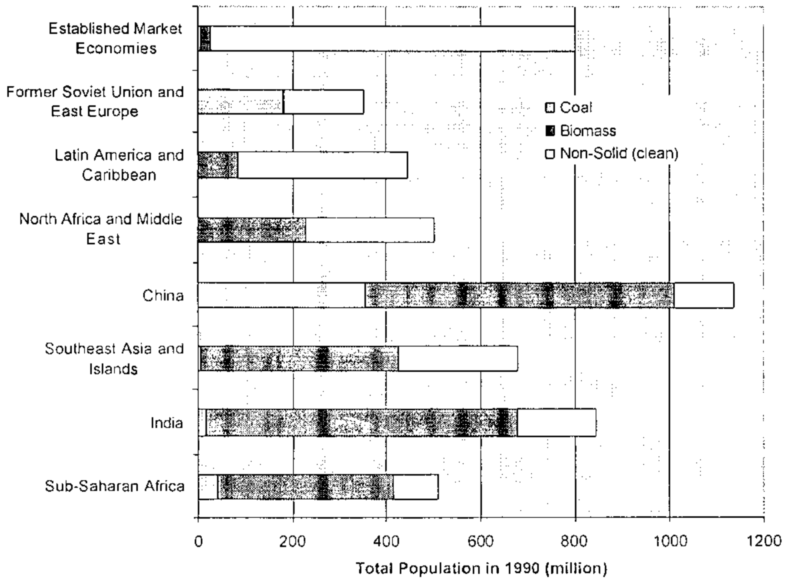
Although work on deriving simple exposure indicators urgently needs to be encouraged, realistically it is likely to be some years before sufficient environmental monitoring can be undertaken in most developing countries. In the interim, simple affordable exposure assessment tools are needed to assist in estimating the scale of the problem in local areas.

Simple indicators of poor water quality and sanitation have been developed and implemented successfully by WHO and others. These indicators are widely used to show trends and locate special problem areas. They do not require actual measurements but are able to be collected from other socio-economic information on households.

It should be possible to collect a set of indicators of the potential for air-pollution-related diseases from the segments of the population with:

- Access to clean fuels (defined to be stoves using liquid and gaseous fuels or electricity, or defined as use of the clean fuels themselves) and,
- Access to venting [or ventilation] (defined to be the use of flues, chimneys, or outdoor cooking).

Although both of these indicators are subsets of broad goals related to achieving adequate, healthy and sustainable living environments, such simple indicators have high utility because of their ability to be quantified and easily understood. Trends over time and comparisons among different regions or populations are thus facilitated. Figure 6.7 is a preliminary attempt at reporting the first of these indicators at the global level.



Note: Most use of solid fuels in the first two regions is in vented heating stoves.

Figure 6.7 World population using clean and potentially dirty (solid) household fuels

Such indicators will help focus efforts to develop interventions. Eventual control of indoor air exposure from solid fuel cooking and heating is likely to require many years, and the integrated efforts of several sectors, including health, environment, energy and housing. Nevertheless, efforts to accelerate this process are likely to be rewarded with major improvements in human health.

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7. Priority Setting in Air Quality Management

7.1 Introduction

This chapter is intended to give guidance on how to set priorities in rational air quality management. Actual priorities will differ for each country; therefore, each country sets priorities in air quality management according to its policy objectives, needs and capabilities. Priority setting in air quality management refers to prioritizing the health risks of air pollution, with corresponding prioritization of the pollutants, and concentrating on the most important sources of the pollutants. Conceptually, prioritizing health risks is straightforward (WHO 1999a; WHO 1999d). High priority health risks will be given to those compounds for which "high" toxicity and "high" exposure of the population are entailed.

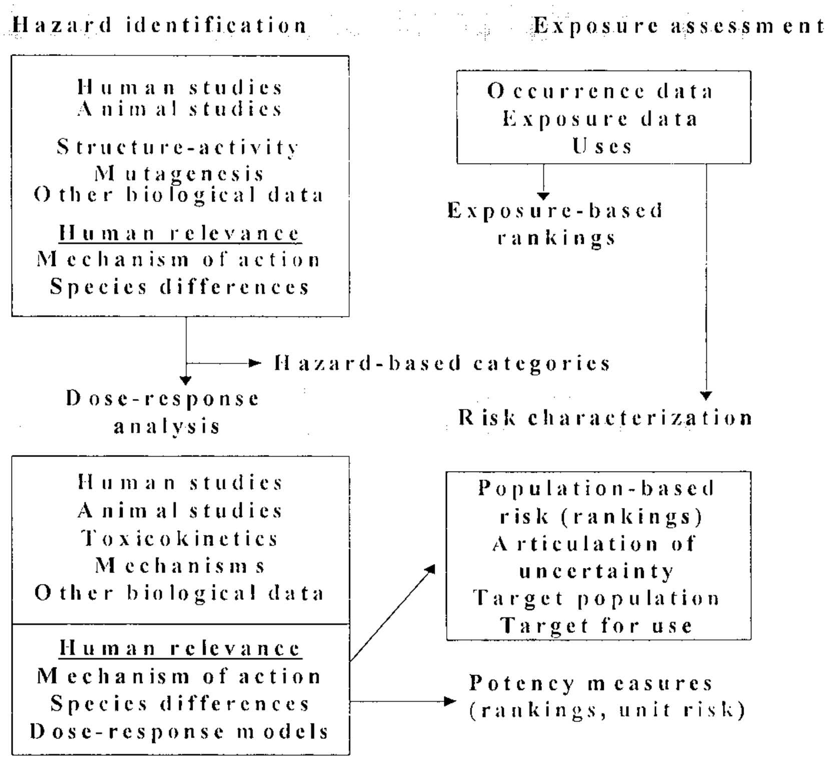

Figure 7.1 Basic elements of the estimation and prioritization of health risks

Conversely, low priority health risks involve agents of "low" toxicity and "low" exposure. "Medium" priority risks include compounds for which toxicity is "low" and exposure is "high," or vice versa. Basic elements of the estimation and prioritization of health risks is illustrated in Figure 7.1 (Sexton 1993; Younes et al 1998).

For effective air quality management, goals, policies, strategies and tactics need to be defined. These are discussed in Chapter 6.

A framework for a political, regulatory and administrative approach is required to guarantee a consistent and transparent derivation of air quality standards and to ensure a basis for decisions on risk-reducing measures and abatement strategies. In such a framework the following considerations need to be included:

- legal aspects.
- the potential of air pollution to cause adverse effects on health, taking into account populations at risk.
- exposure-response relationships of pollutants and pollutant mixtures and the actual exposure responsible for related health and/or environmental risks.
- the acceptability of risk.
- cost-benefit analysis.
- stakeholder contribution in setting standards.

7.2 Legal aspects

A legislative framework usually provides the basis for policies that set air quality standards at the municipal, regional, national or supranational level. The setting of standards strongly depends on the risk management strategy adopted which, in turn, is influenced by country-specific socio-political considerations and/or international agreements. Legislation and air quality standards vary from country to country, but in general the following issues may be taken into consideration:

- Identification and selection of the adverse effects on public health and the environment to be avoided.
- Identification of the population to be protected from the adverse health effects.
- Identification of the pollutants to be considered.
- The numerical value of the standards for the various pollutants or the decision-making process.
- Existing background concentrations of air pollutants.
- Applicable monitoring methodology and its quality assurance.
- Enforcement procedures to implement air quality standards within a defined time frame, to achieve compliance.
- Emission control measures and emission standards.
- Environmental impact assessment procedures.
- Identification of responsible enforcement authorities.
- Resource commitment.

Air quality standards may be based solely on scientific and technical data. However, other aspects such as technological feasibility, costs of compliance, prevailing exposure levels, social, economic and cultural conditions, are also usually considered in setting standards or in designing appropriate emission abatement measures. These are discussed in Section 2.4. As a consequence, air quality standards differ widely from country to country (WHO 1998b).

Air quality standards can set the reference point for emission control and abatement policies at national, regional or municipal levels. The latter two levels are only effective if long-distance transport of air pollution does not influence exposure. In the case of exposure to pollutants from long-range transboundary transport, however, adequate measures can only be achieved through appropriate international agreements.

Air quality standards strongly influence the implementation of air pollution control policies. In many countries, there is an obligation to develop action plans at the municipal, regional or national level to abate air pollution (clean air implementation plans) if standards are exceeded. Such plans have to address all relevant sources. Air quality standards also play a role in environmental impact assessments and in the provision of public information on the state of the environment.

7.3 Adverse effects on health

In setting air quality standards on the basis of air quality guidelines, it is necessary to define from which effects the population is to be protected. Health effects range from death and acute illness, through chronic and lingering diseases, to temporary physiological or psychological changes.

The distinction between adverse and non-adverse effects poses considerable difficulties. WHO has given a definition of adverse effects as "any effect resulting in functional impairment and/or pathological lesions that may affect the performance of the whole organism, or which contribute to a reduced ability to respond to an additional challenge" (WHO 1987). A more recent definition was given in the framework of the International Programme for Chemical Safety in its Environmental Health Criteria Series (WHO 1994c): "An adverse effect is any change in morphology, physiology, growth, development or life span of an organism which results in impairment of functional capacity, or impairment of capacity to compensate for additional stress, or increase in susceptibility to the harmful effects of other environmental influences." Even this elaborate definition incorporates significant subjectivity and uncertainty in defining an adverse effect of air pollutants on health.

More serious effects are generally accepted as adverse. But when the health effects are either temporary and reversible, or involve biochemical or functional changes with uncertain clinical significance, a judgement is required on whether these less serious effects should be considered when deriving the standards. Judgements as to whether the health effects are adverse may differ between countries, because of factors including different cultural backgrounds and different levels of health status. The use of biomarkers or other indicators of exposure may provide a basis for setting air quality standards. Changes in such indicators, while not necessarily being adverse effects in themselves, may be harbingers of adverse effects on health. An example is blood lead content as an indicator of likely impairment of neuro-behavioural development.

7.4 Population at risk

The population at risk is that part of the population that is exposed to enhanced concentrations of air pollution. Each population has sensitive groups or sub-populations that are at higher risk for developing health effects following exposure to air pollutants. Sensitive groups include individuals impaired by concurrent diseases or other physiological limitations, and those with specific characteristics, which makes them more vulnerable to air pollutants (e.g. infants, elderly people). Other groups may be judged to be at higher risk due to enhanced exposure (outdoor workers, athletes, children). The sensitive groups in a population may vary across countries due to differences in medical care, nutritional status, lifestyle, and/or prevailing genetic factors, or due to the existence of endemic diseases or the prevalence of debilitating diseases

7.5 Exposure-response relationships

Chapter 3 provides exposure-response relationships for a number of pollutants, including graphs for particulate matter and O_3. The percent change of various health endpoints, such as daily mortality and hospital admissions, are derived for a 10 $\mu g/m^3$ increase in PM_{10} and $PM_{2.5}$ concentrations. Assuming linearity, the relationships apply from 0 and 200 $\mu g/m^3$. For carcinogenic compounds quantitative assessment of the unit risks provides an approximate estimate of responses at different concentrations. In setting standards, the definition of acceptable risk is related to risk perception and economic and social circumstances.

In developing standards, regulators should consider the degree of uncertainty in the exposure-response relationships provided in the air quality guidelines. Differences in the population structure (age, health status) climate (temperature and humidity), and geography (altitude, environment) can influence the prevalence, frequency and severity of health effects. Consequently, modified exposure-response relationships should be applied when setting standards (see Section 2.4).

7.6 Exposure characterization

When setting standards it is not enough to simply consider the pollutant concentrations in ambient air. Personal exposure of the population should also be considered. As discussed in Section 4.2.3, the total exposure of people to pollutants also depends on the time people spend in the polluted environments, i.e. outdoor, indoor, workplace, in-vehicle etc. Exposure also depends on the various routes of intake of the pollutants into the human body, for example air, water, food and tobacco smoking. Multiple exposures may vary across these routes which should be considered in the standard setting procedure. In deriving air quality standards, the size of the population at risk (i.e. exposed to enhanced air pollutant concentrations) is also an important factor to consider. Models of exposure estimates should be used in addition to ambient and indoor concentration monitoring.

7.7 Risk assessment

The development of air quality standards should be based on health and ecological risk models. Increasingly, these models are used to inform policy makers on some of the possible consequences of air pollutants at levels corresponding to various options for standards. Using this information, the policy maker can better assess the effects of air pollution.

Regulatory risk assessment in air pollution management includes a consideration of hazard identification, exposure-response relationships, exposure assessment and quantitative risk characterization. The first step, hazard identification, and to some extent exposure-response relationships, have already been provided in the *Guidelines for Air Quality*. Exposure assessment may predict changes in exposure associated with reductions in emissions from a specific source or group of sources. When using ambient air concentrations in the assessment of exposure, the issues discussed in Section 7.4 have to be taken into consideration. The final step in regulatory risk assessment, risk characterization, refers to the quantitative estimation of the health effects in the population at risk. Examples for such estimates were given by Hong 1995; Ostro 1996; Schwela 1996a; Schwela 1996b; Schwela 1998; Murray and Lopez 1996.

Regulatory risk assessments are likely to result in different risk estimates across countries and economic regions, owing to differences in exposure patterns, and in the size and characteristics of sensitive groups. Differences in the legislation and availability of information may also lead to differing results. There are many uncertainties at each step of a regulatory risk assessment. Therefore, the methods used to conduct the risk assessments should be clearly described and the limitations associated with the analysis discussed. A sensitivity and uncertainty analysis should be performed to characterize the major uncertainties of the risk estimates.

7.8 Acceptability of risk

In the absence of thresholds for the onset of health effects - as in the cases of fine and ultra-fine particulate matter and carcinogenic compounds - the selection of an air quality standard requires that the regulator determine an acceptable risk for the population. This also applies in cases where thresholds are present, but it would not be feasible to adopt air quality guidelines as standards because of economic or technical constraints. The acceptability of the risks and, therefore, the standards selected, depends on the expected incidence and severity of the potential effects, the size of the population at risk, the perception of related risks and the degree of scientific uncertainty that the effects will occur at a specific level of air pollution. For example, if a suspected but uncertain health effect is severe, and the size of the population at risk is large, a more cautious approach would be appropriate than if the effect were less severe, or if the population were smaller.

The acceptability of risk may vary among countries because of differences in social norms, the degree of adversity and risk perception in the general population, and because of the influences of various stakeholders. Risk acceptability is also influenced by how the risks associated with air pollution compare with risks from other pollution sources or human activities.

7.9 Cost-benefit analysis

In the derivation of air quality standards from air quality guidelines two different approaches for decision making can be applied. Decisions can be based purely on health, cultural and environmental consequences with little weight to economic efficiency. This approach would have the objective of reducing the risk of adverse effects to a socially acceptable level. The second approach would be based on a formal cost-effectiveness or cost-benefit analysis (CBA), with the objective of identifying the control action that achieves greatest net economic benefit, or is the most economically efficient. The development of air quality standards should account for both extremes, and encompass a process that involves stakeholders and assures social equity to all involved. It should also provide sufficient information to guarantee that the stakeholders understand the scientific and economic consequences. Cost benefit analysis is discussed in Section 2.4.7.

The steps in a cost-benefit analysis include:

- Identification and cost analysis of control action (emission abatement strategies and tactics).
- Assessment of air quality and population exposure, with and without the control action.
- Identification of benefit categories (health effects, material damage, damage to ecosystems).
- Comparison of health and environmental effects, with and without control action.
- Comparison of the estimated costs of control action and benefits.
- Sensitivity and uncertainty analysis.

Cost analysis of control action. To determine the financial burden of control action, cost assessment should include all costs of investment, operation and maintenance. This is usually not a problem for direct abatement measures at the source, which can be monetarized. It may be more difficult to determine the costs of indirect measures, such as alternative traffic plans or change in behaviour of individuals. Even when secondary air pollutants are not monitored they should be included in the CBA.

Assessment of air quality. An assessment of air quality includes information about expected air quality, both with and without control measures. Typically, the assessment is based on air quality monitoring data and dispersion modelling. The types of data requested in a CBA include pollutant concentrations (evaluated for relevant averaging times), site classification, emission data (with sufficient temporal and spatial resolution), and meteorological and topographical data relevant to the dispersion of emissions. The air quality guidelines are based on a set of health and environmental effect endpoints determined by consensus and scientific judgement. Other effects that were not included in the air quality guidelines may occur in a special local situation and may be considered in an analysis of costs and benefits.

Identification of benefit categories. Relevant benefit categories defined in existing CBAs include: mortality and morbidity due to long- and short-term exposures, climate and visibility effects, non-human biological effects, soiling and material damage (USEPA 1987a,b); total premature mortality and mortality due to respiratory and cardiovascular diseases, hospital admissions, upper and lower respiratory symptoms, symptom exacerbation among asthmatics and reduced activity days (EC DG XII 1995; GVF 1996). The quantification of benefit categories included in a CBA is a difficult task. Some indicators of diseases can be quantified, such as the use of medication, number of hospital admissions, outpatient visits or days of labour lost. Other effects, such as premature death of the elderly or excess mortality present more difficult problems. Well-being, the quality of life or the value of ecosystems may be difficult or even impossible to monetarize. The values assigned to benefit categories might differ substantially among countries due to different cultural or social attitudes. It is better, however, to include the relevant benefit categories, even if the economic assessment is uncertain or ambiguous.

Comparison of health and environmental effects. A comparison of the health and environmental benefits with and without control action, and information on exposure-response relationships, should be combined with information on air quality assessment. The combined information is applied to the population at risk. To assess the influence of air pollution, knowledge is needed of the prevalence of different health effects in the population at risk and the percent increase of health effects with one unit of pollutant concentration.

Comparison of costs and benefits. The CBA should provide a benefit-cost ratio based on monetarized costs and benefits, and be accompanied by a description of the non-monetarized items that also should be considered. Monetary valuation of control actions, and of the effects on health and the environment, may be different in concept and vary substantially from country to country. There may be differences in assessing costs, and the relative value of benefit categories can vary. The costs of environmental policy action may also vary according to the scale and level of decision making, e.g. with respect to transfer costs (taxes, subsidies aimed at redistribution of costs). Benefits may also be transferable between groups of the population. Furthermore, action taken to reduce one pollutant may increase or decrease the concentration of other pollutants. These additional effects should be considered, as well as pollutant interactions, which may lead to double counting of costs or benefits, or to disregarding some costly but necessary action. Due to different levels of knowledge about the costs of control action and the costs of health effects there is a tendency to overestimate the cost of control action and underestimate the benefits. Thus, CBAs in two areas with otherwise similar conditions may differ significantly.

Sensitivity and uncertainty analysis. In a CBA, sensitivity analysis provides valuable insight into the properties and assumptions underlying the results of the CBA. Sensitivity methods include comparison with other CBA studies, recalculation of the whole chain of CBA using other assumptions, or ranges around a central value. Sensitivity analysis has to be carefully designed and requires considerable resources.

In conclusion, CBA is a highly interdisciplinary task. Appropriately applied, CBA is a legitimate and useful way to provide information for risk managers making decisions that will affect public health and the environment. CBAs should be peer-reviewed and not be used as the sole and overriding determinant of these decisions.

7.10 Review of standard setting

The setting of standards should involve stakeholders (industry, local authorities, non-governmental organisations and the general public) that assures, as far as possible, social equity or fairness to all the parties involved. It should also provide sufficient information to guarantee that stakeholders understand the scientific and economic consequences. The earlier stakeholders are involved the more likely is their Cupertino. Transparency in moving from air quality guidelines to air quality standards helps to increase public acceptance of necessary measures. Raising public awareness of air pollution-induced health and environmental effects (changing of risk perception) serves to obtain public support for necessary control action. Information to the public about the air quality during episodes, as well as the risks entailed, lead to a better understanding of the issue (risk communication).

Air quality standards should be regularly reviewed and revised as new scientific evidence on the effects on public health and the environment emerges.

7.11 Enforcement of air quality standards: Clean air implementation plans

The aim of enforcement is to attain compliance with the standards. The instruments used to achieve this goal are Clean Air Implementation Plans (CAIPs). The outline of such a plan should be defined in regulatory policies and strategies. Clean air implementation plans were formulated in several developed countries during the 1970s and 1980s. Air pollution was characterized by many sources and many different types of air pollutants. Consequently it was extremely difficult to assess the public health risks associated with a single source or group of sources. As a consequence, on the basis of the polluters pay principle (Chapter 6), sophisticated tools were developed to assess the sources (e.g. air pollutant concentrations, health and environmental effects, control measures) and to make a causal link between emissions, air pollution and the necessary and efficient control measures. A typical clean air implementation plan (CAIP) includes:

- Description of area.
- Emissions inventory.
- Air pollutant concentrations inventory - monitored and simulated.
- Comparison of emissions and air quality standards or guidelines.
- Inventory of effects on public health and the environment.
- Causal analysis of effects and attribution to individual sources.
- Control measures and their costs.
- Transportation and land-use planning.
- Enforcement procedures.
- Resource commitment.
- Projections for the future.

Costs of public health and environmental effects have not been included in published clean air implementation plans. However, the CAIP has been a very efficient instrument of air pollution abatement in developed countries (Schwela and Köth-Jahr 1994, WHO 1997a). In the cities of developing countries, or countries in transition, much simplified CAIPs would have to be developed. The main sources of emissions in many cities of the developing world are old vehicles and some industrial sources such as power plants, brick kilns, cement factories and a few others. Their relative contribution to air pollution could be determined by use of rapid emission inventories. The emission factors used in such inventories are published (WHO 1993a 1993b), and a PC programme is available (WHO 1995; WHO 1997b; WHO 1998) that enables emissions and ambient air concentrations to be estimated, and the impact of possible control measures to be evaluated. Projections for the future can also be evaluated by the programme. By using the experience obtained in developed countries, the control action to be taken is very often obvious. As a consequence less monitoring could be sufficient, and dispersion models could help simulate spatial distributions of concentrations when little useful monitoring data are available. 0

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Appendix 2 Acronyms

ACGIH	American Conference of Governmental Industrial Hygienists
ADI	Acceptable daily intake
ALA	Amino-Levulinic Acid
ALAD	Amino-Levulinic Acid Dehydratase
AMIS	Air Management Information System (WHO, Healthy Cities)
AMRO	WHO Regional Office for the Americas
AR	Allergic Rhinitis
ARI	Acute Respiratory Infection
ATDSR	Agency for Toxic Substances and Disease Registry (USA)
BMEPB	Beijing Municipal Environment Protection Bureau
BRI	Building Related Illness
BS	Black Smoke
bw	body weight
$CaCO_3$	Calciumcarbonate
CAIP	Clean Air Implementation Plan
CBA	Cost-benefit analysis
Cd	Cadmium
CEN	European Committee for Standardization
CFC	ChloroFluoroCarbon
CFR	Code of Federal Regulations
CH_4	Methane
CI	95% Confidence Interval
CMD	Cyclopedic Medical Dictionary
CMD	Count Median Diameter
CNS	Central Nervous System
CO	Carbon monoxide
CO_2	Carbon dioxide
COHb	Carboxyhemoglobin
COPD	Chronic Obstructive Pulmonary Disease
CS_2	Carbon disulphide
Cu	Copper
DOAS	Differential Optical Absorption System
DQOs	Data Quality Objectives
EA	Environment Agency of Japan
EC DG	European Commission Directorate General
ECA	European Concerted Action
ECE	Economic Commission for Europe
ECEH	WHO European Centre of Environment and Health
EHC	Environmental Health Criteria
ETS	Environmental Tobacco Smoke
EURO	WHO Regional Office for Europe
FEF_{25-75}	Forced Expiratory Flow – interquartile range
FEP	Free Erythrocyte Protoporphyrin
FEV_1	Forced Expiratory Volume in first second of expiration
FVC	Forced Vital Capacity
GEMS	Global Environmental Monitoring System (UNEP/WHO)
GC/FID	Gas Chromatography/Flame Ionization Detector
GIS	Geographic Information System

GVF	Dienst für GesamtVerkehrsFragen des Eidg. Verkehrs- und Energiewirtschafts-departementes (Switzerland)
H^+	Hydrogen ion
H_2S	Hydrogen sulphide
$H_2S\ O_4$	Sulphuric acid droplets
HC	Hydrocarbons
HCl	Hydrochloric acid
HF	Hydrogen fluoride
HNO_3	Nitric acid
HOP	Hydroxyproline
HVAC	High Volume Air conditioning System
IARC	International Agency for Research on Cancer
ICRP	International Commission on Radiological Protection
IgE	Immunglobulin E
IgG	Immunglobulin G
IOMC	Inter-Organization Programme for the sound Management of Chemicals
IPCS	International Programme on Chemical Safety
IR	Infrared Radiation
ISO	International Standards Organization
ISO/DIS	ISO Draft International Standard
ISO/FDIS	ISO Final Draft International Standard
KI	Potassium iodide
KOH	Potassium hydroxyde
LOAEL	Lowest-Observed-Adverse-Effect-Level
LOEL	Lowest-Observed-Effect-Level
LPG	Liquefied petroleum gas
μm	micrometer
μg	microgram
MMD	Mass median diameter
MMVF	Man-Made Vitreous Fibres
Mn	Manganese
MSDS	Material Safety Data Sheets
Na_2CO_3	Sodium carbonate
NaCl	Sodium chloride
$NaNO_2$	Sodium nitrite
NH_3	Ammonia
NH_4^+	Univalent ammonium radical
NH_4HSO_4	Ammonium bisulphate
$(NH_4)_2HSO_4$	Ammonium hydrogen sulphate
NH_4NO_3	Ammonium nitrate
Ni	Nickel
NO	Nitrogen oxide
NO_2	Nitrogen dioxide
NO_x	Nitrogen oxides
NOAEL	No Observed Adverse Effect Level
NOEL	No Observed Effect Level
O_3	Ozone
OECD	Organization for Economic Cupertino and Development
OEH	Occupational and Environmental Health, WHO, PHE, Geneva

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OH	Hydroxyl radical
OR	Odds Ratio
PAH	Polycyclic (Polynuclear) Aromatic Hydrocarbons
PAHO	Pan American Health Organization
PAN	PeroxyAcetyl Nitrate
Pb	Lead
PBPK	Physiologically Based Pharmaco-Kinetic model
PCDDs	Polychlorinated dibenzodioxins
PCDFs	Polychlorinated dibenzofurans
PCBs	Polychlorinated biphenyls
PEF	Peak Expiratory Flow
PEFR	Peak Expiratory Flow Rate
PHA	PhytoHemAgglutinin
PHE	Department for Protection of the Human Environment, WHO, Geneva
PM	Particulate matter with no regard to size of particles
PM_{10}	Concentration of particles with aerodynamic particle diameters of less than 10 micrometers.
$PM_{2.5}$	Concentration of particles with aerodynamic particle diameters of less than 2.5 micrometers.
QA/QC	Quality Assurance/Quality Control
QAP	Quality Assurance Programme
R-SH	Mercaptan
RSP	Respirable Suspended Particles
SBS	Sick Building Syndrome
SERPLAC	Secretarias Regionales de Planificación y Coordinación
Si	Silicium
SO_2	Sulphur dioxide
SO^{3-}	Sulphur trioxide ion
$SO4^{2-}$	Sulphate ion
SPM	Suspended particulate matter
STPD	Standard Temperature and Pressure Dry
sRAW	Specific AirWay Resistance
TEA	Triethanolamine
TC	Tolerable concentration
TCDD	2,3,7,8-tetrachlorodibenzo-p-dioxin
TCM	Tetrachloromercurate
TDI	Tolerable daily intake
TEOM	Tapered Element Oscillating Microbalance
TEQ	Toxicity EQuivalent concentration or uptake
TI	Tolerable intake
TSP	Total Suspended Particles
UK	United Kingdom
UN	United Nations
UNEP	United Nations Environment Programme
UR	Unit Risk
USEPA	United States Environmental Protection Agency
USA	United States of America
UV	Ultra Violet radiation
UVF	Ultra-Violet Fluorescence
V	Vanadium

VOC	Volatile Organic Compounds
WHO	World Health Organization
WRAC	Wide Ranging Aerosol Classifier
Zn	Zinc

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Appendix 3 Glossary

Acidity	The quality of possessing hydrogen ions (CMD 1997).
Adverse effect	Change in morphology, physiology, growth, development or life span of an organism exposed to air pollution, which results in impairment of functional capacity or impairment of capacity to compensate for additional stress or increase in susceptibility to the harmful effects of other environmental influences (WHO 1994a).
Aerosol	A suspension in a gaseous medium of solid particles, liquid particles or solid and liquid particles having a negligible falling velocity (ISO 1994).
Airway permeability	Capability of allowing the passage of air through the natural passageway for air to and from the lungs (CMD 1997).
Allergen	Any substance that causes manifestations of allergy. Among common allergens are inhalants, foods, drugs, infectious agents, contactants, and physical agents (CMD 1997).
Allergic	Pertaining to, sensitive to, or caused by an allergen (CMD 1997).
Allergy	An acquired, abnormal immune response to a substance that does not normally cause a reaction (CMD 1997).
Anemia	A reduction in the number of circulating red blood cells (CMD 1997).
Asthma	A disease caused by increased responsiveness of the tracheobronchial tree to various stimuli, which results in paroxysmal constriction of the bronchial airways (CMD 1997). Also see paroxysm.
Atherogenic	Pertaining to the formation of degenerated or thickened walls of the larger arteries, marked by cholesterol-lipid-calcium deposits (CMD 1997).
Biomarker	Any parameter that can be used to measure an interaction between a biological system and an environment agent, which may be chemical, physical or biological (WHO 1993).
Biomass	Organic substance of biotic origin: either living organisms or dead substances such as wood, crop residues, or animal dung.
Biomass smoke	Term used for convenience for the smoke generated by burning biomass.
Biotic	Of or relating to life (Webster 1994).
Bronchi	The two main branches leading from the trachea to the lungs, providing a passageway for air (CMD 1997).
Bronchiole	One of the smaller subdivisions of the bronchial tube (CMD 1997).
Bronchiolitis	Inflammation of the bronchioles (CMD 1997).

Bronchitis	Inflammation of the mucous membrane of the bronchial airways (CMD 1997)
Bronchoconstriction	Constriction of the bronchial tubes (CMD 1997).
Bronchodilator	A drug that expands the bronchial tubes by relaxing bronchial muscle (CMD 1997).
Building related illness	Illness related to indoor exposures to biological agents (e.g. fungi, bacteria), biological and chemical substances (e.g. endotoxins, mycotoxins, radon, carbon monoxide, formaldehyde) which is experienced by some people working or living in a particular building and it does not disappear after leaving it.
Carbon dioxide	A colourless, odourless, non-combustible gas, formula CO_2. It is approximately 50% heavier than air, of which it is a normal constituent. It is formed by certain natural processes (see carbon cycle) and by the combustion of fuels containing carbon, and it has been estimated that the amount in the air is increasing by 0.27% annually. Only in the most exceptional circumstances do local concentrations of carbon dioxide in air rise to levels that are dangerous to health, but it plays a significant role in the decay of building stones and in corrosion (WHO 1980).
Carbon monoxide	A colourless, almost odourless, tasteless, flammable gas, formula CO. It is produced, *inter alia*, by the incomplete combustion of organic materials (e.g. in automobile engines) and normally occurs in trace amounts in the atmosphere. At concentrations exceeding about 100 cm^3/m^3 (0.01%) it is highly toxic. Its affinity for hemoglobin (with which it forms carboxyhemoglobin) is between 200 and 300 times that of oxygen, and it has the effect of reducing the oxygen-transport capacity of hemoglobin and leading to death by asphyxiation. Concentrations of carbon monoxide in city streets (arising mainly from motor vehicle exhausts) can be sufficiently high to cause concern, as can those resulting from tobacco smoking in unventilated rooms (WHO 1980).
Carcinogenicity	The production of cancer, equivalent to carcinogenesis (CMD 1997)
Cardiovascular	Pertaining to the heart and blood vessels (CMD 1997).
Centri-acinar	Pertaining to the central terminal respiratory gas exchange unit of the lung, composed of airways and alveoli distal to a terminal bronchiole (CMD 1997).
Chemiluminiscence	Cold light or light resulting from a chemical reaction and without heat production (CMD 1997).
Chromatography	The separation of two or more chemical compounds in solution by their removal from the solution at different rates (CMD 1997).
Chronic obstructive	

Pulmonary disease (COPD)	A disease process that decreases the ability of the lungs to perform ventilation. Diagnostic criteria include a history of persistent dyspnea on exertion, with or without chronic cough, and less than half of normal predicted maximum breathing capacity. Diseases that cause this condition are chronic bronchitis, pulmonary emphysema, chronic asthma, and chronic bronchiolitis (CMD 1997).
Coagulation, blood	The process of clumping together of blood cells to form a clot (CMD 1997).
Cognitive	Adjective to cognition. the awareness with perception. reasoning, judgement, intuition and memory, the mental process by which knowledge is acquired (CMD 1997).
Collagen	A strong, fibrous insoluble protein found in connective tissue (CMD 1997)
Combustion	A chemical reaction in which a material combines with oxygen with the evolution of heat: "burning". The combustion of fuels containing carbon and hydrogen is said to be complete when these two elements are all oxidized to carbon dioxide and water. Incomplete combustion may lead to (1) appreciable amounts of carbon remaining in the ash; (2) emission of some of the carbon as carbon monoxide; and (3) reaction of the fuel molecules to give a range of products of greater complexity than that of the fuel molecules themselves (if these products escape combustion they are emitted as smoke) (WHO 1980).
Contagion	A disease that is easily transmitted from host to host by casual dermal contact or respiratory droplets (CMD 1997).
Coproporyphyrin	A porphyrin present in urine and feces (CMD 1997).
Cor pulmonale	Hypertrophy or failure of the cavity of the heart that receives blood from the right atrium and pumps it into the lungs via the pulmonary artery (CMD 1997).
Cough	A forceful and sometimes violent expiratory effort preceded by a preliminary inspiration (CMD 1997).
Cytochrome	An iron-containing protein found in the mitochondria (cell parts of rod or oval shape that perform a distinctive function) of eukaryotic cells (CMD 1997)
Cytochrome oxidase	An enzyme complex of two cytochromes and two copper atoms found in the mitochondria of eukaryotic cells (CMD 1997)
Cytochrome P-450	A group of enzymes, called hemethiolate protein P450. present on every type of cell in the body except red blood cells and skeletal muscle cells (CMD 1997).
Diesel exhaust	Diesel exhaust emissions contain hundreds of chemical compounds, which are emitted partly in the gaseous phase and partly in the particulate phase

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of the exhaust. The major gaseous products are carbon dioxide, oxygen, nitrogen, and water vapour; carbon monoxide, sulphur dioxide, nitrogen oxides, and hydrocarbons and their derivatives are also present. Benzene and toluene are present in the lower range (percentage weight) in the gaseous part of the hydrocarbon fraction. Other gaseous exhaust compounds are low-relative-molecular-mass polycyclic aromatic hydrocarbons.

A main characteristic of diesel exhaust is the release of particles at a rate about 20 times greater than that from gasoline-fuelled vehicles. The particles are composed of elemental carbon, organic compounds adsorbed from fuel and lubricating oil, sulphates from fuel-sulphur, and traces of metallic components. Most of the total particulate matter appears to occur in the submicrometre range, between 0.02 and 0.5 µm (WHO 1996b).

Disease — A pathological condition of the body that presents a group of clinical signs, symptoms, and laboratory findings peculiar to it and setting the condition apart as an abnormal entity differing from other normal or pathological condition (CMD 1997).

Dry deposition — Removal of contaminants of air onto a substrate without involvement of rain, clouds or fog.

Dust — Small solid particles, conventionally taken as those particles below 75 µm in diameter, which settle out under their own weight but which may remain suspended for some time (ISO 1994). National standards may be more specific and include particle diameters or a definition in terms of a sieve of specified aperture. Dust occurs in the atmosphere both naturally and as a result of the activities of man (Willeke 1993).

Dyspnea — Air hunger resulting in laboured or difficult breathing, sometimes accompanied by pain (CMD 1997).

Effect — Change in morphology, physiology, growth, development of life span of an organism exposed to air pollution. It might be either an adverse effect or an alteration, which is not distinguishable from the range of a target variable observed in not exposed organisms of the same species (WHO 1994c).

Emergency Department — The portion of a hospital that treats patients experiencing an emergency (CMD 1997).

Emphysema — A chronic pulmonary disease marked by an abnormal increase in the size of air spaces distal (farthest from the centre) to the terminal bronchioles with destructive changes in their walls (CMD 1997)

Encephalopathic — Pertaining to any dysfunction of the brain (CMD 1997).

Endogenous — Produced or originating from within a cell or organism (CMD 1997).

Endometriosis — The presence of functioning ectopic (in an abnormal position) endometrial (pertaining to the lining of the uterus) glands and stroma (foundation-supporting tissues of an organ) outside the uterine cavity (CMD 1997).

Endotoxin — A lipopolysaccharide (linkage of molecules of lipds with polysaccharides) that is part of the cell wall of gram-negative bacteria (CMD 1997).

Environmental Tobacco Smoke (ETS) — ETS is generated by the combustion of tobacco products. ETS is a complex mixture of over 4000 compounds. These include over 40 known or suspected human carcinogen, such as 4-aminobiphenyls, 2-naphthylamine, benzene, nickel, and a variety of PAH and N-nitrosamines. A number of irritants, such as ammonia, nitrogen oxides, sulphur dioxide, various aldehydes, and cardiovascular toxicants, such as carbon monoxide and nicotine are also present (WHO 1999a).

Enzyme — An organic catalyst produced by living cells but capable of acting outside cells. Enzymes are proteins that change the rate of chemical reactions without needing an external energy source of being changed themselves (CMD 1997).

Epithelioma — A malignant tumour consisting primarily of epithelial cells (epidermis of the skin or a mucous membrane) (CMD 1997).

Epithelium — The layer of cells forming the epidermis of the skin and the surface layer of mucous and serous membranes (CMD 1997).

Erythrocyte — A mature red blood cell (CMD 1997).

Expiration — Expulsion of air from the lungs in breathing. Normally the duration of expiration is shorter than that of inspiration. In general, if expiration lasts longer than inspiration, a pathological condition such as emphysema or asthma is present (CMD 1997).

Exposure — Exposure to a chemical is the contact of that chemical with the outer boundary of the human body. The outer boundary of the human body is the skin and the openings into the body such as the mouth. the nostrils, and punctures and lesions in the skin (WHO 1999).

Exposure assessment — Quantitative or qualitative evaluation of the contact of a chemical with the outer boundary of the human body, which includes consideration of the intensity, frequency and duration of contact, the route of exposure (e.g. dermal, oral or respiratory), rates (chemical intake or uptake rates), the resulting amount that actually crosses the boundary (a dose), and the amount absorbed (internal dose) (WHO 1999).

Fibrotic — Marked by or pertaining to abnormal formation of fibrous tissues (CMD 1997).

Fine particles — Particles with aerodynamic diameters below 2.5 micrometer.

Fog — As international standard fog is a general term applied to a suspension of droplets in a gas. In meteorology, it refers to a suspension of water droplets resulting in a visibility of less than 1 km (ISO 1994). WMO defines fog as a suspension of very small, usually microscopic water droplets in the air, generally reducing the horizontal visibility at the earth's surface too less than 1 km (WMO 1992).

Folliculi	Small secretory sacs or cavities (CMD 1997).
Forced expiratory Volume (FEV)	The volume of air that can be expired after a full inspiration. The expiration is done as quickly as possible and the volume measured at precise times; at ½, 1, 2 and 3 seconds. This provides valuable information concerning the ability to expel air from the lungs (CMD 1997).
Fume	Aerosol of solid particles, usually from metallurgical processes, generated by condensation from the gaseous state, generally after volatilisation from melted substances and often accompanied by chemical reactions such as oxidation (ISO 1994). By extension, also the gases charged by particles resulting from a chemical process or a metallurgical operation (WHO 1980). Often used in the plural, *fumes* for visible clouds of gases, vapours, or aerosols that have an unpleasant and malodorous smell (WHO 1980; ISO 1994).
Function	The act of carrying on or performing a special activity. Normal function is the normal action of an organ. Abnormal activity or the failure of an organ to perform its activity is the basis of disease or disease processes (CMD 1997).
Genotoxic	Toxic to the genetic material in cells (CMD 1997).
Gestational	Pertaining to the length of time from conception to birth (CMD 1997).
Gram-negative	Losing the crystal violet stain and taking the colour of the red counterstain in Gram's method of staining bacteria (CMD 1997).
Gram-positive	Retaining the colour of the crystal violet stain in Gram's method of staining bacteria (CMD 1997).
Guideline	Any kind of recommendation or guidance on the protection of human beings or receptors in the environment from the adverse effects of air pollutants. As such, it is not restricted to a numerical value but might also be expressed in a different way, for example as exposure-response information or as a unit risk estimate (WHO 1998a).
Guideline value	A particular form of a guideline. It has a numerical value expressed either as a concentration in ambient air, a tolerable intake, or as a deposition level, which is linked to an averaging time (WHO 1998a). In the case of human health, the guideline value defines a concentration below which the risk for the occurrence of adverse effects is negligibly low. It does, however, not guarantee the absolute exclusion of effects at concentrations at or below the guideline value. For odorous compounds the guideline value represents an odour threshold.
Haze	A suspension in the atmosphere of extremely small (dry) particles, individually invisible to the naked eye, but which are numerous enough

to give the atmosphere an appearance of opalescence together with reduced visibility (ISO 1994, WMO 1992).

Heat	Means both thermal energy and thermal energy transfer.
Hemangiosarkoma	A malignant neoplasm (new and abnormal formation of tissue) originating from the blood vessels (CMD 1997).
Hematological	Pertaining to the science concerned with blood and blood-forming tissues (CMD 1997).
Heme	An iron-containing non-protein portion of the hemoglobin molecule (CMD 1997).
Hemoglobin	The iron-containing pigment of the red blood cells which carries oxygen from the lungs to the tissues (CMD 1997).
Hepatocellular	Concerning the cells of the liver (CMD 1997).
Hepatoxic	Toxic to the liver (CMD 1997).
Hydrocarbon	An organic compound containing only the elements carbon and hydrogen. The carbon atoms may be arranged either in open-ended chains, which may or may not be branched or in closed rings. There are two types of ring hydrocarbons: *alicyclic compounds*, consisting of three or more carbon atoms arranged in a closed ring (and whose properties are similar to those of the open-chain compounds of the same molecular mass), and aromatic compounds. The molecular structure of aromatic compounds is based on that of benzene, the simplest member of the class, which contains six carbon atoms joined by three single and three double carbon-carbon bonds. Such compounds are described as *polycyclic* if they contain two or more rings; the term "polynuclear" (as in "polynuclear aromatic hydrocarbon", frequently abbreviated as PAH) is also used. The major constituents of gasoline and other petroleum fuels are hydrocarbons of the open-chain type. These compounds are not considered to be a hazard to health even at the concentrations at which they are encountered in city air. Many aromatic hydrocarbons, on the other hand, are highly toxic (WHO 1980; WHO 1997). Well known examples of polycyclic aromatic hydrocarbons are anthracene, naphthalene, and benzo[a]pyrene (WHO 1980).
Hydroxyproline	An amino acid found in collagen (CMD 1997).
Hyperplasia	Excessive proliferation of normal cells in the normal tissue arrangement of an organ (CMD 1997).
Hypoimmunity	Diminished immunity.
Hypoxia	An oxygen deficiency (CMD 1997).
Hypoxic	Oxygen deficient (CMD 1997).
Illness	The state of being sick (CMD 1997).

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Immune function	Function of being protected from or resistant to a disease or infection by a pathogenic organism as a result of the development of antibodies or cell-mediated immunity (CMD 1997).
Immunoglobulin	One of a family of closely related though not identical proteins capable of acting as antibodies, abbreviation Ig (CMD 1997).
Immunoglobulin A	The principal immunoglobulin in external gland secretions such as respiratory and intestinal mucin (mucus glycoprotein), saliva, and tears (CMD 1997).
Immunoglobulin E	An immunoglobulin that attaches to mast cells in the respiratory and intestinal tracts and plays a major role in allergic reactions, abbreviation IgE (CMD 1997).
Immunoglobulin G	The principal immunoglobulin in human serum, important in producing immunity in the infant before birth, abbreviation IgG (CMD 1997).
Inflammation	The non-specific immune response that occurs in reaction to any type of bodily injury (CMD 1997).
Influenza	An acute, contagious respiratory infection characterized by the sudden onset of fever, chills, headache, tenderness or pain in the muscles, and sometimes absolute exhaustion (CMD 1997).
Interstitium	The space or gap in a tissue or structure of an organ (CMD 1997).
Ischemic	Pertaining to a local and temporary deficiency of blood supply due to obstruction of the circulation to a part (CMD 1997).
Legionnaires' disease	A severe, often fatal disease characterized by pneumonia, dry cough, tenderness or pain in the muscles, and sometimes gastro-intestinal symptoms (CMD 1997).
Leukemia	A malignancy of the blood-forming cells in the bone marrow (CMD 1997).
Life expectancy	The number of years that an average person of a given age may be expected to live, according to mortality tables (CMD 1997).
Low birth weight	Abnormally low weight of a new-born, usually below 2000 g (CMD 1997).
Lower respiratory symptom	Symptom in the lower respiratory tract (i.e. the respiratory tract from trachea to bronchioles).
Lowest-observed-adverse-effect level	Lowest concentration or amount of a substance, found by observation or experiment, which causes an adverse effect (WHO 1994c).
Lowest-observed-effect level	Lowest concentration or amount of a substance, found by observation or experiment, which causes an effect.

Lung cancer	Cancer that may appear in the trachea, air sacs and other lung tubes. It may appear as an ulcer in the windpipe. as a nodule or small flattened lump, or on the surface blocking air tubes. It may extend into the lymphatic and blood vessels (CMD 1997).
Lysozyme	An enzyme found in white blood cells and in body secretions that destroys bacteria by breaking down their walls (CMD 1997).
Malaise	Discomfort, uneasiness, or indisposition, often indicative of infection (CMD 1997).
Metaplasia	Conversion of one kind of tissue into a form that is not normal for that tissue (CMD 1997).
Mist	Loose term applied to a suspension of droplets in a gas. In meteorology it relates to visibility of less than 2 km but greater than 1 km (ISO 1994). See also fog.
Morbidity	The number of sick persons or cases of disease in relationship to a specific population (CMD 1997).
Morphological	Pertaining to the science of structure and form of organisms without regard of function (CMD 1997).
Mortality	The death rate; the ratio of the number of deaths to a given population (CMD 1997).
Mutagenic	Pertaining to an agent that causes genetic mutations (CMD 1997).
Myoglobin	The iron-containing protein found in muscle cells that stores oxygen for use in cell respiration (CMD 1997).
Mycotoxin	Substance produced by mould growing in food or animal feed and causing illness or death when ingested by humans or animals (CMD 1997).
Nausea	An unpleasant sensation usually preceding vomiting (CMD 1997).
Neurological	Pertaining to the branch of medicine that deals with the nervous system and its diseases (CMD 1997).
Neurotoxicity	Having the capability of harming nerve tissue (CMD 1997).
Neutrophil	A granular white blood cell (CMD 1997).
Nitrate	See *nitric acid*.
Nitric acid	A colourless or yellowish fuming liquid, formula HNO_3. It is highly corrosive and the vapour is very hazardous. Nitric acid and nitrates (mainly ammonium nitrate) occur in the atmosphere in the form of aerosols: the acid is formed from oxides of nitrogen and then reacts with ammonia to form ammonium nitrate (WHO 1997c).
Nitric oxide	See *nitrogen oxides*.

Nitrogen	A gaseous element, atomic number 7, relative atomic mass 14.0067, symbol N. It is the principal constituent of air (78% by volume).
Nitrogen dioxide	See *nitrogen oxides.*
Nitrogen oxides	A series of seven compounds, of which only three are of any significance in the atmosphere. *Dinitrogen oxide* (nitrous oxide), formula N_2O, is a colourless gas that is believed to play an important role in the nitrogen cycle. It is the most abundant atmospheric nitrogen compound and a greenhouse gas but is of no significance as a pollutant. *Nitrogen oxide* (nitric oxide), formula NO, is a colourless poisonous gas that reacts readily with oxygen (and very rapidly with O_3) to form the dioxide. It is formed in combustion processes, e.g., in furnaces and internal combustion engines. NO is an active participant in the atmospheric reactions that lead to the production of *photochemical smog*. Nitrogen dioxide, formula NO_2, is a reddish-brown poisonous gas. At ordinary temperatures the vapour is an equilibrium mixture of NO_2 and the dimer N_2O_4 (dinitrogen tetroxide); on heating, the latter dissociates and the NO_2 content increases. Above 140^0C, the NO_2 dissociates into NO and oxygen (WHO 1997). In the air pollution literature, the term "nitrogen oxides" and the formula NO_x are used for the mixture of NO and NO_2 in the air (WHO 1997).
No-observed-adverse-effect Level	Greatest concentration or amount of a substance, found by observation or experiment, which causes no detectable adverse effect (WHO 1994c). Effects may be detected at this level, which are not judged to be adverse.
No-observed-effect level	Greatest concentration or amount of a substance, found by observation or experiment, which causes no detectable effect (WHO 1994c).
Nucleation	The process of forming a central point about which matter is gathered (CMD 1997).
Outpatient	One who receives treatment at a hospital, clinic, or dispensary but is not hospitalised (CMD 1997).
Oxidant (in atmospheric chemistry)	A very qualitative term which includes any and all trace gases which have a greater oxidation potential than oxygen (for example O_3, peroxyacetyl nitrate, hydrogen peroxide, organic peroxides, NO_3, etc.). It is recommended that alternative, more definitive terms be used which define the specific oxidant of interest whenever possible (IUPAC 1997).
Oxidant defense	Protective action against harm or injury from oxidants.
Oxygen	A gaseous element, atomic number 8, relative atomic mass 15.9994, symbol O. Oxygen is a colourless, odourless gas which supports combustion in air. Molecular oxygen (O_2) constitutes 20.95% by volume of dry air in the lower part of the atmosphere. O_2 is essential for the

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maintenance of almost all forms of life. Above an altitude of 20 km atomic oxygen appears in significant amounts and at 100 km it is in the predominant form. For the tri-atomic form of oxygen, see *ozone*.

Ozone	The tri-atomic allotrope of oxygen; a pale blue gas with a distinctive pungent odour, formula O_3. It is a highly reactive oxidising agent and is very poisonous, and is considered a serious pollutant at concentrations much in excess of 125 ? g/m^3 (WHO 1980). It is naturally occurring in the atmosphere. It occurs at large concentrations in the upper atmosphere, where it is formed by the action of solar ultraviolet radiation. In the troposphere, O_3 is mostly formed by photochemical reactions involving hydrocarbons and nitrogen oxides.
Paroxysm	A sudden, periodic attack or recurrence of symptoms of a disease; an exacerbation of the symtoms of a disease (CMD 1997)
Particle	Small discrete mass of solid or liquid matter (ISO 1994).
Particle aerodynamic diameter	Diameter of a sphere of density 1 g/cm^3 with the same terminal velocity due to gravitational force in calm air as the particle, under the prevailing conditions of temperature, pressure and relative humidity (ISO 1995).
Particle size distribution	The distribution of equivalent diameters of particles in a sample or the proportion of particles for which the equivalent diameter lies between defined limits (Willeke 1993).
Peak expiratory flow rate	See rate.
Perinatal	Concerning the period beginning after the 28th week of pregnancy and ending 28 days after birth (CMD 1997).
Pharyngitis	Inflammation of the passageway for air from the nasal cavity to the larynx (CMD 1997).
Phytohemagglutinin	A protein substance derived from red kidney beans that agglutinates red blood cells, used to study the proliferation of lymphocytes, abbreviation PHA (CMD 1997).
Phlegm	Thick mucus, especially that from the respiratory passages (CMD 1997).
Photochemical smog	Result of reactions in the atmosphere between nitrogen oxides, organic compounds and oxidants under the influence of sunlight, leading to the formation of oxidising compounds or possibly causing poor visibility, eye irritation or damage to material and vegetation if sufficiently concentrated (ISO 1994).
Pneumonia	An inflammation of the alveoli, interstitial tissue, and bronchioles of the lungs due to infection by bacteria, viruses, or other pathogenic organisms,

	or to irritation by chemicals or other agents (CMD 1997).
Pneumonitis	Inflammation of the lung, usually due to hypersensitivity (allergic) reactions to organic dust, such as wheat or other grains, or chemicals (CMD 1997).
Polycyclic aromatic Hydrocarbon	See hydrocarbon
Polynuclear aromatic hydrocarbon	See hydrocarbon
Protoporphyrin	A derivative of hemoglobin containing four pyrole nuclei (CMD 1997).
Rate	The speed or frequency of occurrence of an event, usually expressed with respect to time or some other known standard (CMD 1997). *Death rate* or *mortality rate* is the number of deaths in a specified population, usually expressed per 100 000 population, over a given period, usually 1 year. *Morbidity rate* is the number of cases per year of certain diseases in relation to the population in which they occur. *Infant mortality rate* is the number of deaths per year of live-born infants less than 1 year of age divided by the number of live births in the same year. *Peak expiratory flow rate* is the maximum rate of exhalation during forced expiration, measured in litres per second or litres per minute.
Renal	Pertaining to the kidney (CMD 1997).
Respiration	The act of breathing (i.e. inhaling and exhaling) during which the lungs are provided with air through inhaling and carbon dioxide is removed through exhaling (CMD 1997).
Respiratory	Pertaining to respiration (CMD 1997).
Retropharyngeal	Behind the passageway for air from the nasal cavity to the larynx (CMD 1997).
Rhinitis	Inflammation of the mucous membrane of the nose. Symptoms include nasal congestion, thin watery discharge from the nose, sneezing and itching of the nose (CMD 1997).
Rhino-conjunctivitis	Rhinitis and inflammation of the mucous membrane that lines the eyelids and is reflected onto the eyeball
Sampling	The collection of a representative portion for analysis and testing (WHO 1980). *Continuous sampling* is sampling, without interruptions, throughout an operation or for a predetermined time. *Grab sampling* or *spot sampling* is the taking of a sample in a very short time (ISO 1994).
Scavenging by precipitation	The process of removing pollutants from the atmosphere by precipitation (WMO 1992).

Sick building syndrome	Specific symptoms with unspecified aetiology which are experienced by a proportion of people working or living in a particular building and disappear after leaving it.
Spectrophotometry	An estimation of colouring matter in a solution (CMD 1997).
Standard	A level of an air pollutant, e.g. a concentration or a deposition value, which is adopted by a regulatory authority as enforceable. Unlike a guideline value, a number of elements in addition to the effect-based level and the averaging time must be specifies in the formulation of a standard. These elements include the measurement strategy, data handling procedures, statistics used to derive, from measurements, the value to be compared with the standard. The numerical value of a standard may also include the permitted number of exceedings (WHO 1998a).
Symptom	Any perceptible change in the body or its functions that indicates disease or the kind or phases of disease (CMD 1997).
Teratogenicity	Causation of abnormal development of the embryo (CMD 1997).
Tolerable intake	An estimate of the intake of a substance over a lifetime that is considered to be without appreciable health risk (WHO 1994c)
Tonsillitis	Inflammation of a tonsil (CMD 1997).
Trachea	A cylindrical tube from the larynx to the primary bronchi (CMD 1997).
Tubular	Relating to or having the form of a tube (CMD 1997).
Ultra-fine particles	Particles with aerodynamic diameters below 0.1 micrometer.
Uncertainty factor	
Unit risk	The additional lifetime cancer risk occurring in a hypothetical population in which all individuals are exposed continuously from birth throughout their lifetimes to a concentration of 1 $\mu g/m^3$ of the agent in the air they breathe (WHO 1987).
Viable organisms	An organism that is able to live outside a host (CMD 1997).
Vital capacity	The volume of air that can be quickly and forcibly breathed out (CMD 1997).
Vitamin D3	One of several vitamins having anti-rachitic activity (CMD 1997).
Wet deposition	Removal of pollutants from the air through the processes of wash-out, rain-out , fog. and dew
Wheeze	A continuous musical sound caused by narrowing of the space of a respiratory passageway (CMD 1997).

For references see the bibliographical reference list in Appendix 1.

Appendix 4 Environmental Health Criteria documents

Environmental Health Criteria	Volume number	Year
Acetaldehyde	167	1995
Acetone	207	1998
Acetonitrile	154	1993
Acrolein	127	1991
Acrylamide	49	1985
Acrylic acid	191	1997
Acrylonitrile	28	1983
Aged population principles for evaluating the effects of chemicals in the	144	1992
Aldicarb	121	1991
Aldrin and dieldrin	91	1989
Alkylbenzene sulphonates, linear and related compounds	169	1996
Allethrins	87	1989
Aluminium	194	1997
Amitrole	158	1994
Ammonia	54	1986
Anticoagulant rodenticides	175	1995
Arsenic	18	1981
Asbestos and other natural mineral fibres	53	1986
Barium	107	1990
Benomyl	148	1993
Benzene	150	1993
Beryllium	106	1990
Biomarkers and risk assessment: concepts and principles	155	1993
Biotoxins, aquatic (marine and freshwater)	37	1984
Boron	204	1998
Brominated diphenylethers	162	1994
Butanols - four isomers	65	1987
Cadmium	134	1992
Cadmium - environmental aspects	135	1992
Camphechlor	45	1984
Carbamate pesticides: a general introduction	64	1986
Carbaryl	153	1994
Carbendazim	149	1993
Carbon disulphide	10	1979
Carbon monoxide	13	1979
Carbon Tetrachloride	208	1999
Carcinogens, summary report on the evaluation of short-term in vitro tests	47	1985
Carcinogens, summary report on the evaluation of short-term in vivo tests	109	1990
Chlordane	34	1984
Chlordecone	43	1984
Chlordimeform	199	1998
Chlorendic acid and anhydride	185	1996
Chlorinated paraffins	181	1996
Chlorine and hydrogen chloride	21	1982
Chlorobenzene other than hexachlorobenzene	128	1991
Chlorofluorocarbons, fully halogenated	113	1990
Chlorofluorocarbons, partially halogenated (ethane derivatives)	139	1992
Chlorofluorocarbons, partially halogenated (methane derivatives)	126	1991

Chloroform	163	1994
Chlorothalonil	183	1996
Chlorphenols	93	1989
Chromium	61	1988
Chrysotile Asbestos	203	1998
Copper	200	1998
Cresols	168	1995
Cyhalothrin	99	1990
Cypermethrin	82	1989
Cypermethrin, alpha	142	1992
DDT and its derivatives	9	1979
DDT and its derivatives - environmental aspects	83	1989
Deltamethrin	97	1990
Diaminotoluenes	74	1987
Diazinon	198	1998
Dibromoethane, 1,2-	177	1996
Dibromopropyl (2,3-) phosphate	173	1995
Dichloroethane, 1,2- (1st edition)	62	1987
Dichloroethane, 1,2- (2nd edition)	176	1995
Dichloropropene, 1,3-, 1,2-dichloropropane and mixtures	146	1993
Dichlororphenoxyacetic acid, 2,4-	29	1984
Dichlororphenoxyacetic acid, 2,4-, - environemntal aspects	84	1989
Dichlorvos	79	1988
Diesel fuel and exhaust emissions	171	1996
Diethylhexyl phthalate	131	1992
Diflubenzuron	184	1996
Dimethoate	90	1989
Dimethyl sulfate	48	1985
Dimethylformamide	114	1991
Dimeton-S-methyl	197	1997
Di-n-butyl phthalate	189	1997
Diseases of suspected etiology and their prevention, principles of studies on	72	1987
Dithiocarbamate pesticides, ethylenethiourea, and propylenethiourea: a general introduction	78	1988
Electromagnetic fields	137	1992
Endosulfan	40	1984
Endrin	130	1992
Environmental epidemiology, guidelines on studies in	27	1983
Epichlorohydrin	33	1984
Ethylbenzene	186	1996
Ethylene oxide	55	1985
Extremely low frequency (ELF) fields	35	1984
Fenitrothion	133	1992
Fenvalerate	95	1990
Flame retardants: a general introduction	192	1997
Flame Retardants: Tris (chloropropyl) Phosphate and Tris 2-chloroethyl) Phosphate	209	1998
Fluorine and fluorides	36	1984
Food additives and contaminants in food, principles for the safety assessment of	70	1987
Formaldehyde	89	1989
Genetic effects in human populations, guidelines for the study of	46	1985
Glyphosate	159	1994
Health Effects of Interactions between Tobacco Use and Exposure to other	211	1999

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Agents		
Heptachlor	38	1984
Hexachlorobenzene	195	1997
Hexachlorobutadiene	156	1994
Hexachlorocyclohexanes, alpha- and beta-	123	1992
Hexachlorocyclopentadiene	120	1991
Hexan, n-	122	1991
Human exposure limits, guidance values	170	1994
Hydrazine	68	1987
Hydrogen sulfide	19	1981
Hydroquinone	157	1994
Immunotoxicity associated with exposure to chemicals, principles and methods for assessments	180	1996
Infancy and early childhood, principles for evaluating health risks from chemicals during	59	1986
Isobenzan	129	1991
Isophorone	174	1995
Kelevan	66	1986
Lasers and optical radiation	23	1982
Lead	3	1977
Lead, environmental aspects	85	1989
Lead, inorganic	165	1995
Lindane	124	1991
Magnetic fields	69	1987
Manganese	17	1981
Man-made mineral fibres	77	1988
Mercury	1	1976
Mercury - environmental aspects	86	1989
Mercury, inorganic	118	1991
Methanol	196	1997
Methomyl	178	1996
Methoxyethanol, 2-, 2-ethoxyethanol, and their acetates	115	1990
Methyl bromide	166	1995
Methyl ethyl ketone	143	1992
Methyl isobutyl ketone	117	1990
Methyl parathion	145	1992
Methyl tertiary-Butyl Ether	206	1998
Methylene chloride, 1st edition	32	1984
Methylene chloride, 2nd edition	164	1996
Methylmercury	101	1990
Mirex	44	1984
Morpholine	179	1996
Mutagenic and carcinogenic chemicals, guide to short-term tests for detecting	51	1985
Mycotoxins	11	1979
Mycotoxins, selected: ochratoxins, trichothecenes, ergot	105	1990
Nephrotoxicity associated with exposure to chemicals, principles and methods for the assessment of	119	1991
Neurotoxicity associated with exposure to chemicals, principles and methods for the assessment of	60	1986
Nickel	108	1991
Nitrates, nitrites, and N-nitroso compounds	5	1978
Nitrogen oxides, 1st edition	4	1977
Nitrogen oxides, 2nd edition	188	1997

Nitropropane. 2-	138	1992
Noise	12	1980
Organophosphorus insecticides: a general introduction	63	1986
Paraquat and diquat	39	1984
Pentachlorophenol	71	1987
Permethrin	94	1990
Pesticide residues in food, principles for the assessment of	104	1990
Petroleum products, selected	20	1982
Phenol	161	1994
Phenothrin, d-	96	1990
Phosgene	193	1997
Phosphine and selected metal phosphides	73	1988
Photochemical oxidants	7	1978
Platinum	125	1991
Polybrominated biphenyls	152	1994
Polybrominated Dibenzo-p-dioxins and Dibenzofurans	205	1998
Polychlorinated biphenyls and terphenyls, 1st edition	2	1976
Polychlorinated biphenyls and terphenyls, 2nd edition	140	1992
Polychlorinated dibenzo-p-dioxins and dibenzofurans	88	1989
Principles of the Assessment of Risks to Human Health from Exposure to chemicals	210	1999
Progeny, principles for evaluating health risks associated with exposure to chemicals during pregnancy	30	1984
Propachlor	147	1993
Propanol, 1-	102	1990
Propanol, 2-	103	1990
Propylene oxide	56	1985
Pyrrolizidine alkaloids	80	1988
Quality management for chemical safety testing	141	1992
Quintozene	41	1984
Radiofrequency and microwaves	16	1981
Radionuclides, selected	25	1983
Resmethrins	92	1989
Selected Chloroalkyl Ethers	201	1998
Selected Non-heterocyclic Polycyclic Aromatic Hydrocarbons	202	1998
Selenium	58	1986
Styrene	26	1983
Sulfur oxides and suspended particulate matter	8	1979
Synthetic organic fibres, selected	151	1993
Tecnazene	42	1984
Tetrabromobisphenol A and derivatives	172	1995
Tetrachloroethylene	31	1984
Tetradifon	67	1986
Tetramethrin	98	1990
Thallium	182	1996
Thiocarbamate pesticides: a general introduction	76	1988
Tin and organotin compounds	15	1980
Titanium	24	1982
Toluene	52	1986
Toluene diisocyanates	75	1987
Toxicity of chemicals (Part 1), principles and methods for evaluating the	6	1978
Toxicokinetic studies, principles of	57	1986
Tributyl phosphate	112	1991

Tributyltin compounds	116	1990
Trichlorfon	132	1992
Trichloroethane, 1,1,1-	136	1992
Trichloroethylene	50	1985
Tricresyl phosphate	110	1990
Triphenyl phosphate	111	1991
Ultrasound	22	1982
Ultraviolet radiation, 1st edition	14	1979
Ultraviolet radiation, 2nd edition	160	1994
Vanadium	81	1988
Vinylidene chloride	100	1990
White spirit	187	1996
Xylenes	190	1997

Appendix 5 Participants list

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DIRECTIVA 1999/30/CE DEL CONSEJO

de 22 de abril de 1999

relativa a los valores límite de dióxido de azufre, dióxido de nitrógeno y óxidos de nitrógeno, partículas y plomo en el aire ambiente

EL CONSEJO DE LA UNIÓN EUROPEA,

Visto el Tratado constitutivo de la Comunidad Europea y, en particular, el apartado 1 de su artículo 130 S,

Vista la propuesta de la Comisión [1],

Visto el dictamen del Comité Económico y Social [2],

De conformidad con el procedimiento establecido en el artículo 189 C del Tratado [3],

(1) Considerando que, basándose en los principios consagrados en el artículo 130 R del Tratado, el programa comunitario de política y actuación en materia de medio ambiente y desarrollo sostenible (quinto programa de acción en materia de medio ambiente) [4] prevé en particular la modificación de la legislación vigente sobre contaminantes atmosféricos; que el mencionado programa recomienda fijar objetivos a largo plazo en relación con la calidad del aire;

(2) Considerando que el artículo 129 del Tratado establece que las exigencias en materia de protección de la salud deben constituir un componente de las demás políticas de la Comunidad; que la letra o) del artículo 3 del Tratado establece que la acción de la Comunidad debe implicar una contribución al logro de un alto nivel de protección de la salud;

(3) Considerando que el apartado 5 del artículo 4 de la Directiva 96/62/CE del Consejo, de 27 de septiembre de 1996, sobre evaluación y gestión de la calidad del aire ambiente [5] dispone que el Consejo adopte la legislación contemplada en el apartado 1 y las normas contempladas en los apartados 3 y 4 de dicho artículo;

(4) Considerando que los valores límite establecidos por la presente Directiva constituyen requisitos mínimos; que, de conformidad con el artículo 130 T del Tratado, los Estados miembros podrán mantener y adoptar valores límite más exigentes; que, en particular, se podrán establecer disposiciones más exigentes para proteger la salud de categorías de la población especialmente vulnerables, como los niños y los pacientes hospitalizados; que los Estados miembros podrán establecer valores límite que deban alcanzarse en una fecha anterior a la establecida en la presente Directiva;

(5) Considerando que es preciso proteger los ecosistemas frente a los efectos adversos del dióxido de azufre; que es preciso proteger la vegetación de los efectos perjudiciales de los óxidos de nitrógeno;

(6) Considerando que los distintos tipos de partículas pueden tener distintos efectos nocivos en la salud de las personas; que se ha demostrado que los riesgos que supone para la salud de las personas la exposición a partículas producidas por las actividades humanas son superiores a los riesgos que lleva aparejados la exposición a partículas de origen natural en el aire ambiente;

(7) Considerando que la Directiva 96/62/CE requiere la elaboración de planes de acción para las zonas en las que las concentraciones de uno o más contaminantes superan el valor o valores límite incrementados por el margen de tolerancia temporal en orden a asegurar el cumplimiento del valor o valores límite en la fecha especificada; que esos planes de acción y demás estrategias de reducción, cuando guarden relación con las partículas, deben tener por objeto reducir las concentraciones de partículas finas, como parte de la reducción global de las concentraciones de partículas;

(8) Considerando que la Directiva 96/62/CE establece que los valores límite numéricos de los valores límite y de los umbrales de alerta deben basarse en los resultados de la labor realizada por grupos científicos internacionales que se ocupan de esta materia; que la Comisión debe tener en cuenta los datos más recientes sobre epidemiología y medio ambiente obtenidos en los trabajos de investigación científica, así como los últimos avances en métodos de medición, para reexaminar los elementos en los que se basan los valores límite y los umbrales de alerta;

(9) Considerando que, para facilitar la revisión de la presente Directiva en el año 2003, la Comisión y los Estados miembros deberían considerar la posibilidad de alentar la investigación sobre los efectos de los contaminantes a los que la Directiva se refiere, es decir, el dióxido de azufre, el dióxido de nitrógeno y los óxidos de nitrógeno, las partículas y el plomo;

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(1) DO C 9 de 14.1.1998, p. 6.
(2) DO C 214 de 10.7.1998, p. 1.
(3) Dictamen del Parlamento Europeo de 13 de mayo de 1998 (DO C 167 de 1.6.1998, p. 103), Posición común del Consejo de 24 de septiembre de 1998 (DO C 360 de 23.11.1998, p. 99) y Decisión del Parlamento Europeo de 13 de enero de 1999 (DO C 104 de 14.4.1999, p. 44).
(4) DO C 138 de 17.5.1993, p. 5.
(5) DO L 296 de 21.11.1996, p. 55.

(10) Considerando que unas técnicas normalizadas de medición que permiten obtener resultados precisos y unos criterios comunes para la ubicación de los centros de medición son elementos importantes para la evaluación de la calidad del aire ambiente con vistas a obtener datos comparables en toda la Comunidad;

(11) Considerando que, de conformidad con el apartado 1 del artículo 12 de la Directiva 96/62/CE, las modificaciones necesarias para la adaptación al progreso científico y técnico sólo podrán referirse a los criterios y técnicas de evaluación de las concentraciones de dióxido de azufre, dióxido de nitrógeno y óxidos de nitrógeno, partículas y plomo o a las disposiciones detalladas para la transmisión de información a la Comisión, y que dichas modificaciones no deberán suponer una modificación, directa o indirecta, de los valores límite ni de los umbrales de alerta;

(12) Considerando que la población debe poder acceder con rapidez a información actualizada sobre las concentraciones de dióxido de azufre, dióxido de nitrógeno, partículas y plomo en el aire ambiente,

HA ADOPTADO LA PRESENTE DIRECTIVA:

Artículo 1

Objetivos

La presente Directiva tiene por objeto:

— establecer valores límite y, en su caso, umbrales de alerta con respecto a las concentraciones de dióxido de azufre, dióxido de nitrógeno y óxidos de nitrógeno, partículas y plomo en el aire ambiente para evitar, prevenir o reducir los efectos nocivos para la salud humana y para el medio ambiente en su conjunto;

— evaluar, a partir de métodos y criterios comunes, las concentraciones de dióxido de azufre, dióxido de nitrógeno, partículas y plomo en el aire ambiente;

— obtener información adecuada sobre las concentraciones de dióxido de azufre, dióxido de nitrógeno y óxidos de nitrógeno, partículas y plomo en el aire ambiente y velar por que la población tenga conocimiento de la misma;

— mantener la calidad del aire ambiente cuando ésta sea buena y mejorarla en los demás casos con respecto al dióxido de azufre, dióxido de nitrógeno y los óxidos de nitrógeno, las partículas y el plomo.

Artículo 2

Definiciones

A efectos de la presente Directiva se entenderá por:

1) «aire ambiente»: el aire exterior de la troposfera, excluidos los lugares de trabajo;

2) «contaminante»: cualquier sustancia introducida directa o indirectamente por el hombre en el aire ambiente que pueda tener efectos nocivos sobre la salud humana o el medio ambiente en su conjunto;

3) «nivel»: la concentración de un contaminante en el aire ambiente o su depósito en superficies en un momento determinado;

4) «evaluación»: cualquier método utilizado para medir, calcular, predecir o estimar el nivel de un contaminante en el aire ambiente;

5) «valor límite»: un nivel fijado basándose en conocimientos científicos, con el fin de evitar, prevenir o reducir los efectos nocivos para la salud humana y/o para el medio ambiente en su conjunto, que debe alcanzarse en un plazo determinado y no superarse una vez alcanzado;

6) «umbral de alerta»: un nivel a partir del cual una exposición de breve duración supone un riesgo para la salud humana y a partir del cual los Estados miembros deberán tomar medidas inmediatas como establece la Directiva 96/62/CE;

7) «margen de tolerancia»: el porcentaje del valor límite en el que éste puede sobrepasarse con arreglo a las condiciones establecidas en la Directiva 96/62/CE;

8) «zona»: la porción de su respectivo territorio delimitada por los Estados miembros;

9) «aglomeración»: un área que se caracteriza por una concentración de población de más de 250 000 habitantes o, cuando la concentración de población es inferior o igual a 250 000 habitantes, por una densidad de habitantes por km^2 que justifica que los Estados miembros evalúen y controlen la calidad del aire ambiente;

10) «óxidos de nitrógeno»: la suma, en partes por billón de óxido nítrico y dióxido de nitrógeno expresada como dióxido de nitrógeno, en microgramos por metro cúbico;

11) «PM_{10}»: las partículas que pasan a través de un cabezal de tamaño selectivo para un diámetro aerodinámico de 10 μm con una eficiencia de corte del 50 %;

12) «$PM_{2,5}$»: las partículas que pasan a través de un cabezal de tamaño selectivo para un diámetro aerodinámico de 2,5 μm con una eficiencia de corte del 50 %;

13) «Umbral de evaluación superior»: el nivel especificado en el anexo V, por debajo del cual puede utilizarse una combinación de mediciones y técnicas de modelización para evaluar la calidad del aire ambiente, con arreglo al apartado 3 del artículo 6 de la Directiva 96/62/CE;

14) «umbral de evaluación inferior»: el nivel especificado en el anexo V, por debajo del cual es posible limitarse al empleo de técnicas de modelización o de estimación objetiva para evaluar la calidad del aire ambiente, con arreglo al apartado 4 del artículo 6 de la Directiva 96/62/CE;

15) «fenómeno natural»: las erupciones volcánicas, las actividades sísmicas, actividades geotérmicas, o los incendios de zonas silvestres, los fuertes vientos o la resuspensión atmosférica o el transporte de partículas naturales procedentes de regiones áridas;

16) «mediciones fijas»: las mediciones realizadas con arreglo a lo dispuesto en el apartado 5 del artículo 6 de la Directiva 96/62/CE.

Artículo 3

Dióxido de azufre

1. Los Estados miembros adoptarán las medidas necesarias para que las concentraciones de dióxido de azufre en el aire ambiente, evaluadas con arreglo al artículo 7, no excedan de los valores límite fijados en el la sección I del anexo I a partir de las fechas que en el mismo se indican.

Los márgenes de tolerancia que se especifican en la sección I del anexo I se aplicarán de conformidad con el artículo 8 de la Directiva 96/62/CE.

2. El umbral de alerta para las concentraciones de dióxido de azufre en el aire ambiente figura en la sección II del anexo I.

3. Para ayudar a la Comisión a preparar el informe que cita el artículo 10, los Estados miembros registrarán hasta el 31 de diciembre de 2003, donde es posible, las concentraciones de dióxido de azufre promediadas en períodos de diez minutos en algunas estaciones de medición seleccionadas por los Estados miembros como representativas de la calidad del aire en las áreas habitadas próximas a las fuentes y en las que se midan las concentraciones horarias. Al mismo tiempo que se suministren los datos sobre las concentraciones horarias de conformidad con lo dispuesto en el punto 1 del artículo 11 de la Directiva 96/62/CE, los Estados miembros comunicarán a la Comisión, respecto a las estaciones de medición seleccionadas, el número de las concentraciones promediadas durante períodos de diez minutos que excedan los 500 $\mu g/m^3$, el número de días dentro del año civil en que ocurrió tal hecho, el número de días simultáneos en que las concentraciones horarias de dióxido de azufre excedieron también los 350 $\mu g/m^3$ y la máxima concentración registrada en los períodos de diez minutos.

4. Los Estados miembros podrán designar zonas o aglomeraciones dentro de las que se rebasen los valores límite de dióxido de azufre a que se refiere la sección I del anexo I debido a concentraciones de dióxido de azufre en el aire ambiente producidas por fuentes naturales. Los Estados miembros remitirán a la Comisión una lista de cualesquiera de esas zonas o aglomeraciones junto con la información sobre las concentraciones y fuentes de dióxido de azufre dentro de las mismas. Cuando informen a la Comisión de conformidad con lo dispuesto en el apartado 1 del artículo 11 de la Directiva 96/62/CE, los Estados miembros facilitarán la justificación necesaria para demostrar que los rebasamientos se deben a fuentes naturales.

Dentro de dichas zonas o aglomeraciones los Estados miembros estarán obligados a ejecutar planes de actuación de conformidad con el apartado 3 del artículo 8 de la Directiva 96/62/CE sólo cuando se rebasen los valores límite a que se refiere la sección I del anexo I debido a emisiones antropogénicas.

Artículo 4

Dióxido de nitrógeno y óxidos de nitrógeno

1. Los Estados miembros adoptarán las medidas necesarias para que las concentraciones de dióxido de nitrógeno y, en su caso, las concentraciones de óxidos de nitrógeno y en su caso de óxido nítrico en el aire ambiente, evaluadas con arreglo al artículo 7, no excedan de los valores límite fijados en la sección I del anexo II a partir de las fechas indicadas.

Los márgenes de tolerancia que se especifican en la sección I del anexo II se aplicarán de conformidad con el artículo 8 de la Directiva 96/62/CE.

2. El umbral de alerta para las concentraciones de dióxido de nitrógeno en el aire ambiente figura en la sección II del anexo II.

Artículo 5

Partículas

1. Los Estados miembros adoptarán las medidas necesarias para que las concentraciones de PM_{10} en el aire ambiente, evaluadas con arreglo al artículo 7, no excedan de los valores límite indicados en la sección I del anexo III a partir de las fechas indicadas.

Los márgenes de tolerancia que se especifican en la sección I del anexo III se aplicarán de conformidad con el artículo 8 de la Directiva 96/62/CE.

2. Los Estados miembros garantizarán que se instalen y exploten estaciones de medición que proporcionen datos sobre las concentraciones de $PM_{2,5}$. El número y situación de las estaciones en que se mida $PM_{2,5}$ serán elegidos por los Estados miembros para que sean representativos de las concentraciones de $PM_{2,5}$ en esos Estados miembros. Donde sea posible, los puntos de muestreo de $PM_{2,5}$ se ubicarán en el mismo lugar que los puntos de muestreo de PM_{10}.

Los Estados miembros presentarán cada año a la Comisión, a más tardar nueve meses después de finalizar cada año, la media aritmética, la mediana, el percentil 98 y la concentración máxima calculados a partir de las mediciones de $PM_{2,5}$ durante 24 horas en ese año. El percentil 98 se calculará con arreglo al procedimiento establecido en la sección 4 del anexo I de la Decisión 97/101/CE del Consejo, de 27 de enero de 1997, por la que se establece un intercambio recíproco de información y datos de las redes y estaciones aisladas de medición de la contaminación atmosférica en los Estados miembros (1).

3. Los planes de actuación correspondientes a las partículas PM_{10} preparados con arreglo al artículo 8 de la Directiva 96/62/CE y las estrategias generales de reducción de las concentraciones de PM_{10} también tendrán por objetivo reducir las concentraciones de $PM_{2,5}$.

(1) DO L 35 de 5.2.1997, p. 14.

4. Cuando se superen los valores límite de PM_{10} a que se refiere la sección I del anexo III debido a concentraciones de PM_{10} en el aire ambiente producidas por fenómenos naturales, que supongan concentraciones considerablemente superiores a los niveles de fondo procedentes de fuentes naturales, los Estados miembros informarán de ello a la Comisión de conformidad con el apartado 1 del artículo 11 de la Directiva 96/62/CE y facilitarán la justificación necesaria para demostrar que dichos rebasamientos se deben a fenómenos naturales. En estos casos, los Estados miembros tendrán la obligación de ejecutar planes de actuación con arreglo al apartado 3 del artículo 8 de la Directiva 96/62/CE sólo cuando se rebasen los valores límite a que se refiere la sección I del anexo III por causas que no sean tales fenómenos naturales.

5. Los Estados miembros podrán designar zonas o aglomeraciones en las cuales se rebasen los valores límite de PM_{10} a que se refiere la sección I del anexo III a causa de la existencia de concentraciones de PM_{10} en el aire ambiente debidas a la resuspensión de partículas a raíz del vertido invernal de arena para el mantenimiento de las carreteras. Los Estados miembros remitirán a la Comisión una lista de las posibles zonas o aglomeraciones de este tipo, junto con información sobre las concentraciones y fuentes de PM_{10} existentes en las mismas. Cuando informen a la Comisión con arreglo a lo dispuesto en la sección 1 del artículo 11 de la Directiva 96/62/CE, los Estados miembros suministrarán la información necesaria para demostrar que los rebasamientos se deben a la mencionada resuspensión de partículas y que se han adoptado medidas razonables para reducir las concentraciones.

Dentro de dichas zonas o aglomeraciones, los Estados miembros sólo estarán obligados a aplicar planes de actuación de conformidad con lo dispuesto en el apartado 3 del artículo 8 de la Directiva 96/62/CE en caso de que se rebasen los valores límite a que se refiere la sección I del anexo III debido a la presencia de niveles de PM_{10} distintos de los que se deriven del vertido invernal de arena para el mantenimiento de las carreteras.

Artículo 6

Plomo

Los Estados miembros adoptarán las medidas necesarias para que las concentraciones de plomo en el aire ambiente, evaluadas con arreglo al artículo 7, no excedan de los valores límite fijados en la sección I del anexo IV a partir de las fechas indicadas.

Los márgenes de tolerancia que se especifican en la sección I del anexo IV se aplicarán de conformidad con el artículo 8 de la Directiva 96/62/CE.

Artículo 7

Evaluación de las concentraciones

1. En la sección I del anexo V figuran los umbrales de evaluación superior e inferior correspondientes al dióxido de azufre, dióxido de nitrógeno y óxidos de nitrógeno, las partículas y el plomo a los fines del artículo 6 de la Directiva 96/62/CE.

La clasificación de cada zona o aglomeración a efectos de lo dispuesto en el artículo 6 de la mencionada Directiva se revisará por lo menos cada cinco años con arreglo al procedimiento establecido en la sección II del anexo V. Esa revisión podrá tener lugar antes de lo establecido si se producen cambios significativos en las actividades que pueden tener una incidencia sobre las concentraciones en el ambiente de dióxido de azufre, dióxido de nitrógeno o, cuando proceda, óxidos de nitrógeno, partículas o plomo.

2. En el anexo VI se establecen los criterios que deben aplicarse para determinar el emplazamiento de los puntos de muestreo con vistas a la medición de dióxido de azufre, dióxido de nitrógeno y óxidos de nitrógeno, partículas y plomo. El anexo VII establece el número mínimo de puntos de muestreo para las mediciones fijas de concentraciones de cada contaminante pertinente.

3. En las zonas y aglomeraciones en las que la información proporcionada por las estaciones de medición fijas se complete con información procedente de otras fuentes, tales como, inventarios de emisiones, métodos de medición indicativa y modelos de la calidad del aire, el número de estaciones de medición fijas que deben instalarse y la resolución espacial de las demás técnicas deben ser suficientes para que sea posible determinar las concentraciones de los contaminantes atmosféricos establecidos con arreglo a la sección I del anexo VI y en la sección I del anexo VIII.

4. En las zonas y aglomeraciones en que no se requieran mediciones podrán utilizarse técnicas de modelización o de estimación objetivas.

5. En las secciones I a III del anexo IX figuran los métodos de referencia para el análisis de dióxido de azufre, dióxido de nitrógeno, óxidos de nitrógeno y plomo, y para el muestreo y el análisis de plomo.

El método de referencia para el muestreo y análisis de PM_{10} figura en la sección IV del anexo IX.

El método de referencia provisional para el muestreo y el análisis de $PM_{2,5}$ figura en la sección V del anexo IX.

La sección VI del anexo IX establece las técnicas de referencia para la modelización de la calidad del aire.

6. La fecha en que los Estados miembros informarán a la Comisión acerca de los métodos empleados para la evaluación preliminar de la calidad del aire con arreglo a la letra d) del punto 1 del artículo 11 de la Directiva 96/62/CE será de dieciocho meses después de la entrada en vigor de la Directiva.

7. Las modificaciones que sean necesarias para adaptar las disposiciones del presente artículo y de los anexos V a IX al progreso científico y técnico se adoptarán con arreglo al procedimiento establecido en el artículo 12 de la Directiva 96/62/CE.

Artículo 8

Información al público

1. Los Estados miembros garantizarán que periódicamente esté disponible información actualizada sobre las concentraciones de dióxido de azufre, dióxido de nitrógeno y óxidos de nitrógeno, partículas y plomo en el aire ambiente, para la población así como para las organizaciones interesadas, tales como organizaciones medioambientales, organizaciones de consumidores, organizaciones que representen los intereses de los grupos de población sensible y otros organismos sanitarios relacionados, a través de medios de difusión apropiados como, por ejemplo, la radio y la televisión, la prensa, pantallas de información o servicios de redes informáticas.

La información sobre las concentraciones de dióxido de azufre, dióxido de nitrógeno y partículas en el aire ambiente se actualizará, como mínimo, cada día, y cada hora por lo que respecta a los valores horarios de dióxido de azufre y de dióxido de nitrógeno, en caso de que resulte viable. La información sobre concentraciones de plomo en el aire ambiente se actualizará en base trimestral.

La información indicará, al menos, todos los casos en que las concentraciones superen los valores límite y los umbrales de alerta durante los períodos de promedio especificados en los anexos I a IV. También incluirá una breve evaluación en relación con los valores límite y con los umbrales de alerta, así como información adecuada en relación con las repercusiones para la salud.

2. Cuando los Estados miembros pongan a disposición de la población planes o programas realizados con arreglo al apartado 3 del artículo 8 de la Directiva 96/62/CE, incluyendo los planes o programas contemplados en el apartado 4 del artículo 3 y en los apartados 4 y 5 del artículo 5 de la presente Directiva los pondrán también a disposición de las organizaciones contempladas en el apartado 1.

3. Cuando se rebase el umbral de alerta citado en la sección II de los anexos I o II, los detalles difundidos al público con arreglo al artículo 10 de la Directiva 96/62/CE incluirán, como mínimo, los aspectos citados en la lista de la sección III de los anexos I y II.

4. La información diponible por el público y para las organizaciones en virtud de lo dispuesto en los anteriores apartados 1 y 3 deberá ser clara, comprensible y accesible.

Artículo 9

Derogaciones y disposiciones transitorias

1. La Directiva 80/779/CEE del Consejo, de 15 de julio de 1980, relativa a los valores límite y a los valores guía de calidad atmosférica para el anhídrido sulfuroso y las partículas en suspensión ([1]) quedará derogada con efectos a partir del 19 de julio de 2001, excepto el artículo 1, el apartado 1 del artículo 2, el apartado 1 del artículo 3, los artículos 9, 15 y 16 y los anexos I, III b y IV, que quedarán derogados con efectos a partir del 1 de enero de 2005.

2. La Directiva 82/884/CEE del Consejo, de 3 de diciembre de 1982, relativa al valor límite para el plomo contenido en la atmósfera ([2]) quedará derogada con efectos a partir del 19 de julio de 2001, excepto los artículos 1 y 2, el apartado 1 del artículo 3, y los artículos 7, 12 y 13, que quedarán derogados con efectos a partir del 1 de enero de 2005.

3. La Directiva 85/203/CEE del Consejo, de 7 de marzo de 1985, relativa a las normas de calidad del aire para el dióxido de nitrógeno ([3]) quedará derogada con efectos a partir del 19 de julio de 2001, excepto el primer guión del apartado 1 del artículo 1, el apartado 2 del artículo 1, el primer guión del artículo 2, el apartado 1 del artículo 3, los artículos 5, 9, 15 y 16 y el anexo I, que quedarán derogados con efectos a partir del 1 de enero de 2010.

4. A partir del 19 de julio de 2001, los Estados miembros utilizarán estaciones de medición y otros métodos de evaluación de la calidad del aire de conformidad con la presente Directiva para evaluar las concentraciones de dióxido de azufre, dióxido de nitrógeno y plomo en el aire ambiente con objeto de obtener los datos destinados a demostrar que se cumplen los valores límite establecidos en las Directivas 80/779/CEE, 82/884/CEE y 85/203/CEE hasta el momento en que dejen de aplicarse los valores límite establecidos en esas Directivas.

5. A partir del 19 de julio de 2001, los Estados miembros podrán utilizar estaciones de medición y otros métodos de evaluación de la calidad del aire de conformidad con la presente Directiva por lo que respecta al PM_{10} para evaluar las concentraciones de partículas en suspensión a fin de demostrar el cumplimiento de los valores límite establecidos en el anexo IV de la Directiva 80/779/CEE, si bien, para demostrar dicho cumplimiento, los datos así recogidos deberán multiplicarse por un factor de 1,2.

6. Los Estados miembros informarán a la Comisión de todo rebasamiento de los valores límite establecidos por las Directivas 80/779/CEE, 82/884/CEE y 85/203/CEE, así como de los valores registrados, las razones de cada caso registrado y las medidas adoptadas para evitar cualquier posible repetición; dicha información se comunicará a la Comisión anualmente durante los nueve primeros meses de cada año de conformidad con el procedimiento establecido en el artículo 11 de la Directiva 96/62/CE, y hasta tanto dejen de aplicarse los valores límite pertinentes.

7. En las zonas en las que un Estado miembro considere necesario limitar o prevenir un incremento previsible de la contaminación causada por dióxido de azufre, dióxido de nitrógeno o partículas en suspensión, podrá seguir utilizando los valores guía para la protección de los ecosistemas que figuran en el anexo II de la Directiva 80/779/CEE y en el anexo II de la Directiva 85/203/CEE.

([1]) DO L 229 de 30.8.1980, p. 30.

([2]) DO L 378 de 31.12.1982, p. 15.

([3]) DO L 87 de 27.3.1985, p. 1.

Artículo 10

Informe y revisión

A más tardar el 31 de diciembre de 2003 la Comisión presentará al Parlamento Europeo y al Consejo, un informe basado en la experiencia adquirida en la aplicación de la presente Directiva y, en particular, sobre los resultados de las investigaciones científicas más recientes acerca de los efectos en la salud humana y en los ecosistemas de la exposición al dióxido de azufre, dióxido de nitrógeno y óxidos de nitrógeno, las distintas fracciones de partículas y el plomo, así como sobre la evolución de la tecnología, incluidos los avances realizados en relación con los métodos de medición y otros tipos de evaluaciones de las concentraciones de partículas en el aire ambiente y de la sedimentación de las partículas y del plomo en superficies.

Con vistas a mantener un elevado nivel de protección de la salud humana y del medio ambiente y teniendo en cuenta la experiencia obtenida gracias a la aplicación de la Directiva en los Estados miembros, incluidas, en particular, las condiciones en que, de conformidad con lo dispuesto en el anexo VI, se hayan llevado a cabo las mediciones, dicho informe se acompañará, cuando proceda, de propuestas de modificación de la presente Directiva. En especial, la Comisión estudiará los valores límite de PM_{10} para la segunda fase con miras a hacerlos obligatorios, y considerará la posibilidad de confirmar o modificar los valores límite para la segunda fase y, si procede, para la primera. Además, la Comisión concederá especial atención al establecimiento de valores límite para $PM_{2,5}$ o para diferentes fracciones de partículas, según resulte adecuado y estudiará el valor límite anual para la protección de la salud humana para el dióxido de nitrógeno y presentará una propuesta que confirme o modifique dicho valor. También examinará el valor límite horario para el dióxido de nitrógeno a la luz de las directrices de la Organización Mundial de la Salud y considerará si el valor límite debe ser confirmado o modificado.

La Comisión prestará una atención especial a la fijación de umbrales de alerta, en consonancia con los fijados para los demás contaminantes contemplados en la presente Directiva, para las PM_{10} y $PM_{2,5}$ o para las fracciones específicas de partículas, según resulte adecuado.

Artículo 11

Sanciones

Los Estados miembros determinarán el régimen de sanciones aplicable a las infracciones de las disposiciones nacionales adoptadas en aplicación de la presente Directiva. Las sanciones serán eficaces, proporcionadas y disuasorias.

Artículo 12

Aplicación

1. Los Estados miembros adoptarán las disposiciones legales, reglamentarias y administrativas necesarias para cumplir la presente Directiva a más tardar el 19 de julio de 2001. Informarán inmediatamente de ello a la Comisión.

Cuando los Estados miembros adopten dichas disposiciones, éstas harán referencia a la presente Directiva o irán acompañadas de dicha referencia en su publicación oficial. Los Estados miembros establecerán las modalidades de la mencionada referencia.

2. Los Estados miembros comunicarán a la Comisión el texto de las disposiciones de Derecho interno que adopten en el ámbito regulado por la presente Directiva.

Artículo 13

Entrada en vigor

La presente Directiva entrará en vigor el vigésimo día siguiente al de su publicación en el *Diario Oficial de las Comunidades Europeas.*

Artículo 14

Destinatarios

Los destinatarios de la presente Directiva serán los Estados miembros.

Hecho en Luxemburgo, el 22 de abril de 1999.

Por el Consejo

El Presidente

W. MÜLLER

ANEXO I

VALORES LÍMITE Y UMBRAL DE ALERTA PARA EL DIÓXIDO DE AZUFRE

I. Valores límite del dióxido de azufre

Los valores límite se expresarán en µg/m³. El volumen se normalizará a la temperatura 293 °K y a la presión de 101,3 kPa.

	Período de promedio	Valor límite	Margen de tolerancia	Fecha de cumplimiento del valor límite
1. Valor límite horario para la protección de la salud humana	1 hora	350 µg/m³, valor que no podrá superarse en más de 24 ocasiones por año civil	150 µg/m³ (43 %) a la entrada en vigor de la Directiva, con una reducción lineal a partir del 1 de enero de 2001 y posteriormente cada 12 meses hasta alcanzar el 0 % el 1 de enero de 2005	1 de enero de 2005
2. Valor límite diario para la protección de la salud humana	24 horas	125 µg/m³, valor que no podrá superarse en más de 3 ocasiones por año civil	Ninguno	1 de enero de 2005
3. Valor límite para la protección de los ecosistemas	Año civil e invierno (del 1 de octubre al 31 de marzo)	20 µg/m³	Ninguno	19 de julio de 2001

II. Umbral de alerta del dióxido de azufre

El valor correspondiente al umbral de alerta del dióxido de azufre se sitúa en 500 µg/m³ registrados durante tres horas consecutivas en lugares representativos de la calidad del aire en una área de como mínimo 100 km² o en una zona o aglomeración entera, tomando la superficie que sea menor.

III. Informaciones mínimas que deberán comunicarse a la población en caso de superación del umbral de altera del dióxido de azufre

La información que debe comunicarse a la población incluirá, como mínimo, los detalles siguientes:

- fecha, hora y lugar del episodio y causas del episodio si se conocen;
- previsiones:
  - modificación de las concentraciones (mejora, estabilización o deterioro), causa de la modificación prevista,
  - zona geográfica afectada,
  - duración;
- tipo de población potencialmente sensible al episodio;
- precauciones que debe adoptar la población sensible.

ANEXO II

VALORES LÍMITE PARA EL DIÓXIDO DE NITRÓGENO (NO_2) Y LOS ÓXIDOS DE NITRÓGENO Y UMBRAL DE ALERTA PARA EL DIÓXIDO DE NITRÓGENO

I. Valores límite del dióxido de nitrógeno y de los óxidos de nitrógeno

Los valores límite se expresarán en µg/m³. El volumen se normalizará a la temperatura 293 °K y a la presión de 101,3 kPa.

	Período de promedio	Valor límite	Margen de tolerancia	Fecha de cumplimiento del valor límite
1. Valor límite horario para la protección de la salud humana	1 hora	200 µg/m³ de NO_2 que no podrán superarse en más de 18 ocasiones por año civil	50 % a la entrada en vigor de la Directiva, con una reducción lineal a partir del 1 de enero de 2001 y posteriormente cada 12 meses en un porcentaje anual idéntico hasta alcanzar el 0 % el 1 de enero de 2010	1 de enero de 2010
2. Valor límite anual para la protección de la salud humana	1 año civil	40 µg/m³ de NO_2	50 % a la entrada en vigor de la presente Directiva, con una reducción lineal a partir del 1 de enero de 2001 y posteriormente cada 12 meses hasta alcanzar el 0 % el 1 de enero de 2010	1 de enero de 2010
3. Valor límite anual para la protección de la vegetación	1 año civil	30 µg/m³ NO_x	Ninguno	19 de julio de 2001

II. Umbral de alerta del dióxido de nitrógeno

El valor correspondiente al umbral de alerta del dióxido de nitrógeno se sitúa en 400 en µg/m³ registrados durante tres horas consecutivas en lugares representativos de la calidad del aire en una área de como mínimo 100 km² o en una zona o aglomeración entera, tomando la superficie que sea menor.

III. Informaciones mínimas que deberán comunicarse a la población en caso de superación del umbral de alerta del dióxido de nitrógeno

La información que debe comunicarse a la problación incluirá, como mínimo, los datos siguientes:

- fecha, hora y lugar del episodio y causa del episodio si se conocen;
- previsiones:
  - modificación de las concentraciones (mejora, estabilización o deterioro), causa de la modificiación prevista,
  - zona geográfica afectada,
  - duración;
- tipo de población potencialmente sensible al episodio;
- precauciones que debe adoptar la población sensible.

ANEXO III

VALORES LÍMITE PARA LAS PARTÍCULAS (PM_{10})

	Período de promedio	Valor límite	Margen de tolerancia	Fecha de cumplimiento del valor límite
FASE 1				
1. Valor límite diario para la protección de la salud humana	24 horas	50 µg/m³ de PM_{10} que no podrán superarse en más de 35 ocasiones por año	50 % a la entrada en vigor de la presente Directiva, con una reducción lineal para el 1 de enero de 2001 y a continuación cada 12 meses hasta alcanzar el 0 % para el 1 de enero de 2005	1 de enero de 2005
2. Valor límite anual para la protección de la salud humana	1 año civil	40 µg/m³ de PM_{10}	20 % a la entrada en vigor de la presente Directiva, una reducción lineal para el 1 de enero de 2001 y a continuación cada 12 meses hasta alcanzar el 0 % para el 1 de enero de 2005	1 de enero de 2005
FASE 2 (¹)				
1. Valor límite diario para la protección de la salud humana	24 horas	50 µg/m³ de PM_{10} que no podrán superarse en más de 7 ocasiones por año	Se derivará de los datos y será equivalente al valor límite de la fase 1	1 de enero de 2010
2. Valor límite anual para la protección de la salud humana	1 año civil	20 µg/m³ de PM_{10}	50 % el 1 de enero de 2005 y a continuación cada 12 meses en un porcentaje anual idéntico hasta alcanzar el 0 % para el 1 de enero de 2010	1 de enero de 2010

(¹) Los valores límites indicativos que deberán revisarse a la luz de una mayor información acerca de los efectos sobre la salud y el medio ambiente, la viabilidad técnica y la experiencia en la aplicación de los valores límite de la fase 1 en los Estados miembros.

ANEXO IV

VALOR LÍMITE PARA EL PLOMO

	Período de promedio	Valor límite	Margen de tolerancia	Fecha en que debe cumplirse el valor límite
Valor límite anual para la protección de la salud humana	1 año civil	0,5 µg/m^3 (1)	100 % cuando entre en vigor la presente Directiva, con una reducción lineal a partir del 1 de enero de 2001 y posteriormente cada 12 meses hasta alcanzar el 0 % el 1 de enero de 2005 o el 1 de enero de 2010 en las inmediaciones de fuentes específicas, que se notificarán a la Comisión	1 de enero de 2005 o el 1 de enero de 2010, en las inmediaciones de fuentes industriales específicas, situadas en lugares contaminados a lo largo de decenios de actividad industrial. Dichas fuentes se notificarán a la Comisión el 19 de julio de 2001 (2). En tales casos, el valor límite a partir del 1 de enero de 2005 será de 1,0 µg/m^3

(1) En la revisión de la presente Directiva, mencionada en el artículo 10, se tendrá en cuenta la posibilidad de completar o sustituir el valor límite mediante un valor límite de sedimentación en las inmediaciones de fuentes puntuales.

(2) Dicha notificación deberá ir acompañada de una justificación apropiada. La zona en que sean aplicables valores límite superiores no sobrepasará un radio de 1 000 metros a contar de dichas fuentes específicas.

ANEXO V

DETERMINACIÓN DE LOS REQUISITOS NECESARIOS PARA LA EVALUACIÓN DE LAS CONCENTRACIONES DE DIÓXIDO DE AZUFRE, DIÓXIDO DE NITRÓGENO (NO_2), Y ÓXIDOS DE NITRÓGENO (NO_x), PARTÍCULAS (PM_{10}) Y PLOMO EN EL AIRE AMBIENTE DENTRO DE UNA ZONA O AGLOMERACIÓN

I. Umbrales superior e inferior de evaluación

Serán aplicables los siguientes umbrales de evaluación superior e inferior:

a) DIÓXIDO DE AZUFRE

	Protección de la salud	Protección de los ecosistemas
Umbral de evaluación superior	60 % del valor límite diario (75 µg/m³ que no podrán superarse en más de 3 ocasiones por año civil)	60 % del valor límite de invierno (12 µg/m³)
Umbral de evaluación inferior	40 % del valor límite diario (50 µg/m³ que no podrán superarse en más de 3 ocasiones por año civil)	40 % del valor límite de invierno (8 µg/m³)

b) DIÓXIDO DE NITRÓGENO Y ÓXIDOS DE NITRÓGENO

	Valor límite horario para la protección de la salud humana (NO_2)	Valor límite anual para la protección de la salud humana (NO_2)	Valor límite anual para la protección de la vegetación (NO_x)
Umbral de evaluación superior	70 % del valor límite (140 µg/m³ que no podrán superarse en más de 18 ocasiones por año civil)	80 % del valor límite (32 µg/m³)	80 % del valor límite (24 µg/m³)
Umbral de evaluación inferior	50 % del valor límite (100 µg/m³ que no podrán superarse en más de 18 ocasiones por año civil)	65 % del valor límite (26 µg/m³)	65 % del valor límite (19,5 µg/m³)

c) PARTICULAS

Los umbrales superior e inferior de evaluación correspondientes a PM_{10} se basan en los valores límite que deben cumplirse para el 1 de enero de 2010.

	Media diaria	Media anual
Umbral de evaluación superior	60 % del valor límite (30 µg/m³ que no podrán superarse en más de 7 ocasiones por año civil)	70 % del valor límite (14 µg/m³)
Umbral de evaluación inferior	40 % del valor límite (20 µg/m³ que no podrán superarse en más de 7 ocasiones por año civil)	50 % del valor límite (10 µg/m³)

d) PLOMO

	Media anual
Umbral de evaluación superior	70 % del valor límite (0,35 μg/m³)
Umbral de evaluación inferior	50 % del valor límite (0,25 μg/m³)

II. **Determinación del rebasamiento de los umbrales superior e inferior de evaluación**

El rebasamiento de los umbrales superior e inferior de evaluación se determinará sobre la base de las concentraciones registradas durante los cinco años anteriores, si se dispone de datos suficientes. Se considerará que se ha rebasado un umbral de evaluación si el número total de casos de rebasamiento del valor numérico del umbral en esos cinco años es tres veces superior al número de casos anuales de rebasamiento autorizados.

Cuando los datos disponibles se refieran a un período inferior a cinco años, los Estados miembros podrán combinar las campañas de medición de corta duración realizadas durante el período del año y en los lugares susceptibles de registrar los niveles más altos de contaminación con los resultatos obtenidos de los inventarios de emisiones y modelización para determinar los casos de rebasamiento de los umbrales superior e inferior de evaluación.

ANEXO VI

UBICACIÓN DE LOS PUNTOS DE MUESTREO PARA LA MEDICIÓN DE LAS CONCENTRACIONES DE DIÓXIDO DE AZUFRE, DIÓXIDO DE NITRÓGENO Y ÓXIDOS DE NITRÓGENO, PARTÍCULAS Y PLOMO EN EL AIRE AMBIENTE

Las consideraciones que a continuación se exponen se aplican a la medición fija.

I. Macroimplantación

a) *Protección de la salud humana*

Los puntos de muestreo orientados a la protección de la salud humana estarán situados de manera que:

i) proporcionen datos sobre las áreas situadas dentro de las zonas y aglomeraciones que registren las concentraciones más altas a las que la población puede llegar a verse expuesta directa o indirectamente durante un período significativo en comparación con el período de promedio utilizado para el cálculo del valor o valores límite;

ii) proporcionen datos sobre los niveles registrados en otras áreas dentro de las zonas y aglomeraciones que sean representativas del grado de exposición de la población.

Por regla general, los puntos de muestreo estarán situados de tal manera que se evite la medición de microambientes muy pequeños en las inmediaciones. A título indicativo, un punto de muestreo estará situado de manera que sea representativo de la calidad del aire en sus alrededores dentro de un área de, al menos, 200 m^2 para emplazamientos orientados al tráfico y de varios kilómetros cuadrados para emplazamientos orientados al fondo urbano.

Cuando sea posible, los puntos de muestreo deberán ser también representativos de emplazamientos similares que no estén en las inmediaciones.

Deberá tenerse en cuenta la necesidad de situar los puntos de muestreo en islas cuando ello sea necesario para la protección de la salud humana.

b) *Protección de los ecosistemas y de la vegetación*

Los puntos de muestreo dirigidos a la protección de los ecosistemas y de la vegetación estarán situados a una distancia superior a 20 km de las aglomeraciones o a más de 5 km de otras zonas edificadas, instalaciones industriales o carreteras. A título indicativo, un punto de muestreo estará situado de manera que sea representativo de la calidad del aire en sus alrededores dentro de un área de al menos 1 000 km^2. Los Estados miembros podrán establecer que un punto de muestreo esté situado a una distancia menor o que sea representativo de la calidad del aire en una zona de menor superficie, teniendo en cuenta las condiciones geográficas.

Deberá tenerse en cuenta la necesidad de evaluar la calidad del aire en las zonas insulares.

II. Microimplantación

En la medida de lo posible, deberían seguirse las recomendaciones siguientes:

— no deberían existir restricciones al flujo alrededor de la entrada del muestreo ni obstrucciones que afecten al flujo de aire en la vecindad del sistema de muestreo (se colocará, por regla general, a varios metros de edificios, balcones, árboles y otros obstáculos y, como mínimo, a 0,5 m del edificio más próximo en el caso de puntos de muestreo representativos de la calidad del aire en la línea de edificios);

— en general, el punto de entrada del muestreo debería estar situado entre 1,5 m (zona de respiración) y 4 m sobre el nivel del suelo. En algunos casos podrá resultar necesaria una posición más elevada (hasta 8 m). Posiciones más elevadas pueden ser adecuadas si la estación representa a una zona extensa;

— la entrada del muestreo no debería estar situada en las proximidades de fuentes de emisión para evitar la entrada directa de emisiones sin mezclar con el aire ambiente;

— la salida del sistema de muestreo debería colocarse de tal manera que se evite la recirculación del aire saliente hacia la entrada del sistema;

— situación de los sistemas de muestreo orientados al tráfico:

  — para todos los contaminantes, deberían estar por lo menos a más de 25 m de los grandes cruces y al menos a 4 m del centro del carril más próximo;

  — para el dióxido de nitrógeno, las entradas de aire no deberían estar a más de 5 m del bordillo de la acera;

  — para partículas y plomo, las entradas de aire deberían estar situadas de tal manera que fueran representativas de la calidad del aire cercana a la línea de edificios.

Además, podrán tenerse en cuenta los factores siguientes:

— fuentes de interferencias,

— seguridad,

— accesos,

— posibilidad de conexión a la red eléctrica y telefónica,

— visibilidad del lugar en relación con su entorno,

— seguridad de la población y de los técnicos,

— interés de una implantación común de puntos de muestreo de distintos contaminantes,

— normas urbanísticas.

III. Documentación y revisión de la elección del emplazamiento

Los procedimientos de elección del emplazamiento deberían documentarse completamente en la fase de clasificación, por ejemplo mediante fotografías del area circundante con indicación de la orientación y un mapa detallado. La elección del emplazamiento debería revisarse a intervalos regulares con nueva documentación para demostrar que los criterios de selección siguen siendo válidos.

ANEXO VII

CRITERIOS DE DETERMINACIÓN DEL NÚMERO MÍNIMO DE PUNTOS DE MUESTREO PARA LA MEDICIÓN FIJA DE LAS CONCENTRACIONES DE DIÓXIDO DE AZUFRE (SO_2), DIÓXIDO DE NITRÓGENO (NO_2) Y ÓXIDOS DE NITRÓGENO, PARTÍCULAS Y PLOMO EN EL AIRE AMBIENTE

I. Número mínimo de puntos de muestreo para la medición fija dirigida a evaluar el cumplimiento de los valores límite establecidos para la protección de la salud humana y sobre los umbrales de alerta en zonas y aglomeraciones donde la medición fija es la única fuente de información

a) *Fuentes difusas*

Población de la zona o aglomeración (miles)	Si las concentraciones superan el umbral de evaluación superior	Si las concentraciones máximas se encuentran entre los umbrales de evaluación superior e inferior	Para SO_2 y el NO_2, en aglomeraciones donde las concentraciones máximas son inferiores al umbral de evaluación inferior
0-250	1	1	no aplicable
250-499	2	1	1
500-749	2	1	1
750-999	3	1	1
1 000-1 499	4	2	1
1 500-1 999	5	2	1
2 000-2 749	6	3	2
2 750-3 749	7	3	2
3 750-4 749	8	4	2
4 750-5 999	9	4	2
> 6 000	10	5	3
	Con respecto al NO_2 y las partículas: deben instalarse, como mínimo, una estación urbana de fondo y una estación orientada al tráfico		

b) *Fuentes puntuales*

Para evaluar la contaminación en las proximidades de fuentes puntuales el número de puntos de muestreo para la medición fija debe calcularse teniendo en cuenta las densidades de emisión, las pautas probables de distribución de la contaminación del aire ambiente y la exposición potencial de la población.

II. **Número mínimo de puntos de muestreo para la medición fija destinada a evaluar el cumplimiento de los valores límite para la protección de ecosistemas y de vegetación en zonas que no sean aglomeraciones**

Si las concentraciones máximas son superiores al umbral de evaluación superior	Si las concentraciones máximas se encuentran entre los umbrales de evaluación superior e inferior
1 estación por 20 000 km^2	1 estación por 40 000 km^2

En las zonas insulares el número de puntos de muestreo se calculará teniendo en cuenta las pautas probables de distribución de la contaminación del aire ambiente y la exposición potencial de los ecosistemas y de la vegetación.

ANEXO VIII

OBJETIVOS DE CALIDAD DE LOS DATOS Y PRESENTACIÓN DE LOS RESULTADOS DE LA EVALUACIÓN DE LA CALIDAD DEL AIRE

I. Objetivos de calidad de los datos

A título orientativo para los programas de garantía de la calidad, se han establecido los siguientes objetivos de calidad de los datos, para la exactitud requerida de los métodos de evaluación, la periodicidad mínima y la captura mínima de datos.

	Dióxido de azufre, dióxido de nitrógeno y óxidos de nitrógeno	Partículas y plomo
Medición fija		
Exactitud	15 %	25 %
Captura mínima de datos	90 %	90 %
Medición indicativa		
Exactitud	25 %	50 %
Mínimo número de datos	90 %	90 %
Periodicidad mínima	14 % (una medición por semana al azar, distribuidas uniformemente a lo largo del año, u 8 semanas distribuidas uniformemente a lo largo del año)	14 % (un medición por semana al azar, distribuidas uniformemente a lo largo del año, u 8 semanas distribuidas uniformemente a lo largo del año)
Modelización		
Exactitud:		
Medias horarias	50 - 60 %	
Medias diarias	50 %	sin definir por el momento [1]
Medias anuales	30 %	50 %
Estimación objetiva		
Exactitud	75 %	100 %

[1] Las modificaciones necesarias para adaptar este punto al progreso científico y técnico se adoptarán de conformidad con el procedimiento establecido en el apartado 2 del artículo 12 de la Directiva 96/62/CE.

La exactitud de las mediciones queda definida como se establece en la «Guía de la expresión de la incertidumbre de las medidas» (ISO 1993), o en la ISO 5725-1, «Exactitud (veracidad y precisión) de los métodos de medición y de sus resultados» (1994). Los porcentajes de la tabla se refieren a mediciones individuales, promediadas en el período considerado para el valor límite, para un intervalo de confianza del 95 % (sesgo + 2 veces la desviación estándar). La exactitud de las mediciones en continuo se debería interpretar como aplicable en la región del valor límite apropiado.

La exactitud de la modelización y la estimación objetiva se definen como la desviación máxima de los niveles de concentración medidos y calculados durante el período considerado por el valor límite, sin tener en cuenta la periodicidad de los fenómenos.

Los requisitos para la toma mínima de datos y la periodicidad mínima no incluyen las pérdidas de datos debido a la calibración regular o al mantenimiento normal de la instrumentación.

Como excepción, los Estados miembros podrán aplicar mediciones al azar en lugar de mediciones continuas para las partículas y el plomo, si pueden demostrar a la Comisión que la exactitud con respecto a las mediciones continuas se encuentra dentro del 10 % con un nivel de confianza del 95 %. El muestreo al azar deberá distribuirse uniformemente a lo largo del año.

II. Resultados de la evaluación de la calidad del aire

Debería reunirse la información siguiente para las zonas o aglomeraciones donde se emplean otras fuentes que complementan los datos de la medición o son los únicos medios de evaluación de la calidad del aire:

— descripción de las actividades de evaluación realizadas;

— métodos específicos utilizados, con referencias a descripciones del método;

— fuentes de datos e información;

— descripción de los resultados, incluida la exactitud y los datos sobre la exactitud y, en particular, la extensión de cada área o, si procede, la longitud de la carretera en el interior de la zona o aglomeración en la que las concentraciones superan el valor o valores límite o, según el caso, el valor o valores límite incrementados por el margen o márgenes de tolerancia de cada zona donde las concentraciones superen el umbral de evaluación superior o el umbral de evaluación inferior;

— con respecto a los valores límite cuyo objeto es la protección de la salud humana, la población potencialmente expuesta a concentraciones superiores al valor límite.

Cuando sea posible, los Estados miembros deberían elaborar mapas que indiquen la distribución de las concentraciones dentro de cada zona y aglomeración.

III. Normalización

Respecto al dióxido de azufre y a los óxidos de nitrógeno, el volumen deberá normalizarse temperatura a una de 293°K y presión de 101,3 kPa.

ANEXO IX

MÉTODOS DE REFERENCIA PARA LA EVALUACIÓN DE LAS CONCENTRACIONES DE DIÓXIDO DE AZUFRE, DIÓXIDO DE NITRÓGENO Y ÓXIDOS DE NITRÓGENO, PARTÍCULAS (PM_{10} Y $PM_{2,5}$) Y PLOMO

I. Método de referencia para el análisis del dióxido de azufre

ISO/FDIS 10498 (proyecto de norma) Aire ambiente — Determinación del dióxido de azufre — Método de fluorescencia utravioleta.

Los Estados miembros podrán utilizar cualquier otro método si pueden demostrar que da resultados equivalentes al método anterior.

II. Método de referencia para el análisis del dióxido de nitrógeno y los óxidos de nitrógeno

ISO 7996: 1985 Aire ambiente — Determinación de la concentración másica de los óxidos de nitrógeno — Método de quimiluminiscencia.

Los Estados miembros podrán utilizar cualquier otro método si pueden demostrar que dicho método da resultados equivalentes al método anterior.

III.A. Método de referencia para el muestreo de plomo

El método de referencia para el muestreo de plomo será el descrito en el anexo de la Directiva 82/884/CEE hasta la fecha en que debe cumplirse el valor límite especificado en el anexo IV de la presente Directiva, a partir de entonces el método de referencia será el del PM_{10}, como se especifica en la sección IV del presente anexo.

Los Estados miembros podrán utilizar cualquier otro método si pueden demostrar que dicho método da resultados equivalentes al método anterior.

III.B. Método de referencia para el análisis del plomo

ISO 9855: 1993 Aire ambiente — Determinación del contenido particulado de plomo en aerosoles captados en filtros. Método de espectroscopia de absorción atómica.

Los Estados miembros podrán utilizar cualquier otro método si pueden demostrar que dicho método da resultados equivalentes al método anterior.

IV. Método de referencia para el muestreo y análisis de PM_{10}

El método de referencia para el muestreo y análisis de PM_{10} será el descrito en la norma EN 12341 «Calidad del aire — Procedimiento de ensayo en campo para demostrar la equivalencia de referencia de los métodos de muestreo para la fracción PM_{10} de materia en suspensión». El principio de medición se basa en la captación en un filtro de la fracción de PM_{10} de materia en suspensión del ambiente y en la determinación gravimétrica de la masa.

Los Estados miembros podrán utilizar cualquier otro método si pueden demostrar que dicho método da resultados equivalentes al método anterior, o cualquier otro método si el Estado miembro de que se trate puede demostrar que muestra una relación coherente con el método de referencia. En tal caso, los resultados obtenidos con dicho método deberán corregirse mediante un factor pertinente para producir resultados equivalentes a los que se habrían obtenido con el método de referencia.

Los Estados miembros informarán a la Comisión del método utilizado para el muestreo y análisis de PM_{10}. La Comisión llevará a cabo, lo antes posible, ejercicios de intercomparación de los métodos de muestreo y análisis de PM_{10} con el objeto de suministrar información para la revisión de las disposiciones de la presente Directiva de conformidad con el artículo 10.

V. Método de referencia provisional para el muestreo y análisis de $PM_{2,5}$

La Comisión, en consulta con el comité mencionado en el artículo 12 de la Directiva 96/62/CE, presentará directrices para un método de referencia provisional adecuado para el muestro y análisis de $PM_{2,5}$, en la fecha estipulada en el artículo 12, de la presente Directiva.

Los Estados miembros podrán utilizar cualquier otro método que consideren adecuado.

Los Estados miembros informarán a la Comisión del método utilizado para el muestreo y análisis de $PM_{2,5}$. La Comisión llevará a cabo, lo antes posible, ejercicios de intercomparación de los métodos de muestreo y análisis de $PM_{2,5}$ con el objeto de suministrar información para la revisión de las disposiciones de la presente Directiva de conformidad con el artículo 10.

VI. **Técnicas de modelización de referencia**

Las técnicas modelización de referencia no pueden especificarse en este momento. Las modificaciones para adaptar este punto al progreso científico y técnico se adoptarán de conformidad con el procedimiento establecido en el apartado 2 del artículo 12 de la Directiva 96/62/CE.

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COLEGIO DE INGENIEROS DE CHILE A.G.

7D #18846

COMISION NACIONAL DEL MEDIO AMBIENTE
OFICINA DE PARTES Y ARCHIVO
Nº INGRESO: 3521 / 3186
FECHA: 10 ABR 2000
DESPACHADO:
OBS.: 12
A Sepúlveda

Santiago, 7 de Abril de 2000

G/175

Señor
Alvaro Sapag R.
Director Ejecutivo (S)
Comisión Nacional del Medio Ambiente
PRESENTE

De nuestra consideración:

Acusamos recibo de ORD. OF. Nº 00172 en el que nos informa que se ha dado inicio al proceso de revisión de las normas primarias de calidad de aire, con la publicación en el Diario Oficial de la Resolución Exenta Nº 1514 de esa Comisión y nos solicita la nominación de un representante oficial y un reemplazante, para integrar un Comité Ampliado que intervenga en su elaboración.

Por medio de la presente comunicamos a usted la nominación del Ing. Aníbal Mege Thierry como representante oficial del Colegio de Ingenieros de Chile A.G. al Comité Ampliado antes mencionado.

Saluda atentamente a usted,

Ing. PEDRO TORRES OJEDA
Gerente

c.c. Ing. Anibal Mege Thierry

Revisión Normas de Calidad del Aire

ACTA DE REUNION DE COMITÉ OPERATIVO
1ª Reunión del Grupo de Trabajo Anhídrido Sulfuroso

FECHA REUNION : 17 de Abril de 2000
LUGAR : CONAMA. Obispo Donoso 6. Santiago
ASISTENCIA : Se adjunta hoja de asistencia

Tabla :

1. Presentación de antecedentes sobre normativa internacional (Rodrigo Cerda, OPS)
2. Discusión

Discusión :

- En relación a las normativas internacionales presentadas se comenta que Argentina ha sido, en general, muy renovadora en su normativa. En el caso de Venezuela, se sostiene que sus normas aportan al tema de los picks, y que no se sabe bien si tienen incorporado niveles de emergencia. Se informa que Venezuela tiene una red nacional de calidad del aire desde 1981, con 11 estaciones, 4 de ellas en Caracas. Se aclaran los valores de norma para el caso de Japón.

- **R.Vargas** *(S.Salud VIII)* menciona que sería importante contar con una análisis de la relación entre emisión y calidad en otros países. **F.Farías** *(CONAMA)* sostiene que sería muy complejo establecer esas relaciones, sin embargo informa que para los casos de las fundiciones de cobre en Chile se cuenta con ese tipo de relación. **R.Cerda** *(OPS)* informa que se cuenta con antecedentes de emisiones al aire de SO2 en Costa Rica.

- **I.Olaeta (***SESMA)* consulta si se considerará en la normativa el sinergismo entre SO2 y PM10. **F.Farías** *(CONAMA)* indica que, si bien es cierto, la OMS al definir los valores guías para SO2 ponía una nota al pié de página respecto a su relación con el material particulado, en su última revisión las guías de la OMS, establecen que SO2 por sí solo presenta problemas y se mantiene los valores recomendados pero sin la nota al pié de la página.

- **C.Salvo** *(SONAMI)* consulta qué información se tiene en Chile respecto al impacto del SO2 en la salud de las personas, como realidad nacional. **F.Farías** *(CONAMA)* sostiene que los procesos normativos actuales en Chile están recogiendo la realidad local y esos serán los temas a discutir en el presente proceso. Indica que si bien la OMS fija valores estrictos, ésta no se refiere a condiciones de excedencia. En la Comunidad Europea, en tanto, se dan varios años para el cumplimiento de las metas. En el caso de Chile se evaluará la realidad nacional. Anuncia que se contempla la revisión de distintos ámbitos en las próximas reuniones, tales como salud nacional e internacional, emisiones, etc. **C.Santana** (*CONAMA RM)* a su vez, señala que no hay que caer ne el inmobilismo. Un inicio básico es la existencia de efectos y que se debe avanzar en la regulación del contaminante a la par con la obtención de mayores antecedentes. **A.Tchernitchin** *(Colegio Médico)*, señala que no existe mucha diferencia en la sensibilidad entre un grupo de personas y otros, en lo que se refiere a adaptación o acostumbramiento a un contaminante. Pueden existir deferencias en cuanto a los efectos agudos. En ese sentido es muy válida la consideración de antecedentes y estudios internacionales. **A.Muñoz** *(ASIMET)* a su vez, señala no estar de acuerdo con CONAMA RM, por cuanto él estima que es necesario contar con los estudios pertinentes, a objeto de tener una norma justificable científicamente y ésta debe ser aplicable en Chile.

- **R.Pedreros** *(CODELCO)* sostiene que ha escuchado de otros procesos normativos que hacer un estudio requiere gran tiempo. Si uno toma la normativa extranjera hay que revisar el tema económico. Por ejemplo, uno podría ser muy estricto en normar uranio, pero en SO2 hay que considerar la realidad chilena.

Rodrigo Lucero Ch.
Depto. Descontaminación, Planes y Normas
CONAMA

Revisión Normas de Calidad del Aire

ACTA DE REUNION DE COMITÉ OPERATIVO
1ª Reunión del Grupo de Trabajo Ozono y Dióxido de Nitrógeno

FECHA REUNION : 17 de Abril de 2000
LUGAR : CONAMA. Obispo Donoso 6. Santiago
ASISTENCIA : Se adjunta hoja de asistencia

Tabla :

1. Introducción (Fernando Farías, Depto. Descontaminación, Planes y Normas)
2. Presentación de antecedentes sobre normativa internacional (Rodrigo Cerda, OPS)
3. Discusión

Discusión :

- En relación a los antecedentes de la OMS presentados se señala que corresponden al documento de guías emitido en 1999, el cual está disponible en la página web. En cuanto a los datos de la EPA, los datos presentados también corresponden a 1999.

- **C.Santana** *(CONAMA RM)* consulta, en relación a la norma horaria y a la de 8 horas, cuál de ellas es más estricta o más difícil de cumplir en EEUU. **F.Farías** *(CONAMA)* indica que, en general, una vez que se cumple la horaria, después se puede cumplir la de 8 horas. **C.Santana** *(CONAMA RM)* sostiene que en Santiago, pareciese darse una situación distinta, dado que las variaciones en las concentraciones son muy bruscas. **F.Farías** *(CONAMA)* indica que se presentarán los datos de la red MACAM en una futura reunión.

- **I.Olaeta** *(SESMA)* comenta que la problemática del ozono contempla diferentes factores y es bastante compleja. Informa que en Santiago, gran parte de las excedencias ocurren en primavera y verano, con peaks en septiembre y marzo. Sin embargo, también en invierno se supera la normas. **C.Santana** *(CONAMA RM)* agrega que en las 8 estaciones de la red se ha superado la norma, por lo que no se trata de una situación local. En Peldehue, en la zona norte no urbana, en Talagante también se ha estado superando la norma. Sostiene que las mayores concentraciones se han registrado en la zona nororiente y hacia el Cajón del Mapocho, sin embargo, informa que en el resto de la ciudad las concentraciones no son bajas. Las mayores concentraciones en el resto de la ciudad no ocurren en verano. En relación a situaciones de pre-emergencia por ozono, se aclara que actualmente no se tienen valores críticos asociados a la norma.

- **A.Mege** *(SOFOFA)* coincide en que se trata de un problema difícil por la complejidad de las emisiones. Aclara que las emisiones de la industria son más complicadas de controlar en comparación con las fuentes móviles. Se tiene emisiones de COV a través de escapes de gas licuado, bencineras, etc. Los causantes del O3 son difíciles de controlar y de gran dispersión. **P.Oyola** *(CONAMA RM)* sostiene que no se conoce ningún país que haya logrado controlar el problema de la formación de O3, pero que si se ha reducido. En Chile aún se desconoce cuál de los precursores (COV o NOx) controla realmente la formación del ozono. Los efectos en la formación del ozono no se han visto claramente con la reducción de uno de los precursores. Por otro lado opina que es importante definir claramente el objetivo de protección de la norma.

Rodrigo Lucero Ch.
Depto. Descontaminación, Planes y Normas
CONAMA

COMISION NACIONAL DEL MEDIO AMBIENTE
DEPTO. DESCONTAMINACION, PLANES Y NORMAS

Reunión "Revisión Normas Primarias de Calidad de Aire para SO2, PTS, CO, NO2 Y O3"
Santiago, Abril 17 de 2000

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Normas Primarias de Calidad de Aire NO_2, O_3 y SO_2

Organización Panamericana de la Salud

El Proceso Normativo a nivel Internacional

- El objetivo del proceso de fijación y revisión de normas de calidad del aire en exteriores es establecer puntos de referencia cuantitativos de los niveles de contaminación coherentes con un riesgo aceptable para la protección de la salud y el ambiente que tengan fuerza legal.
- Las normas se pueden clasificar de varias formas. Una forma de clasificarlas es en primarias y secundarias. Las normas primarias constituyen niveles máximos permisibles de concentración de contaminantes del aire en exteriores para tiempos promedio de muestreo variables coherentes con un riesgo aceptable para la protección de la salud pública.
- Las normas secundarias constituyen los niveles máximos permisibles de concentración de contaminantes del aire en exteriores para tiempos promedio de muestreo variables coherentes con un riesgo aceptable para la protección de los recursos naturales y el patrimonio ambiental.
- Otra forma de clasificar las normas es de acuerdo a las áreas en donde se deben cumplir estableciendo valores para áreas sensibles de protección especial, áreas urbanas y rurales típicas y áreas industriales especiales.

•"En México, la normatividad con respecto a calidad del aire establece valores límite que se dividen en los de exposición aguda y los de exposición crónica, estos últimos para la protección de la salud de la población susceptible, además de que se cuenta con valores de alerta.

•La Comisión de Comunidades Europeas, presenta valores límites para la protección de la salud, valores límite para ecosistemas y vegetación y umbrales de alerta.

•En Estados Unidos de Norteamérica se cuenta con estándares nacionales primarios y secundarios de calidad de aire, definiéndose a los estándares primarios como los niveles de calidad de aire a los cuales el administrador de la EPA juzga necesario, con un adecuado margen de seguridad, proteger la salud pública, y los secundarios que definen niveles de calidad de aire a los cuales este mismo administrador juzga necesario proteger el bienestar público de cualquier efecto adverso anticipado o conocido de un contaminante."

- En algunos países como Estados Unidos y la Unión Europea, la ley fija plazos específicos para el cumplimiento de las normas y sanciones para las zonas afectadas que no los cumplan.
- En otros países como Canadá y Japón, las normas de calidad del aire en exteriores son tratadas como objetivos a lograr a largo plazo sin fecha límite. Sin embargo, se requiere que las instituciones fiscalizadoras y las fuentes de emisión lleguen a consensos sobre las formas y fechas para el cumplimiento de los planes de acción para mejorar la calidad del aire.

Las normas son un instrumento muy poderoso no sólo por su capacidad de regular y controlar los procesos productivos, sino particularmente por su capacidad de inducir cambios de conducta e internalizar costos ambientales, lo que las convierte en un mecanismo que promueve cambios tecnológicos. (Kork ,M; Farías F, 2000)

Valor de la norma

- El valor de la norma es el límite máximo permisible o rango de límites máximos permisibles especificados para la concentración de un contaminante en un tiempo promedio de muestreo determinado.
- La norma de Brasil para dióxido de nitrógeno para un tiempo promedio de muestreo de 1 año tiene un solo valor límite de 100 $\mu g/m^3$.
- La norma de Canadá tiene dos valores límites, un nivel máximo aceptable de 100 $\mu g/m^3$ y un nivel máximo deseable de 60 $\mu g/m^3$.
- El nivel máximo aceptable intenta proveer una protección adecuada contra los efectos adversos en humanos, animales, vegetación, suelos, agua, materiales y visibilidad.
- El nivel máximo deseable define una meta a largo plazo y provee una base para las políticas de prevención del deterioro de la calidad del aire en áreas no contaminadas.
- Las normas de China. para cada contaminante y tiempo promedio de muestreo la norma establece tres valores. Un valor para las regiones definidas como áreas de protección especial como parques nacionales y sitios históricos (Región Tipo I), un valor para regiones definidas como áreas urbanas y rurales típicas (Región Tipo II) y un valor para regiones definidas como áreas industriales especiales (región Tipo III). La norma china para dióxido de nitrógeno para un tiempo promedio de muestreo de un año tiene un valor para las Regiones Tipo I y II de 40 $\mu g/m^3$ y para la Región Tipo III de 80 $\mu g/m^3$.

Umbral de alerta

- El umbral de alerta es un nivel de concentración de un contaminante a partir del cual una exposición de breve duración supone un riesgo para la salud humana y por encima del cual se deben tomar medidas inmediatas de reducción de emisiones y de precaución para la población.
- Algunos países como Canadá o la Unión Europea ha establecido un umbral de alerta. Las directivas de la Unión Europea establecen un umbral de alerta para dióxido de nitrógeno de 400 $\mu g/m^3$ registrados durante tres horas consecutivas
- En el caso de países como Brasil, Chile, México y Estados Unidos, han establecido varios umbrales de alerta por encima de los cuales se toman medidas cada vez más estrictas.
- La norma de Brasil establece tres umbrales de alerta: 1130 $\mu g/m^3$ (atención), 2260 $\mu g/m^3$ (alerta) y 3000 $\mu g/m^3$ (emergencia) para un tiempo promedio de muestreo de una hora.

Frecuencia de la excedencia permitida

- La frecuencia de la excedencia permitida es el número máximo de excedencias del valor de la norma para un tiempo promedio de muestreo determinado permitido en un período de tiempo, generalmente un año.
- La frecuencia de excedencia permitida depende de la forma en que se implementa la norma dentro de la estrategia de manejo de la calidad del aire.
- Por ejemplo, en los Estados Unidos, la ley demanda grandes cambios en las estructuras de los programas de calidad del aire para las zonas que pasan del cumplimiento al incumplimiento de una norma.
- En estos casos, es fundamental que la frecuencia máxima permitida sea definida en una forma estadísticamente sólida para que zonas no tengan el potencial de pasar del cumplimiento al incumplimiento de una norma de un año a otro como resultado de las fluctuaciones aleatorias en las concentraciones del contaminante en el ambiente, a pesar del hecho de que las emisiones permanecían inalteradas.
- En otros países como Canadá y Japón, las normas de calidad del aire en exteriores son tratadas como objetivos a lograr a largo plazo sin fechas fijas para su cumplimiento y no hay demandas legales especiales para las zonas que pasan del cumplimiento al incumplimiento de la norma. Por lo tanto, en estos casos, no es tan necesario definir la frecuencia máxima permitida en una forma estadísticamente sólida.

Guías de calidad del Aire de OMS

- La publicación de la OMS titulada "Guías globales sobre calidad del aire" consolida los resultados de los estudios del impacto de los contaminantes del aire en la salud y ofrece recomendaciones sobre valores guía para los niveles de los contaminantes en el aire y sus tiempos promedio de exposición coherentes con un riesgo aceptable para la protección de la salud desde un punto de vista estrictamente científico. Los valores guía representan metas ideales hacia las cuales los países deberían avanzar

Criterios Estalecidos por OMS para determinación de peligro de contaminante

- La OMS recomienda cinco criterios para determinar el peligro de un contaminante (OMS, 1976):

- .Severidad y frecuencia de los efectos adversos en la salud observados o sospechosos.
- .Ubicuidad y abundancia del contaminante en el aire.
- .Persistencia del contaminante en el ambiente.
- .Transformaciones del contaminante en el ambiente y alteraciones metabólicas.
- .Tamaño de la población expuesta.

Idealmente, al concluir esta etapa debería ser posible establecer valores guías para los niveles de los contaminantes y sus tiempos promedio de exposición que no ponen ningún peligro a la salud y el ambiente. Sin embargo, los juicios y consensos científicos son inevitables por la falta de información e incertidumbres en los resultados de los estudios.

Lineamientos OMS periodo 1987-1997

Componente	Lineamiento OMS, 1987 µg/m³	Lineamiento OMS, 1997 µg/m³	Intervalo Promedio
SO_2		500	10 min.
	125	125	24 h.
		50	1 año
NO_2		40	1 año
	400	200	1h.
	150		24h.
O_3	100-120	120	8 h.
	150-200		1 h.

El proceso Normativo de calidad del Aire en la Región de las Américas

- En 13 países de América Latina y el Caribe se han fijado normas de calidad del aire en exteriores para contaminantes tradicionales: Argentina, Belice, Bolivia, Brasil, Chile, Colombia, Costa Rica (aprobado por el Ministerio de Salud y en consulta pública para su promulgación definitiva), Cuba, Ecuador, Guatemala, Jamaica, México, Perú (propuesta) y Venezuela.

Normas Primarias de Calidad de Aire - NO_2

Organización Panamericana de la Salud

Características del NO_2

- El NO_2 es un gas de color marrón claro que se produce directa e indirectamente por la quema de combustibles a altas temperaturas como los automóviles o las plantas termoeléctricas. En el proceso de combustión, el nitrógeno en el combustible y aire se oxida para formar principalmente óxido nítrico (NO) y en menor proporción NO_2.
- El NO emitido se convierte en NO_2 mediante reacciones fotoquímicas condicionadas por la luz solar. El NO_2 se combina con compuestos orgánicos volátiles en presencia de luz solar para formar ozono. También, se combina con agua para formar ácido nítrico y nitratos. Esto contribuye a la producción de lluvia ácida y al aumento de los niveles de MP_{10} y $MP_{2,5}$.
- El NO es relativamente inofensivo. Sin embargo, el NO_2 puede causar problemas respiratorios principalmente en asmáticos y niños. Estudios en animales han reportado que una exposición de corto plazo a NO_2 puede debilitar los mecanismos de defensa e incrementar la susceptibilidad a infecciones respiratorias. Estudios de exposición de largo plazo han demostrado cambios estructurales en los pulmones de animales.

Umbrales de alerta para NO_2

- Cuando las concentraciones de NO_2 sobrepasan los umbrales de alerta, se toman medidas inmediatas para reducir emisiones y prevenir a la población.
- Por ejemplo, la Unión Europea ha establecido el umbral de alerta en 400 $\mu g/m^3$ para un tiempo promedio de muestreo de una hora registrados durante tres horas consecutivas.
- Otros países han establecido varios umbrales de alerta por encima de los cuales se toman medidas cada vez más estrictas. Por ejemplo, los umbrales de alerta establecidos en la norma de Brasil son: 1.130 $\mu g/m^3$ (atención), 2.260 $\mu g/m^3$ (alerta) y 3.000 $\mu g/m^3$ (emergencia) para un tiempo promedio de muestreo de una hora.
- Los planes de acción para mejorar la calidad del aire deben especificar las medidas que se deben tomar en caso de que los niveles de contaminación sobrepasen los umbrales de alerta.

Métodos de referencia para el muestreo y análisis de NO_2

- Estos pueden ser automáticos o manuales.
- Por ejemplo, el método de referencia establecido en las normas de Chile es el método automático para la toma continua de muestras de NO_2 basado en quimiluminiscencia.
- En Venezuela son el método automático basado en quimiluminiscencia y el método manual basado en colorimetría usando una muestra tomada en arsenito de sodio en forma continua durante 24 horas.
- Generalmente, la frecuencia mínima de muestreo usando el método manual es cada 3 días. Información detallada sobre los métodos de referencia pueden obtenerse en los documentos de la ISO.

Valores guía para NO_2 recomendados por la OMS

Efectos sobre la salud	Nivel de efecto observable ($\mu g/m^3$)	Factor de incertidumbre	Valor guía ($\mu g/m^3$)	Tiempo promedio de exposición
Ligeros cambios en la función pulmonar de individuos asmáticos	**365 - 565**	**0.5**	**200**	**1 hora**
			40	**1 año**

Estándares de Calidad de Aire Para Diferentes Comunidades en $\mu g/m^3$ (ppm)

Contaminante	Tiempo promedio	Brasil	Chile	Colombia	México	Perú	Venezuela
Bióxido de Azufre (SO_2).	Anual [b] 24 Horas 1 Hora	80 (0.03) 365 (0.14)	80 (0.03) 365 (0.14)	100 (0.04) 400 (0.15)	79 (0.03) 341 (0.13)	160 (0.06)	80 (0.03) 365 (0.14)
Bióxido de Nitrógeno (NO_2).	Anual [b] 24 Horas 1 Hora	100 (0.05) 320	100 (0.05) 470 (0.25)	100 (0.05)	395 (0.21)		100 (0.05)

Nota : Todos los valores horarios y de 24 horas, no deberán de excederse más de una vez por año.
[a] Media Geométrica.
[b] Media Aritmética.
Fuente: , Martínez P. Romieu I, Introducción al monitoreo atmosférico; ECO- OPS/OMS, México. 1997

Estándares de Calidad de Aire SO_2 y NO_2 µg/m³ (ppm)

Contaminante	Tiempo promedio	Guías OMS	E.U.A. EPA	E.U.A. Estado De California	Japón	Alemania	Guías CE, hasta 1996 Actuales	Guías CE, hasta 1996 Consideradas para 1997
Bióxido de Azufre (SO_2)	Anual [b] 24 Horas 1 Hora 10 min.	50 (0.02) 125 (0.04) 500 (0.18)	79 (0.03) 341(0.13) 1046(0.40)		125 (0.04) (0.1)	140 400 [c]	140 400 [c]	125 350 [c]
Bióxido de Nitrógeno, NO_2.	Anual [c] 24 Horas 1 Hora	40-50 (0.02) 200 (0.11)	100 (0.05) 300 (0.16)	(0.25)	(0.04 - 0.06)	80 200 [c]	200 [c]	40 200 [c]

[a] Media Geométrica.
[b] Media Aritmética
[c] 98 Percentil.
[d] Valores de alerta.

Valores límite para la protección de la salud pública, tiempos promedio de muestreo y frecuencias de excedencia permitida para las normas de NO_2 en América Latina y el Caribe, Canadá, China, Estados Unidos, Japón y la Unión Europea.

País	Valor límite (µg/m³)[1]	Tiempo promedio de muestreo	Frecuencia de excedencia permitida
Argentina [2,3]	**846** **282**	**1 hora** **24 horas**	**El valor límite no podrá superarse en ninguna ocasión**
Belice [4, 5]	**30 (I), 80 (II), 120 (III)**		**El valor límite no podrá superarse en ninguna ocasión**
Bolivia	**400** **150**	**1 hora** **24 horas**	**El valor límite no podrá superarse en ninguna ocasión**

País	Valor límite (μg/m³)[1]	Tiempo promedio de muestreo	Frecuencia de excedencia permitida
México	**395**	**1 hora**	**El valor límite no podrá superarse en más de una ocasión por año**
Venezuela	**100 – 300**	**24 horas**	**El valor 100μg/m³ límite no podrá superarse en más de 50% de las mediciones y el valor 300μg/m³ límite no podrá superarse en más de 5% de las mediciones por año.**

País	Valor límite (μg/m³)[1]	Tiempo promedio de muestreo	Frecuencia de excedencia permitida
Canadá [7]	**400 (aceptable) 1.000 (tolerable)**	**1 hora**	
	200 (aceptable) 300 (tolerable)	**24 horas**	
	60 [6] (deseable) 100 [6] (aceptable)	**1 año**	
China [4]	**120 (I, II), 240 (III)**	**1 hora**	**El valor límite no podrá superarse en ninguna ocasión**
	80 (I, II), 120 (III)	**24 horas**	
	40 (I, II), 80 (III) [6]	**1 año**	

País	Valor límite ($\mu g/m^3$)[1]	Tiempo promedio de muestreo	Frecuencia de excedencia permitida
Estados Unidos	**100**[6]	**1 año**	**El valor límite no podrá superarse en ninguna ocasión**
Japón	**80-110**	**24 horas**	**El valor límite no podrá superarse en ninguna ocasión**
Unión Europea	**200**	**1 hora**	**El valor límite no podrá superarse en más de 18 ocasiones por año**
	40[6]	**1 año**	**El valor límite no podrá superarse en ninguna ocasión**

1 Las concentraciones de los contaminantes se calculan para condiciones de 1 atmósfera y 298 K.
2 Óxidos de nitrógeno medidos como dióxido de nitrógeno
3 Valores de la norma son aproximados: 0,45 ppm (1 hora) y 0,15 ppm (24 horas)
4 (I) áreas sensibles de protección especial; (II) áreas urbanas y rurales típicas y (III) áreas industriales especiales.
5 El tiempo promedio de muestreo no esta estipulado en la norma
6 Promedio aritmético anual
7 El nivel máximo deseable define una meta a largo plazo y provee una base para las políticas de prevención del deterioro de la calidad del aire en áreas no contaminadas. El nivel máximo aceptable intenta proveer una adecuada protección contra los efectos adversos en humanos, animales, vegetación, suelos, agua, materiales y visibilidad. El nivel máximo tolerable indica concentraciones de contaminantes por encima de las cuales se deben tomar medidas inmediatas para proteger la salud de la población en general.

Normas Primarias de Calidad de Aire - O_3

Organización Panamericana de la Salud

Características del Ozono (O_3)

- El O_3 es un gas incoloro que se forma mediante una serie de complejas reacciones en la troposfera. En términos sencillos, se forma mediante la reacción química del NO_2 y compuestos orgánicos volátiles (COV) en presencia de luz solar.
- La concentración de ozono en una determinada localidad depende de varios factores, incluida las emisiones de óxidos de nitrógeno y COV en la zona, el tipo de COV emitidos, la intensidad de la luz solar y las condiciones del clima.
- Cabe anotar que el ozono producido naturalmente en la estratosfera es beneficioso porque protege a la tierra de la nociva radiación ultravioleta del sol.

Efectos en la Salud del O3

- La población de mayor riesgo a la contaminación por O_3 son los ancianos, neonatos y nonatos.
- El O_3 irrita las membranas de la mucosa de la nariz, garganta y tracto respiratorio.
- Los síntomas asociados a la exposición a O_3 incluyen: tos, dolores en el pecho e irritación de la garganta. Los efectos son más severos en individuos con sistemas respiratorios sensibles.
- Un tema de gran preocupación es la posibilidad de efectos crónicos causados por exposiciones repetidas a O_3.
- Estudios en el laboratorio muestran que personas expuestas a bajos niveles de ozono por un período mayor de 6 a 8 horas pueden desarrollar una inflamación pulmonar y estudios en animales indican que si las exposiciones a O_3 son repetidas a lo largo de la vida, la inflamación pulmonar puede causar un daño permanente al tejido pulmonar, causar una disminución de la función pulmonar y reducir la elasticidad de los tejidos pulmonares.

Umbrales de alerta para O_3

- Cuando las concentraciones de O_3 sobrepasan estos umbrales, se toman medidas inmediatas para reducir emisiones y prevenir a la población.
- Brasil ha establecido varios umbrales de alerta por encima de los cuales se toman medidas cada vez más estrictas. Los umbrales de alerta establecidos en la norma de Brasil son: 400 $\mu g/m^3$ (atención), 800 $\mu g/m^3$ (alerta) y 1.000 $\mu g/m^3$ (emergencia) para un tiempo promedio de muestreo de una hora.
- Los planes de acción para mejorar la calidad del aire deben especificar las medidas que se deben tomar en caso de que los niveles de contaminación sobrepasen los umbrales de alerta.

Métodos de referencia para el muestreo y análisis de O_3

- Los métodos de referencia para el muestreo y análisis de O_3 establecidos en las normas son generalmente los métodos automáticos para la medición continua de O_3 basados en quimiluminiscencia o absorción ultravioleta.
- Información detallada sobre los métodos de referencia pueden obtenerse en los documentos de la ISO y en los documentos criterio para contaminantes tradicionales de la U.S. EPA

Valores Guía para O_3 Recomendados por la OMS

Efectos sobre la salud	Nivel de efecto observable ($\mu g/m^3$)	Factor de incertidumbre	Valor guía ($\mu g/m^3$)	Tiempo promedio de exposición
Respuestas de la función del sistema respiratorio	**n.a**	**n.a**	**120**	**8 horas**

n.a. no aplicable

Estándares de calidad de aire para O_3 en mg/m^3

Contaminante	Tiempo promedio	Brasil	Chile	Colombia	México	Perú	Venezuela
Ozono (O_3).	8 Horas 1 Hora	160 (0.08)	160 (0.08)	170 (0.09)	216 (0.11)		200 (0.10)

Estándares de calidad del aire O_3 $\mu g/m^3$ (ppm)

Contami-nante	Tiempo promedio	Guías OMS	E.U.A.EPA	E.U.A. EstadoDe California	Japón	Alemania	Guías CE, hasta 1996	
							Actuales	Consideradas para 1997
Ozono (O_3).	8 Horas 1 Hora	120 (0.06)	235 (0.12)	(0.10)	118 (0.06)	180 - 360[d]		

Todos los valores horarios y de 24 horas no deberán de excederse más de una vez por año.

[d] Valores de alerta

Fuente: , Martínes P. Romieu I, Introducción al monitoreo atmosférico; ECO- OPS/OMS, México. 1997

- **Los valores de ozono que utiliza Alemania son valores de alerta, correspondiendo el valor de 180 al primer umbral, que al rebasarse se notificará a la población, y el valor de 360, al segundo umbral, que al rebasarse se recomendará a la población permanecer en casa.**

Valores límite para la protección de la salud pública, tiempos promedio de muestreo y frecuencias de excedencia permitida para las normas de O_3 en América Latina y el Caribe, Canadá, China, Estados Unidos, Japón y la Unión Europea.

País	Valor límite ($\mu g/m^3$)[1]	Tiempo promedio de muestreo	Frecuencia de excedencia permitida
Argentina[2]	**195**	**1 hora**	**El valor límite no podrá superarse en ninguna ocasión**
Bolivia	**236**	**1 hora**	**El valor límite no podrá superarse en ninguna ocasión**
Brasil	**160**	**1 hora**	**El valor límite no podrá superarse en más de una ocasión por año**

País	Valor límite ($\mu g/m^3$)[1]	Tiempo promedio de muestreo	Frecuencia de excedencia permitida
Chile[4]	**160**	**1 hora**	**El valor límite no podrá superarse en más de una ocasión por año**
Colombia[4]	**170**	**1 hora**	**El valor límite no podrá superarse en más de una ocasión por año**
Costa Rica	**160**	**1 hora**	**El valor límite no podrá superarse en ninguna ocasión**
Cuba	**160**	**20 minutos**	**El valor límite no podrá superarse en ninguna ocasión**
	30	**24 horas**	

País	Valor límite ($\mu g/m^3$)[1]	Tiempo promedio de muestreo	Frecuencia de excedencia permitida
Ecuador[4]	**200**	**1 hora**	**El valor límite no podrá superarse en más de una ocasión por año**
México	**216**	**1 hora**	**El valor límite no podrá superarse en más de una ocasión por año en un período de tres años.**
Venezuela[4]	**240**	**1 hora**	**El valor límite no podrá superarse en más de 0.02% de las mediciones por año.**

País	Valor límite ($\mu g/m^3$)[1]	Tiempo promedio de muestreo	Frecuencia de excedencia permitida
Canadá[5]	**100 (deseable) 160 (aceptable) 300 (tolerable)**	**1 hora**	
	30 (deseable) 50 (aceptable)	**24 horas**	
	30[6] (aceptable)	**1 año**	
China[7]	**120 (I), 160 (II), 200 (III)**	**1 hora**	**El valor límite no podrá superarse en ninguna ocasión**

País	Valor límite ($\mu g/m^3$)[1]	Tiempo promedio de muestreo	Frecuencia de excedencia permitida
Estados Unidos	**235**[8]	**1 hora**	**El valor límite no podrá superarse en más de tres ocasiones por el máximo diario en un período de tres años consecutivos**
	160[9]	**8 horas**	**El promedio de tres años consecutivos del cuarto valor más alto anual del máximo diario no debe superar la norma.**
Japón[10]	**120**	**1 hora**	**El valor límite no podrá superarse en ninguna ocasión**
Unión Europea[11]	**110**	**8 horas**	**El valor límite no podrá superarse en ninguna ocasión**

1 Las concentraciones de los contaminantes se calculan para condiciones de 1 atmósfera y 298 K.
2 Valores de la norma son aproximados: 0,10 ppm (1 hora)
3 No tiene normas para O_3
4 Oxidantes totales expresados como ozono
5 El nivel máximo deseable define una meta a largo plazo y provee una base para las políticas de prevención del deterioro de la calidad del aire en áreas no contaminadas. El nivel máximo aceptable intenta proveer una adecuada protección contra los efectos adversos en humanos, animales, vegetación, suelos, agua, materiales y visibilidad. El nivel máximo tolerable indica concentraciones de contaminantes por encima de las cuales se deben tomar medidas inmediatas para proteger la salud de la población en general.
6 Promedio aritmético
7 (I) áreas sensibles de protección especial; (II) áreas urbanas y rurales típicas y (III) áreas industriales especiales.
8 Esta norma no se aplicará más para una zona una vez que la Agencia de Protección Ambiental determine que la zona está por debajo de la norma.
9 Valor es aproximado: 0.08 ppm
10 Oxidantes fotoquímicos totales
11 Umbral de protección de la salud. El promedio de 8 horas es de tipo móvil sin traslape; se calcula cuatro veces al día sobre la base de 8 valores horarios comprendidos entre 0 y 9 horas, 8 y 17 horas, 16 y 1 horas y 12 y 21 horas. El umbral de información a la población 180 $\mu g/m^3$ en un tiempo promedio de muestreo de 1 hora.

Normas Primarias de Calidad de Aire - SO_2

Organización Panamericana de la Salud

Características del SO_2

- El SO_2 es un gas incoloro e inodoro en concentraciones bajas y de olor acre en concentraciones altas. Es producido por la combustión de combustibles fósiles que contienen azufre como el carbón y el petróleo y por varios procesos industriales, como la fundición de metales no ferrosos, la producción de ácido sulfúrico y la conversión de pulpa en papel.

- Cuando el SO_2 y los oxidantes fotoquímicos reaccionan en la atmósfera, se forma el trióxido de azufre, el cual se combina con agua para formar ácido sulfúrico y partículas sulfatadas. Esto contribuye a la producción de lluvia ácida y al aumento de los niveles de MP con diámetro aerodinámico menor o igual a 10 micrómetros (MP_{10}) y 2.5 micrómetros ($MP_{2.5}$).

Impacto en la Salud del SO_2

- La exposición a SO_2 puede causar un decrecimiento de la función pulmonar, agravación de enfermedades respiratorias pre-existentes (especialmente bronquitis) y decrecimiento de la habilidad de los pulmones de liberar partículas extrañas.
- También puede contribuir al incremento de la mortalidad, especialmente si las concentraciones de MP también son elevadas.
- Los asmáticos, personas con otras enfermedades pulmonares obstructivas crónicas (EPOC) y con problemas cardíacos son los más sensibles a los efectos del SO_2.
- También es probable que los adultos mayores y niños sean sensibles a los efectos del SO2.
- La exposición a corto plazo a altas concentraciones de SO_2 puede irritar el tracto respiratorio y congestionar los conductos bronquiales en asmáticos.

Valores guías para SO_2 Recomendados por OMS

Efectos sobre la salud	Nivel de efecto observable ($\mu g/m^3$)	Factor de incertidumbre	Valor guía ($\mu g/m^3$)	Tiempo promedio de exposición
Cambios en la función pulmonar de individuos asmáticos	**1000**	**2**	**500**	**10 minutos**
Exacerbaciones de los síntomas respiratorios en individuos sensibles	**250**	**2**	**125**	**24 horas**
	100	**2**	**50**	**1 año**

Estándares de Calidad de Aire Para Diferentes Comunidades en $\mu g/m^3$ (ppm)

Contaminante	Tiempo promedio	Brasil	Chile	Colombia	México	Perú	Venezuela
Bióxido de Azufre (SO_2).	Anual [b] 24 Horas 1 Hora	80 (0.03) 365 (0.14)	80 (0.03) 365 (0.14)	100 (0.04) 400 (0.15)	79 (0.03) 341 (0.13)	160 (0.06)	80 (0.03) 365 (0.14)
Bióxido de Nitrógeno (NO_2).	Anual [b] 24 Horas 1 Hora	100 (0.05) 320	100 (0.05) 470 (0.25)	100 (0.05)	395 (0.21)		100 (0.05)

Nota : Todos los valores horarios y de 24 horas, no deberán de excederse más de una vez por año.

[a] Media Geométrica.

[b] Media Aritmética.

Fuente: . Martínes P. Romieu I. Introducción al monitoreo atmosférico: ECO- OPS/OMS, México. 1997

Estándares de Calidad de Aire SO_2 y NO_2 $\mu g/m^3$ (ppm)

Contami-nante	Tiempo promedio	Guías OMS	E.U.A. EPA	E.U.A. Estado De California	Japón	Alema-nia	Guías CE, hasta 1996	
							Actuales	Consideradas para 1997
Bióxido de Azufre (SO_2)	Anual [b] 24 Horas 1 Hora 10 min.	50 (0.02) 125 (0.04) 500 (0.18)	79 (0.03) 341(0.13) 1046(0.40)		125 (0.04) (0.1)	140 400 [c]	140 400 [c]	125 350 [c]
Bióxido de Nitrógeno, NO_2.	Anual [c] 24 Horas 1 Hora	40-50 (0.02) 200 (0.11)	100 (0.05) 300 (0.16)	(0.25)	(0.04 - 0.06)	80 200 [c]	200 [c]	40 200 [c]

[a] Media Geométrica.
[b] Media Aritmética
[c] 98 Percentil.
[d] Valores de alerta.

Umbrales de alerta para SO_2

- Cuando las concentraciones de SO_2 sobrepasan estos umbrales, se toman medidas inmediatas para reducir emisiones y prevenir a la población.
- La Unión Europea ha establecido el umbral de alerta en 500 $\mu g/m^3$ registrados durante tres horas consecutivas.
- Otros países han establecido varios umbrales de alerta por encima de los cuales se toman medidas cada vez más estrictas.
- Por ejemplo, los umbrales de alerta establecidos en la norma de Brasil son: 800 $\mu g/m^3$ (atención), 1.600 $\mu g/m^3$ (alerta) y 2.100 $\mu g/m^3$ (emergencia) para un tiempo promedio de muestreo de 24 horas. Los planes de acción para mejorar la calidad del aire deben especificar las medidas que se deben tomar en caso de que los niveles de contaminación sobrepasen los umbrales de alerta.

Métodos de referencia manuales y automáticos para el muestreo y análisis de SO_2

- El método de referencia establecido en las directivas de la Unión Europea es el método automático basado en fluorescencia ultravioleta.
- Ecuador haestablecido es el método manual basado en colorimetría usando una muestra tomada en pararosanilina en forma continua durante 24 horas, al menos cada tres días.
- Información detallada sobre los métodos de referencia pueden obtenerse en los documentos de la Organización Internacional de Estándares (ISO por sus siglas en inglés) y en los documentos criterio para contaminantes tradicionales de la U.S. EPA

Valores límite para la protección de la salud pública, tiempos promedio de muestreo y frecuencias de excedencia permitida para las normas de SO_2 en América Latina y el Caribe, Canadá, Estados Unidos, Japón y la Unión Europea.

País	Valor límite ($\mu g/m^3$)[1]	Tiempo promedio de muestreo	Frecuencia de excedencia permitida
Argentina	2620[2]	1 hora	El valor límite no podrá superarse en ninguna ocasión
	780[2]	8 horas	
	70[3]	1 mes	
Belice[4,5]	30 (I), 80 (II), 120 (III)		El valor límite no podrá superarse en ninguna ocasión
Bolivia	365	24 horas	El valor límite no podrá superarse en ninguna ocasión
	80[6]	1 año	

País	Valor límite (μ g/m [3]) [1]	Tiempo promedio de muestreo	Frecuencia de excedencia permitida
Brasil	365	24 horas	El valor límite no podrá superarse en más de una ocasión por año
	80 [6]	1 año	El valor límite no podrá superarse en ninguna ocasión
Chile	365	24 horas	El valor límite no podrá superarse en más de una ocasión por año
	80 [6]	1 año	El valor límite no podrá superarse en ninguna ocasión
Colombia	1500	3 horas	El valor límite no podrá superarse en más de una ocasión por año
	400	24 horas	
	100 [6]	1 año	El valor límite no podrá superarse en ninguna ocasión

País	Valor límite (μ g/m [3]) [1]	Tiempo promedio de muestreo	Frecuencia de excedencia permitida
Costa Rica	1500	3 horas	El valor límite no podrá superarse en más de una ocasión por año
	365	24 horas	
	80 [6]	1 año	El valor límite no podrá superarse en ninguna ocasión
Cuba	500	20 minutos	El valor límite no podrá superarse en ninguna ocasión
	50	24 horas	
Ecuador	1500	3 horas	El valor límite no podrá superarse en más de una ocasión por año
	400	24 horas	
	80 [6]	1 año	El valor límite no podrá superarse en ninguna ocasión

País	Valor límite (μ g/m^3)[1]	Tiempo promedio de muestreo	Frecuencia de excedencia permitida
México	**341**	**24 horas**	**El valor límite no podrá superarse en más de una ocasión por año**
	79[6]	**1 año**	**El valor límite no podrá superarse en ninguna ocasión**
Venezuela	**80 – 365**	**24 horas**	**El valor 80 μ g/m^3 no podrá superarse en más de 50% de las mediciones, el valor 200 μ g/m^3 no podrá superarse en más de 5% de las mediciones, el valor 250 μ g/m^3 no podrá superarse en más de 2% de las mediciones y el valor 365 μ g/m^3 no podrá superarse en más de 0.5% de las mediciones por año.**

País	Valor límite (μ g/m^3)[1]	Tiempo promedio de muestreo	Frecuencia de excedencia permitida
Canadá[7]	**450 (deseable) 900 (aceptable)**	**1 hora**	
	150 (deseable) 300 (aceptable) 800 (tolerable)	**24 horas**	
	30[6] **(deseable) 60**[6] **(aceptable)**	**1 año**	
China[4]	**150 (I), 500 (II), 700 (III)**	**1 hora**	**El valor límite no podrá superarse en ninguna ocasión**
	50 (I), 150 (II), 250 (III)	**24 horas**	
	20 (I), 60 (II), 100 (III)[6]	**1 año**	

País	Valor límite ($\mu g/m^3$)[1]	Tiempo promedio de muestreo	Frecuencia de excedencia permitida
Estados Unidos	**365**	**24 horas**	**El valor límite no podrá superarse en más de una ocasión por año**
	80[6]	**1 año**	**El valor límite no podrá superarse en ninguna ocasión**
Japón	**260**	**1 hora**	**El valor límite no podrá superarse en ninguna ocasión**
	110	**24 horas**	
Unión Europea	**350**	**1 hora**	**El valor límite no podrá superarse en más de 24 ocasiones por año**
	125	**24 horas**	**El valor límite no podrá superarse en más de 3 ocasiones por año**

1 Las concentraciones de los contaminantes se calculan para condiciones de 1 atmósfera y 298 K.
2 Valores de la norma son aproximados: 1ppm (1 hora) y 0,3 ppm (8 horas)
3 Promedio aritmético mensual
4 (I) áreas sensibles de protección especial; (II) áreas urbanas y rurales típicas y (III) áreas industriales especiales.
5 El tiempo promedio de muestreo no esta estipulado en la norma
6 Promedio aritmético anual
7 El nivel máximo deseable define una meta a largo plazo y provee una base para las políticas de prevención del deterioro de la calidad del aire en áreas no contaminadas. El nivel máximo aceptable intenta proveer una adecuada protección contra los efectos adversos en humanos, animales, vegetación, suelos, agua, materiales y visibilidad. El nivel máximo tolerable indica concentraciones de contaminantes por encima de las cuales se deben tomar medidas inmediatas para proteger la salud de la población en general.

Fuente: Korc, M. Farías. El Proceso de Fijación y Revisión de Normas de Calidad del Aire. OPS-OMS/CONAMA. Cepis.2000

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Normas Primarias de Calidad de Aire NO_2, O_3 y SO_2

Organización Panamericana de la Salud

El Proceso Normativo a nivel Internacional

- El objetivo del proceso de fijación y revisión de normas de calidad del aire en exteriores es establecer puntos de referencia cuantitativos de los niveles de contaminación coherentes con un riesgo aceptable para la protección de la salud y el ambiente que tengan fuerza legal.
- Las normas se pueden clasificar de varias formas. Una forma de clasificación es en primarias y secundarias. Las normas primarias constituyen niveles máximos permisibles de concentración de contaminantes del aire en exteriores para tiempos promedio de muestreo variables coherentes con un riesgo aceptable para la protección de la salud pública.
- Las normas secundarias constituyen los niveles máximos permisibles de concentración de contaminantes del aire en exteriores para tiempos promedio de muestreo variables coherentes con un riesgo aceptable para la protección de los recursos naturales y el patrimonio ambiental.
- Otra forma de clasificar las normas es de acuerdo a las áreas en donde se deben cumplir, estableciendo valores para áreas sensibles de protección especial, áreas urbanas y rurales típicas y áreas industriales especiales.

•"En México, la normatividad con respecto a calidad del aire establece valores límite que se dividen en los de exposición aguda y los de exposición crónica, éstos últimos para la protección de la salud de la población susceptible , además de que se cuenta con valores de alerta.

•La Comisión de Comunidades Europeas, presenta valores límites para la protección de la salud, valores límite para ecosistemas y vegetación y umbrales de alerta.

•En Estados Unidos de Norteamérica se cuenta con estándares nacionales primarios y secundarios de calidad de aire, definiéndose a los estándares primarios como los niveles de calidad de aire a los cuales el administrador de la EPA juzga necesario, con un adecuado margen de seguridad, proteger la salud pública, y los secundarios que definen niveles de calidad de aire a los cuales este mismo administrador juzga necesario proteger el bienestar público de cualquier efecto adverso anticipado ó conocido de un contaminante ."

- En algunos países como Estados Unidos y la Unión Europea, la ley fija plazos específicos para el cumplimiento de las normas y sanciones para las zonas afectadas que no los cumplan.

- En otros países como Canadá y Japón, las normas de calidad del aire en exteriores son tratadas como objetivos a lograr a largo plazo sin fecha límite. Sin embargo, se requiere que las instituciones fiscalizadoras y las fuentes de emisión lleguen a consensos sobre las formas y fechas para el cumplimiento de los planes de acción para mejorar la calidad del aire.

Las normas son un instrumento muy poderoso no sólo por su capacidad de regular y controlar los procesos productivos, sino particularmente por su capacidad de inducir cambios de conducta e internalizar costos ambientales, lo que las convierte en un mecanismo que promueve cambios tecnológicos (Kock, M; Farias F, 2000)

Valor de la norma

- El valor de la norma es el límite máximo permisible o rango de límites máximos permisibles especificados para la concentración de un contaminante en un tiempo promedio de muestreo determinado.
- La norma de Brasil para dióxido de nitrógeno para un tiempo promedio de muestreo de 1 año tiene un solo valor límite de 100 $\mu g/m^3$.
- La norma de Canadá tiene dos valores límites, un nivel máximo aceptable de 100 $\mu g/m^3$ y un nivel máximo deseable de 60 $\mu g/m^3$.
- El nivel máximo aceptable intenta proveer una protección adecuada contra los efectos adversos en humanos, animales, vegetación, suelos, agua, materiales y visibilidad.
- El nivel máximo deseable define una meta a largo plazo y provee una base para las políticas de prevención del deterioro de la calidad del aire en áreas no contaminadas.
- Las normas de China, para cada contaminante y tiempo promedio de muestreo la norma establece tres valores. Un valor para las regiones definidas como áreas de protección especial como parques nacionales y sitios históricos (Región Tipo I), un valor para regiones definidas como áreas urbanas y rurales típicas (Región Tipo II) y un valor para regiones definidas como áreas industriales especiales (región Tipo III). La norma china para dióxido de nitrógeno para un tiempo promedio de muestreo de un año tiene un valor para las Regiones Tipo I y II de 40 $\mu g/m^3$ y para la Región Tipo III de 80 $\mu g/m^3$.

Umbral de alerta

- El umbral de alerta es un nivel de concentración de un contaminante a partir del cual una exposición de breve duración supone un riesgo para la salud humana y por encima del cual se deben tomar medidas inmediatas de reducción de emisiones y de precaución para la población.
- Algunos países como Canadá o la Unión Europea ha establecido un umbral de alerta. Las directivas de la Unión Europea establecen un umbral de alerta para dióxido de nitrógeno de 400 µg/m³ registrados durante tres horas consecutivas
- En el caso de países como Brasil, Chile, México y Estados Unidos, han establecido varios umbrales de alerta por encima de los cuales se toman medidas cada vez más estrictas.
- La norma de Brasil establece tres umbrales de alerta: 1130 µg/m³ (atención), 2260 µg/m³ (alerta) y 3000 µg/m³ (emergencia) para un tiempo promedio de muestreo de una hora.

Frecuencia de la excedencia permitida

- La frecuencia de la excedencia permitida es el número máximo de excedencias del valor de la norma para un tiempo promedio de muestreo determinado permitido en un periodo de tiempo, generalmente un año.
- La frecuencia de excedencia permitida depende de la forma en que se implementa la norma dentro de la estrategia de manejo de la calidad del aire.
- Por ejemplo, en los Estados Unidos, la ley demanda grandes cambios en las estructuras de los programas de calidad del aire para las zonas que pasan del cumplimiento al incumplimiento de una norma.
- En estos casos, es fundamental que la frecuencia máxima permitida sea definida en una forma estadísticamente sólida para que zonas no tengan el potencial de pasar del cumplimiento al incumplimiento de una norma de un año a otro como resultado de las fluctuaciones aleatorias en las concentraciones del contaminante en el ambiente, a pesar del hecho de que las emisiones permanecían inalteradas.
- En otros países como Canadá y Japón, las normas de calidad del aire en exteriores son tratadas como objetivos a lograr a largo plazo sin fechas fijas para su cumplimiento y no hay demandas legales especiales para las zonas que pasan del cumplimiento al incumplimiento de la norma. Por lo tanto, en estos casos, no es tan necesario definir la frecuencia máxima permitida en una forma estadísticamente sólida.

Guías de calidad del Aire de OMS

- La publicación de la OMS titulada "Guías globales sobre calidad del aire" consolida los resultados de los estudios del impacto de los contaminantes del aire en la salud y ofrece recomendaciones sobre valores guía para los niveles de los contaminantes en el aire y sus tiempos promedio de exposición coherentes con un riesgo aceptable para la protección de la salud desde un punto de vista estrictamente científico. Los valores guía representan metas ideales hacia las cuales los países deberían avanzar.

Criterios Estalecidos por OMS para determinación de peligro de contaminante

- La OMS recomienda cinco criterios para determinar el peligro de un contaminante (OMS, 1976):
- .Severidad y frecuencia de los efectos adversos en la salud observados o sospechosos.
- .Ubicuidad y abundancia del contaminante en el aire.
- .Persistencia del contaminante en el ambiente.
- .Transformaciones del contaminante en el ambiente y alteraciones metabólicas.
- .Tamaño de la población expuesta.

Idealmente, al concluir esta etapa debería ser posible establecer valores guías para los niveles de los contaminantes y sus tiempos promedio de exposición que no ponen ningún peligro a la salud y el ambiente. Sin embargo, los juicios y consensos científicos son inevitables por la falta de información e incertidumbres en los resultados de los estudios.

Lineamientos OMS periodo 1987-1997

Componente	Lineamiento OMS, 1987 µg/m	Lineamiento OMS, 1997 µg/m³	Intervalo Promedio
SO_2		500	10 min.
	125	125	24 h.
		50	1 año
NO_2		40	1 año
	400	200	1h.
	150		24h.
O_3	100-120	120	8 h.
	150-200		1 h.

El proceso Normativo de calidad del Aire en la Región de las Américas

- En 13 países de América Latina y el Caribe se han fijado normas de calidad del aire en exteriores para contaminantes tradicionales: Argentina, Belice, Bolivia, Brasil, Chile, Colombia, Costa Rica (aprobado por el Ministerio de Salud y en consulta pública para su promulgación definitiva), Cuba, Ecuador, Guatemala, Jamaica, México, Perú (propuesta) y Venezuela.

Normas Primarias de Calidad de Aire - NO2

Organización Panamericana de la Salud

Características del NO2

- El NO_2 es un gas de color marrón rojizo que se produce directa e indirectamente por la quema de combustibles a altas temperaturas como los automóviles o las plantas termoeléctricas. En el proceso de combustión, el nitrógeno en el combustible y aire se oxida para formar principalmente óxido nítrico (NO) y en menor proporción NO_2.
- El NO emitido se convierte en NO_2 mediante reacciones fotoquímicas condicionadas por la luz solar. El NO_2 se combina con compuestos orgánicos volátiles en presencia de luz solar para formar ozono. También, se combina con agua para formar ácido nítrico y nitratos. Esto contribuye a la producción de lluvia ácida y al aumento de los niveles de MP_{10} y $MP_{2.5}$.
- El NO es relativamente inofensivo. Sin embargo, el NO_2 puede causar problemas respiratorios principalmente en asmáticos y niños. Estudios en animales han reportado que una exposición de corto plazo a NO_2 puede debilitar los mecanismos de defensa e incrementar la susceptibilidad a infecciones respiratorias. Estudios de exposición de largo plazo han demostrado cambios estructurales en los pulmones de animales.

Umbrales de alerta para NO_2

- Cuando las concentraciones de NO_2 sobrepasan los umbrales de alerta, se toman medidas [illegible] proteger a la población.
- Por ejemplo, la Unión Europea ha establecido el umbral de alerta en 400 µg/m³ para un tiempo promedio de muestreo de una hora registrados durante tres horas consecutivas.
- Otros países han establecido varios umbrales de alerta por encima de los cuales se toman medidas cada vez más estrictas. Por ejemplo, los umbrales de alerta establecidos en la norma de Brasil son: 1.130 µg/m³ (atención), 2.260 µg/m³ (alerta) y 3.000 µg/m³ (emergencia) para un tiempo promedio de muestreo de una hora.
- Los planes de acción para mejorar la calidad del aire deben especificar las medidas que se deben tomar en caso de que los niveles de contaminación sobrepasen los umbrales de alerta.

Métodos de referencia para el muestreo y análisis de NO_2

- Estos pueden ser automáticos o manuales.
- Por ejemplo, el método de referencia establecido en las normas de Chile es el método automático para la toma continua de muestras de NO_2 basado en quimiluminiscencia.
- En Venezuela son el método automático basado en quimiluminiscencia y el método manual basado en colorimetría usando una muestra tomada en arsenito de sodio en forma continua durante 24 horas.
- Generalmente, la frecuencia mínima de muestreo usando el método manual es cada 3 días. Información detallada sobre los métodos de referencia pueden obtenerse en los documentos de la ISO.

Valores guía para NO_2 recomendados por la OMS

Efectos sobre la salud	Nivel de efecto observable ($\mu g/m^3$)	Factor de incertidumbre	Valor guía ($\mu g/m^3$)	Tiempo promedio de exposición
Ligeros cambios en la función pulmonar de individuos asmáticos	365 - 565	0.5	200 40	1 hora 1 año

Estándares de Calidad de Aire Para Diferentes Comunidades en $\mu g/m^3$ (ppm)

Contaminante	Tiempo promedio	Brasil	Chile	Colombia	México	Perú	Venezuela
Bióxido de Azufre (SO_2).	Anual 24 Horas 1 Hora	80 (0.03) 365 (0.14)	80 (0.03) 365 (0.14)	100 (0.04) 400 (0.15)	78 (0.03) 341 (0.13)	160 (0.06)	80 (0.03) 365 (0.14)
Bióxido de Nitrógeno (NO_2).	Anual[b] 24 Horas 1 Hora	100 (0.05) 320	100 (0.05) 470 (0.25)	100 (0.05)	 395 (0.21)		100 (0.05)

Nota : Todos los valores horarios y de 24 horas no deberán de excederse más de una vez por año.

[a] Media Geométrica.

[b] Media Aritmética.

Fuente: Martinez P, Romieu I, Introducción al monitoreo atmosférico, ECO-OPS/OMS, México 1997

Estándares de Calidad de Aire SO_2 y NO_2 ug/m³ (ppm)

Contaminante	Tiempo promedio	Guías OMS	E.U.A. EPA	E.U.A. Estado De Californi	Japón	Alemania	Guías CE hasta 1996	
							Actuales	Consideradas para 1997
Bióxido de Azufre (SO_2)	Anual[b] 24 Horas 1 Hora 10 min.	50 (0.02) 125 (0.04) 500 (0.18)	79 (0.03) 341(0.13) 1046(0.40)		125 (0.04) (0.1)	140 400[c]	140 400[c]	125 350[c]
Bióxido de Nitrógeno, NO_2.	Anual[b] 24 Horas 1 Hora	40-50 (0.02) 200 (0.11)	100 (0.05) 400 (0.16)	(0.25)	(0.04 – 0.06)	80 200[c]	 200[c]	40 200[c]

[a] Media Geométrica.
[b] Media Aritmética
[c] 98 Percentil.
[d] Valores de alerta.

Valores límite para la protección de la salud pública, tiempos promedio de muestreo y frecuencias de excedencia permitida para las normas de NO_2 en América Latina y el Caribe, Canadá, China, Estados Unidos, Japón y la Unión Europea.

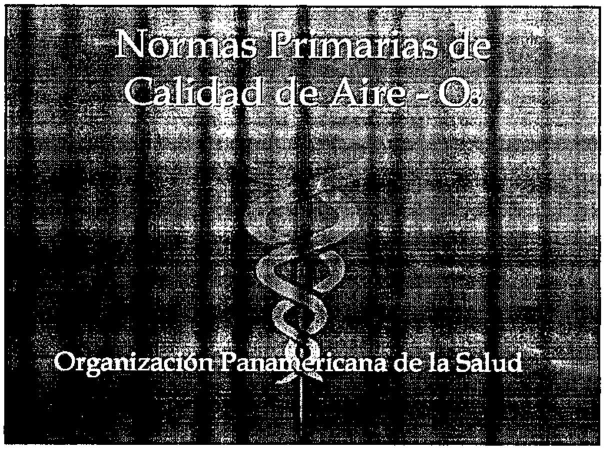
País	Valor límite (µg/m³)	Tiempo promedio de muestreo	Frecuencia de excedencia permitida
Argentina[2,3]	846 282	1 hora 24 horas	El valor límite no podrá superarse en ninguna ocasión
Belice[4,5]	30 (I), 80 (II), 120 (III)		El valor límite no podrá superarse en ninguna ocasión
Bolivia	400 150	1 hora 24 horas	El valor límite no podrá superarse en ninguna ocasión

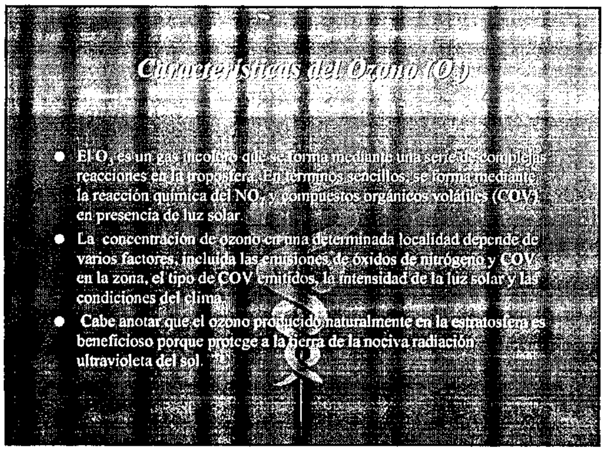
País	Valor límite (µg/m³)[1]	Tiempo promedio de muestreo	Frecuencia de excedencia permitida
México	395	1 hora	El valor límite no podrá superarse en más de una ocasión por año.
Venezuela	100 – 300	24 horas	El valor 100 µg/m³ límite no podrá superarse en más de 50% de las mediciones y el valor 300 µg/m³ límite no podrá superarse en más de 5% de las mediciones por año.

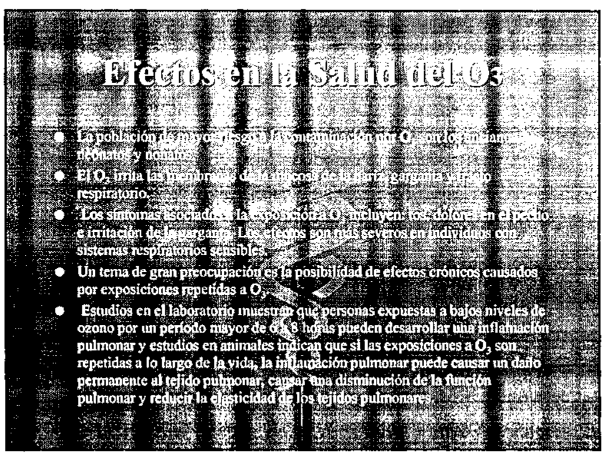
País	Valor límite ($\mu g/m^3$)[1]	Tiempo promedio de muestreo	Frecuencia de excedencia permitida
Canadá[7]	400 (aceptable) 1,000 (tolerable)	1 hora	
	200 (aceptable) 300 (tolerable)	24 horas	
	60[6] (deseable) 100[6] (aceptable)	1 año	
China[4]	120 (I, II), 240 (III)	1 hora	El valor límite no podrá superarse en ninguna ocasión
	80 (I, II), 120 (III)	24 horas	
	40 (I, II), 80 (III)[6]	1 año	

País	Valor límite ($\mu g/m^3$)[1]	Tiempo promedio de muestreo	Frecuencia de excedencia permitida
Estados Unidos	100[6]	1 año	El valor límite no podrá superarse en ninguna ocasión
Japón	80-110	24 horas	El valor límite no podrá superarse en ninguna ocasión
Unión Europea	200	1 hora	El valor límite no podrá superarse en más de 18 ocasiones por año
	40[6]	1 año	El valor límite no podrá superarse en ninguna ocasión

1 Las concentraciones de los contaminantes se calculan para condiciones de 1 atmósfera y 298 K.
2 Óxidos de nitrógeno medidos como dióxido de nitrógeno
3 Valores de la norma son aproximados: 0,45 ppm (1 hora) y 0,15 ppm (24 horas)
4 (I) áreas sensibles de protección especial; (II) áreas urbanas y rurales típicas y (III) áreas industriales especiales.
5 El tiempo promedio de muestreo no esta estipulado en la norma
6 Promedio aritmético anual
7 El nivel máximo deseable define una meta a largo plazo y provee una base para las políticas de prevención del deterioro de la calidad del aire en áreas no contaminadas. El nivel máximo aceptable intenta proveer una adecuada protección contra los efectos adversos en humanos, animales, vegetación, suelos, agua, materiales y visibilidad. El nivel máximo tolerable indica concentraciones de contaminantes por encima de las cuales se deben tomar medidas inmediatas para proteger la salud de la población en general.


Normas Primarias de
Calidad de Aire - O3
Organización Panamericana de la Salud


Características del Ozono (O3)
El O3 es un gas incoloro que se forma mediante una serie de complejas reacciones en la troposfera. En términos sencillos, se forma mediante la reacción química del NOx y compuestos orgánicos volátiles (COV) en presencia de luz solar.
La concentración de ozono en una determinada localidad depende de varios factores, incluida las emisiones de óxidos de nitrógeno y COV en la zona, el tipo de COV emitidos, la intensidad de la luz solar y las condiciones del clima.
Cabe anotar que el ozono producido naturalmente en la estratosfera es beneficioso porque protege a la tierra de la nociva radiación ultravioleta del sol.


Efectos en la Salud del O3
Un tema de gran preocupación es la posibilidad de efectos crónicos causados por exposiciones repetidas a O3.
Estudios en el laboratorio muestran que personas expuestas a bajos niveles de ozono por un período mayor de 6 a 8 horas pueden desarrollar una inflamación pulmonar y estudios en animales indican que si las exposiciones a O3 son repetidas a lo largo de la vida, la inflamación pulmonar puede causar un daño permanente al tejido pulmonar, causar una disminución de la función pulmonar y reducir la elasticidad de los tejidos pulmonares.

Umbrales de alerta para O_3

- Cuando las concentraciones de O_3 sobrepasan estos umbrales, se toman medidas inmediatas para reducir emisiones y prevenir a la población.
- Brasil ha establecido varios umbrales de alerta por encima de los cuales se toman medidas cada vez más estrictas. Los umbrales de alerta establecidos en la norma de Brasil son: 400 µg/m³ (atencion), 800 µg/m³ (alerta) y 1,000 µg/m³ (emergencia) para un tiempo promedio de muestreo de una hora.
- Los planes de acción para mejorar la calidad del aire deben especificar las medidas que se deben tomar en caso de que los niveles de contaminación sobrepasen los umbrales de alerta.

Métodos de referencia para el muestreo y análisis de O_3

- Los métodos de referencia para el muestreo y análisis de O_3 establecidos en las normas son generalmente los métodos automáticos para la medición continua de O_3 basados en quimiluminiscencia o absorción ultravioleta.
- Información detallada sobre los métodos de referencia pueden obtenerse en los documentos de la ISO y en los documentos criterio para contaminantes tradicionales de la U.S. EPA

Valores Guía para O_3 Recomendados por la OMS

Efectos sobre la salud	Nivel de efecto observable (µg/m³)	Factor de incertidumbre	Valor guía (µg/m³)	Tiempo promedio de exposición
Respuestas de la función del sistema respiratorio	**n.a**	**n.a**	**120**	**8 horas**

n.a. no aplicable

Estándares de calidad de aire para O_3 en mg/m^3

Contaminante	Tiempo promedio	Brasil	Chile	Colombia	México	Perú	Venezuela
Ozono (O_3).	8 Horas 1 Hora	160 (0.08)	160 (0.08)	170 (0.09)	216 (0.11)[c]		200 (0.10)

[c] No debe excederse más de una vez cada tres años. Todos los demás valores horarios y de 24 horas, no deberán de excederse más de una vez por año.

Estándares de calidad del aire O_3 µg/m^3 (ppm)

Contami-nante	Tiempo promedio	Guías OMS	E.U.A. EPA	E.U.A. Estado De California	Japón	Alemania	Guías CE, hasta 1996	
							Actuales	Consideradas para 1997
Ozono (O_3).	8 Horas 1 Hora	120 (0.06)	235 (0.12)	(0.10)	118 (0.06)	180 - 360[d]		

Todos los valores horarios y de 24 horas no deberán de excederse más de una vez por año.

[d] Valores de alerta

Fuente: , Martínez P. Romieu I. Introducción al monitoreo atmosférico, ECO- OPS/OMS, México. 1997

- Los valores de ozono que utiliza Alemania son valores de alerta correspondiendo el valor de 180 al primer umbral, que al rebasarse se notificará a la población, y el valor de 360, al segundo umbral, que al rebasarse se recomendará a la población permanecer en casa.

Valores límite para la protección de la salud pública, tiempos promedio de muestreo y frecuencias de excedencia permitida para las normas de O_3 en América Latina y el Caribe, Canadá, China, Estados Unidos, Japón y la Unión Europea.

País	Valor límite ($\mu g/m^3$)	Tiempo promedio de muestreo	Frecuencia de excedencia permitida
Argentina[2]	195	1 hora	El valor límite no podrá superarse en ninguna ocasión
Bolivia	236	1 hora	El valor límite no podrá superarse en ninguna ocasión
Brasil	160	1 hora	El valor límite no podrá superarse en más de una ocasión por año

País	Valor límite ($\mu g/m^3$)	Tiempo promedio de muestreo	Frecuencia de excedencia permitida
Chile[4]	160	1 hora	El valor límite no podrá superarse en más de una ocasión por año
Colombia[4]	170	1 hora	El valor límite no podrá superarse en más de una ocasión por año
Costa Rica	160	1 hora	El valor límite no podrá superarse en ninguna ocasión
Cuba	160 30	20 minutos 24 horas	El valor límite no podrá superarse en ninguna ocasión

País	Valor límite ($\mu g/m^3$)	Tiempo promedio de muestreo	Frecuencia de excedencia permitida
Ecuador[4]	200	1 hora	El valor límite no podrá superarse en más de una ocasión por año
México	216	1 hora	El valor límite no podrá superarse en más de una ocasión por año en un periodo de tres años.
Venezuela[4]	240	1 hora	El valor límite no podrá superarse en más de 0.02% de las mediciones por año.

País	Valor límite ($\mu g/m^3$)[1]	Tiempo promedio de muestreo	Frecuencia de excedencia permitida
Canadá[5]	100 (deseable) 160 (aceptable) 300 (tolerable)	1 hora	
	30 (deseable) 50 (aceptable)	24 horas	
	30[6] (aceptable)	1 año	
China[7]	120 (I), 160 (II), 200 (III)	1 hora	El valor límite no podrá superarse en ninguna ocasión

País	Valor límite ($\mu g/m^3$)	Tiempo promedio de muestreo	Frecuencia de excedencia permitida
Estados Unidos	[illegible]	[illegible] hora	El valor límite no podrá superarse [illegible] tres años consecutivos
	160[9]	8 horas	El promedio de tres años consecutivos del cuarto valor más alto anual del máximo diario no debe superar la norma.
Japón[10]	120	1 hora	El valor límite no podrá superarse en ninguna ocasión
Unión Europea[11]	110	8 horas	El valor límite no podrá superarse en ninguna ocasión

1 Las concentraciones de los contaminantes se calculan para condiciones de 1 atmósfera y 298 K.
2 Valores de la norma son aproximados: 0,10 ppm (1 hora)
3 No tiene normas para O_3
4 Oxidantes totales expresados como ozono
5 El nivel máximo deseable define una meta a largo plazo y provee una base para las políticas de prevención del deterioro de la calidad del aire en áreas no contaminadas. El nivel máximo aceptable intenta proveer una adecuada protección contra los efectos adversos en humanos, animales, vegetación, suelos, agua, materiales y visibilidad. El nivel máximo tolerable indica concentraciones de contaminantes por encima de las cuales se deben tomar medidas inmediatas para proteger la salud de la población en general.
6 Promedio aritmético
7 (I) áreas sensibles de protección especial; (II) áreas urbanas y rurales típicas y (III) áreas industriales especiales.
8 Esta norma no se aplicará más para una zona una vez que la Agencia de Protección Ambiental determine que la zona está por debajo de la norma.
9 Valor es aproximado: 0,08 ppm
10 Oxidantes fotoquímicos totales
11 Umbral de protección de la salud. El promedio de 8 horas es de tipo móvil sin traslape; se calcula cuatro veces al día sobre la base de 8 valores horarios comprendidos entre 0 y 9 horas, 8 y 17 horas, 16 y 1 horas y 12 y 21 horas. El umbral de información a la población 180 $\mu g/m^3$ en un tiempo promedio de muestreo de 1 hora.

Normas Primarias de Calidad de Aire - SO_2

Organización Panamericana de la Salud

Características del SO_2

- El SO_2 es un gas incoloro e inodoro en concentraciones bajas y de olor acre en concentraciones altas. Es producido por la combustión de combustibles fósiles que contienen azufre como el carbón y el petróleo y por varios procesos industriales, como la fundición de metales no ferrosos, la producción de ácido sulfúrico y la conversión de pulpa en papel.
- Cuando el SO_2 y los oxidantes fotoquímicos reaccionan en la atmósfera, se forma el trióxido de azufre, el cual se combina con agua para formar ácido sulfúrico y partículas sulfatadas. Esto contribuye a la producción de lluvia ácida y al aumento de los niveles de MP con diámetro aerodinámico menor o igual a 10 micrómetros (MP_{10}) y 2.5 micrómetros ($MP_{2.5}$).

Impacto en la Salud del SO_2

- La exposición a SO_2 puede causar un decrecimiento de la función pulmonar, agravación de enfermedades respiratorias pre-existentes (especialmente bronquitis) y decrecimiento de la habilidad de los pulmones de liberar partículas extrañas.
- También puede contribuir al incremento de la mortalidad, especialmente si las concentraciones de MP también son elevadas.
- Los asmáticos, personas con otras enfermedades pulmonares obstructivas crónicas (EPOC) y con problemas cardíacos son los más sensibles a los efectos del SO_2.
- También es probable que los adultos mayores y niños sean sensibles a los efectos del SO2.
- La exposición a corto plazo a altas concentraciones de SO_2 puede irritar el tracto respiratorio y congestionar los conductos bronquiales en asmáticos.

Valores guías para SO_2 Recomendados por OMS

Efectos sobre la salud	Nivel de efecto observable (µg/m³)	Factor de incertidumbre	Valor guía (µg/m³)	Tiempo promedio de exposición
Cambios en la función pulmonar de individuos asmáticos	1000	2	500	10 minutos
Exacerbaciones de los síntomas respiratorios en individuos sensibles	250 100	2 2	125 50	24 horas 1 año

Estándares de Calidad de Aire Para Diferentes Comunidades en µg/m³ (ppm)

Contaminante	Tiempo promedio	Brasil	Chile	Colombia	México	Perú	Venezuela
Bióxido de Azufre (SO_2)	Anual[b] 24 Horas 1 Hora	80 (0.03) 365 (0.14)	80 (0.03) 365 (0.14)	100 (0.04) 400 (0.15)	79 (0.03) 341 (0.13)	160 (0.06)	80 (0.03) 365 (0.14)
Bióxido de Nitrógeno (NO_2)	Anual[b] 24 Horas 1 Hora	100 (0.05) 320	100 (0.05) 470 (0.25)	100 (0.05)	395 (0.21)		100 (0.05)

Nota : Todos los valores horarios y de 24 horas, no deberán de excederse más de una vez por año.
[a] Media Geométrica.
[b] Media Aritmética.
Fuente: Martínez F. Romieu I. Introducción al monitoreo atmosférico. ECO-OPS-OMS, México. 1997

Estándares de Calidad de Aire SO_2 y NO_2 µg/m³ (ppm)

Contaminante	Tiempo promedio	Guías OMS	E.U.A. EPA	E.U.A. Estado De California	Japón	Alemania	Guías CE hasta 1996: Actuales	Guías CE hasta 1996: Consideradas para 1997
Bióxido de Azufre (SO_2)	Anual[a] 24 Horas 1 Hora 10 min.	50 (0.02) 125 (0.04) 500 (0.18)	79 (0.03) 341 (0.1 [illegible]) 1046 (0.40)		125 (0.04) (0.1)	140 400[c]	140 400[c]	125 350[c]
Bióxido de Nitrógeno, NO_2	Anual[b] 24 Horas 1 Hora	40-50 (0.02) 200 (0.11)	100 (0.05) 400 (0.[illegible]6)	(0.25)	(0.04 - 0.06)	80 200[c]	 200[c]	40 200[c]

[a] Media Geométrica.
[b] Media Aritmética
[c] 98 Percentil.
[d] Valores de alerta.

Umbrales de alerta para SO_2

- Cuando las concentraciones de SO_2 sobrepasan estos umbrales, se toman medidas inmediatas para reducir emisiones y prevenir a la población.
- La Unión Europea ha establecido el umbral de alerta en 500 µg/m³ registrados durante tres horas consecutivas.
- Otros países han establecido varios umbrales de alerta por encima de los cuales se toman medidas cada vez más estrictas.
- Por ejemplo, los umbrales de alerta establecidos en la norma de Brasil son: 800 µg/m³ (atención), 1.600 µg/m³ (alerta) y 2.100 µg/m³ (emergencia) para un tiempo promedio de muestreo de 24 horas. Los planes de acción para mejorar la calidad del aire deben especificar las medidas que se deben tomar en caso de que los niveles de contaminación sobrepasen los umbrales de alerta.

Métodos de referencia manuales y automáticos para el muestreo y análisis de SO_2

- El método de referencia establecido en las directivas de la Unión Europea es el método automático basado en fluorescencia ultravioleta.
- Ecuador haestablecido es el método manual basado en colorimetría usando una muestra tomada en pararosanilina en forma continua durante 24 horas, al menos cada tres días.
- Información detallada sobre los métodos de referencia pueden obtenerse en los documentos de la Organización Internacional de Estándares (ISO por sus siglas en inglés) y en los documentos criterio para contaminantes tradicionales de la U.S. EPA

Valores límite para la protección de la salud pública, tiempos promedio de muestreo [illegible] América Latina y el Caribe, Canadá, Estados Unidos, Japón y la Unión Europea

País	Valor límite (µg/m³)	Tiempo promedio de muestreo	Frecuencia de excedencia permitida
Argentina	2620[1] 780[1] 70[?]	1 hora 8 horas 1 mes	El valor límite no podrá superarse en ninguna ocasión
Belice [4,6]	30 (I), 80 (II), 120 (III)	[illegible]	El valor límite no podrá superarse en ninguna ocasión
Bolivia	365 80[a]	24 horas 1 año	El valor límite no podrá superarse en ninguna ocasión

País	Valor límite (µg/m³)*	Tiempo promedio de muestreo	Frecuencia de excedencia permitida
Brasil	365	24 horas	El valor límite no podrá superarse en más de una ocasión por año
	80*	1 año	El valor límite no podrá superarse en ninguna ocasión
Chile	[illegible]	24 horas	El valor límite no podrá superarse en más de una ocasión por año
	80*	1 año	El valor límite no podrá superarse en ninguna ocasión
Colombia	1500 400	3 horas 24 horas	El valor límite no podrá superarse en más de una ocasión por año
	100*	1 año	El valor límite no podrá superarse en ninguna ocasión

País	Valor límite (µg/m³)	Tiempo promedio de muestreo	Frecuencia de excedencia permitida
Costa Rica	1500 365	3 horas 24 horas	El valor límite no podrá superarse en más de una ocasión por año
	80	1 año	El valor límite no podrá superarse en ninguna ocasión
Cuba	500 50	20 minutos 24 horas	El valor límite no podrá superarse en ninguna ocasión
Ecuador	1500 400	3 horas 24 horas	El valor límite no podrá superarse en más de una ocasión por año
	80	1 año	El valor límite no podrá superarse en ninguna ocasión

País	Valor límite (µg/m³)	Tiempo promedio de muestreo	Frecuencia de excedencia permitida
México	341	24 horas	El valor límite no podrá superarse en más de una ocasión [illegible]
	[illegible]	[illegible]	El valor límite no podrá superarse en ninguna ocasión
Venezuela	80 – 365	24 horas	El valor 80 µg/m³ no podrá superarse en más de 50% de las mediciones, el valor 200 µg/m³ no podrá superarse en más de 5% de las mediciones, el valor 250 µg/m³ no podrá superarse en más de 2% de las mediciones y el valor 365 µg/m³ no podrá superarse en más de [illegible] las mediciones por año.

País	Valor límite (µg/m³)[1]	Tiempo promedio de muestreo	Frecuencia de excedencia permitida
Canadá[7]	450 (deseable) 900 (aceptable)	1 hora	
	150 (deseable) 300 (aceptable) 800 (tolerable)	24 horas	
	30[6] (deseable) 60[6] (aceptable)	1 año	
China[4]	150 (I), 500 (II), 700 (III)	1 hora	El valor límite no podrá superarse en ninguna ocasión
	50 (I), 150 (II), 250 (III)	24 horas	
	20 (I), 60 (II), 100 (III)[6]	1 año	

País	Valor límite (µg/m³)[1]	Tiempo promedio de muestreo	Frecuencia de excedencia permitida
Estados Unidos	365	24 horas	El valor límite no podrá superarse en más de una ocasión por año
	80	1 año	El valor límite no podrá superarse en ninguna ocasión
Japón	260	1 hora	El valor límite no podrá superarse en ninguna ocasión
	110	24 horas	
Unión Europea	350	1 hora	El valor límite no podrá superarse en más de 24 ocasiones por año
	125	24 horas	El valor límite no podrá superarse en más de 3 ocasiones por año

1 Las concentraciones de los contaminantes se calculan para condiciones de 1 atmósfera y 298 K.
2 Valores de la norma son aproximados: 1ppm (1 hora) y 0.3 ppm (8 horas)
3 Promedio aritmético mensual
4 (I) áreas sensibles de protección especial; (II) áreas urbanas y rurales típicas y (III) áreas industriales especiales.
5 El tiempo promedio de muestreo no esta estipulado en la norma
6 Promedio aritmético anual
7 El nivel máximo deseable define una meta a largo plazo y provee una base para las políticas de prevención del deterioro de la calidad del aire en áreas no contaminadas. El nivel máximo aceptable intenta proveer una adecuada protección contra los efectos adversos en humanos, animales, vegetación, suelos, agua, materiales y visibilidad. El nivel máximo tolerable indica concentraciones de contaminantes por encima de las cuales se deben tomar medidas inmediatas para proteger la salud de la población en general.

COMISIÓN NACIONAL DEL MEDIO AMBIENTE
DEPARTAMENTO DE DESCONTAMINACIÓN, PLANES Y NORMAS

Revisión Norma de Calidad Primaria contenidas en la Resolución Nº 1215/78
Grupo de Trabajo Monóxido de carbono -COMITÉ OPERATIVO Y AMPLIADO

18 de abril de 2000. CONAMA: Obispo Donoso 6. Santiago
Hora inicio: 9:30 hrs

Asistentes: Se adjunta hoja de asistencia

Tema de la reunión: Efectos en la salud del contaminante Monóxido de carbono. Presentación de la Dra. Jeanette Vega (Facultad de Medicina, P.U.Católica de Chile)

La **Dra. Vega** (*P.U.CatólicaChile*) presentó los resultados de sus investigaciones en el tema, e hizo llegar para difusión dentro del grupo de trabajo una primera versión de su documento "Efectos de la contaminación atmosférica en la salud humana. Evidencias de estudios recientes. Abril 2000". Los principales temas tratados durante su exposición fueron: Efectos en mortalidad. Efectos en admisiones hospitalarias y consultas de emergencia. Efectos fisiopatológicos. Estudios internacionales. Estudios chilenos.

A continuación de la presentación, se abrió una ronda de preguntas y respuestas y de opiniones en general:

Representantes de la ONG **Renace**, consultaron acerca del mecanismo de ingreso del CO al cuerpo humano, y presentaron material al respecto para el Grupo de Trabajo. También consultaron por efectos neurológicos por la presencia de este contaminante, lo que fue respondido por la **Dra.Vega** (*P.U.CatólicaChile*) en términos que hay que distinguir efectos por dosis altas (intoxicaciones agudas con consecuencias mortales) de dosis bajas, que son las que se encuentran en el aire, y éstas corresponden principalmente a efectos sobre los sistemas cardiovasculares y respiratorios

Se trató también el tema de cómo a través de la evaluación de las concentraciones de carboxihemoglobina en la sangre se podía registrar la presencia en el cuerpo humano de este contaminante. Al respecto el **Dr.Tchernitchin** *(Colegio Médico)* indicó que la vida media en la sangre de este compuesto orgánico es de 120 días. La **Dra.Vega** (*P.U.CatólicaChile*) acotó que no ha encontrado que se hayan descrito efectos de largo plazo o acumulativos en la literatura. **M.Adonis** *(UdeChile)* indicó que se están estudiando efectos a nivel celular a través de la evaluación sobre la citrocromo oxidasa. El **Dr.Tchernitchin** *(Colegio Médico)* indicó que en casos de exposición perinatal, pueden generarse secuelas irreversibles para distintos contaminantes, y que el CO podría ser uno de ellos.

I.Olaeta *(SESMA)* consultó si existía información acerca de mecanismos somáticos de adaptación a la presencia del contaminante CO. La **Dra.Vega** (*P.U.CatólicaChile)* indicó al respecto que el CO interfiere procesos básicos del individuo y que no se han encontrado beneficios asociados a la inhalación de CO, cuyo efecto se encuentra a nivel celular principalmente.

En cuanto a la exposición a distintos plazos de este contaminante, **C.Santana** *(CONAMA)* consultó que tan adecuadas son las normas horarias, de 8 horas, etc. Al respecto **L.Cifuentes** (*P.U.CatólicaChile)* indicó que los estándares actuales de corto plazo para el CO están basados en estudios clínicos y no en epidemiología.

J.Sánchez *(SESMA)* consultó respecto a la existencia de estudios en que aparezca correlación del CO con otros contaminantes. Al respecto, la **Dra.Vega** (*P.U.CatólicaChile)* indicó que cuando se analizan contaminantes en pares, el CO se mantiene constante, incluso más que el material particulado.

Finalmente, se indicó que en las próximas reuniones se verían los temas de normativa internacional, monitoreo e inventarios de emisiones de CO, así como metodologías de medición.

Rodrigo Lucero Ch.
Depto. Descontaminación, Planes y Normas
CONAMA

COMISION NACIONAL DEL MEDIO AMBIENTE
DEPTO. DESCONTAMINACION, PLANES Y NORMAS

Reunión "Revisión Normas Primarias de Calidad de Aire para SO2, PTS, CO, NO2 Y O3"
Santiago, Abril 18 de 2000

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Delfino et al ([i]) Montreal, Quebec. Periodo: 1992- 1993	Visitas diarias a la Sala de Emergencias (SE) por enfermedades respiratorias.	1992, no hubo asociación significativa con las visitas a la SE. 1993, ozono máximo 1-h, PM10, PM2.5, y SO4 se asociaron con visitas respiratorias para pacientes > 64 años. Un incremento en el nivel promedio de ozono máximo 1-h (36 ppb) se asoció con un incremento de 21% sobre el número promedio de visitas diarias a la SE (95% intervalo de confianza [IC]: 8a 34%). El efecto de las partículas fue menor, con incrementos promedio de 16% (4 a 28%), 12% (2 a 21%) y 6% (1 a 12%) para PM10, PM2.5, y SO4, respectivamente.
Delfino et al ([ii]) Montreal, Quebec Periodo: junio-agosto, 1989-1990	Visitas diarias a la Sala de Emergencias (SE) por enfermedades respiratorias	1989: Asociación entre visitas respiratorias a la SE (>64 años) y ozono máximo 1- y 8-h. (1 día antes de la visita a la SE, en verano). Las visitas a SE incrementaron 18.7% y 21.8% sobre el promedio, para un aumento promedio de 44 ppb ozono (máximo 1-h) y 38 ppb ozono (máximo 8-h). PM2.5 se asocia con visitas respiratorias a la SE de los adultos mayores..
Gordian et al ([iii]) Anchorage, Alaska mayo 1992 a marzo 1994	Visitas diarias de pacientes ambulatorios por enfermedades respiratorias, incluyendo asma, bronquitis, y enfermedades del tracto superior	Un incremento de 10 (ug/m3) en PM10 arrojó un incremento de 3-6% en las visitas por asma y un incremento de 1-3% en las visitas por enfermedades del tracto respiratorio superior. CO se asoció con bronquitis, enfermedades del tracto respiratorio superior. No con asma (invierno).

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[i] Delfino RJ, Murphy-Moulton AM, Burnett RT, Brook JR, Becklake MR. Effects of air pollution on emergency room visits for respiratory illnesses in Montreal, Quebec. Am J Respir Crit Care Med 1997; 155:568-76.

[ii] Delfino RJ, Murphy-Moulton AM, Becklake MR. Emergency room visits for respiratory illnesses among the elderly in Montreal: association with low level ozone exposure. Environ Res 1998; 76:67-77.

[iii] Gordian ME, Ozkaynak H, Xue J, Morris SS, Spengler JD. Particulate air pollution and respiratory disease in Anchorage, Alaska. Environ Health Perspect 1996; 104:290-7.

000465

Hernandez Garduno et al ([i]) Ciudad de México	Visitas al consultorio por infecciones del tracto respiratorio superior	La contaminación del aire se asoció con 10 a 16% de las visitas al consultorio.. O_3 y NO_2 incrementaron las visitas al consultorio entre 19 y 43% sobre el promedio. Otros contaminantes y el grupo control no demostraron asociaciones significativas.
Anderson et al ([ii]) Amsterdam, Barcelona, Londres, Milán, París, Rótterdam	Ingresos hospitalarios por enfermedad pulmonar obstructiva crónica (EPOC)	La contaminación del aire (SO2, BS, PMT, NO2, O3) se asoció con lo ingresos diarios por EPOC.
Burnett et al ([iii]) 16 ciudades en Canadá 1981-1991	Ingresos hospitalarios por enfermedades respiratorias	O3 se asocia con admisiones respiratorias (excepto en los meses de invierno). PM, CO se asocian con hospitalizaciones respiratorias.
Choudhury et al ([iv]) Anchorage, (Alaska) Período: 1992-1994	Visitas médicas por asma, bronquitis, infecciones del tracto respiratorio superior.	PM10 se asocia con la morbilidad. Las asociaciones son mas poderosas con niveles PM10 en días concurrentes.

[i] Hernandez-Garduno E, Perez-Neria J, Paccagnella AM, Pina-Garcia M, Munguia-Castro M, Catalan-Vazquez M, Rojas-Ramos M. Air pollution and respiratory health in Mexico City. J Occup Environ Med 1997; 39:299-307.

[ii] Anderson HR, Spix C, Medina S, Schouten JP, Castellsague J, Rossi G, Zmirou D, Touloumi G, Wojtyniak B, Ponka A, Bacharova L, Schwartz J, Katsouyanni K. Air pollution and daily admissions for chronic obstructive pulmonary disease in 6 European cities: results from the APHEA project. Eur Respir J 1997; 10:1064-71.

[iii] Burnett RT, Brook JR, Yung WT, Dales RE, Krewski D. Association between ozone and hospitalization for respiratory diseases in 16 Canadian cities. Environ Res 1997; 72:24-31.

[iv] Choudhury AH, Gordian ME, Morris SS. Associations between respiratory illness and PM10 air pollution. Arch Environ Health 1997; 52:113-7.

Tellez Rojo et al ([i]) Ciudad de México, 1993	Visitas médica por infecciones respiratorias en niños	Un incremento de 50 ppb en le promedio diario de ozono causa un incremento de 9.9% en las visitas a emergencias por infecciones del tracto respiratorio superior (invierno), que podría elevarse hasta un 30% si el incremento dura 5 días consecutivos.
Scwartz J.[ii] 8 condados de EEUU, 1988-1990	Ingresos por enfermedades cardiovasculares	2,5% de aumento de ingresos en mayores de 65 años para rango intercuartuil de aumento de PM10.. Incrementos de 1,75 ppm de CO asociados a 2,8% de aumento en admisiones.
Sheppard et al[iii] Seattle 1987-1994	Ingresos por asma en pacientes menores de 65 años.	4- 5% de aumento en tasa de ingreso por asma bronquial con aumentos de PM10 de 19 ug/m3, PM2,5 11,8 ug/m3 y 9,3 ug/m3 de PM10-2,5 (IQR). 6% de aumento asociado a aumentos de CO de 924 ppb (IQR).
Norris et al[iv]. Seattle 1995-1996	Consultas de urgencia por asma en niños menores de 18 años.	Aumento de 11 ug/m3 de partículas finas asociados con aumento de 15% de consultas por asma.

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[i] Tellez-Rojo MM, Romieu I, Polo-Pena M, Ruiz-Velasco S, Meneses-Gonzalez F, Hernandez-Avila M. [Effect of environmental pollution on medical visits for respiratory infections in children in Mexico City]. Salud Publica Mex 1997; 39:513-22.

[ii] Scwartz J. Air pollution and hospital admissions for heart disease in eight US counties. Epidemiology 1999;10(1):17-22.

[iii] Sheppard L, Levy D, Norris G, Larson T and Koenig J. Effects of ambient air pollution on nonelderly asthma hospital admissions in Seattle, Washington 1987-1994. Epidemiology 1999;10(1):23-30.

[iv] Norris G, Young S, Koenig J, Larson T, Sheppard L and Stout J. An association between fine particles and asthma emergency department visits for children in Seattle. Environmental Health Perspectives 1999;107(6):489-493.

000467

Riesgos Relativos y Mortalidad Diaria por PM-10 exposición Tipo Santiago 1988-1991.

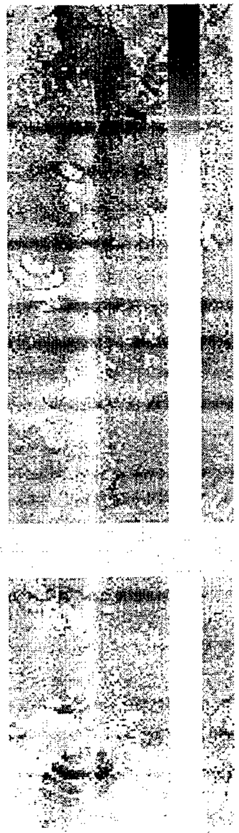
Estudio	Riesgo Relativo a 100 $\mu g/m^3$ PM-10	Mortalidad (Casos Anuales)
CIFUENTES Y LAVE (88-91)	MORTALIDAD TOTAL: 1,058 +CO: 1,027 MORTALIDAD MAYOR 65 AÑOS +CO: 1,036 MORTALIDAD RESPIRATORIA: 1,14 MORTALIDAD CARDIOVASCULAR: 1,08	542
OSTRO, ET AL (89-91)	+OTROS: MORTALIDAD TOTAL: 1,035 MORTALIDAD RESPIRATORIA: 1,13 MORTALIDAD CARDIOVASCULAR: 1,08 MORTALIDAD MENOR 64 AÑOS: 1,09	
SALINAS Y VEGA (88-91)	+CO MORTALIDAD TOTAL: 1,030	602
SANHUEZA ET AL (89-93)	+SO_2 + O_3 MORTALIDAD MAYOR 65 AÑOS: 1,046 MORTALIDAD CARDIOVASCULAR: 1,024 MORTALIDAD RESPIRATORIA: 1,054	600

Efectos cardiovasculares del CO

- Disminución tiempo max ejercicio y VO2 max.
- Reducción en tiempo para desarrollo angina y depresión ST.
- Aparición de arritmias.
- Aumento síntomas y admisiones por enfermedades CV.
- Aumento mortalidad diaria por enfermedades CV.

Efectos respiratorios del CO

- Disminución capacidad difusión CO en sujetos sanos
- Disminución capacidad de ejercicio en pacientes con EBOC



Efectos de la Contaminación Atmosférica en la Salud Humana. Evidencias de Estudios Recientes

Dra. Jeanette Vega M.

Abril 2000

Resultados estudios transversales

Referencia	Año	N ciudades	% incr 50 ug/m3 PM10 Media	intervalo 95%
Lave & Seskin 1977	1960	117	4.2%	1.0% - 7.3%
Lave & Seskin 1977	1969	112	6.9%	3.0% - 10.7%
Ozkaynak & Thurston 1987	1980	98	6.4%	1.8% - 10.9%

000472

Estudio de seis ciudades

- Datos de probabilidad de sobrevida de 8111 adultos reclutados a mediados de los 70 en seis ciudades del Este de EEUU: Portage WI, St Louis MO, Topeka KS, Steubenville OH, Watertown MA y Kingston TN.
- Alrededor de 1500 adultos de cada ciudad seguidos por 14-16 años. Datos incluyen ocupación, tabaquismo, IMC.
- Datos de exposición a través de monitoreo rutinario y campañas.
- De las 1430 muertes se localizaron 98% de los certificados de defunción.

Estudio de la American Cancer Society

- Datos de probabilidad de sobrevida de 550.000 voluntarios seguidos entre 1982 y 1989
- Analisis utilizando modelo de COX. Datos incluyen NSE, tabaquismo, ocupación, alcohol, e IMC.
- 39.000 muertes asignadas a localidad geográfica utilizando ZIP code (3 dígitos).

Resultados estudios prospectivos

Población	Estudio de 6 Ciudades		Estudio de ACS	
	Media	Intervalo 95%	Media	Intervalo 95%
Total	**26%**	8% - 47%	**17%**	9% - 26%
No Fumadores	**19%**	-10% - 57%	**22%**	7% - 39%
Fumadores anteriores	**35%**	2% - 77%		
Fumadores activos (*)	**32%**	4% - 68%	**15%**	5% - 26%

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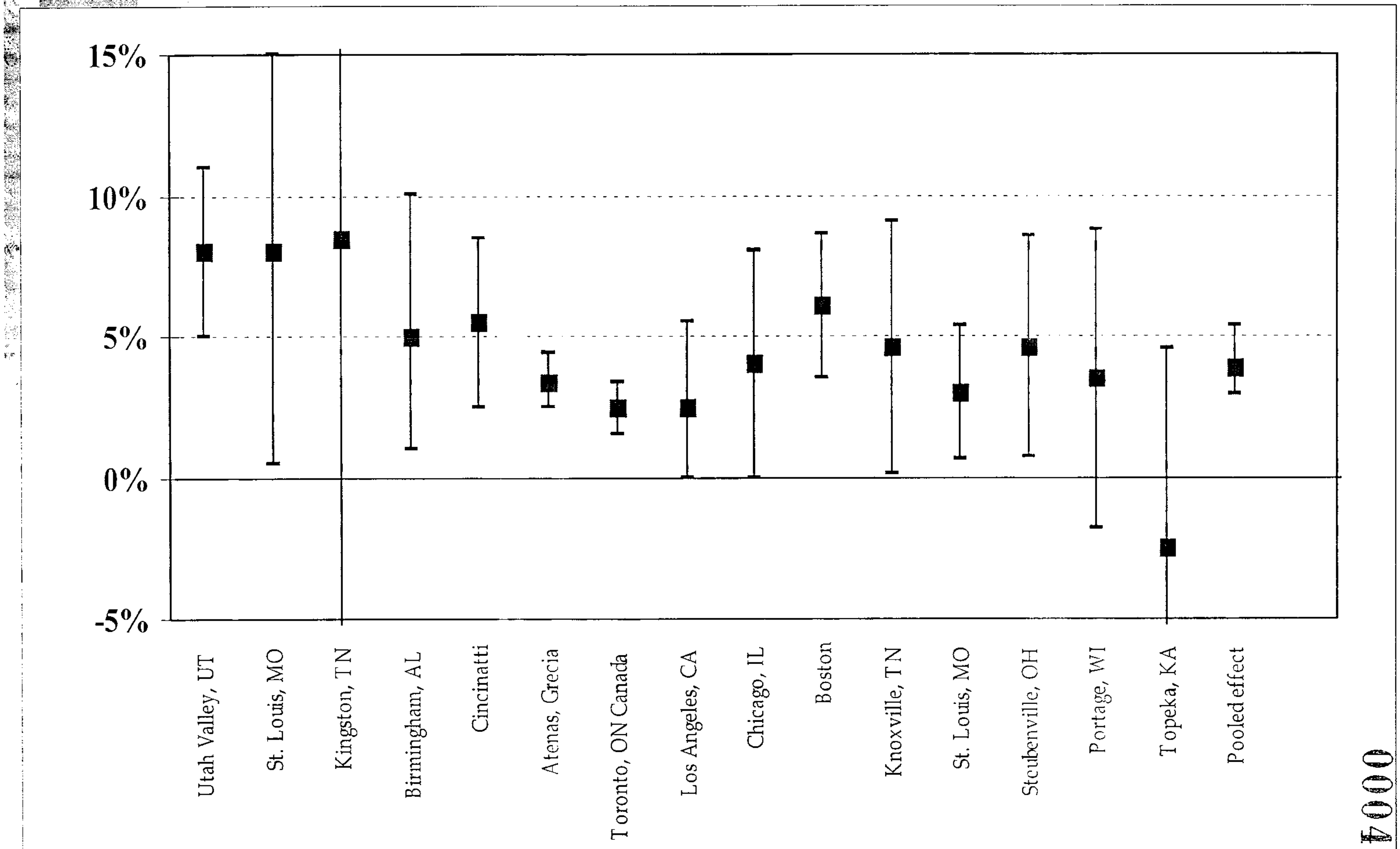
Estudios hasta 1996



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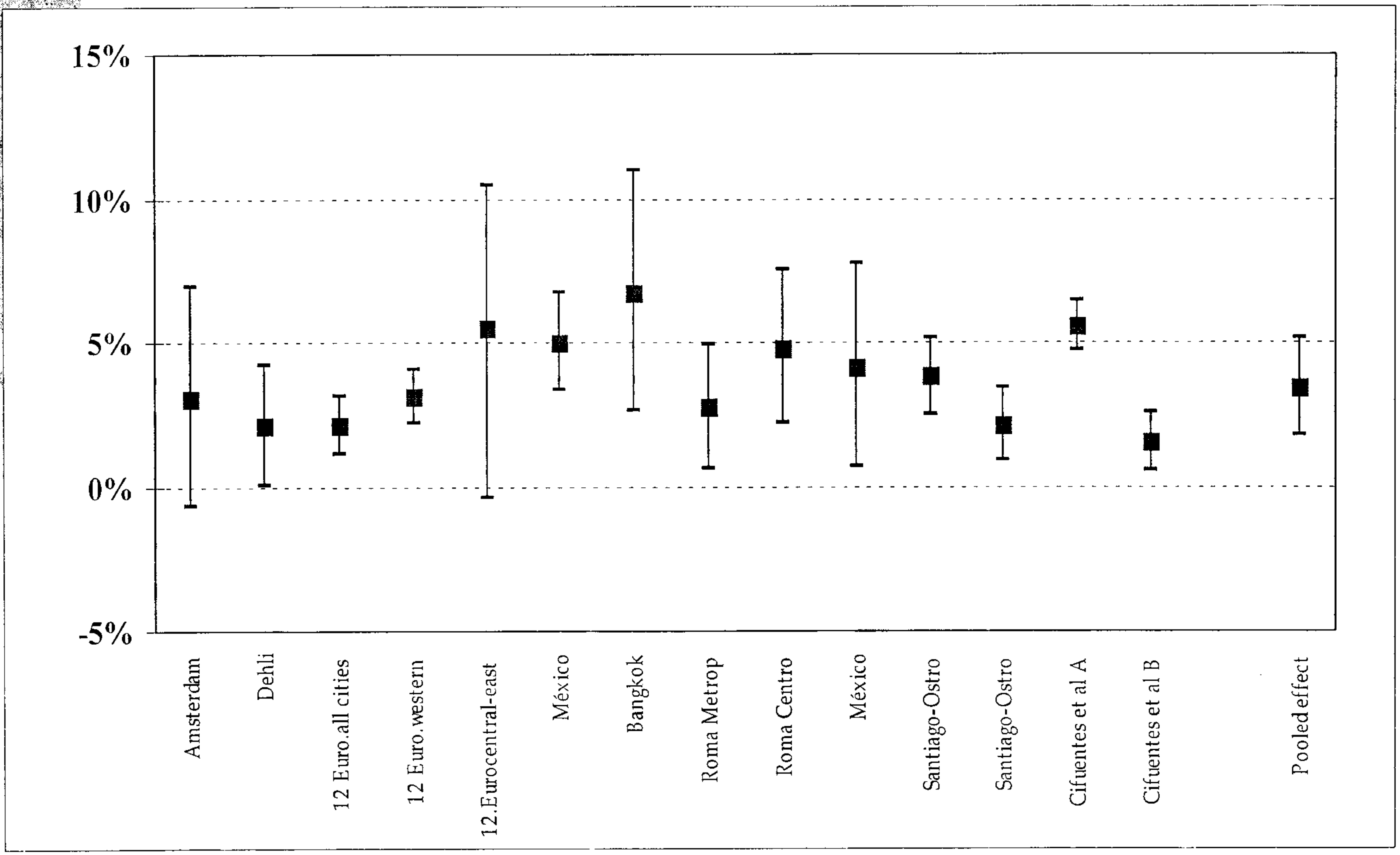
Estudios recientes



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Riesgos Relativos de Morbilidad Exposición Tipo Santiago 1988-1991.

Estudio	PM-10 100 mg/m^3
ILABACA (95-96)	URGENCIAS INFANTILES PM10: 1,08
BELMAR a) (88)	FLUJOMETRIA, AUSENTISMO, RONQUERA
BELMAR b) (88)	CONSULTA ATENCION PRIMARIA EN SALUD NO SIGNIFICATIVA
SANCHEZ (96)	SIBILANCIAS. MEDIA MOVIL 3 DIAS PM10: 1,78

Mortalidad diaria en 8 ciudades canadienses 1986-1996 (Burnett 2000)

Contaminante	Concentración media	Modelo I (efecto individual)	Modelo II (efecto combinado)	Modelo III (efecto con análisis de componentes principales)
PM_{10} (ug/m3)	25,9	1,9 (2,8)	NI	NI
$PM_{2,5}$ (ug/m3)	13,3	1,6 (3,1)	1,0 (2,9)	NI
$PM_{10-2,5}$ (ug/m3)	12,6	0,9 (1,4)	0,6 (1,6)	NI
O_3 (ppb)	31	3,4 (2,6)	1,6 (3,4)	2,0 (3,2)
NO_2 (ppb)	22	3,9 (3,0)	1,1 (3,2)	1,2 (2,7)
SO_2 (ppb)	4,7	1,1 (1,6)	0,7 (2,1)	NI
CO (ppm)	0,9	2,1 (2,1)	0,7 (1,9)	0,7 (1,7)
SO_4 (ug/m3)	2,6	1,2 (3,5)	NI	1,3 (3,5)
Zn (ng/m3)	26	0,8 (2,4)	NI	0,8 (2,1)
Ni (ng/m3)	1,6	0,7 (1,8)	NI	0,8 (1,9)
Fe (ng/m3)	81	1,2 (2,3)	NI	0,8 (1,8)

Estudio, Lugar y Fecha	Efecto	Resultados Resumidos
Burnet et al ([i]) 10 ciudades en Canadá Periodo:1981-1991 .	Admisiones diarias por insuficiencia cardíaca congestiva en ancianos	El monóxido de carbono (CO) mostró asociación consistente con tasa de hospitalización.
Poloniecki et al ([ii]) Londres, Inglaterra	Admisiones de urgencia por enfermedades cardiovasculares (CIE 390-459)	No se encontró asociación con el Ozono. Sin embargo 4 contaminantes estuvieron significativamente asociados a Infarto al Miocardio y Enfermedades Cardiovasculares. No se encontró asociación con insuficiencia cardíaca. Se encontró asociación entre sulfatos y angina y entre NO2 y enfermedades CV totales y por arritmias.
Wordley et al ([iii]) Birmingham, Reino Unido. Período 1992–1994	Mortalidad. Egresos hospitalarios por asma, bronquitis, neumonía, EPOC, enfermedad coronaria aguda, enfermedad cerebrovascular aguda, todas las condiciones respiratorias y todas las condiciones circulatorias.	PM_{10} diario se asoció con todos los ingresos por cuadros respiratorios, cerebrovasculares y bronquitis. PM_{10} promedio (últimos 3 días) se asoció con neumonía, asma, y admisiones respiratorias. La mortalidad por todas las causas se asoció con PM10 de las 24 horas anteriores.

[i] Burnett RT, Dales RE, Brook JR, Raizenne ME, Krewski D. Association between ambient carbon monoxide levels and hospitalizations for congestive heart failure in the elderly in 10 Canadian cities. Epidemiology 1997; 8:162-7.

[ii] Poloniecki JD, Atkinson RW, de Leon AP, Anderson HR. Daily time series for cardiovascular hospital admissions and previous day's air pollution in London, UK. Occup Environ Med 1997; 54:535-40.

[iii] Wordley J, Walters S, Ayres JG. Short term variations in hospital admissions and mortality and particulate air pollution. Occup Environ Med 1997; 54:108-16.

Efectos de la Contaminación Atmosférica en la Salud Humana. Evidencias de Estudios Recientes

Dra. Jeanette Vega M.
Abril 2000

Las concentraciones elevadas de contaminantes del aire, especialmente partículas menores de 10 micrones y dentro de esta menores de 2,5 micrones producen efectos adversos en salud que van desde efectos fisiopatológicos, aumento de consultas, aumento de admisiones hospitalarias totales y por enfermedades respiratorias y cardiovasculares y aumento de mortalidad por enfermedades respiratorias y cardiovasculares. Los efectos en salud asociados a episodios de alta contaminación tales como aquellos que ocurrieron en Londres en 1952 y en Donora Pennsylvania en 1948, han sido descritos en detalle en la literatura en los últimos 20 años[i ii].

La contaminación atmosférica (CA)se asocia a efectos nocivos en la salud humana que van desde efectos fisiopatológicos, aumento de síntomas respiratorios, consultas diarias y hospitalizaciones a aumento de mortalidad. Numerosos estudios en el mundo se han realizado en los últimos años con un crecimiento explosivo de los artículos a partir de la década de los 90. En este artículo se resumen los principales estudios de los últimos años que muestran la evidencia de asociación entre distintos daños en salud y la contaminación del aire

1. Efectos en mortalidad asociados a contaminación del aire

La contaminación atmosférica, provoca aumento de mortalidad diarias y específicamente por enfermedades cardiovasculares y respiratorias. Estos efectos comenzaron a ser mostrados a través de estudios transversales en los cuales se comparaban los niveles promedio de contaminación y las cifras de mortalidad a comienzos de los años setenta. Lave y Seskin[iii] publicaron en 1970 el primero de una serie de estudios que relacionaban la contaminación por partículas de diámetro pequeño y mortalidad en distintas ciudades de Estados Unidos. A partir de entonces ha habido numerosos otros estudios transversales que han mostrado la misma relación en todo el mundo. Esta evidencia ha sido posteriormente corroborada por estudios de seguimiento entre los que destacan el estudio de la American Cancer Society[iv] y el estudio de las seis ciudades[v]. En el estudio de las seis ciudades se estudió probabilidad de sobrevida de 8111 adultos reclutados a mediados de los 70 en seis ciudades del Este de EEU. Alrededor de 1500 adultos de cada ciudad fueron seguidos por 14-16 años. Los datos recolectados incluyeron ocupación, tabaquismo, IMC y se obtuvieron datos de exposición a través de monitoreo rutinario y campañas. Los resultados mostraron aumentos de entre 3 y 8% de la mortalidad por cada 50 ug/m3 de aumento del nivel de partículas de tamaño menor a 10 micrones (PM10).

Resultados estudios transversales de efectos de la contaminación atmosférica en salud

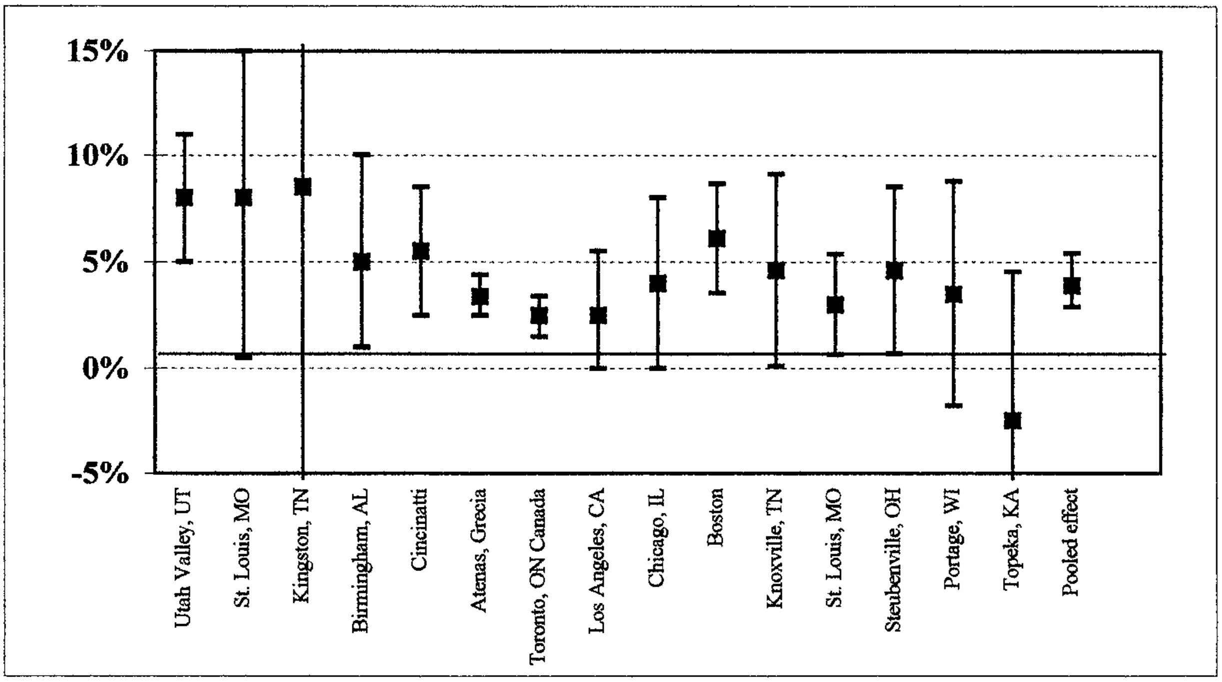
Referencia	Año	N ciudades	% incr 50 ug/m3 PM10			
			Media	intervalo 95%		
Lave & Seskin 1977	1960	117	4.2%	1.0%	-	7.3%
Lave & Seskin 1977	1969	112	6.9%	3.0%	-	10.7%
Ozkaynak & Thurston 1987	1980	98	6.4%	1.8%	-	10.9%

A partir de la década de los noventa, la bibliografía acerca de la asociación entre contaminación atmosférica y efectos agudos en mortalidad y morbilidad comienza a aumentar y los investigadores empiezan a utilizar análisis de series de tiempo para mostrar estos efectos. En éstos, se analiza la relación entre el número de muertes u hospitalizaciones diarias y los niveles de contaminación por partículas medidos simultáneamente a través de monitores en las mismas ciudades. Asumiendo que las muertes y hospitalizaciones tienen una distribución de Poisson se utilizan modelos matemáticos para modelar la relación entre nivel de partículas y efectos. Inicialmente, se introducen en estos modelos la humedad y temperatura de modo de controlar el efecto confundente de ambas, debido a que los efectos también se correlacionan de manera independiente con aquellas. Posteriormente se introducen en los modelos variables de control para estacionalidad y día de la semana y luego los distintos contaminantes de interés: Partículas totales, menores de 10 micrones (PM10), menores de 2,5 micrones (PM2,5), Monóxido de Carbono, Anhídrido Sulfuroso (SO2), Dióxido de Nitrógeno (NO2) y Ozono (O3), además de términos de interacción para todas las combinaciones posibles.

Las siguientes tablas resumen a) algunos estudios relevantes en cuanto a mortalidad analizados por la Environmental Protection Agency de los Estados Unidos (EPA) en 1996 para fijar las normas de material particulado y ozono [vi] b) los resultados de los estudios mas recientes (1996 – 1999).

Estudios epidemiológicos que muestran asociación entre muertes diarias y concentración de PM10. Porcentajes de aumento de mortalidad por cada 50 μg/m3 de incremento en las concentraciones del PM10 de 24 Horas (EPA – 1996)

Ciudad	Referencia	PM-10 (μg/m^3)		% aumento por 50 (μg/m^3) PM-10	
		Media	Máxima	Media	Intervalo 95%
Utah Valley, UT	Pope et al. (1992)	47	297	8.0%	5.0% - 11.0%
St. Louis, MO	Dockery et al. (1992)	28	97	8.0%	0.5% - 15.0%
Kingston, TN	Dockery et al. (1992)	30	67	8.5%	6.0% - 25.0%
Birmingham, AL	Schwartz (1993)	48	163	5.0%	1.0% - 10.0%
Cincinnati, OH	Schwartz (1994)	42		5.5%	2.5% - 8.5%
Atenas, Grecia	Touloumi et al. (1994)	78	306	3.4%	2.5% - 4.4%
Toronto, Canada	Özkaynak et al. (1994)	40	96	2.5%	1.5% - 3.4%
Los Angeles, CA	Kinney et al. (1995)	58	177	2.5%	0.0% - 5.5%
Chicago, IL	Styer et al (1995)	37	365	4.0%	0.0% - 8.0%
Boston	Schwartz et al. (1996)	24	37	6.1%	3.6% - 8.6%
Knoxville, TN	Schwartz et al. (1996)	32	47	4.6%	0.1% - 9.1%
St. Louis, MO	Schwartz et al. (1996)	31	47	3.0%	0.6% - 5.4%
Steubenville, OH	Schwartz et al. (1996)	46	78	4.6%	0.7% - 8.5%
Portage, WI	Schwartz et al. (1996)	18	30	3.5%	1.8% - 8.8%
Topeka, KA	Schwartz et al. (1996)	27	43	-2.5%	-9.6% - 4.6%
Pooled effect				**3.4%**	**1.7% - 5.2%**



Después de 1996, se han efectuado diversos estudios: En Bangkok[vii], ciudad de 6 millones de habitantes, con clima tropical, se observó un aumento de 1 -2% de mortalidad total, 1-2% en mortalidad cardiovascular y 3 –6 % de aumento en muertes por causa respiratoria por cada 10 ug de aumento de PM 10. En India una de las ciudades mas contaminadas del planeta se efectuó un estudio entre 1991 y 1994, encontrándose un promedio total de partículas (TSP) de 375 ug/m3, con efectos significativos de aumento de muertes totales de 0,2%, 0,3% para mortalidad por enfermedades respiratorias y 0,4% para enfermedades cardiovasculares. En cuanto a edad, los mayores efectos se observaron en el grupo de 15- 44, sin efectos significativos en menores de 4 ni en mayores de 65 años. En Beijing, otro estudio encontró diferencias significativas de mortalidad diaria en relación a SO2 pero no a partículas.

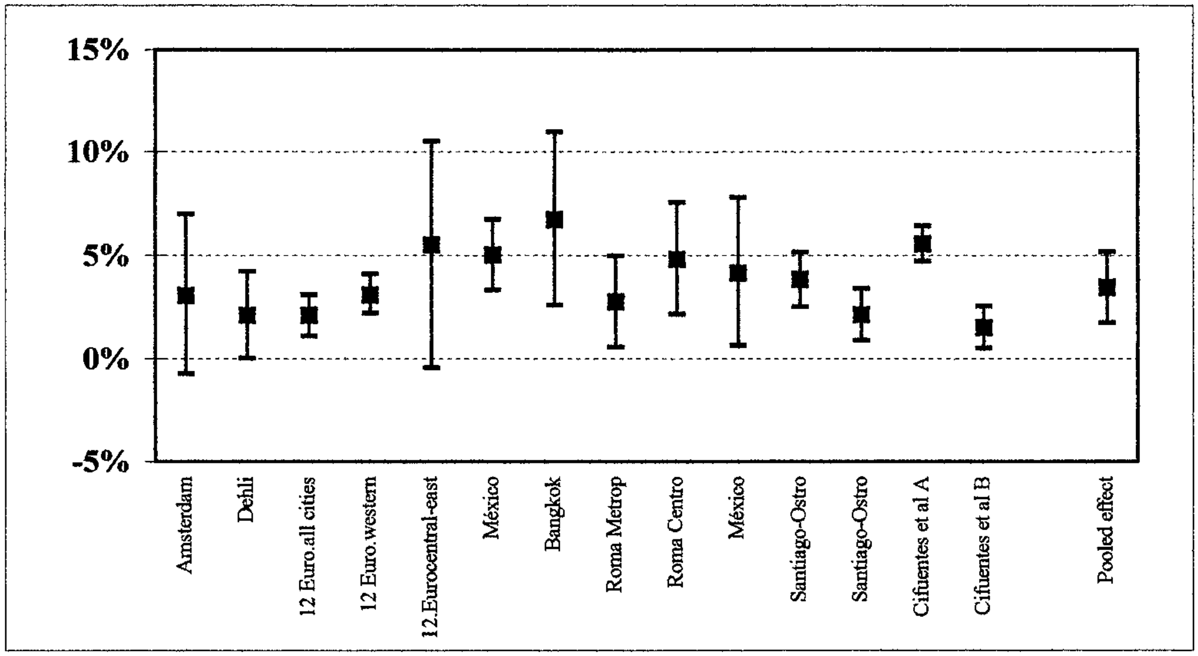
Un reanálisis de los datos de Philadelphia[viii] (1974-1988) que incluyó TSP, SO2, NO2, CO, lagged CO y O3, encontró un aumento de mortalidad diaria para el rango intercuartil de 1,15% para TSP, 1,08% para SO2, 1,13% para lagged CO y 2,28 % para O3. Cuando se incluyen todos los contaminantes se mantiene el efecto para SO2, lagged CO y O3. Otro estudio en Toronto, entre 1980 y 1994, encontró efectos significativos para el rango intercuartil para CO, NO2, SO2, TSP y PM10 y 2,5 estimados. El efecto sin embargo fue explicado casi completamente por los niveles de CO y TSP. La correlación estadística se mantuvo para el CO en todas las edades, estaciones del año y para muertes totales y cardiovasculares[ix].

En Europa, un estudio realizado en Ámsterdam entre 1986 y 1992, examinando hollín, PM10, SO2, CO y O3 encontró efectos en mortalidad asociados a hollín (18,7% de aumento por cada 100 ug/m3) y niveles de Ozono en los dos días previos, sin efectos significativos para PM10, SO2 ni CO. En Roma, un estudio del período 1992 a 1995 mostró efectos sobre la mortalidad total de TSP, CO y SO2, mayores en el centro de la ciudad, efecto sobre la mortalidad cardiovascular solo en el centro de la ciudad sin efectos sobre la mortalidad por enfermedades respiratorias. El PM10 y SO2 también mostraron efectos significativos en un estudio de 12 ciudades europeas.

En Latinoamérica también se han realizado estudios, recientemente. En SaoPaulo (1990-1991) se encontró asociación significativa del PM10, NOx, SO2 y CO sobre mortalidad en mayores de 65 años. Al incluir todos los contaminantes juntos, se mantiene la significación solo para partículas (1,3% de aumento de mortalidad por cada 10 ug/m3 de aumento de partículas. Un estudio reciente en ciudad de México, que estudió el efecto de PM2,5, NO2 y O3, encontró un aumento de 1,4% de mortalidad diaria por cada 10ug/m3 de aumento de PM2,5. También se encontraron efectos mayores para causas cardiovasculares y respiratorias y en mayores de 65 años. El Ozono se correlacionó solo con las causas cardiovasculares y no se encontró efecto para el NO2.

Estudios epidemiológicos recientes que muestran asociación entre muertes diarias y concentración de PM10. Porcentajes de aumento de mortalidad por cada 50 µg/m3 de incremento en las concentraciones del PM10 de 24 Horas.

Ciudad	Referencia	% aumento por 50 (µg/m^3) PM-10			
		Media	Intervalo 95%		
Amsterdam	Verhoeff (1996)	3.1%	-0.7%	-	7.0%
Dehli	Crooper (1997)	2.1%	0.0%	-	4.2%
12 Euro.all cities	Katsouyanni (1997)	2.1%	1.1%	-	3.1%
12 Euro.western	Katsouyanni (1997)	3.1%	2.2%	-	4.1%
12.Eurocentral-east	Katsouyanni (1997)	5.5%	-0.4%	-	10.5%
México	Borja-Aburto (1997)	5.0%	3.3%	-	6.7%
Bangkok	Ostro (1998)	6.7%	2.6%	-	11.0%
Roma Metrop	Michelozzi (1998)	2.8%	0.6%	-	5.0%
Roma Centro	Michelozzi (1998)	4.8%	2.2%	-	7.5%
México	Borja-Aburto (1998)	4.1%	0.6%	-	7.7%
Toronto* (IQ=42)	Burnett (1999)	2.9%	1.5%	-	4.4%
Santiago-Ostro	Ostro (1996)	3.8%	2.5%	-	5.2%
Santiago-Ostro	Ostro (1996)	2.1%	0.9%	-	3.4%
Cifuentes et al A	Cifuentes (1999)	5.6%	4.7%	-	6.4%
Cifuentes et al B	Cifuentes (1999)	1.5%	0.5%	-	2.5%
Pooled effect		**3.4%**	**1.7%**	**-**	**5.2%**



En relación a efectos en mortalidad en grupos específicos, recientemente se estudió la relación entre contaminación del aire y mortalidad infantil por causas a través de un estudio poblacional pareado de casos y controles, en la República Checa entre 1989 y 1991[x]. Se estimó el efecto de TSP, SO2 y NO2, controlando por nivel socioeconómico de la madre, peso al nacer, edad gestacional y condiciones del parto. Se encontró un aumento de razón de riesgos de mortalidad para el período post neonatal de 1,95 (1,09-3,5) para TSP, 1,74 (1,01 – 2,98) para SO2 y 1,66 (0,98 – 2,81) para NO2, solo las partículas permanecieron significativas al incluir todos los contaminantes en el modelo.

En el último par de años, los investigadores han comenzado a profundizar en el efecto diferencial de los distintos componentes de las partículas, así por ejemplo Burnett et al. (en prensa), estudiaron el efecto de distintos componentes de partículas en la mortalidad diaria en 8 ciudades canadienses para los años 1986-1996 inclusive, los resultados se muestran en la tabla siguiente:

Contaminante	Concentración media	Modelo I (efecto individual)	Modelo II (efecto combinado)	Modelo III (efecto con análisis de componentes principales)
PM_{10} (ug/m3)	25,9	1,9 (2,8)	NI	NI
$PM_{2,5}$ (ug/m3)	13,3	1,6 (3,1)	1,0 (2,9)	NI
$PM_{10-2,5}$ (ug/m3)	12,6	0,9 (1,4)	0,6 (1,6)	NI
O_3 (ppb)	31	3,4 (2,6)	1,6 (3,4)	2,0 (3,2)
NO_2 (ppb)	22	3,9 (3,0)	1,1 (3,2)	1,2 (2,7)
SO_2 (ppb)	4,7	1,1 (1,6)	0,7 (2,1)	NI
CO (ppm)	0,9	2,1 (2,1)	0,7 (1,9)	0,7 (1,7)
SO_4 (ug/m3)	2,6	1,2 (3,5)	NI	1,3 (3,5)
Zn (ng/m3)	26	0,8 (2,4)	NI	0,8 (2,1)
Ni (ng/m3)	1,6	0,7 (1,8)	NI	0,8 (1,9)
Fe (ng/m3)	81	1,2 (2,3)	NI	0,8 (1,8)

Como se observa, las partículas finas predicen un mayor porcentaje de muertes (1,6%) que las entre 2,5 y 10 micrones. El efecto de ambas disminuye al incluir los otros contaminantes en el modelo. Cuando se analizan los componentes del material particulado (modelo III), estos predicen un mayor porcentaje del total de muertes (3,7%) que las partículas finas en el modelo II. Otros autores[xi] han mostrado recientemente una asociación significativa entre niveles de H+ y SO(4)(2-), (aerosoles ácidos) y mortalidad por enfermedades respiratorias con un RR de 1,55 (1,09-2,2) y 1,24 (1,01-1,52) respectivamente.

2. Efecto en admisiones hospitalarias y consultas de emergencia

Los estudios de admisiones hospitalarias y consultas de urgencia se han concentrado principalmente en las enfermedades respiratorias y recientemente se han agregado otros efectos, como enfermedades cardiovasculares. Al igual que para el caso de mortalidad, la mayoría de los estudios utilizan series de tiempo y comparan los niveles de contaminación diarios con el número de consultas y admisiones entre 1 y 10 días después, utilizando modelos de series de tiempo, a través de regresión de Poisson, modelos lineales generalizados y modelos aditivos generalizados. Prácticamente todos los estudios han encontrado relación entre la contaminación atmosférica por partículas y aumento de las admisiones y consultas por enfermedades respiratorias y cardiovasculares, especialmente en ancianos. En la siguiente tabla se han resumido algunos estudios recientes, publicados posteriormente a la revisión de la EPA de 1996[13].

Estudio, Lugar y Fecha	Efecto	Resultados Resumidos	Conclusión
Burnet et al (xii) 10 ciudades en Canadá Periodo:1981-1991 .	Admisiones diarias por insuficiencia cardíaca congestiva en ancianos	El monóxido de carbono (CO) mostró asociación consistente con tasa de hospitalización.	CO es el contaminante de mayor asociación con admisiones hospitalarias.
Poloniecki et al (xiii) Londres, Inglaterra	Admisiones de urgencia por enfermedades cardiovasculares (CIE 390-459)	No se encontró asociación con el Ozono. Sin embargo 4 contaminantes estuvieron significativamente asociados a Infarto al Miocardio y Enfermedades Cardiovasculares. No se encontró asociación con insuficiencia cardíaca. Se encontró asociación entre sulfatos y angina y entre NO2 y enfermedades CV totales y por arritmias.	Entre 1 y 50 infartos al miocardio son producidos o inducidos por episodios de contaminación del aire en hospitales en Londres.
Wordley et al (xiv) Birmingham, Reino Unido. Período 1992–1994	Mortalidad. Egresos hospitalarios por asma, bronquitis, neumonía, EPOC, enfermedad coronaria aguda, enfermedad cerebrovascular aguda, todas las condiciones respiratorias y todas las condiciones circulatorias.	PM_{10} diario se asoció con todos los ingresos por cuadros respiratorios, cerebrovasculares y bronquitis. PM_{10} promedio (últimos 3 días) se asoció con neumonía, asma, y admisiones respiratorias. La mortalidad por todas las causas se asoció con PM10 de las 24 horas anteriores.	PM10 se asocia significativamente con varios indicadores de efectos agudos en la salud. Estas asociaciones son similares y consistentes con otros estudios. Sin embargo, el tamaño estimado del efecto en salud pública es pequeño, dando cuenta solo de una pequeña proporción de ingresos hospitalarios y de la mortalidad en un período de dos años.
Delfino et al (xv) Montreal, Quebec. Periodo: 1992- 1993	Visitas diarias a la Sala de Emergencias (SE) por enfermedades respiratorias.	1992, no hubo asociación significativa con las visitas a la SE. 1993, ozono máximo 1-h, PM10, PM2.5, y SO4 se asociaron con visitas respiratorias para pacientes > 64 años. Un incremento en el nivel promedio de ozono máximo 1-h (36 ppb) se asoció con un incremento de 21% sobre el número promedio de visitas diarias a la SE (95% intervalo de confianza [IC]: 8a 34%). El efecto de las partículas fue menor, con incrementos promedio de 16% (4 a 28%), 12% (2 a 21%) y 6% (1 a 12%) para PM10, PM2.5, y SO4, respectivamente.	Una fracción significativa de las visitas a la sala de emergencias se asocian con las concentraciones de ozono y material particulado que están muy por debajo de los estándares actuales.
Delfino et al (xvi) Montreal, Quebec Periodo: junio-agosto, 1989-1990	Visitas diarias a la Sala de Emergencias (SE) por enfermedades respiratorias	1989: Asociación entre visitas respiratorias a la SE (>64 años) y ozono máximo 1- y 8-h. (1 día antes de la visita a la SE, en verano). Las visitas a SE incrementaron 18.7% y 21.8% sobre el promedio, para un aumento promedio de 44 ppb ozono (máximo 1-h) y 38 ppb ozono (máximo 8-h). PM2.5 se asocia con visitas respiratorias a la SE de los adultos mayores..	Los estándares de calidad del aire no protegen la salud de subgrupos susceptibles como los ancianos.
Gordian et al (xvii) Anchorage, Alaska mayo 1992 a marzo 1994	Visitas diarias de pacientes ambulatorios por enfermedades respiratorias, incluyendo asma, bronquitis, y enfermedades del tracto superior	Un incremento de 10 (ug/m3) en PM10 arrojó un incremento de 3-6% en las visitas por asma y un incremento de 1-3% en las visitas por enfermedades del tracto respiratorio superior. CO se asoció con bronquitis, enfermedades del tracto respiratorio superior. No con asma (invierno).	Los hallazgos son consistentes con estudios previos de PM en otras áreas urbanas y aportan evidencia de que la fracción gruesa de PM10 puede afectar la salud de la población trabajadora.
Hernández Garduno et al (xviii) Ciudad de México	Visitas al consultorio por infecciones del tracto respiratorio superior	La contaminación del aire se asoció con 10 a 16% de las visitas al consultorio.. O_3 y NO_2 incrementaron las visitas al consultorio entre 19 y 43% sobre el promedio. Otros contaminantes y el grupo control no demostraron asociaciones significativas.	La contaminación fotoquímica parece ser el problema más severo en Ciudad de México.
Anderson et al (xix) Amsterdam, Barcelona, Londres, Milán, París, Rótterdam	Ingresos hospitalarios por enfermedad pulmonar obstructiva crónica (EPOC)	La contaminación del aire (SO2, BS, PMT, NO2, O3) se asoció con lo ingresos diarios por EPOC.	Los resultados para las partículas y el ozono son ampliamente consistentes con aquellos de América del Norte. Los coeficientes para las partículas son sustancialmente menores.

Burnett et al (xx) 16 ciudades en Canadá 1981-1991	Ingresos hospitalarios por enfermedades respiratorias	O3 se asocia con admisiones respiratorias (excepto en los meses de invierno). PM, CO se asocian con hospitalizaciones respiratorias.	La contaminación del aire (incluyendo el ozono) en concentraciones relativamente bajas se asocia con ingresos al hospital por enfermedades respiratorias, en poblaciones que tienen climas y perfiles de contaminación diversos.
Choudhury et al (xxi) Anchorage, (Alaska) Período: 1992-1994	Visitas médicas por asma, bronquitis, infecciones del tracto respiratorio superior.	PM10 se asocia con la morbilidad. Las asociaciones son mas poderosas con niveles PM10 en días concurrentes.	El Riesgo Relativo de morbilidad es mayor con respecto a la contaminación por PM10 en los días mas tibios.
Tellez Rojo et al (xxii) Ciudad de México, 1993	Visitas médica por infecciones respiratorias en niños	Un incremento de 50 ppb en le promedio diario de ozono causa un incremento de 9.9% en las visitas a emergencias por infecciones del tracto respiratorio superior (invierno), que podría elevarse hasta un 30% si el incremento dura 5 días consecutivos.	La exposición de niños < 15 años al ozono y NO_2 afecta el número de visitas médicas por causas respiratorias.
Scwartz J.[xxiii] 8 condados de EEUU, 1988-1990	Ingresos por enfermedades cardiovasculares	2,5% de aumento de ingresos en mayores de 65 años para rango intercuartuil de aumento de PM10.. Incrementos de 1,75 ppm de CO asociados a 2,8% de aumento en admisiones.	Resultados concordantes con literatura reciente de efectos CV de CO.
Sheppard et al[xxiv] Seattle 1987-1994	Ingresos por asma en pacientes menores de 65 años.	4- 5% de aumento en tasa de ingreso por asma bronquial con aumentos de PM10 de 19 ug/m3, PM2,5 11,8 ug/m3 y 9,3 ug/m3 de PM10-2,5 (IQR). 6% de aumento asociado a aumentos de CO de 924 ppb (IQR).	PM y CO asociados con admisiones por asma
Norris et al[xxv]. Seattle 1995-1996	Consultas de urgencia por asma en niños menores de 18 años.	Aumento de 11 ug/m3 de partículas finas asociados con aumento de 15% de consultas por asma.	

Los resultados de estos estudios son consistentes: tanto el material particulado (medido generalmente como PM_{10}), el SO_2, y el CO aparecen asociados a incrementos en las admisiones hospitalarias respiratorias. El ozono también aparece asociado, principalmente en verano. Los efectos del material particulado se encuentran muchas veces confundidos con aquellos del SO_2 y CO, ya que estos contaminantes tienen fuentes comunes y se encuentran correlacionados. Sin embargo, los efectos del ozono aparecen generalmente independientes del efecto de los otros contaminantes. El rezago del efecto (rezago de las variables de contaminación en los modelos) varía entre el mismo día a algunos días anteriores.

3. Efectos fisiopatológicos

3.1. Efectos respiratorios

En contraste con los numerosos estudios que describen aumento de síntomas respiratorios asociados a CA, aún en sujetos normales, las alteraciones fisiopatológicas manifestadas por cambios en la función pulmonar se han investigado principalmente en niños o sujetos con enfermedades respiratorias pre-existentes[xxvi].

Dassen y cols [xxvii], describen deterioro de la función pulmonar en niños holandeses en relación a un episodio agudo de contaminación atmosférica, cambios que persistieron hasta por 16 días pasado éste. Dockery y cols.[xxviii], comunican hallazgos similares en niños de Ohio, EEUU. Ellos describen una declinación linear de la capacidad vital forzada y VEF 0,75 durante y después de un episodio de contaminación en que el promedio de partículas totales en suspensión (PTS) por 24 hrs fue 422 ug-m^3.

Pope y cols.[xxix] Describen una asociación significativa entre cambios en el VEF1 y niveles de PM10 en fumadores con enfermedad pulmonar crónica obstructiva de grado leve a moderado. El mismo autor encuentra un deterioro significativo del flujo espiratorio máximo en niños asmáticos relacionado con aumentos de la contaminación por material particulado[xxx]. Similar hallazgo ha sido comunicado en niños[xxxi] y adultos[xxxii] asmáticos expuestos a contaminación por ozono.

En 1440 adultos no fumadores de Beijing expuestos a niveles muy elevados de contaminación atmosférica e intradomiciliaria por partículas Xu y Dockery[xxxiii] encuentran una asociación inversa entre PTS en el aire de exteriores y la capacidad vital forzada (CVF) y VEF1 tanto en los sujetos que empleaban sistemas de calefacción contaminante (carbón) como en los que no lo usaban.

Peters et al ([xxxiv]), mostraron en Alemania, entre 1990 y 1992 una disminución de 0,9% en el PEF y un incremento de puntajes en escala de síntomas de 14.7% asociados con un incremento promedio de 28 (ug/m3) de SO2 en 5 días previos.. Los efectos en los adultos fueron menores y menos consistentes. La exposición elevada y prolongada a al contaminación de tipo invernal se asoció con efectos adversos pequeños en los asmáticos.

Estudios mas recientes han mostrado consistentemente la relación entre contaminación atmosférica y efectos en la función pulmonar. Gold y cols[xxxv]. Reportaron efecto de las partículas y =3 reduciendo el flujo espiratorio máximo en niños entre 8 y 11 años en Ciudad de México. El efecto combinado de 7 días de exposición al rango intercuartil de PM2,5 (17 ug/m3) y Ozono (25 ppb) predijeron una reducción de 7,1% (-11 a –3,9%) del flujo espiratorio máximo.

Scchwartz y Neas[xxxvi], han reportado recientemente la asociación entre aumentos de partículas finas (rango intercuartil 15 ug/m3), síntomas respiratorios bajos, con aumento de 29% (6% -57%) y flujo espiratorio máximo, con disminución de –0,91 l/min (-0,14 a –1,68) para 15 ug/m3 de aumento de PM2,5.

Aún cuando se ha especulado que la contaminación ambiental por partículas puede provocar liberación de citoquinas e inflamación alveolar que alteren el intercambio gaseoso[xxxvii], este efecto ha sido escasamente investigado. Sólo recientemente Pope et al[xxxviii] evaluaron el efecto de la exposición aguda a contaminación por partículas en la saturación de oxígeno y frecuencia cardíaca de 90 ancianos residentes en Utah, donde el nivel máximo de PM10 durante el período de estudio fue 140 ug-m^3 . Ellos encuentran un aumento en la frecuencia cardíaca asociado a incrementos en PM10 desde el día que antecede y durante los 5 días siguientes al episodio de contaminación, pero no encuentran una asociación estadísticamente significativa entre PM10 y saturación de Oxígeno. Cabe especular que estas alteraciones se magnifiquen o alcancen significación en poblaciones expuestas crónicamente a niveles muy superiores de contaminación por partículas como es el caso de Santiago.

En nuestro país, Pertuze et al[6] en un estudio efectuado en 1994-95, encontraron un aumento de tos expectoración y carraspera en adultos no fumadores de Santiago (PM10 promedio mensual en 1 año: 102 ug-m3), en comparación a una muestra similar de San Felipe (PM10 promedio mensual en 1 año: 63,7). Asimismo encontraron una disminución de la respuesta tusígena a capsaisina en los sujetos expuestos a niveles elevados de contaminación ambiental. Las alteraciones fisiopatológicas que modificaron la respuesta tusígena a capsaisina revirtieron cuando esta fue medida en los meses de verano en Santiago, período de baja contaminación ambiental[xxxix].

3.2 Efectos cardiovasculares y hematológicos

a) Fibrinógeno y enfermedades cardiovasculares:

La noción de que el fibrinógeno esta relacionado a las enfermedades cardiovasculares apareció por primera vez en la década de los 50 ([xl]), cuando se encontró niveles elevados en pacientes con enfermedad cardíaca isquémica. Desde entonces han aparecido abundantes artículos que muestran que el aumento del fibrinógeno es un factor de riesgo para el desarrollo de enfermedades cardiovasculares. Estudios transversales han mostrado esta relación[xli] y numerosos estudios prospectivos. Un resumen de los principales estudios de seguimiento que han mostrado efectos es el siguiente:

Estudio y fecha	Tipo muestra	Años de seguimiento	Resultados
Northwick Park Heart Study – [xlii] 1986	1511 hombres	10	Fibrinógeno asociado a muertes por enfermedad isquémica y a eventos isquémicos no fatales. Asociación más fuerte que valores de colesterol.
Gothenburg [xliii] 1984	792 hombres	13,5	Fibrinógeno asociado a Infarto al miocardio y AVE.
Framingham Study [xliv] 1987	554 hombres 761 mujeres	12	Fibrinógeno, factor de riesgo independiente para Enfermedad Isquémica y AVE.
PROCAM Study [xlv] 1987	1674 hombres	2	Fibrinógeno factor de riesgo para Enfermedad isquémica severa.
CSCHDS Study[xlvi] 1991	4860 hombres	5,1/3,2	Fibrinógeno factor de riesgo comparable en fuerza a los tradicionales para Enfermedad isquémica.
GRIPS Study [xlvii] 1992	5239 hombres	5	Fibrinógeno factor de riesgo independiente para Infarto.
ECAT Study [xlviii] 1995	3043 hombres y mujeres con angina	2	Fibrinógeno asociado a Enfermedad Isquémica y AVE

Sobre la base de estos estudios se ha estimado la magnitud del efecto para los distintos eventos, para terciles de valores de fibrinógeno, en total se ha estimado un Odds ratio de 2,2 para enfermedades cardiovasculares , es decir aquellas personas con un fibrinógeno elevado (en el tercil más alto), tendrían 2,2 veces más riesgo de presentar enfermedades cardiovasculares que la población general, ajustando por el efecto de otros factores de riesgo tradicionales como por ejemplo niveles de LDL.

Se han postulado varios mecanismos a través de los cuales el fibrinógeno aumentado puede generar atero-trombosis y concomitantemente aumento de probabilidad de isquemia y AVE. El fibrinógeno afecta la hemostasis, agregación plaquetaria, funciones endoteliales, lo que lleva a un estado de hipercoagubilidad que favorece el desarrollo de trombos. Por otra parte, es el mayor determinante de la viscosidad del plasma e induce agregación de los glóbulos rojos reversible. Ambos fenómenos limitan el flujo de sangre. Habría al menos tres mecanismos de daño asociados al aumento de los niveles plasmáticos de fibrinógeno: disminución de flujo, predisposición a trombosis y aumento de aterogénesis[xlix], [l]. El fibrinógeno además se une a receptores de la membrana de las plaquetas, lo que a su vez predispone a mayor agregación[li]. Adicionalmente, se integra a las lesiones vasculares ateroescleróticas donde se convierte a fibrina y factores de degradación del fibrinógeno. Estos últimos, estimulan la proliferación de células de musculatura lisa y migración [lii], [liii]. Estos efectos sugieren que el fibrinógeno está involucrado en las etapas tempranas de la formación de placas en el desarrollo de ateroesclerosis, y que es un reactante de fase aguda inflamatoria, es decir aumenta en forma aguda cuando se producen procesos de tipo inflamatorio en las personas.

b) Viscosidad plasmática, proteína C- reactiva y enfermedades cardiovasculares

Al igual que el Fibrinógeno la elevación de la viscosidad plasmática se asocia a mayor frecuencia de eventos cardiovasculares, especialmente de tipo isquémico[liv]. [lv] y a mayor frecuencia de subsecuentes eventos en sobrevivientes de AVE[lvi] con un riesgo relativo asociado de 1,31 (1,07-1,61) a los dos años. La viscosidad plasmática depende gran parte de los niveles de Fibrinógeno y puede ser por tanto utilizada como un marcador de éste. Se ha encontrado que en adultos aparentemente sanos la viscosidad plasmática esta asociada como factores independientes a género masculino, obesidad, ingesta de sodio, edad, presión arterial diastólica promedio y concentración de triglicéridos y colesterol plasmáticos [lvii].

En concomitancia con lo anteriormente discutido, existen algunos estudios que muestran que la proteína C reactiva está significativamente elevada en pacientes que sufren eventos cardiovasculares (muerte súbita, infarto al miocardio fatal y no fatal), ya sea por primera vez o en pacientes con angina previa [lviii], [lix]. Los pacientes que tienen proteína C reactiva elevada tienen un RR de 1,24 (1,1 -1,6) de desarrollar un evento cardiovascular a los dos años comparado con aquellos que tienen valores normales.

c) Contaminación atmosférica y niveles de fibrinógeno , proteína C- reactiva y viscosidad plasmática.

Desde la década de los 80 han aparecido estudios en la literatura internacional que muestran variaciones estacionales de algunos factores de riesgo para enfermedades cardiovasculares. En 1982, Brennan et al, [lx] mostró como la presión arterial aumentaba en invierno. Gordon et al [lxi] replicaron estos hallazgos en 1988 para los lípidos plasmáticos y lipoproteinas , sin embargo estos factores tienen efecto crónico en el riesgo cardiovascular y no agudo, por lo tanto no explican el aumento agudo de muertes cardiovasculares que se produce en el invierno, particularmente en individuos ancianos. Una explicación alternativa es que este exceso de muertes estuviera ligado a alteraciones de tipo inflamatorio agudo.

En 1991, Stout y Crawford [lxii] mostraron, variaciones estacionales en la concentración de fibrinógeno en el plasma en ancianos y sugirieron por primera vez que variaciones agudas del fibrinógeno (como por ejemplo las que pudieran ocurrir en invierno), podrían tener a su vez un efecto agudo sobre aumento de mortalidad por enfermedades cardiovasculares especialmente en ancianos. En 1994, Woodhouse et al [lxiii] probaron esta hipótesis en un grupo de 96 hombres y mujeres mayores de 65 años viviendo en sus casas. Encontraron que tanto el fibrinógeno como el factor VIIc estaban más elevados en invierno y que estas diferencias podían explicar un 15% y 9% respectivamente del aumento de muertes que ocurría en la frecuencia de enfermedad isquémica. Los aumentos agudos de Fibrinógeno en esta población estaban principalmente inducidos por infecciones respiratorias agudas vía activación de la respuesta de fase aguda del síndrome inflamatorio. Frente a una noxa, en este caso infección, el organismo reacciona aumentando los niveles de estas sustancias(entre ellos fibrinógeno y factor VII), lo que a su vez lleva a mayor probabilidad de formación de trombos, que conlleva mayor riesgo de AVE, angina, infarto y muerte súbita cardiaca. Simultáneamente, Koenig et al, [lxiv] compararon la viscosidad del plasma en dos poblaciones diferentes en Augsburg y Scotland, poblaciones con marcadas diferencias en la incidencia de Enfermedades Cardiovasculares, encontrando diferencias significativas en la viscosidad plasmática incluso luego de ajustar por edad, tabaquismo, lípidos plasmáticos, índice de masa corporal y presión arterial.

Todo esto se produciría a través de una respuesta aguda inflamatoria entre 24 horas y 5 días después, cuyo rol es circunscribir el daño al menor territorio posible. Como parte de esta respuesta, se alteraría la síntesis de ciertas proteínas hepáticas, entre los cuales se encuentran el fibrinógeno y la proteína C reactiva, lo que lleva a aumento de la viscosidad plasmática. Inicialmente, se altera la Proteína C reactiva, alfa1 glicoproteína ácida y proteína A sérica del amiloide. Posteriormente, la haptoglobina y la alfa 1 antitripsina y luego al segundo a quinto día disminuye la transferrina y aumenta el fibrinógeno[lxv].

Una pregunta obvia que surge es que otras noxas agudas podrían activar una respuesta inflamatoria de este tipo, que explicaran exceso de muertes agudas por causa cardiovascular en otras poblaciones. Al respecto, en 1997 Peters et al[lxvi] reportan por primera vez el aumento de viscosidad plasmática en una población, asociado a un episodio agudo de contaminación del aire. En este estudio, se midió la viscosidad plasmática como parte de otro proyecto en 3256 participantes entre 25 y 64 años durante el invierno de 1985. Durante este lapso de tiempo, ocurrió un episodio agudo de aumento de contaminación del aire entre Enero 4 y 19, con aumentos de la concentración de Dióxido de Azufre de 43 ugm3 a 181 ugm3. Simultáneamente las partículas totales aumentaron a niveles mayores de 100 ug/m^3 repetidamente. Los investigadores compararon la viscosidad plasmática promedio durante los días del episodio vs el resto de los días. En promedio, la viscosidad plasmática fue 0,013 mPa mayor en el período del episodio (1,273 vs 1,260 para hombres y 1,263 vs 1,246 para mujeres; p: 0,015). Esta relación fue aun más acentuada luego de ajustar por factores de riesgo convencionales (edad, presión arterial, colesterol y lípidos) y variables meteorológicas en hombres, y se mantuvo igual en mujeres. Recientemente ha aparecido otra publicación[35] que muestra asociación entre niveles diarios de contaminación por partículas y cambios en la frecuencia cardíaca, sin cambios en saturación arterial de Oxígeno, lo que sugiere que las alteraciones inflamatorias tendrían igual o mayor peso que las alteraciones funcionales respiratorias en el exceso de mortalidad asociado a partículas.

4. Estudios chilenos

En Chile existen altos niveles de contaminación del aire, especialmente por partículas tanto menores de 10 micrones como menores de 2,5 micrones. El problema de la contaminación es especialmente grave en la Región Metropolitana en donde las cifras promedio mensuales para los meses de invierno sobrepasan el valor de la norma (150ug/m3), que en teoría no debería ser sobrepasado mas de una vez al año. Debido a lo anterior, se mantiene desde 1988 un sistema de monitoreo de contaminantes del aire basado en 7 estaciones (actualmente) que representan a la región. Este monitoreo incluye partículas totales (PMS), menores de 10 micrones (PM10), menores de 2,5 micrones (PM2,5) Ozono (O3), Anhídrido Sulfuroso (SO2), Dióxido de Nitrógeno (NO2) y Monóxido de Carbono (CO).

Utilizando esta información a partir de los últimos años de la década de los 80 se han realizado varios estudios nacionales que han mostrado el efecto de los niveles de contaminación del aire, especialmente por partículas sobre mortalidad diaria, consultas y síntomas respiratorios. Los resultados de los estudios de mortalidad realizados hasta la fecha se muestran a continuación:

Estudios de asociación entre nivel de PM10 y mortalidad diaria. Chile, Región Metropolitana.
Riesgo relativo de aumento de mortalidad por cada 100~~0~~ ug/m3 de aumento del nivel de PM10.

Autores y periodo de estudio	Riesgo relativo para aumentos de 100 $\mu g/m^3$ de PM10	Mortalidad (casos anuales)
Cifuentes y Lave (88-91)	Mortalidad total: 1,058 +CO: 1,027 Mortalidad mayor 65 años +CO: 1,036 Mortalidad respiratoria: 1,14 Mortalidad cardiovascular: 1,08	542
Ostro, et al (89-91)[2]	Mortalidad total: 1,035 Mortalidad respiratoria: 1,13 Mortalidad cardiovascular: 1,08 Mortalidad menor 64 años: 1,09	542
Salinas y Vega (88-91)[1]	Mortalidad total: 1,030	602
Sanhueza et al (89-93)[3]	Mortalidad mayores 65 años: 1,052 Mortalidad cardiovascular: 1,025 Mortalidad respiratoria: 1,061	600

Como se observa los estudios son consistentes en encontrar efectos del nivel de partículas sobre la mortalidad diaria.

Los últimos datos que existen respecto a efectos en mortalidad corresponde al análisis de las muertes para el período 1988-1996, realizado por nosotros, el cual será analizado en detalle mas adeleante.

En relación a morbilidad, desde el estudio pionero de Belmar en 1988 diversos investigadores han estudiado la asociación entre signos y síntomas respiratorios y frecuencia de consultas a través de series de tiempo en que relacionan los niveles diarios de contaminación con el número de visitas. Los resultados de algunas de estas investigaciones se muestran en la siguiente tabla:

Estudios de asociación entre nivel de PM10 y morbilidad en Chile. Riesgo relativo de aumento de morbilidad por cada 1000 ug/m3 de aumento del nivel de PM10.

Autores y periodo de estudio	Riesgo relativo para aumentos de 100 $\mu g/m^3$ de PM10
Ilabaca et al. (95-96)	Urgencias infantiles PM10: 1,08
Belmar at al a) (88)	Alteraciones del VEF1, ausentismo escolar y mayor frecuencia de ronquera.
Belmar et al b) (88)	Consultas en atención primaria en salud No significativa
Sanchez et al (92-93)	Sibilancias. Media movil 3 dias PM10: 1,78
Oyarzún et al	Bronquitis obstructiva, lag 4 PM10: 1,22 PM 2,5: 1,44
Ostro et al (92-93)	Síntomas respiratorios bajos en niños menores de 2 años PM10: 1,08-1,24 Síntomas respiratorios bajos en niños entre 3-15 años PM10: 1,06- 1,18 Ozono : 1,10

5. Efectos asociados al Monóxido de Carbono

5.1 Efectos Cardiovasculares

- Disminución tiempo máximo de ejercicio y consumo máximo de O2, 1% por cada 1% de aumento sobre 4% de CO-Hb en sujetos normales.

En individuos sanos, el consumo máximo de O2 durante ejercicio progresivo se ha usado como marcador de daño. A niveles tan bajos como 5%, el tiempo máximo de ejercicios y consumo máximo de oxígeno, disminuye aprox. 1% por cada % de aumento sobre 4%.

- Reducción en el tiempo para desarrollar angina y depresión del ST en enfermos con angina estable.

En pacientes con enfermedades CV previas, ya existe una disminución del flujo sanguíneo y por lo tanto cualquier disminución mayor puede resultar en isquemia, lo que a su vez puede disminuir la contractilidad y afectar el pulso y ritmo cardíaco. Aronow y Anderson han mostrado que en pacientes con IHD en que se hacía test de esfuerzo se disminuía el tiempo para producción de angina y se aumentaba la duración de ésta a niveles de COHb entre 2 y 2,9%.). Un estudio multicéntrico realizado en por el Health

Effects Institute mostró que en 63 sujetos no fumadores con angina estable (con depresión del ST), el tiempo de aparición d angina se acortaba en 4,2 y 7,1% para concentraciones de CO HB de 2,2 y 4,3% respectivamente. Similarmente el tiempo para aparición de desnivel del ST se acorto en 5,1 y 12,1%. Kleinman y cols., mostraron que la respuesta a ejercicio de 24 sujetos con angina de ejercicio expuestos a niveles de CO resultantes en concentraciones de COHb de 2,9%. El tiempo de aparición de angina disminuyó en 6% y la VO2 disminuyó en 2%. Otros dos estudios adicionales han mostrado que nivles de COHb en el rango de 2-6% disminuye la respuesta a ejercicio en pacientes con enfermedad cardíaca. Sheps y cols mostraron un 1,9% de disminución en el tiempo de aparición de angina (NS) y 1,3% de disminución en el tiempo máximo de ejercicio, luego de aumentos de COHb a niveles e 3,8%. También se observaron cambios significativos en la fracción de eyección del VI a niveles de 5,9% de COHb. En resumen, se ha observado una disminución del tiempo para desarrollar angina a nivels de COHb entre 2% y 6%.

- Aparición de arritmias cardíacas en pacientes con enfermedad isquémica a niveles de 5,3% de COHb (VPDs) . Resultados no consistentes.

- Lambert mostró aumento de probabilidad de depresión del ST de 1,5 veces para niveles entre 1 y 2% y de 2,1 veces para nivels mayores que 2% en sujetos anginosos en setting de actividad normal.

- Aumento de admisiones por enfermedades cardiovasculares asociadas a CO en numerosos estudios de series de tiempo.

- Aumento de mortalidad diaria especialmente asociada a enfermedades cardiovasculares en numerosos análisis de series de tiempo.

5.2 Efectos Respiratorios

- Disminución de capacidad de difusión del CO (DLCO) a concentraciones de CO2 en aire de 0,7% a 1,2% en sujetos sanos.

- Disminución de capacidad de ejercicio en pacientes con enfermedad pulmonar obstructiva crónica a niveles de alrededor de 4% de COHb.

6. Mecanismos de daño de las partículas

Los efectos biológicos de las partículas dependen de las características físicas y químicas, de la forma de distribución y deposición en el árbol respiratorio y de los efectos biológicos en respuesta. La composición química y física del material particulado en distintos ambientes aún no ha sido totalmente caracterizado y debido a la heterogeneidad de la composición del material particulado es muy difícil hacer estudios experimentales dee dosis respuesta en animales o humanos. Además muchos de los efectos de las partículas reflejan la combinación con otros contaminantes que pueden formar parte de las distintas fracciones del material particulado, por ejemplo sulfuros-sulfatos, aerosoles ácidos o algunos metales. Una de las líneas de investigación actual es la caracterización de partículas y asociación de los componentes con distintos efectos. En Santiago por ej. Oyola y cols han caracterizado recientemente las partículas del aire.

Hay varios mecanismos posibles por los cuales se producirían los daños descritos en salud: Una posibilidad es que los daños estén asociados al componente ácido (H) de las partículas, pero los efectos se han encontrado en distintas mezclas de material particulado con mayor o menor acidez. El otro factor de importancia es el tamaño que determina el mayor o menor grado de depósito en la vía respiratoria. Las partículas mas grandes se depositan en la traquea, bronquios pequeñas se depositan en la vía aérea baja, desde bronquíolos a alveolos. Las partículas de tamaño mayor son limpiadas por los cilios a través de la formación de mucus y son expulsadas a través de la tos o tragar. Las partículas mas pequeñas son limpiadas por los macrófagos que las transportan a los cilios o al sistema linfático. Cuando se inhalan partículas muy pequeñas (0,2 u) estas pueden traspasar el espacio insterticial del alveolo y provocan un síndrome de inflamación crónica. La capacidad inflamatoria depende del contenido de metales y tipo de ellos, así como el contenido derivados orgánicos de combustión. Los aerosoles ácidos y sulfatos a su vez provocan distintos efectos dependiendo del pH. Por lo tanto el contaminante mas irritante es el Sulfato de H2SO4 que tiene un pH menor que 1, seguido por el bisulfato de amonio (NH4HSO4 y el sulfato de amonio (NH42SO4). Los aerosoles ácidos y sulfatos provocan broncoconstricción, inflamación y alteraciones del clearance mucociliar.

7. **Mecanismos de daño del CO**

El CO es un gas incoloro, inodoro e insípido que se produce por combustión incompleta de fósiles carbonáceos como gasolina, gas natural, aceite, carbón, madera y otros como tabaco. Las propiedades tóxicas del CO están relacionadas con la gran afinidad por las proteínas del grupo Hem-Fe (relacionadas con el transporte oxigeno a las celulas) como la Hemoglobina y mioglobina. Por lo tanto los efectos del CO se manifiestan en aquellos órganos mas sensibles a la falta de oxígeno.

El aire contiene cantidades variables de CO, derivadas de la combustión de fosiles. La mayor fuente de CO proviene de los motores vehiculares. La exposición a CO se puede evaluar a través de los niveles de COHb que se expresan como porcentaje de la Hb total que esta bound a CO. En individuos sanos no fumadores, esto niveles están en un rango de 0,3% - 0,7%. El catabolismo normal de los grupos Hem a traves de las enzimas microsomales hem-oxigenasas produce alrededor de 0,4 ml CO por hora lo que resulta en niveles de COHb basales de alrededor de 0,5% a nivel del mar en sujetos normales . La tasa de producción endógena puede aumentar por fiebre, hemólisis, tratrornos de la eritropoyesis y algunas drogas. Por ejemplo en pacientes con anemia hemolítica se pueden encontrar niveles de 3% - 4%. El CO inhalado aumenta los niveles de COHb a aprox. 1% en individuos normales. Sin embargo un porcentaje de la población tiene niveles por sobre 1,5%. Por ejemplo en una medición de 8000 personas en el NHANES se encontró que mas del 4% de la población tenían niveles sobre 2,5% en invierno.

El monóxido de carbono ha emergido en los últimos años como un mensajero celular, producido por las enzimas microsomales hem-oxigenasa, a través de la activación de la guanilato- ciclasa. El aumento de monofosfaro de guanosina cíclica (cGMP) inducido por CO se ha asociado a la inhibición de la quimioluminiscencia y aumento de factor de necrosis tumoral en los macrófagos pulmonares, además de alteraciones en su capacidad microbicida, reducción en la capacidad de fagocitosis y aumento de la producción de superoxidos. El mecanismo enzimático dependiente de CO de la guanilato ciclasa puede además aumentar la migración de neutrófilos (Burnett, 1998).

El pulmón es la principal ruta de excreción y absorción de CO. La tasa de HbCO depende de la concentración de CO en el aire inspirado, la tasa de difusión aire.sangre, el contenido de Hb en la sangre, la tensión capilar de O2 y el nivel de COHb en los capilares pulmonares.

El CO ejerce su efecto tóxico a través de interferir con el transporte de O2, la hemoglobina tiene 220 veces mas afinidad con el CO comparado con el O2. Además cuando baja la tensión de O2, el CO tambin se une a la mioglobina en músculo cardíaco y esquelético, disminuyendo la entrega de oxígeno a los procesos intracelulares involucrados en la contracción muscular.

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8 de mayo

000506

CONAMA
COMISION NACIONAL DEL MEDIO AMBIENTE

OF. ORD. N° 001582

ANT.: Revisión de las normas primarias de calidad de aire

MAT.: Invita a reunión.

SANTIAGO, 20 ABR 2000

A : MAURICIO ILABACA M.
JEFE DIVISIÓN DE SALUD AMBIENTAL
MINISTERIO DE SALUD

DE : PATRICIA MATUS C.
JEFE DEPTO. DESCONTAMINACIÓN, PLANES Y NORMAS
COMISIÓN NACIONAL DEL MEDIO AMBIENTE

A través del presente, informo a usted que se ha dado inicio al proceso de revisión de las normas primarias de calidad de aire para anhídrido sulfuroso (SO2); partículas totales en suspensión (PTS); monóxido de carbono (CO); ozono (O3) y dióxido de nitrógeno (NO2), mediante la publicación en el Diario Oficial de fecha 05 de diciembre de 1999, de la Resolución Exenta N°1514 de la Dirección Ejecutiva de esta Comisión.

Específicamente para los contaminantes SO2, NO2 y O3 se tiene programado abordar, en reunión de Comité Operativo y Ampliado a realizar el día 8 de mayo del presente, los efectos que producen estos contaminantes sobre la salud de la población y los niveles de concentración a los cuales se detectan estos efectos, a la luz de la información disponible a nivel nacional e internacional.

En este sentido y dada la directa relación que su Institución tiene respecto del tema, invito a usted o algún representante, a exponer los antecedentes disponibles en la reunión mencionada. Agradecería confirmar su participación a más tardar el día jueves 27 de abril del presente.

Sin otro particular, le saluda atentamente a usted

PATRICIA MATUS C.
Jefe Depto. Descontaminación, Planes y Normas
Comisión Nacional del Medio Ambiente

RRCH/eab

000507

CONAMA
COMISIÓN NACIONAL DEL MEDIO AMBIENTE

OF. ORD. N° 001608

ANT.: Normas primarias de calidad de aire.

MAT.: Invita a reunión.

SANTIAGO 25 ABR 2000

A : GIANNI LÓPEZ
DIRECTOR
COMISIÓN NACIONAL DEL MEDIO AMBIENTE REGIÓN METROPOLITANA

DE : PATRICIA MATUS CORREA
JEFE DEPTO. DESCONTAMINACIÓN, PLANES Y NORMAS
COMISIÓN NACIONAL DEL MEDIO AMBIENTE

A través del presente, informo a usted que se ha dado inicio al proceso de revisión de las normas primarias de calidad de aire para anhídrido sulfuroso (SO2); partículas totales en suspensión (PTS); monóxido de carbono (CO); ozono (O3) y dióxido de nitrógeno (NO2), mediante la publicación en el Diario Oficial de fecha 05 de diciembre de 1999, de la Resolución Exenta N°1514 de la Dirección Ejecutiva de esta Comisión.

Se tiene programado abordar, en reunión de Comité Operativo y Ampliado a realizar el día 29 de mayo del presente, el tema relativo a inventario de emisiones para los contaminantes en revisión.

En este sentido solicito a usted, si lo tiene a bien, designar un representante de su Institución para que exponga en la reunión mencionada, sobre el inventario de emisiones de la Región Metropolitana. Agradecería confirmar su participación a más tardar el día lunes 15 de mayo del presente.

Sin otro particular, le saluda atentamente a usted,

PATRICIA MATUS C.
Jefe Depto. Descontaminación, Planes y Normas
Comisión Nacional del Medio Ambiente

RLCH/eab

000508

CONAMA

COMISION NACIONAL DEL MEDIO AMBIENTE

OF. ORD. N° 001609

ANT.: Normas primarias de calidad de aire.

MAT.: Invita a reunión.

SANTIAGO 25 ABR 2000

A : JOSÉ CONCHA GÓNGORA
DIRECTOR
SERVICIO DE SALUD METROPOLITANO DEL AMBIENTE

DE : PATRICIA MATUS CORREA
JEFE DEPTO. DESCONTAMINACIÓN, PLANES Y NORMAS
COMISIÓN NACIONAL DEL MEDIO AMBIENTE

A través del presente, informo a usted que se ha dado inicio al proceso de revisión de las normas primarias de calidad de aire para anhídrido sulfuroso (SO_2); partículas totales en suspensión (PTS); monóxido de carbono (CO); ozono (O_3) y dióxido de nitrógeno (NO_2), mediante la publicación en el Diario Oficial de fecha 05 de diciembre de 1999, de la Resolución Exenta N°1514 de la Dirección Ejecutiva de esta Comisión.

Se tiene programado abordar, en reunión de Comité Operativo y Ampliado a realizar el día 16 de mayo del presente, el tema relativo a los niveles de concentración de calidad de aire en el país para los contaminantes en revisión.

En este sentido y dada la directa relación que su Institución tiene respecto del tema, solicito a usted, si lo tiene a bien, designar un representante de su Institución, para que exponga en la reunión mencionada, sobre los niveles de concentración de calidad de aire en la *"Región Metropolitana"* y las metodologías de medición para los contaminantes en revisión. Agradecería confirmar su participación a más tardar el día martes 2 de mayo del presente.

Sin otro particular, le saluda atentamente a usted,

PATRICIA MATUS C.
Jefe Depto. Descontaminación, Planes y Normas
Comisión Nacional del Medio Ambiente

RLCH/eab

COMISIÓN NACIONAL DEL MEDIO AMBIENTE
DEPARTAMENTO DE DESCONTAMINACIÓN, PLANES Y NORMAS

Revisión Norma de Calidad Primaria contenidas en la Resolución Nº 1215/78

ACTA DE REUNION DE COMITÉ OPERATIVO Y AMPLIADO

FECHA REUNION : 8 de Mayo de 2000
LUGAR : CONAMA. Obispo Donoso 6. Santiago
ASISTENCIA : Se adjunta hoja de asistencia

Tabla :

1. Presentación de antecedentes sobre efectos en la salud (Walter Folch, Ministerio de Salud)
2. Discusión

Discusión :

SO2

- En relación a las guías de calidad del aire de la OMS para SO2 se aclara que éstas son resultado de estudios epidemiológicos para valores anuales y de 24 horas y de exposición controlada para 10 minutos.
- Se confirma que en el estudio presentado, el SO2 no se separó de los posibles efectos del PM10 por lo que los efectos podrían estar influenciados por un sinergismo entre ambos contaminantes.
- **P.Oyola** *(CONAMRM)* sostiene que es importante considerar el sulfato como producto final de las emisiones de SO2 en Chile.

Rodrigo Lucero Ch.
Depto. Descontaminación, Planes y Normas
CONAMA

COMISION NACIONAL DEL MEDIO AMBIENTE
DEPTO. DESCONTAMINACION, PLANES Y NORMAS

000510

Reunión "Revisión Normas Primarias de Calidad de Aire para SO2, PTS, CO, NO2 Y O3"
Santiago, 08 de mayo 2000

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Recomendaciones de la Organización Mundial de la Salud OMS, para las concentraciones ambientales de los contaminantes atmosféricos Dióxido de Azufre (SO_2), Dióxido de Nitrógeno (NO_2), y Ozono (O_3).

Rol de las guías de calidad del aire de la OMS (1999):

"Los propósitos de las guías es proporcionar una base para la protección de la salud pública de los efectos adversos de los contaminantes del aire y eliminar, o reducir al mínimo, aquellos contaminantes que se sabe son, o probablemente son, peligrosos para la salud humana y el bienestar". (1987)

Efecto adverso : "cualquier efecto que resulte en un impedimento funcional y/o lesiones patológicas que puedan afectar el buen funcionamiento de todo el organismo, o aquel que contribuye a reducir la habilidad para responder a un desafío adicional"

Debido a que para el desarrollo de las guías, es necesario contar con una gran variedad de información y de estudios, con distintos grados de calidad y especificidad, se requiere contar con algunos criterios que permitan establecer los valores guía de la mejor forma posible.

Por esta razón para los contaminantes no cancerígenos se utilizan los siguientes criterios para establecer los valores contenidos en las guías:

Criterio para efectos distintos a los carcinogénicos

El punto de partida para la derivación de los valores, es definir la menor concentración a la cual se observa efectos en humanos, animales y plantas. Existe además el nivel al cual no hay efecto observado, dicho nivel es preferido en el caso de tratarse de contaminantes con efecto irritan.

Criterio para selección del menor nivel con efecto adverso observado (NOAEL).

En este caso la información se separa en tres categorías descendentes en importancia de influencia para los valores a recomendar: i) Datos que señalan un cambio sustancial en los efectos patológicos. ii) Datos que señalan que el NOAEL, puede resultar en cambios patológicos iii)Datos puntuales que no son usados como base estudio para las guías.

Criterio de selección de factores de incertidumbre.

Se considera la toxicología del contaminante, incluyendo el tipo de metabolitos formados, variaciones en el metabolismo, o respuesta en grupos hipersensibles, así como la posibilidad de que compuestos o sus metabolitos se acumulen en el cuerpo. Los factores de incertidumbre son esencialmente determinados a través del consenso de juicio de expertos.

Criterio de selección de tiempos promedio.

Generalmente cuando exposiciones de periodos cortos conducen a efectos adversos se recomienda utilizar promedios para periodos cortos. En otros casos, se recomienda utilizar promedios de periodos largos. También en esta etapa hay apoyo en el juicio de expertos.

SO_2

Efectos característicos: Broncoconstricción en los primeros segundos de exposición; Alteración en la función pulmonar, aumento en la resistencia al flujo pulmonar.

Valores guía 1999 OMS:

Basados en los estudios controlados con pacientes asmáticos expuestos a SO_2 por periodos cortos , las guías del año 1999 recomiendan que la concentración de 500 $\mu g/m^3$ (0.175 ppm), no debe excederse en un promedio sobre 10 minutos. Debido a que la exposición aguda depende de la naturaleza de las fuentes emisoras y de las condiciones locales, no es posible estimar valores guía para periodos largo, tales como 1 hora.

Respecto de la concentración máxima para 24 horas, las guías recomiendan el mismo valor del año 1987, que es de 125 $\mu g/m^3$ (0.04ppm), el cual considera un factor de incertidumbre de 2 para el Menor Nivel con Efecto Adverso Observado.

El valor de 125 $\mu g/m^3$ se obtuvo de estudios epidemiológicos que relacionaron los efectos del SO_2, material particulado y otros contaminantes. En dichos estudios se observó una exacerbación en los síntomas de los pacientes más sensibles expuestos a concentraciones que superaron los 250 $\mu g/m^3$.

Al igual que para el año 1987, el valor promedio anual se recomienda no exceda los 50 $\mu g/m^3$

NO_2

Efectos característicos: Produce broncoconstricción, aumenta la reactividad inespecífica de las vías aéreas. En concentraciones muy elevadas produce edema y fibrosis pulmonar.

<u>Valores guía 1999 OMS</u>:

Pese al gran número de estudios en humanos con exposiciones agudas, no hay evidencia para una definición clara de una relación concentración - respuesta para el NO_2. Sin embargo, estudios con pacientes asmáticos y con enfermedades pulmonares crónicas, muestran un claro mínimo nivel con efecto observado en un rango de concentraciones de 365 - 565 $\mu g/m^3$ (0.2 a 0.3 ppm).

000518

En este caso las guías utilizaron un factor de incertidumbre de 2 para fijar el valor recomendado, lo anterior, debido a que existen datos estadísticamente significativos, que señalan un aumento de respuesta a la broncoconstricción con exposiciones de 188 $\mu g/m^3$ de NO_2, y también a que hay evidencias de un aumento en la respuesta de las vías aéreas a concentraciones menores a 365 $\mu g/m^3$.

Basados en lo anterior, las guías proponen como concentración promedio máximo para 1 hora de 200 $\mu g/m^3$. Este valor corresponde a la mitad del propuesto en 1987.

Por otro lado, debido a que no hay estudios hasta la fecha que claramente permitan elegir un valor para una recomendación como promedio anual de concentración máxima para NO_2, se propone como valor anual 40 $\mu g/m^3$, que corresponde al valor propuesto el año 1997.

O_3

Efectos característicos: Daña las vías aéreas produciendo aumento de la hiperreactividad bronquial, aumento de la resistencia de las vías aéreas, aumento de la permeabilidad vascular pulmonar.

Valores guía 1999 OMS:

El valor recomendado corresponde a 120 $\mu g/m^3$, como promedio máximo para un periodo de 8 horas. Es importante destacar que se reconoce que este valor implica que efectos agudos en la salud pública son probablemente pequeños, y que aquellas autoridades de salud que no puedan aceptar este nivel de riesgo, usen las curvas dosis respuesta entregadas en las mismas guías. Lo anterior, debido al hecho que existen datos que señalan respuestas a la exposición a O_3, a niveles cercanos o levemente superiores a concentraciones basales. Por lo tanto, no es posible basar

Las recomendaciones sobre el nivel de efectos adversos no observados (NOAEL), o bien en el menor nivel con efectos adversos observados (LOAEL).

Se señala a modo de ejemplo, que a niveles de 200 $\mu g/m^3$, y menos, para exposiciones de 1 a 8 horas, hay una disminución estadísticamente significativa en la función pulmonar, cambios en la inflamación de las vías respiratorias y otros síntomas en personas susceptibles (asmáticos con actividad física).

000522

CONAMA

OF. ORD. N°**001905** COMISION NACIONAL DEL MEDIO AMBIENTE

ANT.:. No hay.

MAT.: Solicitud de información.

SANTIAGO, 15 MAY 2000

A : ALEJANDRO DÍEZ
JEFE MEDIO AMBIENTE
EMPRESA NACIONAL DE MINERÍA, ENAMI

DE : PATRICIA MATUS C.
JEFE DEPTO. DESCONTAMINACIÓN, PLANES Y NORMAS
COMISIÓN NACIONAL DEL MEDIO AMBIENTE

Por medio del presente y con relación a la revisión de las normas primarias de calidad de aire para los contaminantes SO2, PTS, CO, O3 y NO2 (Resolución Exenta N°1514 de la Dirección Ejecutiva de CONAMA), informo a usted que los estudios internacionales han establecido que la exposición a SO2, a partir de un nivel de concentración de 250 ug/Nm3 como media de 24 horas, produce efectos sobre la salud de la población.

Por este motivo, sírvase proporcionarnos si lo tiene a bien, la siguiente información fundada:

1. Factibilidad técnica de reducir emisiones y plazo requerido, asociado a un nivel de concentración de SO2 de 250 ug/Nm3 como media de 24 horas.
2. Factibilidad técnica de reducir emisiones y plazo requerido, asociado a un nivel de concentración de SO2 dentro del rango de 250 a 365 ug/Nm3, como media de 24 horas.

En función de los plazos establecidos para la revisión de la norma, solicito a usted dentro de lo posible, nos remita la información solicitada a más tardar el día 7 de junio del presente.

Sin otro particular, le saluda atentamente a usted,

PATRICIA MATUS C.
Jefe Depto. Descontaminación, Planes y Normas
Comisión Nacional del Medio Ambiente

PMC/RLCH/jra

000523

CONAMA
COMISION NACIONAL DEL MEDIO AMBIENTE

OF. ORD. N°001905

ANT.:. No hay.

MAT.: Solicitud de información.

SANTIAGO, 15 MAY 2000

A : SANTIAGO TORRES
GERENTE MEDIO AMBIENTE
CORPORACIÓN NACIONAL DEL COBRE, CODELCO

DE : PATRICIA MATUS C.
JEFE DEPTO. DESCONTAMINACIÓN, PLANES Y NORMAS
COMISIÓN NACIONAL DEL MEDIO AMBIENTE

Por medio del presente y con relación a la revisión de las normas primarias de calidad de aire para los contaminantes SO2, PTS, CO, O3 y NO2 (Resolución Exenta N°1514 de la Dirección Ejecutiva de CONAMA), informo a usted que los estudios internacionales han establecido que la exposición a SO2, a partir de un nivel de concentración de 250 ug/Nm3 como media de 24 horas, produce efectos sobre la salud de la población.

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Jefe Depto. Descontaminación, Planes y Normas
Comisión Nacional del Medio Ambiente

PMC/RLCH/jra

CONAMA
COMISION NACIONAL DEL MEDIO AMBIENTE

OF. ORD. N°**001905**

ANT.:. No hay.

MAT.: Solicitud de información.

SANTIAGO, 15 MAY 2000

A : CARLOS SALVO
ASESOR ASUNTOS AMBIENTALES
SOCIEDAD NACIONAL DE MINERIA

DE : PATRICIA MATUS C.
JEFE DEPTO. DESCONTAMINACIÓN, PLANES Y NORMAS
COMISIÓN NACIONAL DEL MEDIO AMBIENTE

Por medio del presente y con relación a la revisión de las normas primarias de calidad de aire para los contaminantes SO2, PTS, CO, O3 y NO2 (Resolución Exenta N°1514 de la Dirección Ejecutiva de CONAMA), informo a usted que los estudios internacionales han establecido que la exposición a SO2, a partir de un nivel de concentración de 250 ug/Nm3 como media de 24 horas, produce efectos sobre la salud de la población.

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Sin otro particular, le saluda atentamente a usted,

PATRICIA MATUS C.
Jefe Depto. Descontaminación, Planes y Normas
Comisión Nacional del Medio Ambiente

PMC/RLCH/jra

COMISIÓN NACIONAL DEL MEDIO AMBIENTE
DEPARTAMENTO DE DESCONTAMINACIÓN, PLANES Y NORMAS

Revisión Norma de Calidad Primaria contenidas en la Resolución Nº 1215/78

ACTA DE REUNION DE COMITÉ OPERATIVO Y AMPLIADO

FECHA REUNION : 22 de Mayo de 2000
LUGAR : CONAMA. Obispo Donoso 6. Santiago
ASISTENCIA : Se adjunta hoja de asistencia

Tabla :
1. Presentación de antecedentes sobre calidad del aire en la región Metropolitana (Ignacio Olaeta, SESMA)
2. Presentación antecedentes sobre calidad del aire en otras regiones
3. Discusión

Discusión :

F.Muñoz *(CLAISS)* felicita la presentación y consulta si se tiene un nivel de detalle en relación a las metodologías de medición de efectos en salud (protocolo, estandarización de mediciones, etc.). **F.Farías** *(CONAMA)* indica que, en relación a la evaluación en consultas médicas ésta solamente se vio en el proceso normativo del PM10, y no se ha ahondado en ese tema en lo relativo a la revisión de la resolución 1215.

A.Diez *(ENAMI)* señala que hubiese sido relevante presentar loas mediciones de PTS. **A.Tchernitchin** *(Colegio Médico)* indica que hubiese sido importante conocer las concentraciones horarias, en cuánto se superan las normas, qué pasa en cada parte y con los distintos contaminantes, por ejemplo con las partículas. También señala que sería interesante proyectar una situación considerando un nivel de norma de 125 ug/m3N para el SO2. **I.Olaeta** *(SESMA)* señala que el detalle de la información estará disponible en la Comisión. Por otro lado, hace referencia a la necesidad de que los niveles de norma se estipulen en las unidades que midn los instrumentos (ppm, ppb).

G.Muñoz *(CODELCO)* indica que falta información de la RM respecto a una norma de 250 ug/m3N para el SO2. Además, señala que si bien es bueno tener guías de recomendación, las normas deben ser cumplibles,considerando por ejemplo que la ISO 14000 obliga a algunos a cumplir con las normativas vigentes. **A.Diez** *(ENAMI)* sostiene que hay empresas que aún siguen con Planes de Descontaminación, a las cuales se les cambiaría el escenario.

C.Santana *(CONAMA)* sostiene que se presentan diferencias entre una norma de calidad y las estrategias de control. En contaminantes secundarios es particularmente complejo el establecer mecanismos para dar las soluciones. Para definir el nivel de norma de ozono se cuenta con la información suficiente. En caso de zonas saturadas es importante contar con la información asociada al control de los contaminantes precursores. En ese sentido aclara que no se requiere contar con una norma para el precursor si se quiere solucionar ozono.

Rodrigo Lucero Ch.
Depto. Descontaminación, Planes y Normas
CONAMA

COMISION NACIONAL DEL MEDIO AMBIENTE
DEPTO. DESCONTAMINACION, PLANES Y NORMAS

Reunión "Revisión Normas Primarias de Calidad de Aire para SO2, PTS, CO, NO2 Y O3"
Santiago, 22 de mayo 2000

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000526

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39.					
40.					
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Monitoreo Calidad de Aire SO2

Región	Localidad	Población INE	Red Monitoreo	Estación	Información
I	Iquique (*)	177.892	COSUDE	15 puntos	junio 97 - jun 98
II	Chuquicamata	15.000	CODELCO	A. Huasi	1994 -1999
				J. Bradford	1994 -1999
				S. José	1994 -1999
	Calama	137.000	CODELCO	V. Ayquina	1994 - 1999
				V. Caspana	1994 - 1999
	Tocopilla	29.554	Electroandina	Escuela E.10	1998 - 1999
			Norgener	Comisería	1998 - 1999
	Mejillones	7027	EDELNOR	E. Ferrocarril	ND
	Antofagasta	261025	F. Altonorte	P. Coviefi	1998 - 1999
				La Negra	1998 - 1999
III	Copiapó	120128	ENAMI Paipote	Copiapó	1993 - 1999
	S. Fernando	ND		S. Fernando	1993 - 1999
	Paipote	ND		Paipote	1993 - 1999
	T. Amarilla	14.000		T. Amarilla	1993 - 1999
	Salvador		Estudio Min. Minería	Cine Salvador	mayo 98-mayo 99
	Huasco	7.979	Guacolda	E. Bomberos	1997 - 1999
	Vallenar	51,856	Estudio Min. Minería	E. Ramirez	jun 98-jun 99

(*) Tubos Pasivos

000528

Región	Localidad	Población INE	Red Monitoreo	Estación	Información
V	Viña (*)	335.512	COSUDE		jun 97 - jun 98
	Valparaiso (*)	293.800	COSUDE		jun 97 - jun 98
	Ventanas		ENAMI Ventanas	La Greda	1993 - 1999
		11,692		Puchuncavi	1993 - 1999
				L. Maitenes	1993 - 1999
				V. Alegre	1993 - 1999
				E. Sur	1993 - 1999
	Chagres		Fund. Chagres	Sta. Margarita	1994 -1999
				Lo Campo	1994 -1999
		11,853		Catemu	1996 -1999
				Romeral	1996 -1999
	Quillota	72,87	S.Isidro	Bombero	1999
			Nehuenco	S.Pedro	1998 -1999
				INP	oct98-mar 99
				Limache	ago 99-dic99
				Cajón S.Pedro	oct 98-mar 98
VI	Coya		CODELCO	Coya Pob.	1995 -1999
	Coya Club			Club de Campo	1993 -1999
	Machali			Machali	1993 -1999
	Rancagua (*)	212.977	COSUDE		junio 97-mayo 98
					agosto 98-julio 99
VIII	Talcahuano	277.252	CONAMA	S. Vicente	1998 -1999
			COSUDE	Hualpencillo	1997 -1999
				S. Vicente (*)	1995-1997
IX	Temuco (*)	289.673	COSUDE	16 puntos	junio 97-mayo 98

Cumplimiento Normativa Vigente

Localidad	Estación	Promedio Anual ug/Nm3 Norma: 80 ug/Nm3	Número de veces sobre norma diaria 365 ug/Nm3	Escenario Número veces sobre 300 ug/Nm3	Escenario Número veces sobre 250 ug/Nm3	Concentración Máxima Diaria
Iquique(*)	15 puntos.	Pom. Máx : 12				
Chuquicamata	A. Huasi	145	33	46	60	**1003**
	J. Bradford	153	37	49	71	**1093**
	S. José	146	27	51	63	**960**
Calama	V. Ayquina	4	0	0	0	73
	V. Caspana	2	0	0	0	31
Tocopilla	Escuela E.10	–	0	0	0	95
	Comisería	25	0	0	0	122
Antofagasta	P. Coviefi	2	0	0	0	46
	La Negra	22	0	0	0	152
Copiapó	Copiapó	12	0	0	0	100
S. Fernando	S. Fernando	19	0	0	0	146
Paipote	Paipote	52	**2**	**ND**	**ND**	**560**
T. Amarilla	T. Amarilla	26	0	0	0	162
Salvador	E. Cine Salvador	11	0	0	0	126
Huasco	E. Bomberos	49	0	0	0	208
Vallenar	E. Ramirez	6	0	0	0	23

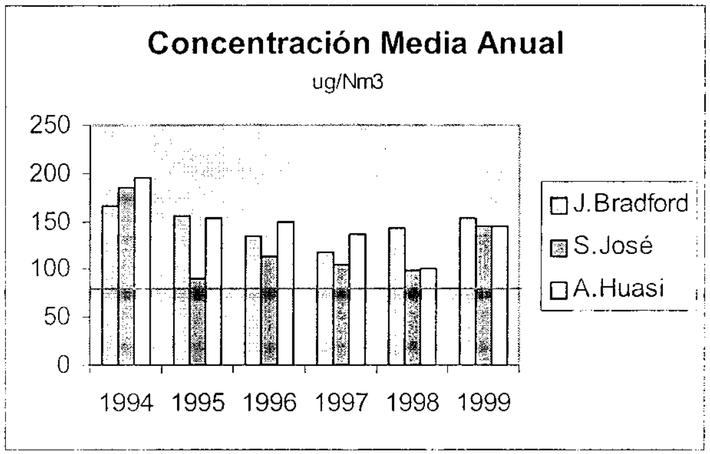
(*) Tubos Pasivos

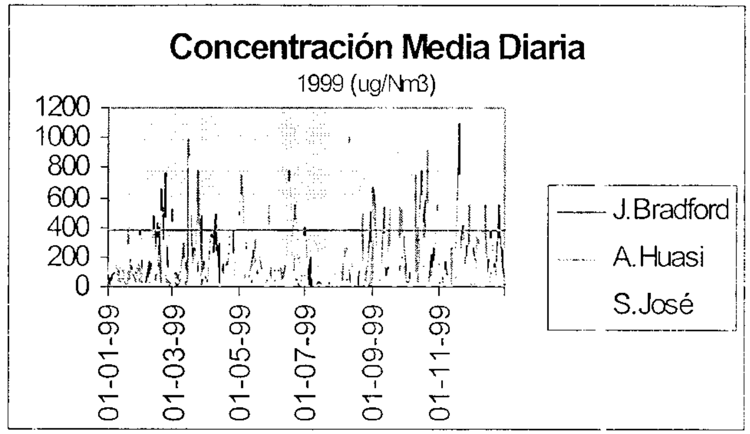
000531

Localidad	Estación	Promedio Anual ug/Nm3 Norma: 80 ug/Nm3	Número de veces sobre norma diaria 365 ug/Nm3	Escenario Número veces sobre		Concentración Máxima Diaria
				300 ug/Nm3	250 ug/Nm3	
Viña (*)	15 puntos	Prom. Máx: 45				
Valparaiso (*)	15 puntos	Prom. Máx: 40				
Ventanas	La Greda	25	0	0	1	**283**
	Puchuncavi	35	0	0	0	152
	L. Maitenes	52	1	**1**	2	**424**
	V. Alegre	20	0	0	0	139
Chagres	Sta. Margarita	63	0	0	0	180
	Lo Campo	32	0	0	0	106
	Catemu	15	0	0	0	55
	Romeral	21	0	0	0	66
Quillota	Bombero	11	0	0	0	58
	S.Pedro	43	0	0	0	83
	INP		0	0	0	46
	Limache		0	0	0	38
	Cajón S.Pedro		0	0	0	17
Coya	Coya Pob.	**42**	**1**	**2**	**4**	**369**
Coya Club	Club de Campo	203	74	89	101	**1997**
Machali	Machali					
Rancagua (*)	15 puntos	Prom. Máx: 40				
El Guindal (*)		100				
Talcahuano	S. Vicente	**81**	**2**	**8**	**9**	**518**
	Hualpencillo	67	0	1	21	314
	S. Vicente (T.Pas.)	Prom. Máx: 170				
Temuco (*)	16 puntos	Pom. Máx: 21				

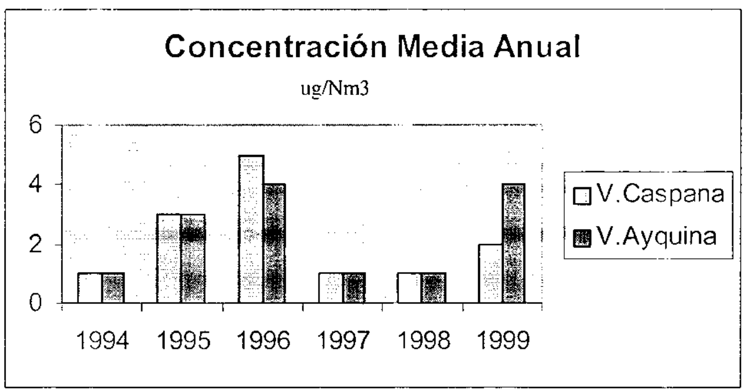
(*) Tubos Pasivos

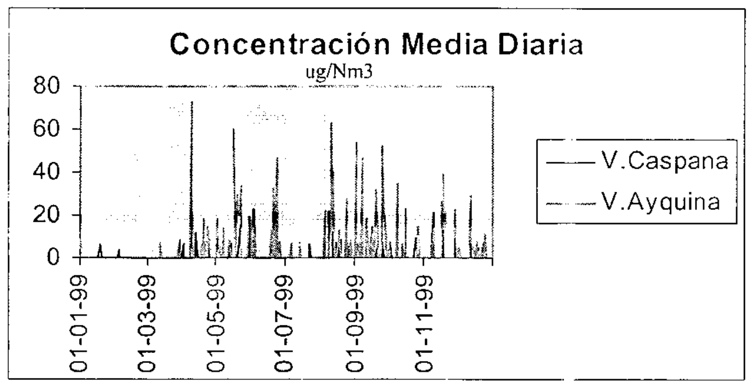
CHUQUICAMATA



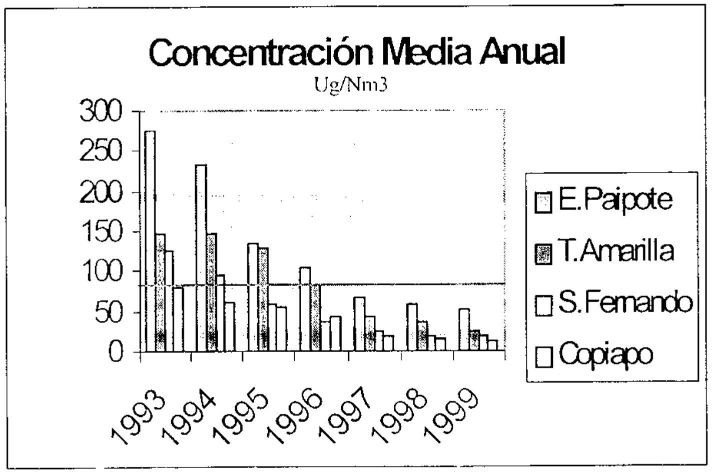


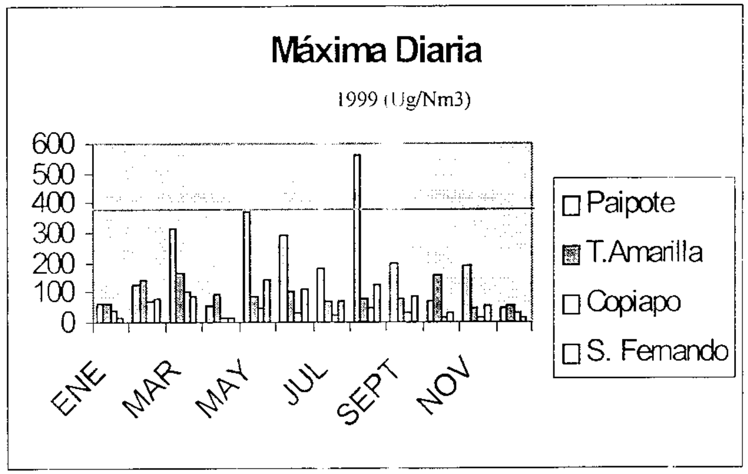
CALAMA

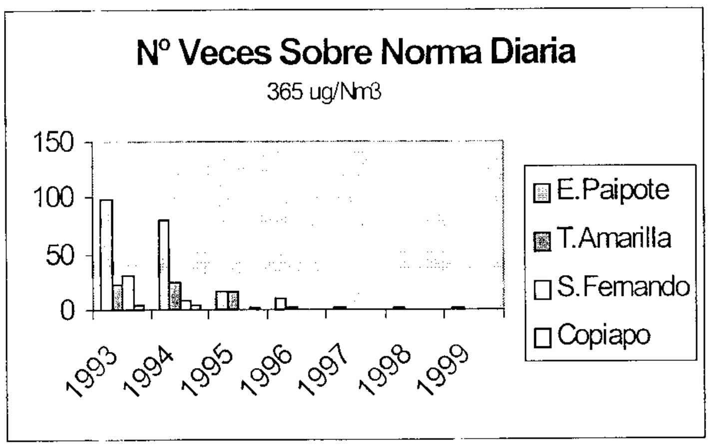


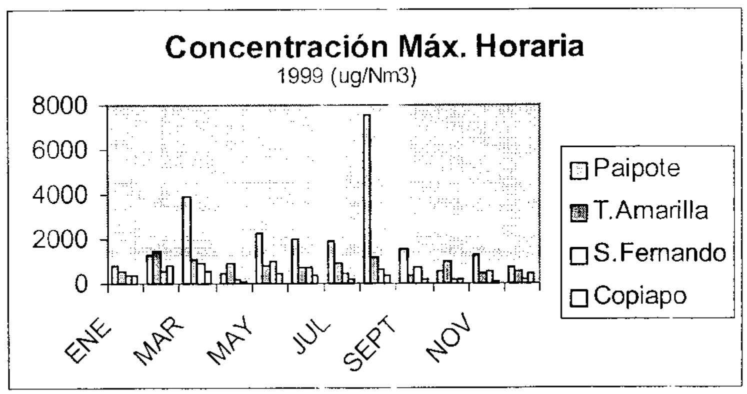


PAIPOTE



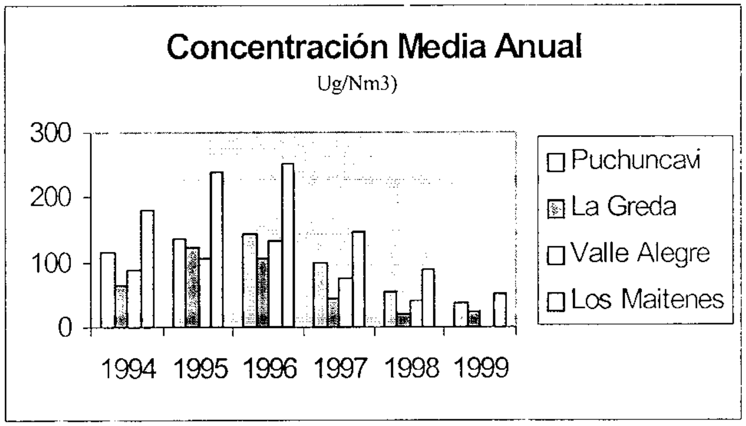


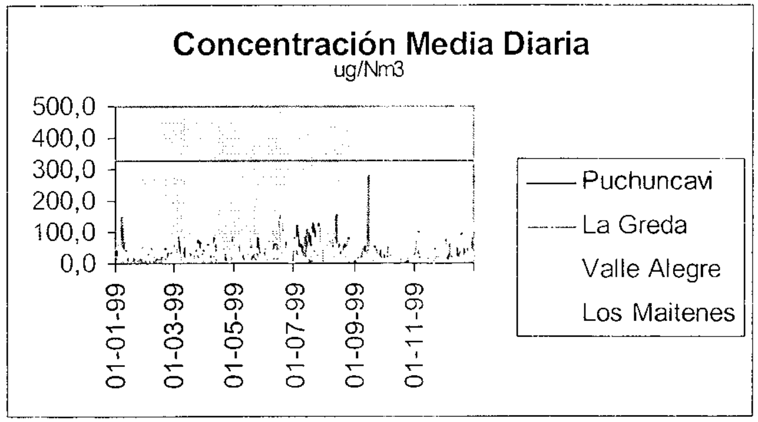


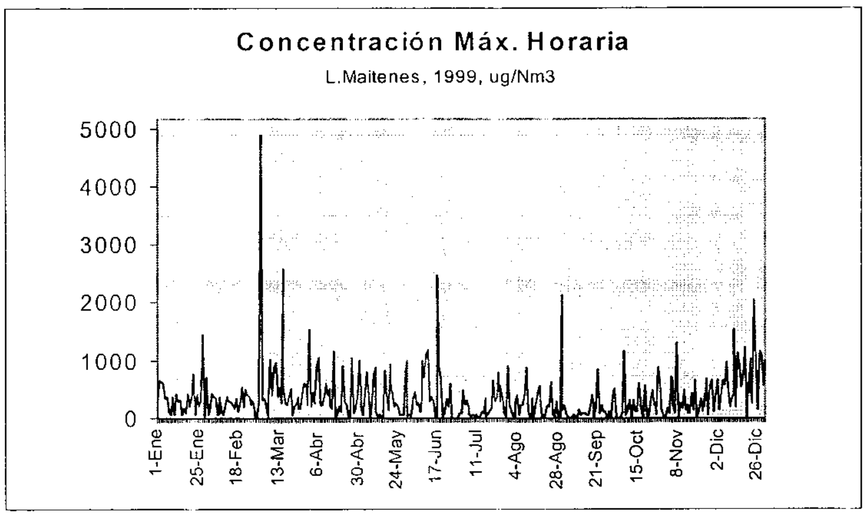


000533

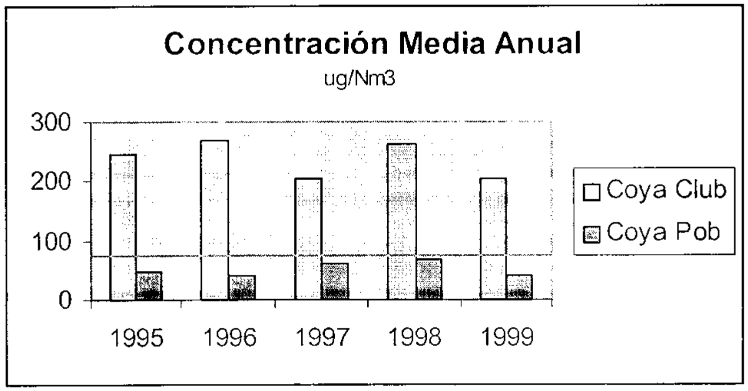
VENTANAS

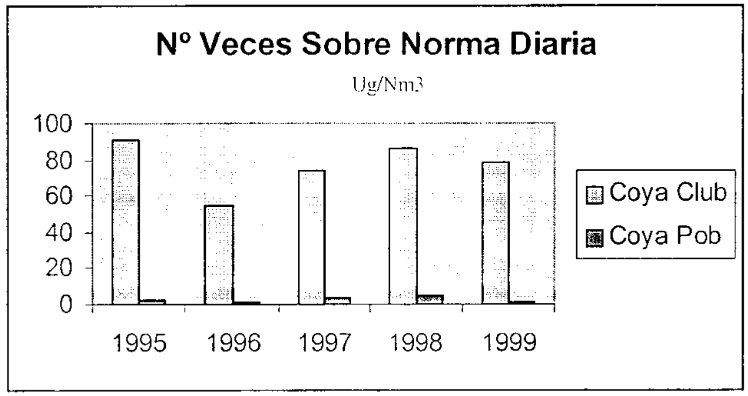

Concentración Media Anual
Ug/Nm3)
300
200
100
0
1994 1995 1996 1997 1998 1999
Puchuncavi
La Greda
Valle Alegre
Los Maitenes

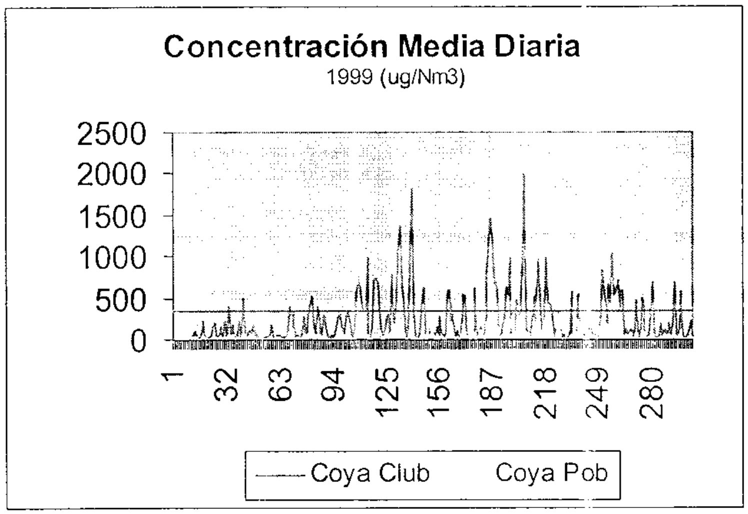

Concentración Media Diaria
ug/Nm3
500,0
400,0
300,0
200,0
100,0
0,0
01-01-99
01-03-99
01-05-99
01-07-99
01-09-99
01-11-99
Puchuncavi
La Greda
Valle Alegre
Los Maitenes

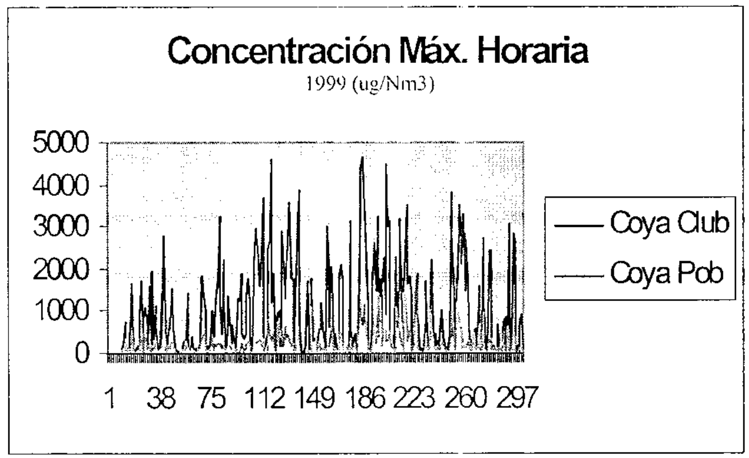

Concentración Máx. Horaria
L.Maitenes, 1999, ug/Nm3
5000
4000
3000
2000
1000
0
1-Ene
25-Ene
18-Feb
13-Mar
6-Abr
30-Abr
24-May
17-Jun
11-Jul
4-Ago
28-Ago
21-Sep
15-Oct
8-Nov
2-Dic
26-Dic

CALETONES



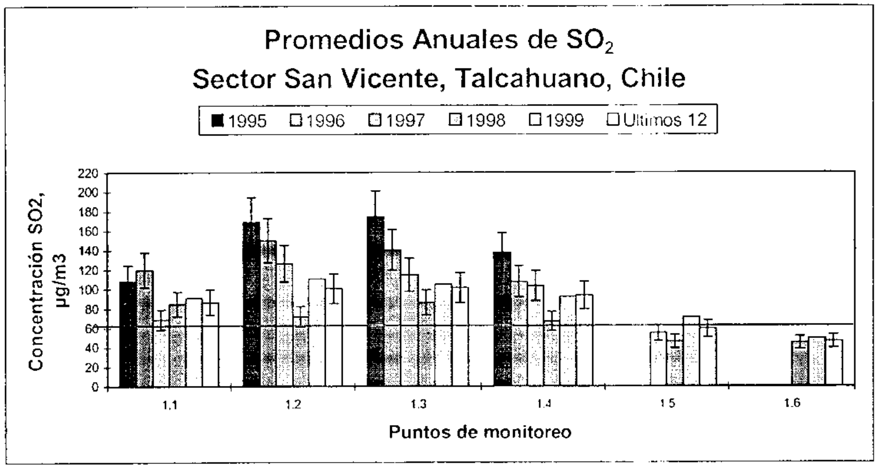


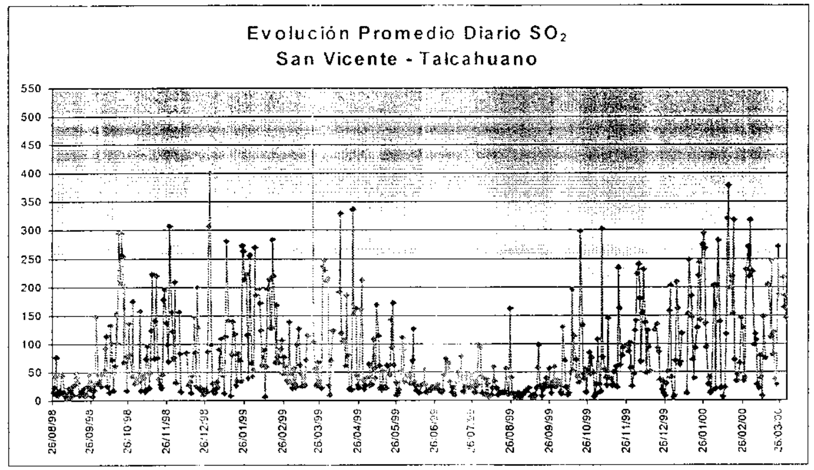


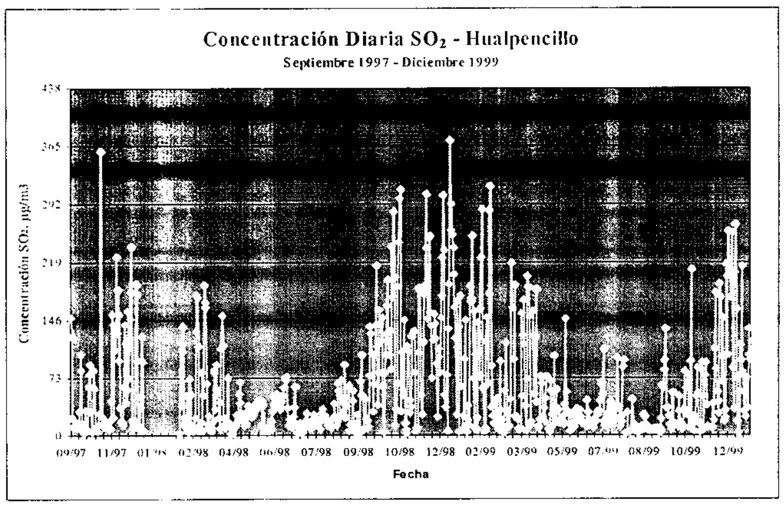


000535

TALCAHUANO







000536

MONOXIDO DE CARBONO (CO)
DATOS DE CALIDAD DEL AIRE

• Viña del Mar	Estudio CIMM (julio.octubre 1993, febrero-abril 1994). Mediciones continuas.
• Valparaíso	Estudio CIMM (julio.octubre 1993, febrero-abril 1994). Mediciones continuas.
• Rancagua	Estudio "Diagnóstico Calidad Aire en Rancagua" (agosto-septiembre 1996). Mediciones continuas.
• Copiapó/ Vallenar/ Huasco	Estudio "Diagnóstico Calidad Aire III Región" (mayo98-junio 1999). Mediciones continuas.

Ciudad	**CO máx. horaria (ug/m3)**	**CO máx. 8 hrs. (ug/m3)**
Valor Norma	*40.000*	*10.000*
Viña del Mar (jul-oct 93)	13.000	
Viña del Mar (feb-mar 94)	20.200	
Valparaíso (jul-oct 93)	12.300	
Valparaíso (feb-mar 94)	12.600	
Rancagua (ago-sep 96)	29.500	23.800 se superó 33 veces la norma

Ciudad	*CO* **máx. horaria (ug/m3)**	*CO* **máx. 8 hrs. (ug/m3)**
Valor norma	*40.000*	*10.000*
Copiapó (may98-jun99)	12.000	5.400
Vallenar (may98-jun99)	11.000	5.800
Huasco (may98-jun99)	4.000	2.000

PROCESO DE REVISIÓN DE LAS NORMAS ATMOSFÉRICAS DE CALIDAD PRIMARIA CONTENIDAS EN LA RESOLUCIÓN N°1215/78 DEL MINISTERIO DE SALUD: O_3, NO_2, SO_2, CO Y PTS

MONITOREO DE LA CALIDAD AIRE: NO_2 Y O_3

CONAMA
Depto. Descontaminación, Planes y Normas

000540

NO_2: efectos crónicos (1-año)

- Norma Chile:
  - 100 ug/m3
- Norma EEUU:
  - 100 ug/m3
- Norma CE:
  - 60 ug/m3 al 2001
  - 40 ug/m3 al 2010

- Propuesta Estudio SGA:
  - 100 ug/m3
- Recomendación OMS:
  - 40 ug/m3*

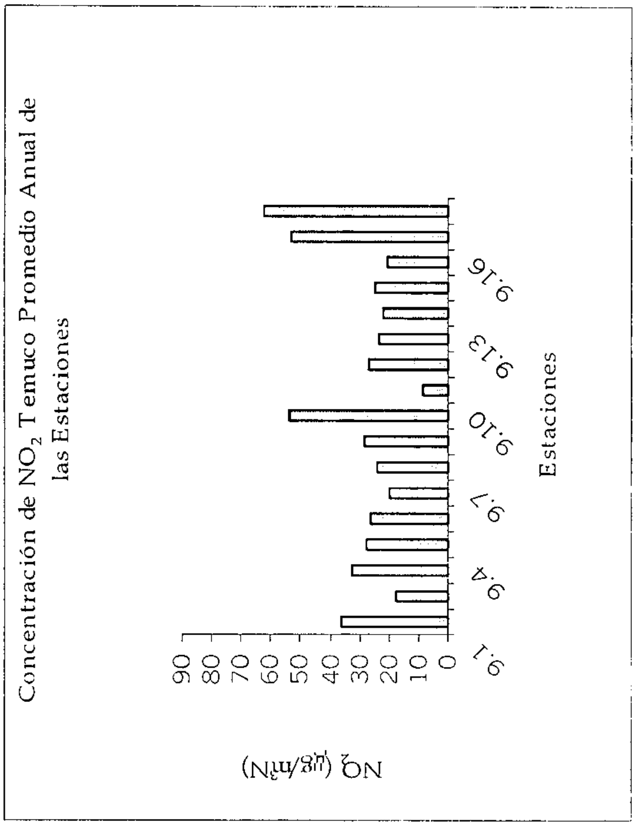
* sugiere efectos respiratorios en niños a promedios anuales de NO_2 en el rango 50-75 ug/m3 o superior.

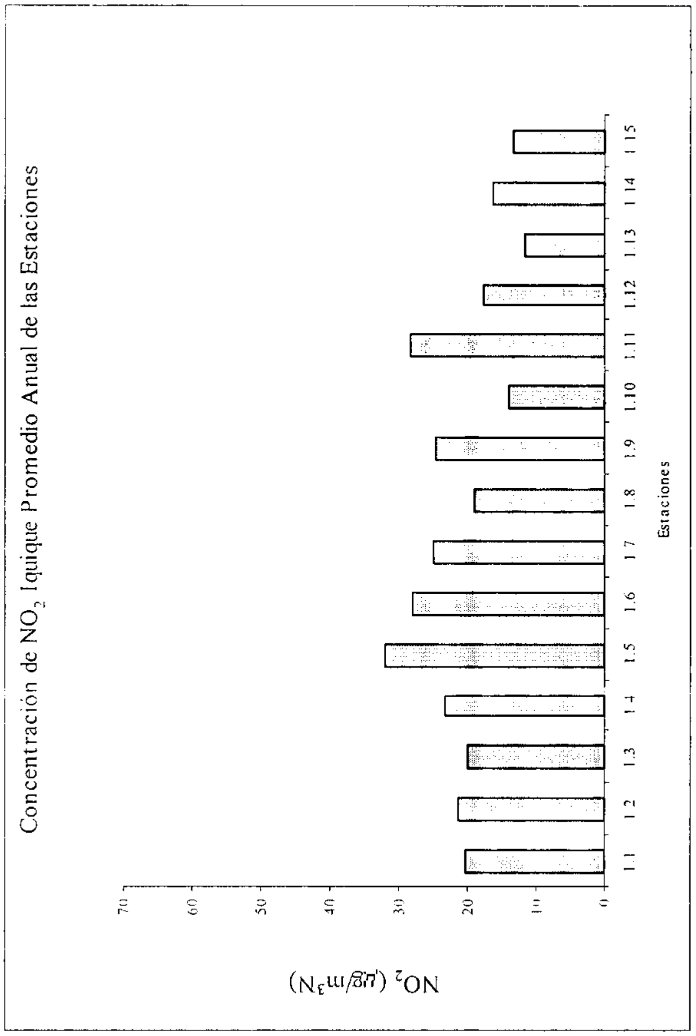
000541

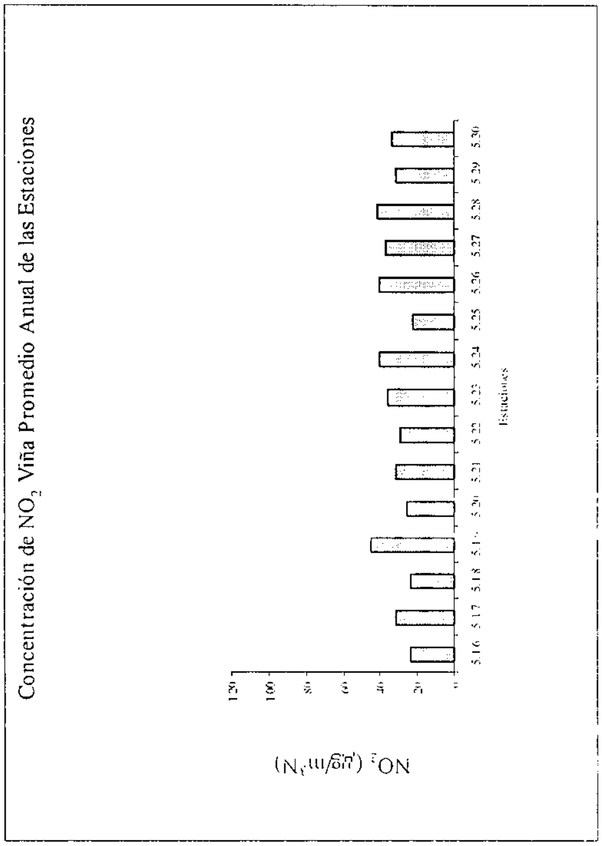
Dioxido de Nitrógeno

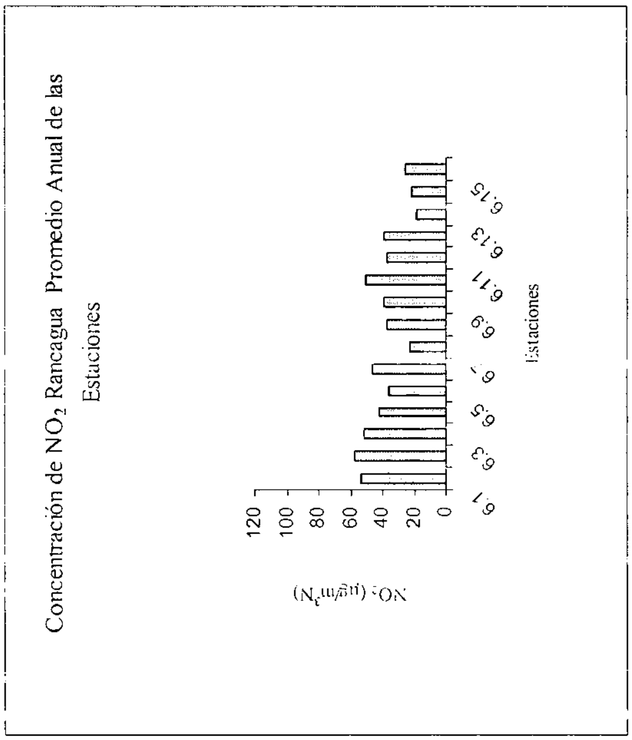
Localidad	Comuna	Población '98 (hab.)	1996	1997	1998	1999	Estación	Localización	Fuente de Información
			Años Concentración Promedio Anual de NO_2 [ug/m3]						
Viña del Mar	Viña del Mar	335512			79 (-)		pto.5.19	AvEcuador: trafico vehicular	COSUDE
Valparaíso	Valparaíso	293800			82 (-)		pto.5.1	Esmeralda: trafico vehicular	COSUDE
Temuco	Temuco	289673			63 (o)		pto.9.17	Centro: trafico vehicular	COSUDE
Rancagua	Rancagua	212977			57 (-)		pto.6.2	Brasil/Rubio: trafico vehicular	COSUDE
Iquique	Iquique	177892			32 (x)		pto.1.5	Municipalidad: trafico vehicular	COSUDE
Copiapó	Copiapó	120128				11 (+)	Copiapó	Gerencia ENAMI	Estudio Min.Minería (98-99)
Vallenar	Vallenar	51856				16 (+)	Bomberos	Ramirez 1198	Estudio Min.Minería (98-99)
Tocopilla	Tocopilla	29554	5 (/)			20 (&)			Electroandina
Huasco	Huasco	7979		20	20	38 (*)	Bomberos	calles Prat y Latorre	Gualcolda
Mejillones	Mejillones	7700			7				Enaex

(-) de junio 97 a mayo 98
(o) de diciembre 97 a septiembre 98
(x) de noviembre 97 a octubre 98
(*) hasta septiembre
(/) desde marzo
(&) hasta octubre
(+) de julio 98 a junio 99


Concentración de NO_2 Temuco Promedio Anual de las Estaciones
NO_2 (µg/m³N)
Estaciones
90
80
70
60
50
40
30
20
10
0
9.1
9.4
9.7
9.10
9.13
9.16


Concentración de NO_2 Iquique Promedio Anual de las Estaciones
NO_2 (µg/m³N)
Estaciones
70
60
50
40
30
20
10
0
1.1
1.2
1.3
1.4
1.5
1.6
1.7
1.8
1.9
1.10
1.11
1.12
1.13
1.14
1.15


Concentración de NO_2 Viña Promedio Anual de las Estaciones
NO_2 (µg/m³N)


Concentración de NO_2 Rancagua Promedio Anual de las Estaciones
NO_2 (µg/m³N)
Estaciones
120
100
80
60
40
20
0
6.1
6.3
6.5
6.9
6.11
6.13
6.15

NO_2: efectos agudos (1-hora)

- Norma Chile:
  - No Existe
- Norma EEUU:
  - No existe
- Norma CE°:
  - 300 ug/m3 al 2001
  - 200 ug/m3 al 2010
- ° no superar en más de 18 ocasiones por año civil

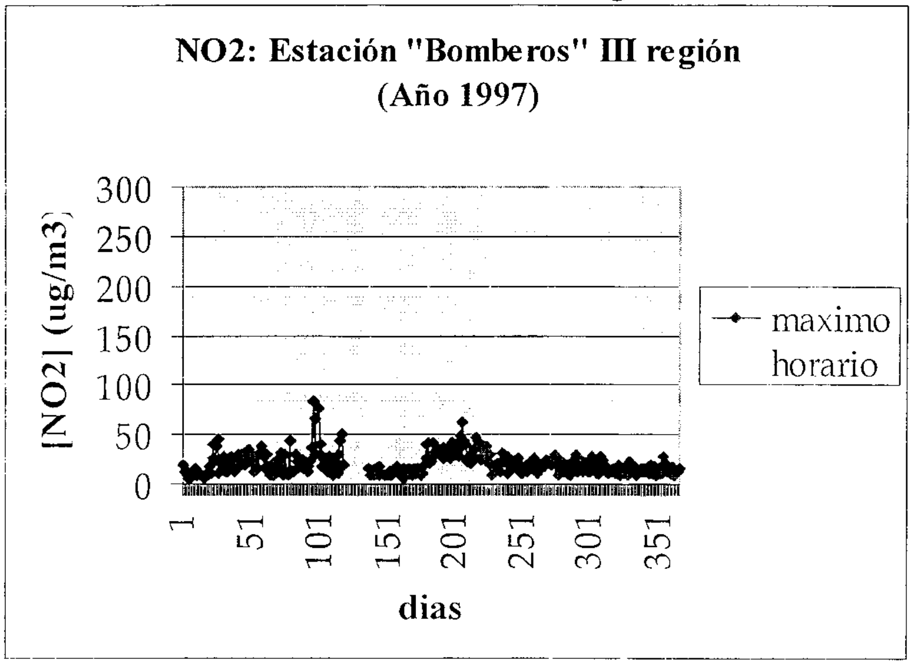
- Propuesta Estudio SGA:
  - 400 ug/m3

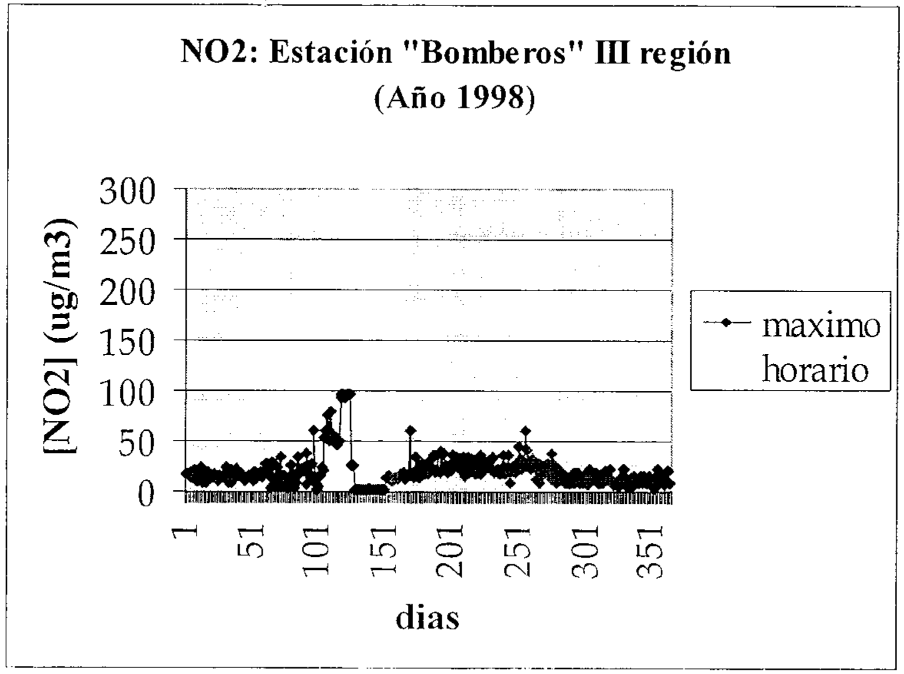
    Percentil 98
- Recomendación OMS:
  - 200 ug/m3*

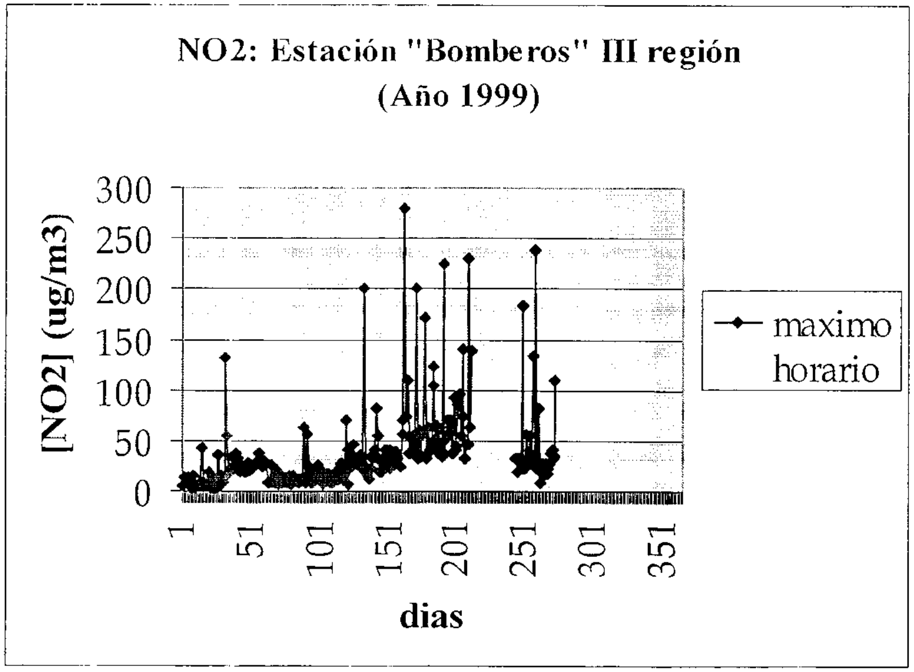
* efectos respiratorios observados en asmáticos a valores 365-565 ug/m3.

Dioxido de Nitrógeno

Localidad	Comuna	Población '98 (hab.)	1997	1998	1999	Estación	Localización	Fuente de Información
			Años					
			Concentración Máxima Horaria de NO2 [ug/m3]					
Copiapó	Copiapó	120128			215	Copiapó	Gerencia ENAMI	Estudio Min Minería (98-99)
Quillota	Quillota	72870						
Vallenar	Vallenar	51856			118	Bomberos	Ramirez 1198	Estudio Min.Minería (98-99)
Huasco	Huasco	7979	83 (45)	96 (94)	280 (201)	Bomberos	calles Prat y Latorre	Guacolda/Estudio Min Minería (98-99)


NO2: Estación "Bomberos" III región
(Año 1997)
[NO2] (ug/m3)
300
250
200
150
100
50
0
1
51
101
151
201
251
301
351
dias
maximo horario


NO2: Estación "Bomberos" III región
(Año 1998)
[NO2] (ug/m3)
300
250
200
150
100
50
0
1
51
101
151
201
251
301
351
dias
maximo horario


NO2: Estación "Bomberos" III región
(Año 1999)
[NO2] (ug/m3)
300
250
200
150
100
50
0
1
51
101
151
201
251
301
351
dias
maximo horario

O3: efectos agudos (1-hora)

- Norma *Chile*:
  - 160 ug/m3

    Hasta 1 vez por año
- Norma EEUU:
  - 240 ug/m3

    Hasta 1 vez por año.

    Cambiando a norma de 8-horas
- Norma *CE*:
  - No existe
- Propuesta Estudio *SGA*:
  - 160 ug/m3

    Percentil 98
- Recomendación OMS:
  - No tiene

    protección cubierta con norma de 8-horas

O3: efectos agudos (8-horas)

- Norma Chile:
  - No Existe
- Norma EEUU:
  - 160 ug/m3 +

  \+ no superar por el promedio de 3 años del 4to mayor valor en cada año
- Norma CE°:
  - 120 ug/m3 al 2001

° no superar en más de 20 días por año civil

- Propuesta Estudio SGA:
- Recomendación OMS:
  - 120 ug/m3*

  * efectos estadísticamente significativos a niveles de 160 ug/m3 por exposiciones de 6,6 horas.

Ozono

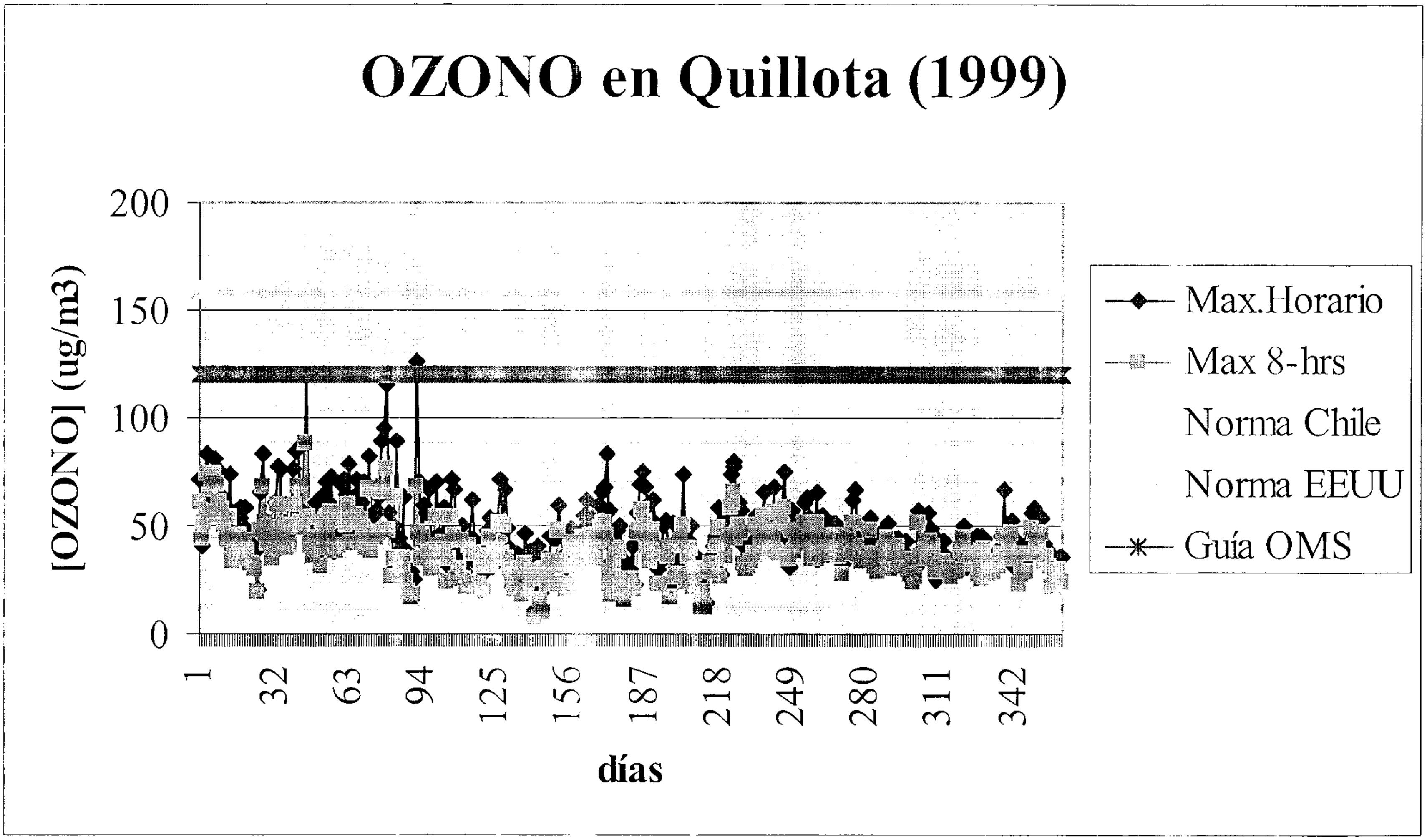
Localidad	Comuna	Población ´98 (hab.)	Años 1997	1998	1999	Estación	Localización	Fuente de Información
			Concentración Máxima Horaria de O3 [ug/m3]					
Quillota	Quillota	72870			126 (85) (-)	Bomberos	sector residencial	Central Nehuenco
Copiapó	Copiapó	120128			68	Copiapó	Gerencia ENAMI	Estudio Min.Minería (98-99)
Vallenar	Vallenar	51856			72	Bomberos	Ramirez 1198	Estudio Min.Minería (98-99)
Huasco	Huasco	7979			76	Bomberos	calles Prat y Latorre	Estudio Min.Minería (98-99)

Ozono (8-horas)

Localidad	Comuna	Población ´98 (hab.)	Años 1997	1998	1999	Estación	Localización	Fuente de Información
			Concentración Máxima 8-Horas de O3 [ug/m3]					
Quillota	Quillota	72870			88 (68) (-)	Bomberos	sector residencial	Central Nehuenco

(*) desde abril

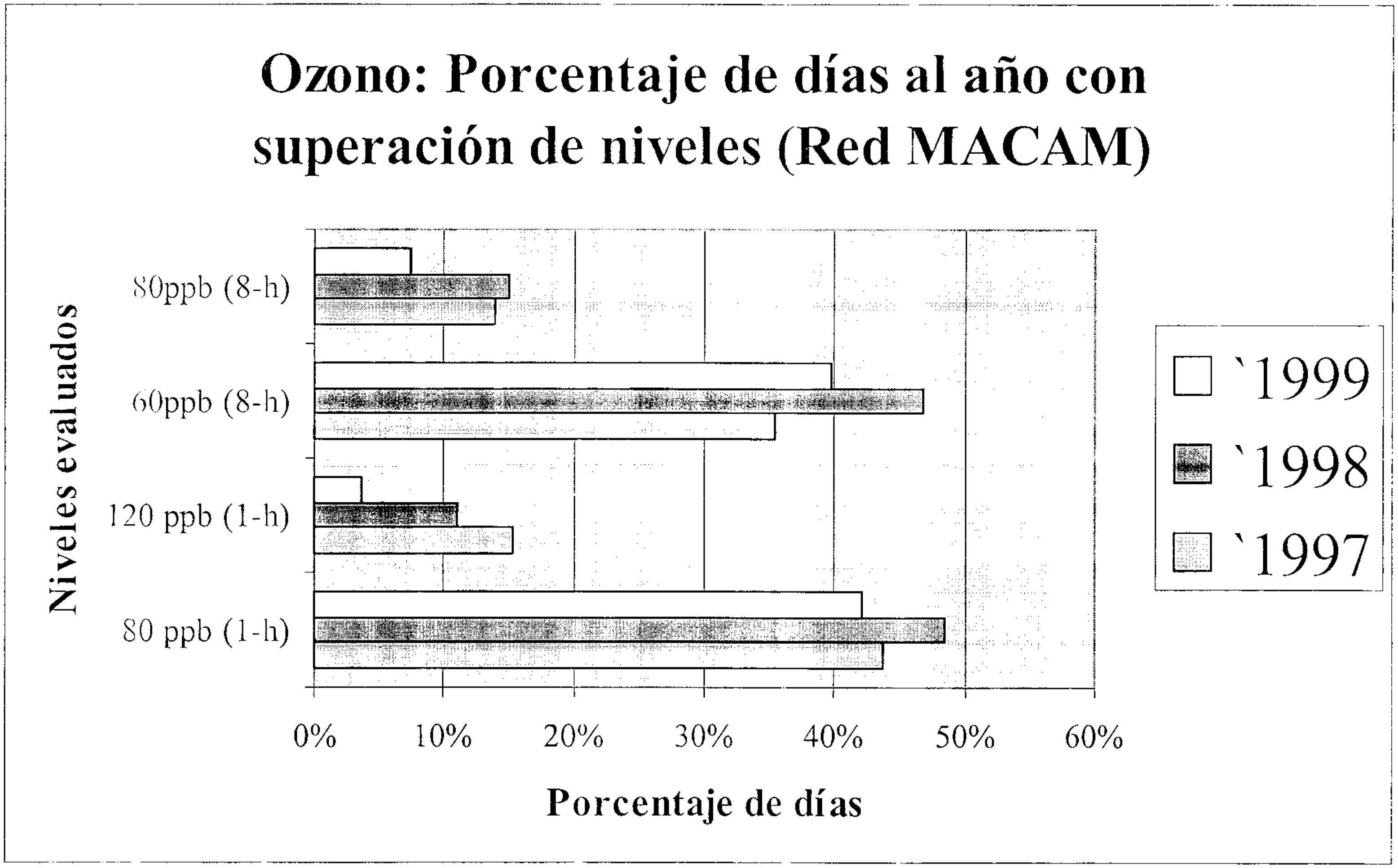
(-) desde febrero hasta enero 2000


OZONO en Quillota (1999)
[OZONO] (ug/m3)
200
150
100
50
0
1
32
63
94
125
156
187
218
249
280
311
342
días
Max.Horario
Max 8-hrs
Norma Chile
Norma EEUU
Guía OMS

OZONO: Simulaciones para los datos de la Región Metropolitana (Red MACAM)

Comparación con niveles Horarios y de 8-Horas

Año	Nºdias		Nº de dias superiores a los valores			
			80 ppb (1-h)	120 ppb (1-h)	60ppb (8-h)	80ppb (8-h)
1997	274	Red MACAM	120	42	97	38
1997	274	Las Condes	118	42	96	37
1998	365	Red MACAM	177	40	171	55
1998	365	Las Condes	174	36	167	54
1999	365	Red MACAM	154	13	145	27
1999	365	Las Condes	148	13	142	26



Ozono: Porcentaje de días al año con superación de niveles (Red MACAM)
Niveles evaluados
80ppb (8-h)
60ppb (8-h)
120 ppb (1-h)
80 ppb (1-h)
0%
10%
20%
30%
40%
50%
60%
Porcentaje de días
`1999
`1998
`1997

Valores Horarios

Concentraciones de Ozono

Año	N°dias	Max 1-h	2° mayor valor (CH, EEUU)	Perc.98 (SGA)
1997	274	175	170	151
1998	365	208	174	152
1999	365	179	146	126

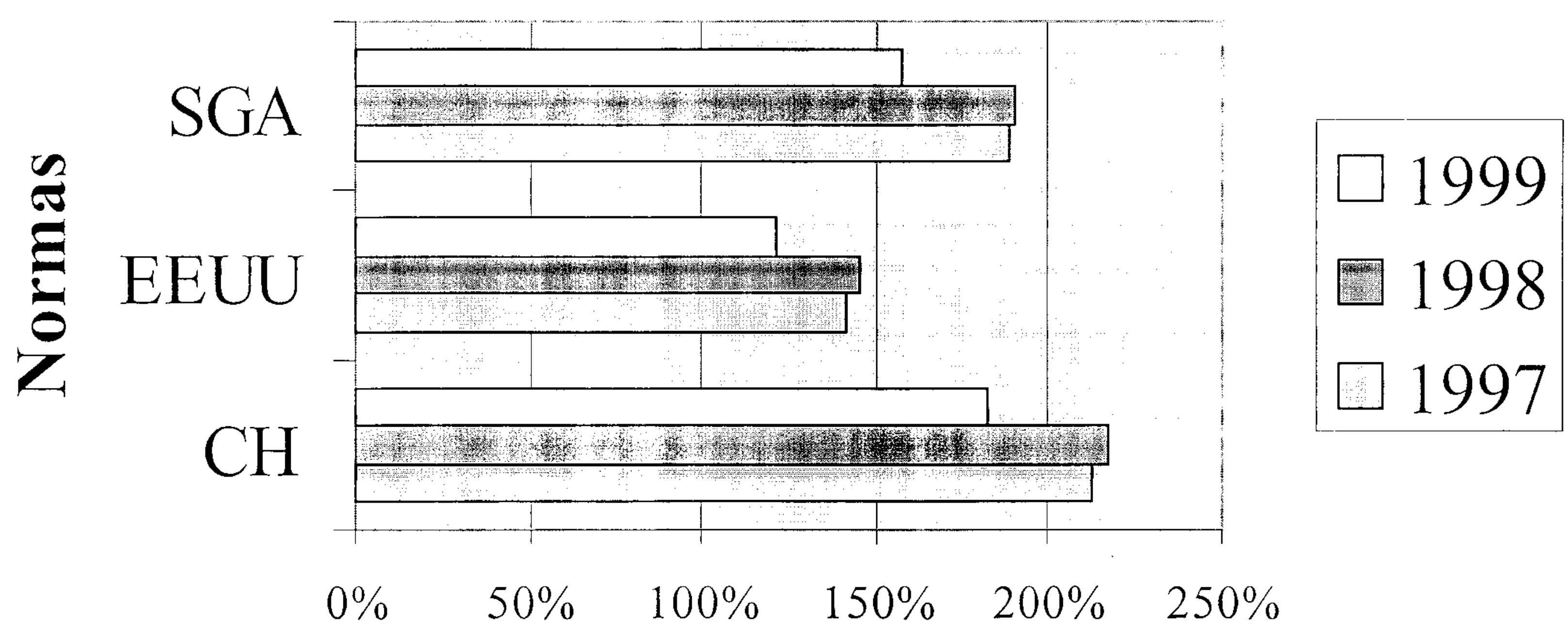
Concentraciones de Ozono en PPB

CH: Norma Chilena Vigente (80ppb)

EEUU: Norma EE.UU. Para 1-hora (120 ppb)

SGA: Propuesta Estudio SGA (80 ppb)

Ozono: Porcentaje de Superación sobre la meta establecida en la Norma Horaria (Red MACAM)



Valores de 8-horas

Concentraciones de Ozono

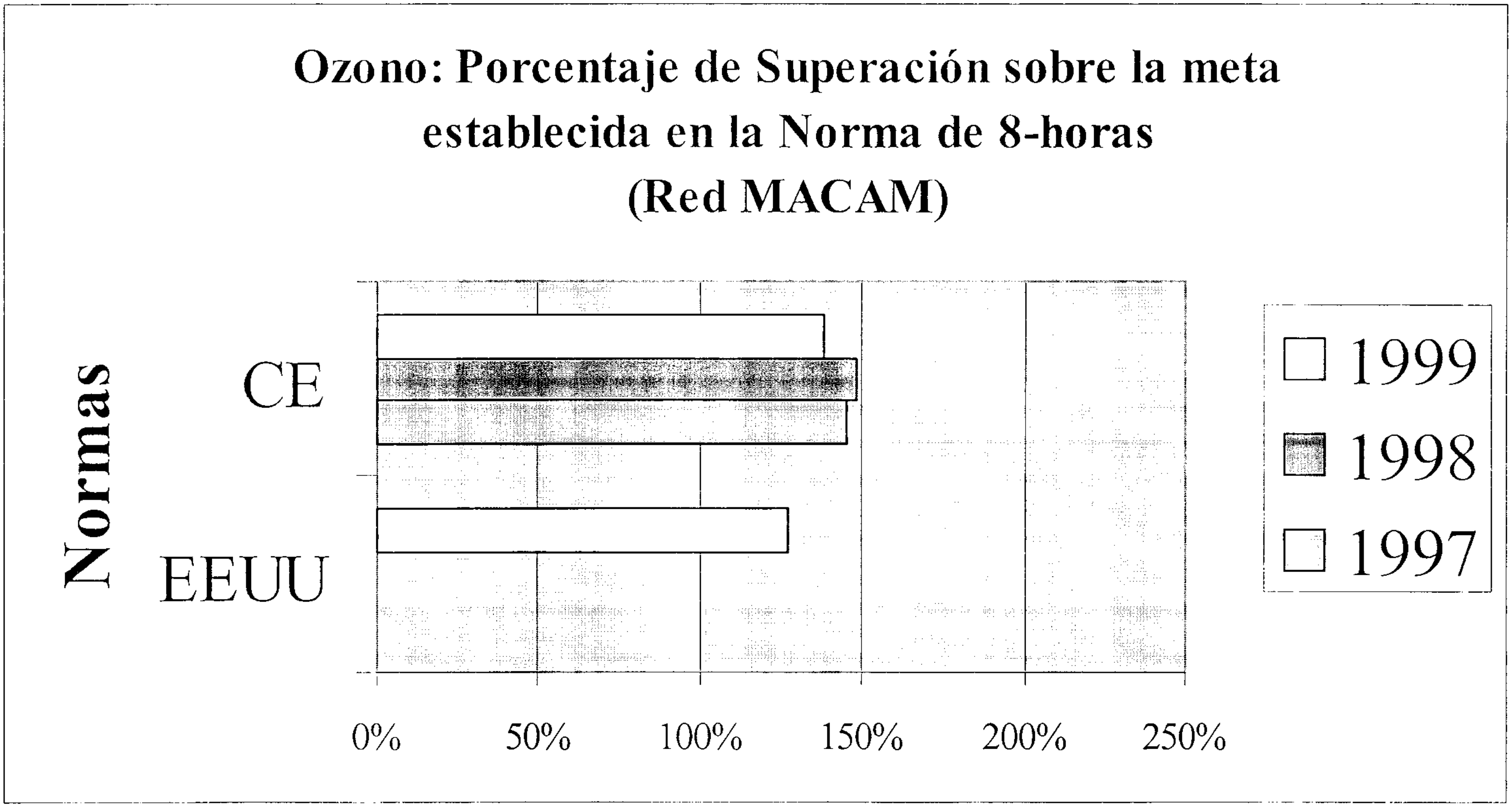
Año	Nºdias	Max 8-h	2º mayor valor	4º mayor valor (EEUU)	Perc.98	20º mayor valor (CE)
1997	274	113	109	100	97	87
1998	365	120	110	107	99	89
1999	365	108	104	97	88	83

Concentraciones de Ozono en PPB

EEUU: Norma EE.UU. Para 8-horas (80 ppb)

CE: Norma Comunidad Europea (60 ppb)

000556


Ozono: Porcentaje de Superación sobre la meta establecida en la Norma de 8-horas (Red MACAM)
Normas
CE
EEUU
0%
50%
100%
150%
200%
250%
1999
1998
1997

000558

REPUBLICA DE CHILE
COMISION NACIONAL DEL MEDIO AMBIENTE
ASR/PMC

AMPLIA PLAZO PARA PREPARACION DE ANTEPROYECTO DE REVISION DE NORMAS PRIMARIAS DE CALIDAD DE AIRE PARA ANHIDRIDO SULFUROSO (SO2), MONOXIDO DE CARBONO (CO), DIOXIDO DE NITROGENO (NO2), OZONO (O3) Y PARTICULAS TOTALES EN SUSPENSION (PTS).

SANTIAGO, 29 MAY 2000

EXENTA N° 0513

VISTOS:

Lo dispuesto en la Ley N°19.300, sobre bases del Medio Ambiente; lo prescrito en el Decreto Supremo N°93, de 1995, del Ministerio Secretaría General de la Presidencia; la Resolución Exenta N°1514 de la Dirección Ejecutiva de la Comisión Nacional del Medio Ambiente de fecha 17 de diciembre de 1999; y la Resolución N°520 de la Contraloría General de la República;

CONSIDERANDO

Lo solicitado por el Departamento Descontaminación Planes y Normas de la Comisión Nacional del Medio Ambiente, sobre la necesidad de ampliar los plazos para preparación del anteproyecto para recabar adecuadamente los antecedentes técnicos necesarios para la formulación del mismo, y de acuerdo a los demás fundamentos planteados a esta Dirección Ejecutiva por dicho departamento:

RESUELVO:

Amplíase el plazo para preparación del anteproyecto de Revisión de Normas Primarias de Calidad de Aire, antes mencionadas, en 97 días, a partir del 3 de junio del año 2000, fecha en que vence el plazo original del proceso.

Anótese, comuníquese, y archívese.

COMISION NACIONAL DEL MEDIO AMBIENTE
DIRECTOR EJECUTIVO

ADRIANA HOFFMANN JACOBY
DIRECTORA EJECUTIVA
COMISION NACIONAL DEL MEDIO AMBIENTE

29 MAY 2000

Lo que transcribo a Ud.
para su conocimiento
saluda atentamente a Ud.,
RODRIGO A. GONZALEZ P.
Oficial de Partes
Comisión Nacional del Medio Ambiente (CONAMA)

COMISIÓN NACIONAL DEL MEDIO AMBIENTE
DEPTO.DESCONTAMINACIÓN, PLANES Y NORMAS

25 de mayo de 2000

INFORME DE AVANCE DE LA ELABORACION DEL ANTEPROYECTO DE REVISION DE NORMAS PRIMARIAS DE CALIDAD DE AIRE PARA SO2, CO, O3, NO2 Y PTS.

1. Mediante Resolución Exenta N°1514 de fecha, 17 de diciembre de 1999, de la Dirección Ejecutiva de la Comisión Nacional del Medio Ambiente publicada en el Diario Oficial y en un Diario de circulación Nacional con fecha 5 de enero del año 2000, se dio inicio al proceso de revisión de las normas primarias de calidad de aire para SO2, CO, O3, NO2 y PTS.
2. Con fecha 27 de enero del año 2000, mediante acuerdo N°142, el Consejo Directivo de la Comisión Nacional del Medio Ambiente aprobó la integración del Comité Operativo propuesto por la Dirección Ejecutiva de CONAMA, que ha estado reuniéndose para la revisión de las normas primarias de calidad de aire.
3. Desde el mes de marzo, a la fecha, se han sostenido reuniones de Comité Operativo y Ampliado en las cuales se han abordado los antecedentes de base para la discusión de la revisión de las normas para los cinco contaminantes, esto es: procedimiento y metodología para la revisión, efectos de los contaminantes sobre la salud de la población, normativa internacional, nivel de cumplimiento de las normas vigentes y vigencia de los objetivos tenidos en cuenta al momento de su dictación, inventario de emisiones y actualización de las metodologías de medición. Durante el mes de junio se abordará en los Comités los niveles que definen situaciones de emergencia y además, durante este mes, se espera contar en forma completa con la actualización de todos los antecedentes necesarios para la revisión de la norma.
4. Una vez terminada la etapa anterior será posible elaborar una primera propuesta normativa para cada contaminante, la que será discutida internamente en CONAMA en el mes de julio y posteriormente presentada para discusión al Comité Operativo y Ampliado de la misma.
5. Especial atención merece la revisión de la norma de PTS (partículas totales en suspención), considerando que la regulación de este contaminante ha sido reemplazada por la regulación de PM10 y/o PM2.5, tanto por la EPA, la CE y en las recomendaciones de la OMS. Por lo anterior, se requiere analizar esta opción para Chile tomando en cuenta la situación particular de las características tóxicas del material particulado asociado, especialmente a la actividad minera en Chile. Este análisis se estima completarlo a mediados del mes de julio, para su posterior discusión.
6. Durante el mes de agosto se estima que estará disponible la propuesta de normativa para la discusión del Comité Operativo y Ampliado, para posteriormente, en base a las observaciones recibidas, elaborar el anteproyecto de norma y someterlo al proceso de consulta pública a principios del mes de septiembre.
7. Sobre la base de lo expuesto anteriormente, es que se requiere la ampliación del plazo original para la elaboración del anteproyecto, en 97 días, a partir de la fecha 03 de junio del año 2000.

COMISIÓN NACIONAL DEL MEDIO AMBIENTE
DEPARTAMENTO DE DESCONTAMINACIÓN, PLANES Y NORMAS

Revisión Norma de Calidad Primaria contenidas en la Resolución Nº 1215/78

ACTA DE REUNION DE COMITÉS OPERATIVO Y AMPLIADO

FECHA REUNION: 29 de Mayo de 2000
LUGAR : CONAMA. Obispo Donoso 6. Santiago

Tabla :

1. Inventarios de emisiones para fundiciones de Cobre: Rodrigo Lucero, Depto. Descontaminación, Planes y Normas.
2. El inventario de emisiones para la Región Metropolitana: Marcelo Fernández, CONAMA RM

En el caso del **punto 1**, se presentaron las emisiones de anhídriodo sulfuroso para las siguientes fundiciones: Chuquicamata, Paipote, Ventanas, Chagres y Caletones

Al respecto, G.Muñoz (CODELCO) indica que como parte del proyecto de reducción de emisiones de arsénico, se esperan importantes reducciones en las emisiones de SO2, especialmente en Chuquicamata. También anuncia que CODELCO ha establecido 95% como su nivel de eficiencia objetivo de captación de SO2 para los próximos años (Reformulación del Plan de Descontaminación).

En el caso de la información correspondiente a la Fundición de Ventanas S.Carstens (ENAMI) indica que las eficiencias obtenidas (cercanas al 90%) son las mayores logrables operacionalmente. Obtención de eficiencias mayores pasaría por cambios drásticos en tecnología. Similarmente C.Salvo (SONAMI, Chagres) indica que aumentar las eficiencias de captación en la Fundición de Chagres, implicaría cambios tecnológicos relevantes, con inversiones en el rango de los US$200 millones.

E.Cohen (Consejo Minero, Altonorte-Noranda) ofrece hacer llegar directamente al Comité de la norma información de las emisiones de anhídrido sulfuroso de la Fundición Altonorte-Noranda.

En el caso del **punto 2**, se presentó una sinopsis de la metodología con que fue construido el inventario actual de emisiones para la RM, y los principales resultados asociados.

El Dr.A.Tchernitchin (U.Chile) consulta si está disponible información para intercomparaciones entre vehículos catalíticos y no-catalíticos, en particular si se considera la variable de condiciones de congestión en las calles de Santiago. M.Fernández responde que se hacen evaluaciones de emisiones considerando distintas velocidades de las fuentes móviles.

La Dra.J.Vega (PUC) consulta cuándo se tendrá el inventario de emisiones para el año 2000, lo que es respondido que a más tardar a fines de año.

C.Salvo pregunta por el nivel de error asociado al inventario, M.Fernández indica que existen distintos niveles de error asociados a las distintas fuentes emisoras, pero que los mejores datos probablemente se encuentran en las fuentes móviles.

M.Muñoz (Illanes y Asoc.), presenta dos puntos: qué pasa con la aplicación de metodologías de generación de inventarios de emisiones fuera de Santiago y cómo se podría usar esta información – de la Región Metropolitana- para fijar normativa de alcance nacional. Al respecto, C.Santana indica que este tipo de inventarios entrega una buena señal del grado de responsabilidad urbana para algunos contaminantes (CO, por ejemplo), y que existen Inventarios de emisiones preliminares en algunas ciudades pero sus resultados no son muy confiables todavía, faltando que se obtenga un mayor detalle de las emisiones así como validar la información generada.

También se hicieron varias consultas relacionadas con las medidas del Plan de Descontaminación de la RM, tales como uso de combustibles menos contaminantes (G.Muñoz, A.Tchernitchin, A.Mege), así como se plantearon opiniones por cuán buenos son los automóviles catalíticos para las condiciones de la ciudad de Santiago: geográficas y de estilo de conducción local. (S.Sanhueza, RENACE).

La reunión finaliza con la presentación de R.Lucero de un cronograma de actividades a desarrollar por el Comité Operativo y el Ampliado, hasta el día 8 de septiembre, fecha en que se debe contar con el anteproyecto de la norma.

Rodrigo Lucero Ch.
Depto. Descontaminación, Planes y Normas
CONAMA

COMISION NACIONAL DEL MEDIO AMBIENTE
DEPTO. DESCONTAMINACION, PLANES Y NORMAS

Reunión "Revisión Normas Primarias de Calidad de Aire para SO2, PTS, CO, NO2 Y O3"
Santiago, 29 de mayo 2000

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24.	Maruel [illegible]	S. Salud Viña del Mar-Quillota	32-680423	32680428	dpavq@ssvq.cl
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FUNDICION CHUQUICAMATA

Plan de Descontaminación

Año	Emisión S t/año	Emisión SO2 t/año
1993	252000	504000
1994	234000	468000
1995	198000	396000
1996	198000	396000
1997	198000	396000
1998	162000	324000

FUNDICION CHUQUICAMATA

Reformulación Plan

Año	Emisión S t/año	Emisión SO2 t/año
Desde 2000	87000	174000
Desde 2002	79000	158000
Desde 2004	28300	56600

FUNDICION CHUQUICAMATA

Emisiones de SO2

Año	Fusión Conc t/año	Emisión Permitida SO2 (t/año)	Emisión S02 t/año	Captación S %
1993		504000		
1994		468000	302000	
1995	1688900	336000	374000	72,4
1996	1591200	396000	296000	71,4
1997	1677500	396000	228000	79,7
1998	1690000	324000	186000	83,6
1999	1741000	-	256000	78,6
2000		174600		85,1
2001		174600		85,2
2002		158000		86,6
2003		56600		95,5

FUNDICION PAIPOTE

Plan de descontaminación

Año	Emisión S t/mes (1)	Emisión S t/mes (2)	Emisión S t/año	Emisión SO2 t/año
1995	2200	3700	39900	79800
1996	2200	3700	39900	79800
1997	2200	3700	39900	79800
1998	2200	2600	30000	60000
1999	1666	1666	19992	39984
2000	*	*	*	*

(*) Cumplimiento Norma

FUNDICION PAIPOTE

Emisiones de SO_2

Año	Emision Permitida SO_2 t/año	Emisión SO_2 t/año	Capatción S %
1995	79800	57324	48.5
1996	79800	49344	49.8
1997	79800	30900	70.5
1998	60000	35506	79.1
1999	[illegible]	[illegible]	88

FUNDICION VENTANAS

Plan de Descontaminación

Año	Emisión S t/año	Emisión SO_2 t/año
1993	62000	124000
1994	62000	124000
1995	62000	124000
1996	62000	124000
1997	62000	124000
1998	45000	90000

FUNDICION VENTANAS

Emisiones de SO2

Año	Fusión Conc. t/año	Emisión Permitida SO2 t/año	Emisión SO2 t/año	Captación S %
1993	464575	124000	117258	52,5
1994	450826	124000	123052	53,6
1995	391291	124000	118436	50
1996	446416	124000	117322	51,4
1997	380159	124000	85218	58,3
1998	390789	90000	44800	80,2
1999	389313		30732	87

FUNDICION CHAGRES

Año	Fusión Conc. t/año	Emisión S t/año	Emisión S02 t/año	Captación S %
1993	133547	8724	17448	75,9
1994	128299	6748	13496	80,5
1995	254819	5054	10108	93,5
1996	ND	ND	ND	ND
1997	384499	8488	16976	92,86
1998	408633	5963	11926	94,91
1999	487027	5572	11144	96

FUNDICION CALETONES

Año	Emisión Permitida S02 (t/año)	Emisión SO2 t/año
Desde 1998	--	710000
Desde1999	494000	478000
Desde 2000	494000	
Desde 2001	230000	
Desde 2002	230000	
Desde 2003	*	

PROGRAMA TRABAJO

Actividades	Plazo	2 0 0 0											
		ene.	feb.	mar.	abr.	may.	jun.	jul.	ago.	sep.	oct.	nov.	dic.
Resolución Inicio .	05-Ene												
Reunión Inicio	27-Mar												
Reunión Normas Internacionales	17-Abr												
Reunión Antecedentes Salud	18-Abr												
Reunión Antecedentes Salud	08-May												
Reunión Calidad y Metodologia Medición	22-May												
Reunión inventario Emisiones y Proyección	29-May												
Reunion de PTS	12-Jun												
Reunión Episodios criticos	19/Jun												
Trabajo Interno CONAMA													
Presentación Propuesta a Comités	24-Jul												
Reuniones de Trabajo por Contaminante													
Presentación Anteproyecto Comité	21-Ago												
Anteproyecto	08-Sep												

REVISIÓN NORMAS PRIMARIAS DE CALIDAD DE AIRE
(SO2, CO, NO2, O3 Y PTS)

Actividades	Plazo	2	0	0	0								
		ene.	feb.	mar.	abr.	may.	jun.	jul.	ago.	sep.	oct.	nov.	dic.
Resolución Inicio .	05-Ene												
Reunión Inicio	27-Mar												
Reunión Normas Internacionales	17-Abr												
Reunión Antecedentes Salud	18-Abr												
Reunión Antecedentes Salud	08-May												
Reunión Calidad y Metodología Medición	22-May												
Reunión Inventario Emisiones y Proyección	29-May												
Reunión de PTS	12-Jun												
Reunión Episodios críticos	19/Jun												
Trabajo Interno CONAMA													
Presentación Propuesta a Comités	24-Jul												
Reuniones de Trabajo por Contaminante													
Presentación Anteproyecto Comité	21-Ago												
Anteproyecto	08-Sep												

DESARROLLO DE INVENTARIOS EN LA REGION METROPOLITANA DE SANTIAGO

Marcelo Fernández

Presentación

- Introducción
- Avances en el desarrollo de inventarios
- Como se construyó el inventario
- Resultados:
  - Línea Base de Emisiones 1997-2005

Marcelo Fernández

¿QUE ES UN INVENTARIO DE EMISIONES ATMOSFERICAS?

Es una estimación de todos los contaminantes de interés emitidos a la atmósfera por las diversas actividades de sus habitantes, para un período y área geográfica determinadas.

- Contaminantes: PM, NOx, SOx, CO, COV, Pb, NH3 etc.
- Area Geográfica:Región Metropolitana.
- Actividades:
  - Transporte
  - Industria
  - Servicios
  - Residencias: Calefacción, uso de solventes, pinturas, etc.
- Período: Base anual, invierno/verano, diaria, etc

¿PARA QUE SIRVE?

- Conocer el aporte de cada sector económico a las emisiones totales, lo cual orienta la asignación de responsabilidades y focalización de medidas
- Servir de base a la modelación de dispersión de contaminantes
- Evaluación de estrategias de control de la contaminación atmosférica
- Generar escenarios futuros, de emisión y concentración de contaminantes.
- Para el SEIA (Sistema de Evaluación de Impacto Ambiental), pues permite estimar emisiones de nuevos proyectos.

Marcelo Fernández

Los inventarios de emisiones pueden ser engañosos si nos se los analiza con cuidado

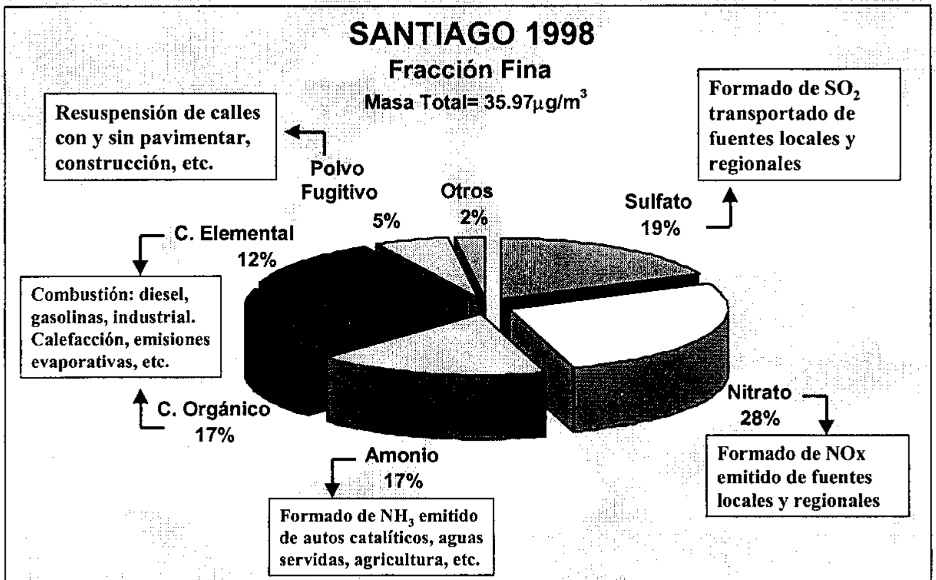
- Son engañosos porque solo representan emisiones primarias.
- Las emisiones se producen a diferente altura.
- Las metodologías de estimación están siendo revisadas constantemente.
- Los niveles de incerteza asociados a las diferentes categorías de fuentes son muy distintos.

Marcelo Fernández

La recomendación es:

"Usarlos acompañados de caracterización química del particulado".

Santiago



AVANCES

- ESTRUCTURA Y ADMINISTRACION
- COBERTURA
- METODOLÓGICAS

Avances en Inventarios de Emisiones en la R.M.

- Estructura y Administración:
  - Estructura: Mayor desagregación de las fuentes, que permite focalizar mejor las estrategias de control.
  - Administración:
    - Se cuenta con el SAIE, orientado a facilitar la construcción y mantención de inventarios
    - Aplicable a cualquier región del país

…..Avances, continuación

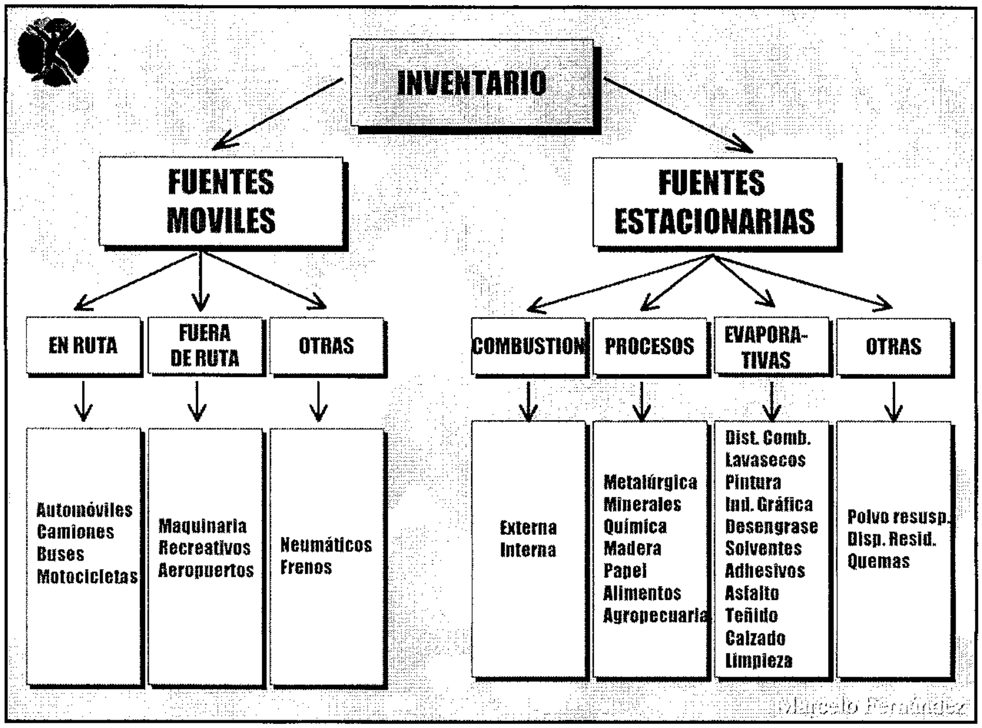
- Cobertura del Inventario:
  - Geográfica: Emisiones estimables a nivel regional, provincial o comunal.
  - Contaminantes:
    - Se agregó un inventario de Amoniaco NH3.
    - El SAIE puede estimar las emisiones de cualquier contaminante en la R.M.
  - Fuentes emisoras: Se han incluido fuentes no consideradas hasta ahora:
    - Fuentes móviles Fuera de Ruta: Aeropuertos, maquinaria.
    - Fugas de LPG, importantes para fotoquímica.
    - Aplicación de asfalto, uso de adhesivos, etc.

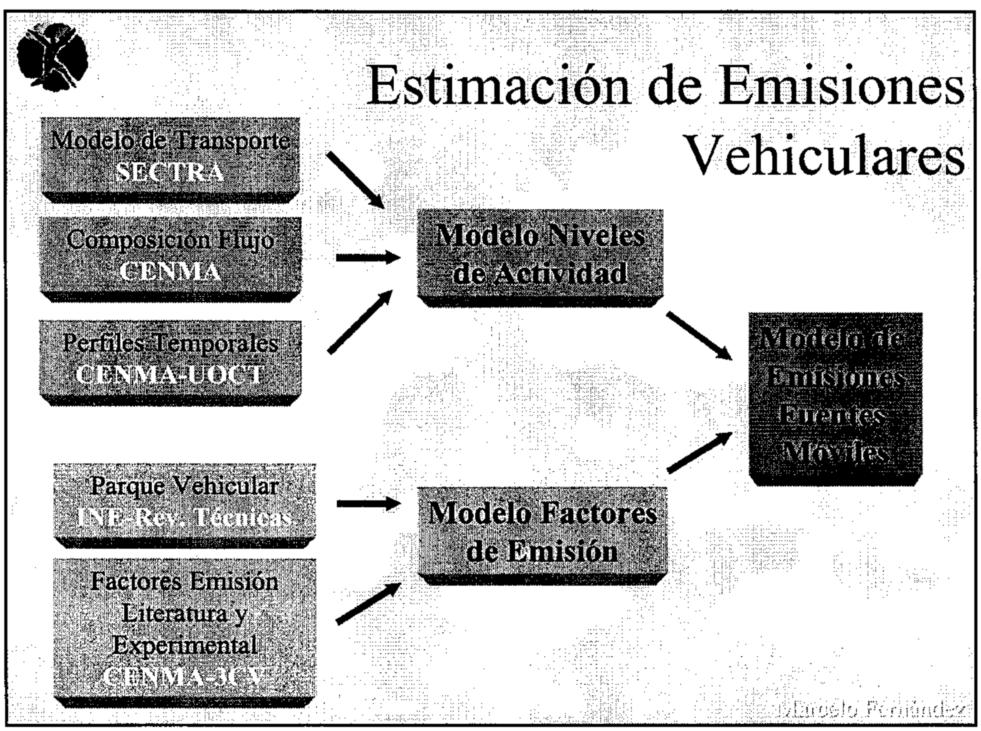
Marcelo Fernández

…..Avances, continuación

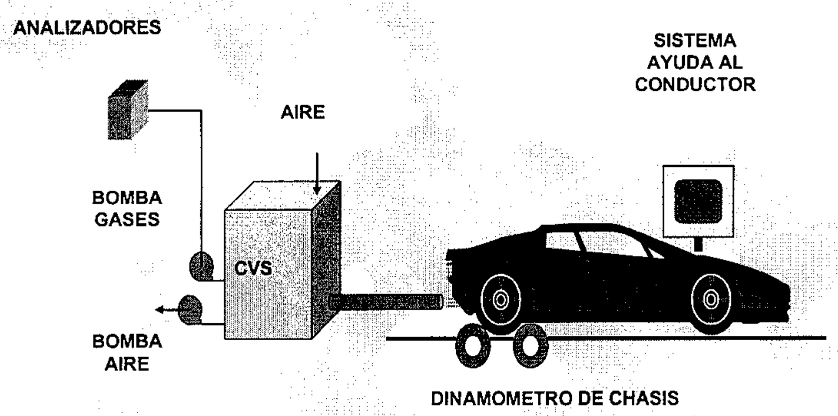
- Metodológicos:
  - Factores de Emisión:
    - Caracterización de fuentes fijas permitió asociar mejores FE EPA para estimar gases.
    - Se cuenta con FE en función de la velocidad para vehículos livianos convencionales y catalíticos.
  - Niveles de Actividad:
    - El principal avance ha sido en fuentes móviles, pues se están usando datos corregidos de la SECTRA para la línea base 1997-2005.

Marcelo Fernández

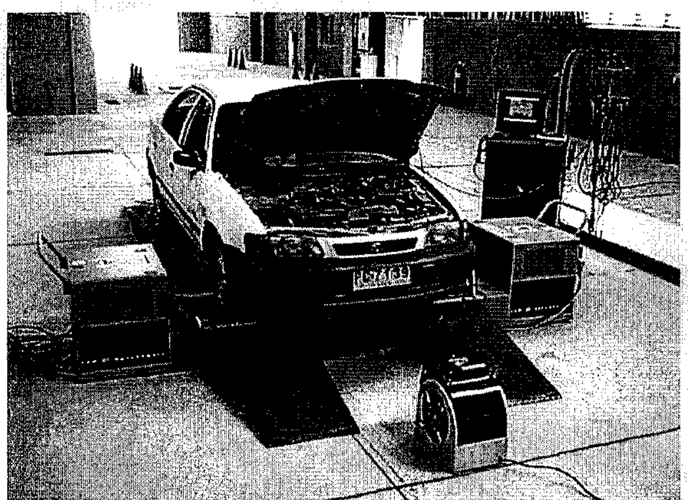

INVENTARIO
FUENTES MOVILES
FUENTES ESTACIONARIAS
EN RUTA
FUERA DE RUTA
OTRAS
COMBUSTION
PROCESOS
EVAPORA-TIVAS
OTRAS
Automóviles
Camiones
Buses
Motocicletas
Maquinaria
Recreativos
Aeropuertos
Neumáticos
Frenos
Externa
Interna
Metalúrgica
Minerales
Química
Madera
Papel
Alimentos
Agropecuaria
Dist. Comb.
Lavasecos
Pintura
Ind. Gráfica
Desengrase
Solventes
Adhesivos
Asfalto
Teñido
Calzado
Limpieza
Polvo resusp.
Disp. Resid.
Quemas
Marcelo Fernández


Estimación de Emisiones Vehiculares
Modelo de Transporte SECTRA
Composición Flujo CENMA
Perfiles Temporales CENMA-UOCT
Modelo Niveles de Actividad
Modelo de Emisiones Fuentes Móviles
Parque Vehicular INE-Rev. Técnicas
Modelo Factores de Emisión
Factores Emisión Literatura y Experimental CENMA-3CV
Marcelo Fernández

Medición de Factores de Emisión



Medición de Factores de Emisión



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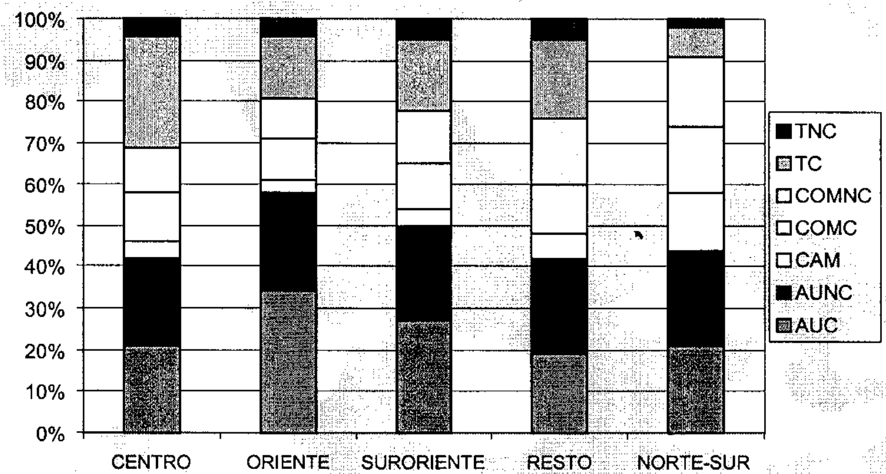
COMPOSICIÓN FLUJO

Transporte Privado



Marcelo Fernández

RESULTADOS ESPERABLES PARA EL AÑO EN CURSO

Marcelo Fernández

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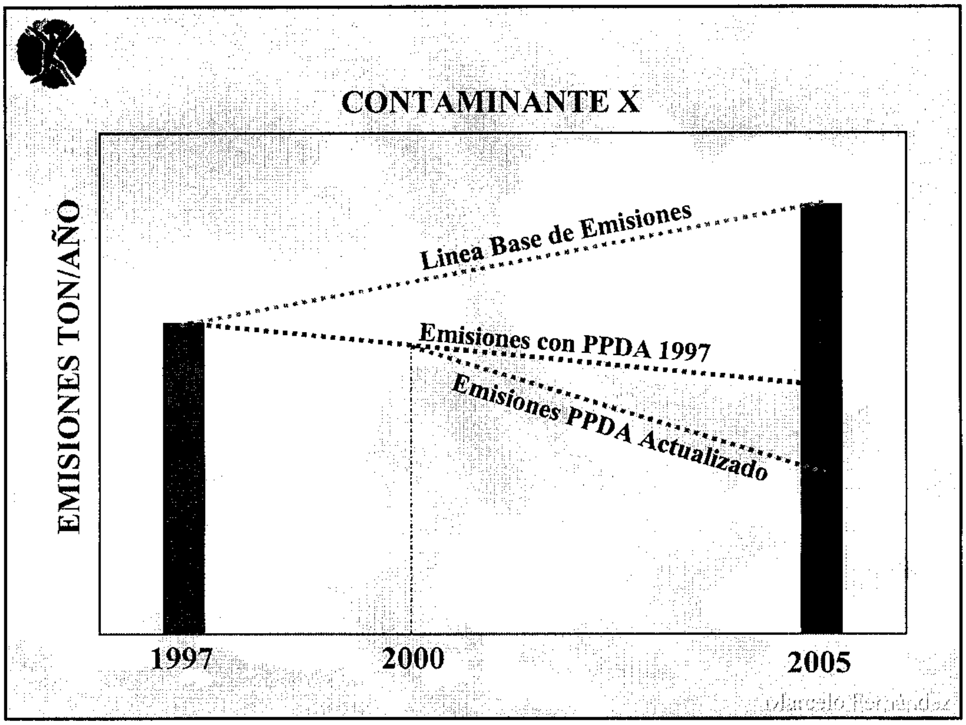
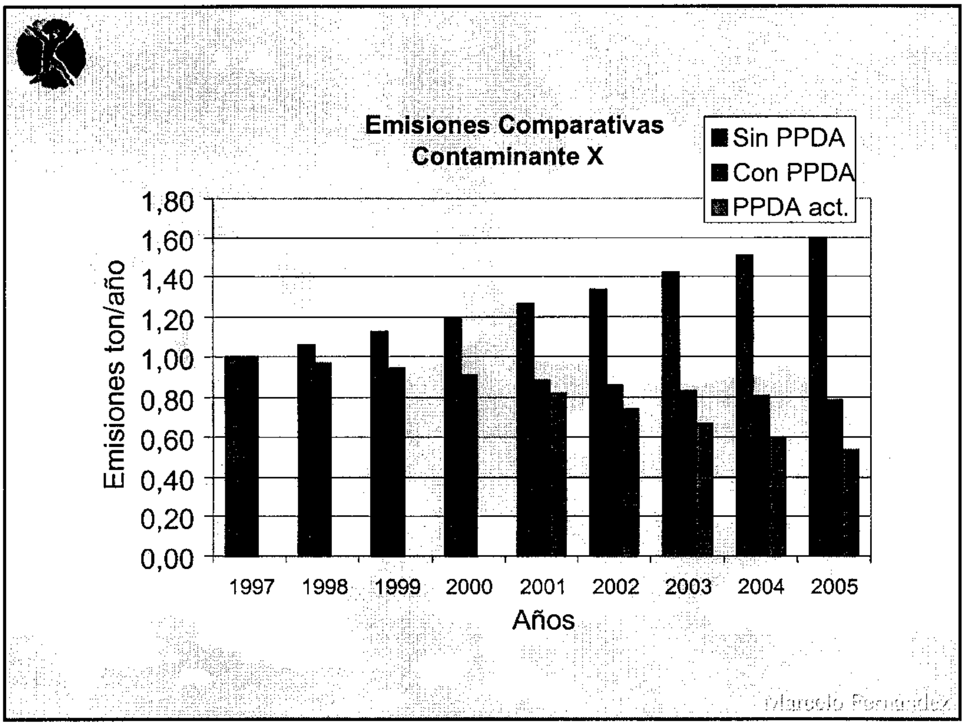

CONTAMINANTE X
EMISIONES TON/AÑO
Linea Base de Emisiones
Emisiones con PPDA 1997
Emisiones PPDA Actualizado
1997
2000
2005
Marcelo Fernández


Emisiones Comparativas
Contaminante X
Sin PPDA
Con PPDA
PPDA act.
Emisiones ton/año
1,80
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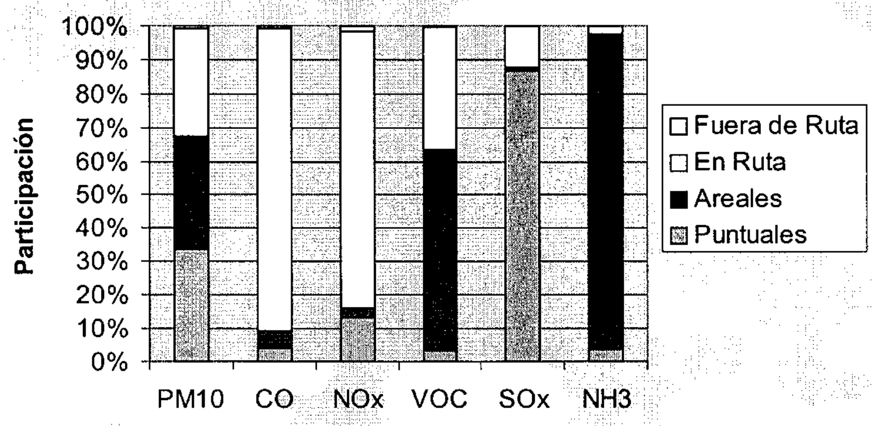
0,00
1997
1998
1999
2000
2001
2002
2003
2004
2005
Años
Marcelo Fernández

RESULTADOS

Línea Base de Emisiones
1997-2005

Inventario Emisiones Base 1997



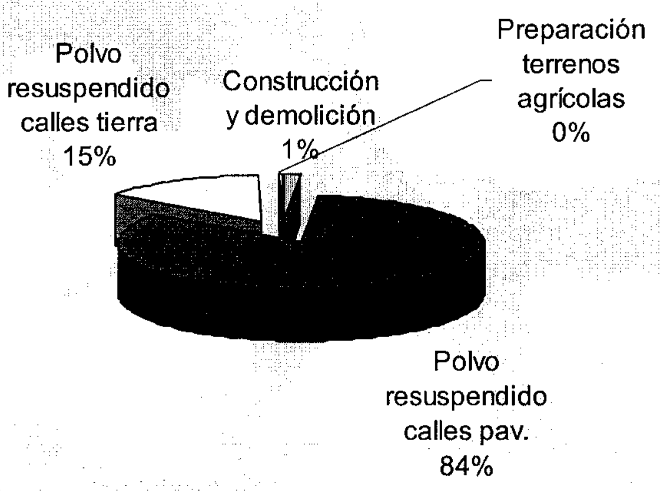
INVENTARIO 1997

Emisiones de Fuentes Móviles

CATEGORIA	SUB-CATEGORIA	MP [ton/año]	CO [ton/año]	NOx [ton/año]	VOC [ton/año]	SOx [ton/año]	NH3 [ton/año]
Buses	Pre-EPA91	762.38	3592.66	10383.90	1206.39	617.20	1.77
	EPA91	220.55	1070.89	4333.28	539.39	367.95	1.05
	EPA94	66.68	469.81	1697.37	276.08	201.78	0.58
	Interurbanos	163.11	760.57	2537.69	209.98	158.98	0.56
	Pullman	111.49	503.50	2043.86	290.70	148.53	0.65
Camiones	2 Ejes	516.70	2194.71	4685.23	1219.91	422.89	2.37
	más de 2 ejes	469.65	1670.75	6791.35	904.23	514.27	1.97
Particulares	Catalíticos	52.99	18470.70	4100.09	2752.42	118.70	282.63
	No Catalíticos	45.07	107421.12	6064.73	10516.30	112.07	6.84
Taxis	Catalíticos	27.05	10298.32	2175.04	1472.79	61.65	144.24
	No catalíticos	6.93	18529.81	1019.05	1778.40	17.86	1.06
Comerciales	Catalíticos	30.49	10185.41	1603.81	1224.18	94.71	4.65
	No catalíticos	16.89	29021.23	2331.02	4787.00	51.90	2.57
	Diesel	159.54	613.31	585.76	138.30	121.13	0.53
Motocicletas	2 Tiempos	0.52	1125.27	1.97	511.49	0.79	0.10
	4 Tiempos	1.05	1746.64	15.38	297.43	2.17	0.20
TOTAL FTES MOVILES EN RUTA		2651.09	207674.69	50369.53	28124.99	3012.57	451.75

Marcelo Fernández

Emisiones de Polvo Natural



Marcelo Fernández

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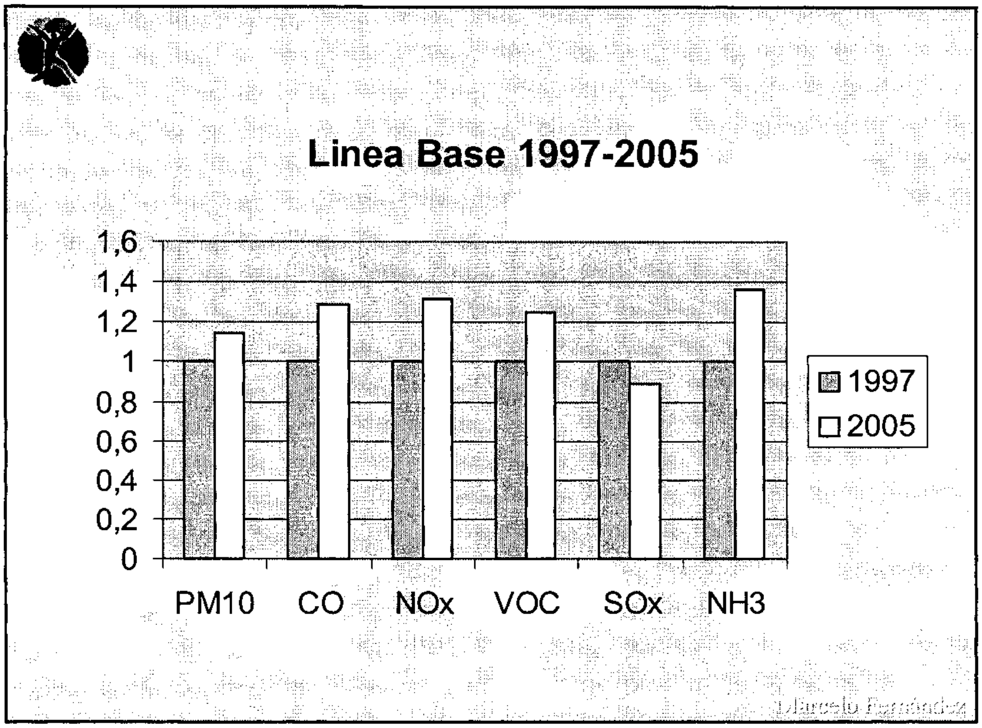

Linea Base 1997-2005
1,6
1,4
1,2
1
0,8
0,6
0,4
0,2
0
PM10
CO
NOx
VOC
SOx
NH3
1997
2005
Marcelo Fernández

GOBIERNO DE CHILE
COMISION NACIONAL DEL MEDIO AMBIENTE

Reunión "Revisión Normas Primarias de Calidad de Aire para SO_2, PTS, CO, NO_2 Y O_3"
Santiago, 2 de junio 2000

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000583

Comisión Nacional del Medio Ambiente
Departamento de Descontaminación Planes y Normas

Revisión Normas Primarias de Calidad de Aire para SO2, CO, O3, NO2 y PTS

ACTA DE REUNIÓN DE COMITÉS OPERATIVO Y AMPLIADO

FECHA REUNION: 02 de junio de 2000
LUGAR: CONAMA, Obispo Donoso 6. Santiago
ASISTENCIA: Se adjunta hoja de asistencia

Tabla:
1. Partículas Totales en Suspensión

Discusión:

- Andrea Muñoz presenta los antecedentes relativos a origen del material particulado, efectos en la salud y gestión ambiental.
- Carlos Salvo (CHAGRES) señala que los antecedentes señalados solo están asociados a la minería y que el material particulado no es solo atribuible a esta actividad. Al respecto indica que el análisis es sesgado y solicita que no se incluyan estos en el expediente público de la norma. CONAMA indica que estos antecedentes son públicos y que se adjuntarán al expediente de la norma. Sin embargo, indica que la solicitud realizada puede ser enviada por escrito y fundada, para ser incorporada al expediente. CONAMA señala además, que los antecedentes mostrados no apuntan a una actividad en particular, sino que solo tienen por objetivo analizar la toxicidad que el material particulado puede tener dependiendo de su composición y toxicidad y que esto depende del origen. En lo que respecta a la salud de la población, CONAMA señala que los efectos en salud están asociados a la fracción fina del material particulado, que es inhalado.
- CONAMA señala que los componentes tóxicos del material particulado en lo que respecta a la fracción gruesa (> a 10 um) tales como plomo y arsénico ya cuentan con norma específica por lo que están regulados.
- Alejandro Diez (ENAMI) consulta si se tienen antecedentes de la composición del material particulado en la fracción gruesa a nivel urbano. CONAMA señala que estos antecedentes se están recopilando, pero reitera que los componentes más tóxicos de este se encuentran en la fracción fina del material particulado.
- Anibal Mesh (SOFOFA), señala que sería conveniente complementar los antecedentes presentados en cuanto a fuentes emisoras de material particulado, como por ejemplo quemas agrícolas.
- Juana Galaz (Asesora CONAMA), señala que si bien la información se podría complementar, en la minería las particulas gruesas están asociadas a la fase de explotación de la mina y la toxicidad a ese nivel es la que tiene naturalmente el

material, por otro lado habría que considerar que los compuestos tóxicos del material particulado, en su fracción gruesa están normados (plomo, arsénico) por lo que el tema a discutir es si se requiere mantener la norma para PTS.

Rodrigo Lucero Ch.

GOBIERNO DE CHILE
COMISION NACIONAL DEL MEDIO AMBIENTE

Reunión "Revisión Normas Primarias de Calidad de Aire para SO2, PTS, CO, NO2 Y O3"
Santiago, 2 de junio 2000

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22.					
23.					
24.					

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PARTICULAS TOTALES EN SUSPENSION

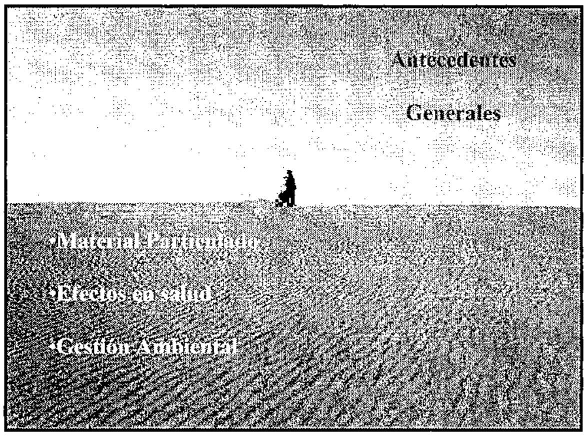
GOBIERNO DE CHILE
COMISION NACIONAL DEL MEDIO AMBIENTE

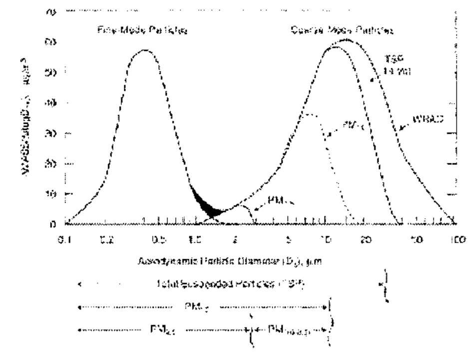
REVISION
NORMA PRIMARIA DE CALIDAD
PARA PARTICULAS TOTALES EN SUSPENSION

CONAMA
Dpto. Descontaminación, Planes y Normas
Junio 2000

Fuentes utilizadas en la recopilación de antecdentes

- Estudio SGA
- Inventario de emisiones CONAMA RM
- Estudio calidad del aire en 5 ciudades
- Estudio Determinación Línea Base As
- Estudio Evaluación contaminación atmosférica en zonas con aportes de fuentes naturales y antropgénicas: caso Andacollo (Geotecnica)
- Expediente Público Norma Plomo
- Guías para calidad del aire OMS, 1999
- Environmental Toxicology 1998
- Tesis, Javier García





Source: USEPA, 1996

PARTICULAS FINAS

Partículas finas primarias son directamente emitidas y se forman por condensación de vapores a muy alta temperatura durante la combustión

Las partículas finas secundarias se forman usualmente desde gases por tres vías:

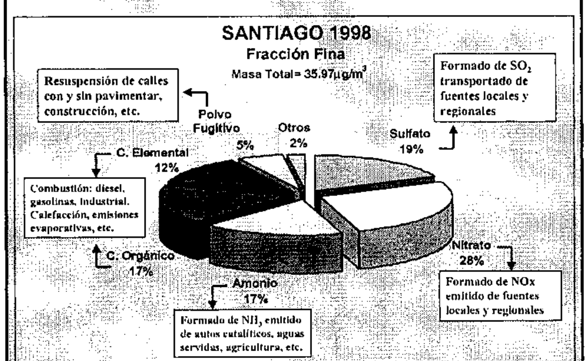
nucleación (moléculas de gases se unen a formar una partícula nueva),

condensación de gases sobre partículas existentes

por reacción de gases absorbidos en gotitas líquidas.

Las partículas formadas por nucleación pueden también coagular para formar partículas de diámetro entre 0.1 y 1 um

Aunque algunas de estas partículas se encuentran en la fracción fina, las partículas secundarias dominan la masa de la fracción fina



PARTICULAS GRUESAS

Son formadas, en su mayoria, directamente desde las fuentes como partículas

a partir de procesos mecánicos (aplastamiento, molienda, etc.)

en procesos de combustión, como la ceniza volante

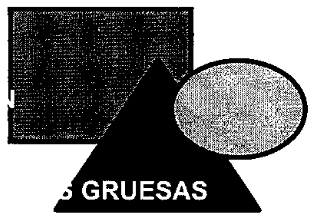
materia biológica como bacterias, polen y esporas

Porcentaje de contribución de las diferentes fuentes a las concentraciones de partículas gruesas

TEMUCO		
FUENTES	%PM - 2,5	%PM - 10
Combustión de Leña	41	29
Sulfuros	29	20
Tráfico Vehicular	26	26
Suelo	2	22
Mar	2	3

RANCAGUA		
FUENTES	%PM - 2,5	%PM - 10
Quema de Leña	37	23
Tráfico Vehicular	30	9
Fundición	27	22
Industria Metalmecánica	4	5
Suelo	2	41

VALPARAISO		
	PM - 2,5	PM - 10
Suelo	1	36
Fundición	6	6
Petróleo	2	2
Tráfico Vehicular	21	11
Fuente de Azufre	40	27
Quema de leña	30	14



EROSION EOLICA

•Una cierta fracción o porcentaje de partículas presentes en una superficie de suelo natural, pila de mineral, o cualquier material granular expuesta al viento son suceptibles de ser emitidas

•La fuerza del viento mueve las partículas del suelo por medio de tres modos de transporte:

- •salto
- •arrastre desde la superficie
- •suspensión

•El salto describe el proceso que sufren las partículas de diámetro entre 75 y 500 um, que son rápidamente arrancadas de la superficie y saltan o rebotan dentro de una capa cercana a la interfase suelo-aire

•Las partículas transportadas por arrastre se encuentran en el rango de diámetros entre 500 y 1000 um. Estas partículas se mueven muy cerca del suelo propulsadas por la fuerza del viento y por el impacto de las pequeñas partículas transportadas por salto

•Partículas con diámetros menores a 75 um se mueven por suspensión y tienden a seguir los flujos de aire.

•Si ocurre un viento suficientemente intenso, estas partículas son emitidas a la atmósfera, ya sea en un único evento de viento fuerte o en varios eventos sucesivos, hasta que la superficie pierda la condición de "erosionable".

•Después de ocurrida la erosión las partículas más gruesas pasan a constituir una cubierta protectora

•Sin embargo, diversas actividades o acciones desarrolladas sobre la superficie pueden otorgar una nueva condición de "erosionable"

RESUSPENSION DE POLVO EN CAMINOS NO PAVIMENTADOS

El tránsito de vehículos en calles y caminos no pavimentados (de tierra) genera emisiones de polvo por:

- pulverización del material rodado (por fricción y abrasión) causado por neumáticos y la turbulencia aerodinámica producida por el paso de vehículos a cierta velocidad

RESUSPENSION DE POLVO EN CAMINOS PAVIMENTADOS

El tránsito de vehículos en calles y caminos pavimentados genera emisiones de polvo, pero en cantidades significativamente inferiores a un camino de tierra

•El polvo emitido está mayormente constituido por materiales de origen mineral (suelo natural) depositadas en el pavimento

EMISION POR TRASPASO DE MATERIAL GRANULAR

Operaciones donde material es traspasado desde un recipiente hacia otro recipiente o superficie receptora

•la fricción interna de las partículas genera partículas más finas y

•la caída libre ocasiona la puesta en suspensión de éstas en el aire (turbulencias aerodinámicas también pueden contribuir al aumento de las emisiones)

EMISION POR CHANCADO DE MINERAL

•Los factores que más inciden en la emisión son:

•dureza y humedad de la roca
•contenido de finos
•el tipo de equipos involucrados
•prácticas de operación
•condiciones meteorológicas (viento y precipitación)

EMISION POR TRONADURA

•Genera el desprendimiento del material, y también la pulverización y trituración de parte de él.

•En momento de la tronadura (un par de segundos), se generan cantidades relativamente significativas de polvo, aunque con baja frecuencia (1 o 2 veces al día).

Los tipos de emisiones antes señaladas presentan las siguientes características:

•Son procesos físicos que no involucran transformaciones químicas del material

•Sólo se ven afectadas las características físicas (tamaño y forma de las partículas).

•En minería se generan en procesos de extracción y procesamiento de mineral (operaciones de molienda y concentración de mineral)

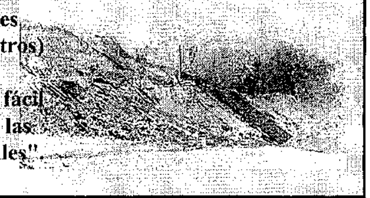
•Tienen la misma composición química y mineralógica que el mineral extraído

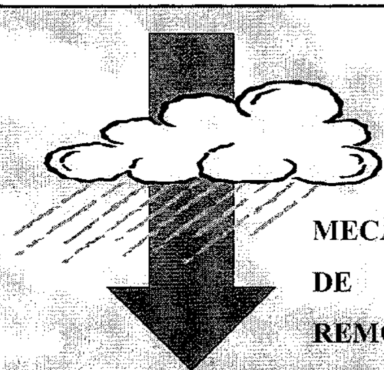
•Resulta difícil distinguir entre partículas "naturales" y partículas "antropogénicas"

A diferencia de las anteriores, las partículas metalúrgicas generadas en las fundiciones tienen características distintas

- Generalmente, son productos oxidados enriquecidos en compuestos volátiles (cinc, arsénico, y otros)

- Es relativamente fácil diferenciarlas de las partículas "naturales".





MECANISMOS DE REMOCION

Coagulación

- afecta preferentemente a las partículas pequeñas en el rango de 0.001-0.1 um, llamadas de Aitken o núcleos de Aitken

Precipitación

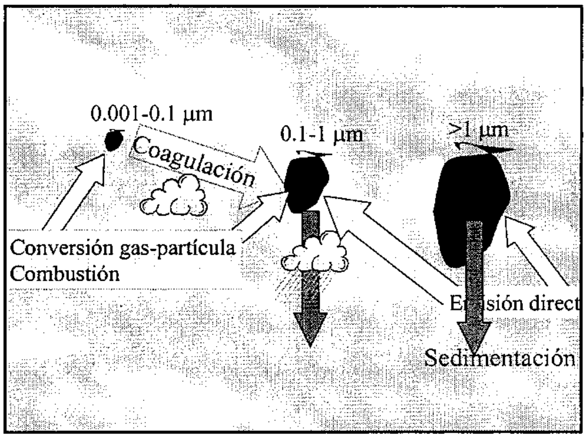
- es dominante para las partículas en el rango 0.1-1 um, llamadas en el "modo de acumulación" pero también es eficiente para partículas de hasta 10 um

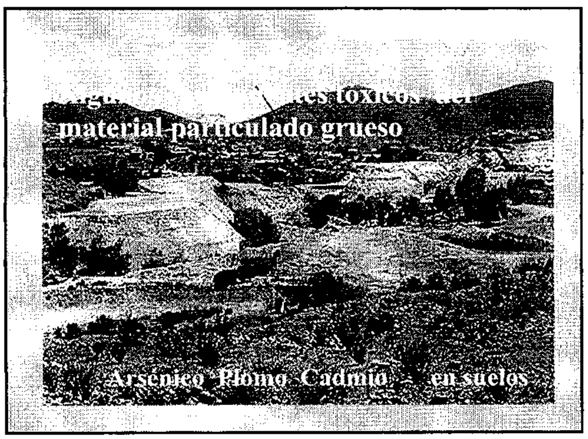
Sedimentación

- proceso de remoción dominante para aquellas partículas de radios superiores a 10 um

•El tamaño y la dimensión de las partículas definen la velocidad con que éstas sedimentan

•Al comparar la cantidad de partículas de gran tamaño con la cantidad de partículas de menor tamaño (MP10) se puede deducir un indicador de la distancia desde la fuente: a mayor distancia de la fuente se observan menos partículas gruesas





•El país posee lo básico para desarrollar una actividad minera de importancia: cuantiosos yacimientos metálicos

•Parte importante del territorio nacional posee en forma natural un alto fondo metálico, quizás largamente por encima de las regiones del planeta con menor riqueza geoquímica

•La actividad minera histórica y actual ha mostrado que en torno a fundiciones se encuentran aumentos metálicos en la superficie de suelos

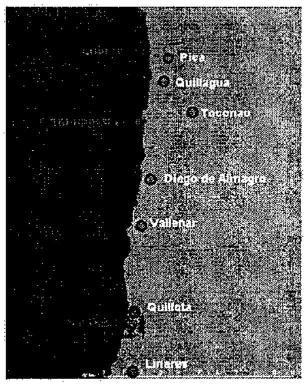
•En nuestro país existen escasos antecedentes de arsénico en los suelos

•Se espera encontrar arsénico de origen natural de los suelos y arsénico antropogénico depositado sobre los suelos

•Estudio Determinación de Línea Base Nacional de As en PM10 (en ejecución) midió concentraciones de As en muestras de suelo (capa superior) en 7 lugares del país

•Se escogieron en lo posible lugares fuera del ambiente urbano y los más lejos posible de fuentes locales de arsénico.

•Los lugares están suficientemente distantes de las fundiciones de cobre para evitar niveles altos de As directamente emitido. Esto significa distancias superiores a 50-100 km.



Resultados preliminares (1 sólo punto), registran un índice alto de 291 mg/kg (Quillagua), comparado con 79 mg/kg en el segundo punto más alto (Pica).

En Quillagua se espera encontrar arsénico transportado por el Río Loa, que atraviesa la zona mineras de Chuquicamata.

Una publicación reciente, Matschullat (2000), entrega para la concentración de As en suelos un promedio global (mundial) en el rango de 5 a 7 mg/kg, con una variación local grande

En Austria el nivel de As natural puede llegar hasta 100-115 mg/kg.

Entre 1981 y 1990 el INIA estudió el contenido en suelos de algunos elementos metálicos. Algunas conclusiones fueron:

- El elemento más importante en términos de contaminación de suelo es el cobre, presente en algunos sectores en niveles muy elevados, significativamente por encima de los valores naturales basales definidos en literatura internacional

•En relación al plomo, resaltó la concidencia de sus máximos promedios y absolutos con los de cobre (exceden nivel nativo) en el Valle Aconcagua, lo que evidencia una asociación a nivel de proceso contaminante (fundición)

•El perfil de cadmio indicó una asociación con cobre en la V Región, la VI Región y la RM, aludibles a emisiones de centros mineros

•En la V Región la presencia de cadmio sólo se detectó en las vecindades de las fundiciones de cobre

•En área de Puchuncaví se detectó importante acumulación metálica en suelos vecinos a zona industrial de Ventanas, que disminuye al alejarse de ésta.

EFECTOS EN SALUD

•Los efectos biológicos de las partículas dependen de :

- •las características físico-químicas
- •la forma de distribución
- •la deposición en el árbol respiratorio

•Un componente importante es el tamaño ya que determina el mayor o menor grado de depósito en la vía respiratoria

•Prácticamente todos los estudios que utilizan series de tiempo y comparan los niveles de contaminación diarios con el número de consultas y admisiones han encontrado relación entre contaminación atmosférica por partículas y aumento de las admisiones y consultas por enfermedades respiratorias y cardiovasculares, especialmente en ancianos.

•Se ha observado que las partículas finas (<2.5um) predicen un mayor porcentaje de muertes, que las entre 2.5 y 10 um

•En Chile se han realizado varios estudios que han mostrado el efecto de los niveles de contaminación del aire, especialmente por partículas, sobre mortalidad diaria, consultas y síntomas respiratorios

•Las partículas >10 um sólo se depositan en la traquea y son limpiadas por los cilios a través de la formación de mucus y son expulsadas a través de la tos o tragar

Arsénico

•Ha sido clasificado por la Agencia Internacional de Investigaciones del Cáncer como agente cancerígeno comprobado

•Puede causar cáncer en tejidos en la boca, esófago, laringe y vejiga

•Puede causar dermatitis y bronquitis

Cadmio

•Presenta un ato riesgo para la salud humana por su fuerte carácter tóxico y por la facilidad con que entra a ser transferido dentro de cadenas tróficas

•Una vez absorbido por el ser humano se acumula en el riñon, hígado y órganos reproductivos.

•Dosis muy bajas puede producir vómito y diarrea.

•Exposición continua al cadmio puede causar hipertensión, efecto crdiovascular y muerte prematura

Plomo

•Los efectos tóxicos del plomo se ven fundamentalmente en el sistema nervioso central, pero prácticamente todos los sistemas pueden ser dañados a dosis altas de exposición.

•Recientes estudios internacionales han revelado diversos efectos del plomo en niños pequeños: efectos neurológicos (hiperactividad, trastornos de la atención) psicológicos (trastornos conductuales), hematológicos (anemia), metabólicos y cardiovasculares.

La recopilación de antecedentes realizada por SGA indica que ninguno de los estudios nacionales más relevantes con respecto a contaminación por MP ha vinculado efectos en salud con PTS, sino que todos han usado MP10 como indicador del factor de riesgo a la salud

GOBIERNO DE CHILE
COMISION NACIONAL DEL MEDIO AMBIENTE

GESTION AMBIENTAL

›Normativas internacionales/nacional
›Fiscalización
›Cumplimiento

		TSP		
	Pays	1 h	24 h	1 y
	WHO 1987		120	
	WHO 1999			
Europe UE	Union européenne			
	Allemagne			
	Anglaterre			
	Autriche			
	Belgique B			
	Belgique F			
	Belgique W			
	Denmark			
	España			
	France			
	Grece			
	Irlande			
	Italia		150	150
	Louxembourg			
	Pays Bas			
	Portugal			150
	Suède			

	Pays	TSP 1 h	TSP 24 h	TSP 1 y
Europe	Albanie			
	Bosnia-H			
	Bulgaria			
	Croacie			300
	Czech R.		150	60
	Estonia	500	150	
	Finlandia		20	50
	Hungary			
	Latvia			
	Liechtenstein			
	Lituania			
	Macedonia			
	Noruega			
	Poland			
	Romania			
	Slovak		150	60
	Slovenia			
	Suisse		*150*	*70*

	Pays	TSP 1 h	TSP 24 h	TSP 1 y
Amerique du Nord				
	EPA (USA) 1997			
	Georgia			
	Florida			
	Washington		150	60
	California			
	Canada		120	60
Amérique Latine				
	Chili		260	75
	Mexico		260	75
	Brasil		240	80
	Venezuela			

	Pays	TSP 1 h	TSP 24 h	TSP 1 y
Asie				
	Chine		*300*	*120*
	Inde		200	140
	Hong-Kong			
	Israel		200	75
	Japon			
	Liban		120	
number of records		1	16	15
max		500	300	300
min		500	20	50

FISCALIZACION Y CUMPLIMIENTO

•Los Servicios de Salud han abandonado las PTS como los mejores indicadores del efecto en la salud de las partículas

•Esto se traduce que los Servicios de Salud han reemplazado paulatinamente la fiscalización del PTS por la del PM10

•En Santiago se mantiene una Red de Vigilancia que mide PTS, pero esta red no es considerada para los efectos de la fiscalización de la calidad del aire en la RM

Nivel de cumplimiento de Normas Diarias de Partículas en Suspensión

CIUDAD	PTS (% de cumplimiento)
Santiago (1990) Santiago (1991) Santiago (1992) Santiago (1993) Santiago (1994) Santiago (1995)	45.00 39.39 45.83 53.52 63.73 49.43
Antofagasta (enero – febrero 1990) Antofagasta (octubre 1991) Antofagasta (agosto – diciembre 1994) Antofagasta (marzo – junio 1995)	100.00 66.66 80.00 75.86
Rancagua (agosto – septiembre 1996)	73.33

De los antecedentes disponibles se desprende:

•Partículas finas (< 2.5 um) presentan diferencias importantes en sus características físico-químicas, fuentes de emisión, comportamiento en la atmósfera y riesgos en salud en relación a aquellas > 2.5 um

•Partículas gruesas sobre 10 um no son respirables y por lo tanto no presentan los efectos en salud atribuibles a aquellas respirables (MP10)

•No se cuenta con una evaluación de riesgo que evidencie la relación entre la exposición a PTS (compuestos tóxicos) y la ocurrencia de enfermedad

•En zonas urbanas la resuspensión de polvo (suelos) es una importante fuente de partículas gruesas

•En zonas mineras las emisiones fugitivas o de chimeneas de fundiciones contienen una concentración significativamente mayor de compuestos volátiles tóxicos en comparación a procesos de extracción, molienda y concentración de mineral (origen natural)

•El material particulado grueso mayormente tóxico sedimenta en las cercanías a fundiciones

•Existe una norma de emisión de Arsénico para fundiciones de cobre y oro

•Está aprobada por Consejo de Ministros una norma de calidad primaria para plomo en aire

• Existe una norma de PM10 promedio para 24 hrs., actualmente en proceso de revisión

•Existe una norma de PTS diaria y anual (1978), cuyos valores están asociados a efectos en salud relativos a la fracción >10 um y sin aplicación efectiva

DISPUTADA

Chagres, 2 de Junio de 2.000

Señores
Comisión Nacional del Medio Ambiente
CONAMA CENTRAL
SANTIAGO
Presente

COMISION NACIONAL DEL MEDIO AMBIENTE
OFICINA DE PARTES Y ARCHIVO
Nº INGRESO: 5743/4954.
FECHA: -5 JUN 2000
DESPACHADO:
OBS.: R. Lucero

21084

At. : Sr. **Rodrigo Lucero.**
Depto. de Descontaminación, Planes y Normas

Estimado Señor:

De acuerdo a su solicitud de datos de nuestra red de monitoreo, anviamos a Ud. la información de los años 1998, 1999 y de enero a abril del presente.

La información será entregada en planillas Excel por el Sr. Carlos Salvo.

Sin otro particular, saluda atentamente a Uds.

Miguel Angel Duran V.
Gerente General Fundición Chagres

COMPAÑIA MINERA DISPUTADA
DE LAS CONDES LTDA.
Av. Pedro de Valdivia 291
Casilla 16178
Santiago, Chile
Teléfono: 2306000
Fax: 2306700
Télex: 341621 CMDLC

CSP/ CG80020d.00

CONAMA, datos red monitoreo 98 a 2K.DOC

noranda

Noranda Chile S. A.
Fundición Altonorte

Avda. Rendic 5032, Casilla 740
Antofagasta, Chile
Fono (56) 55 - 630100

000007

Antofagasta, Junio 7 del 2000
G.G.N°065/2000

COMISION NACIONAL DEL MEDIO AMBIENTE
OFICINA DE PARTES Y ARCHIVO
Nº INGRESO: 6189/5366
FECHA: 14 JUN 2000
DESPACHADO:
OBS.: P. Matus
1452
21423 x Correo.

Señora
Patricia Matus C.
Jefe Depto Descontaminación Planes y Normas
COMISION NACIONAL DEL MEDIO AMBIENTE
Presente

Ref: Consulta sobre factibilidad de cambio de Norma Calidad de aire por SO2.

De nuestra consideración:

Con relación a la consulta de la referencia nos permitimos informar a Ud. que, nuestra Fundición cuenta con una red de monitoreo compuesta por tres estaciones, una de ellas ubicada en el sector Coviefi de Antofagasta, otra en el sector de la Negra y la tercera en una zona desértica al Sur Este. Las dos primeras corresponden a sectores residencial e industrial y la tercera que es operada con el objetivo de evaluar la zona de máxima concentración a nivel de superficie. Inicialmente ubicada dentro del predio industrial fue trasladada al exterior por mandato del Servicio de Salud de Antofagasta.

Como consecuencia del régimen de vientos imperante en esta zona, las concentraciones de punta se producen generalmente entre las 7 y 13 AM, por lo que hemos desarrollado un Plan de Contingencias, que incluye desde la reducción de flujos hasta la detención total del proceso productivo en caso de alerta en la estación La Negra. Aunque esto implica pérdidas de producción, gracias a este procedimiento las estaciones con representatividad poblacional, cumplieron con la normativa vigente por SO2 durante todo 1999 y lo que va corrido de este año. El nivel 250 tampoco fue excedido en este período, lo que podría hacer factible considerar como viable una norma de 24 horas de ese valor.

Distinta es la situación de la estación ubicada en la zona Sur Este de la planta, cuya media anual fue de 162 ugr/m3 en 1999 con 12 días sobre 365 y 51 días sobre 250. Esta estación no tiene representatividad poblacional, no fue incluída en la Resolución que autorizó la actual operación y no ha sido considerada por parte de las Autoridades, en la evaluación de cumplimiento ambiental de esta Fundición. No obstante lo anterior, Noranda Chile S.A., por mandato de su Política Ambiental, ha asumido como objetivo que la normativa se cumpla en toda la red. Por otra parte la condición de desértica de la zona podría variar en el eventual caso de instalación de nuevas empresas.

En este contexto, se ha evaluado que los cambios tecnológicos introducidos en la Fase III de expansión, permitirán satisfacer la actual Normativa Ambiental de SO2 en ese sector. Esta expansión empezará a operará a partir del año 2003. Considera la sustitución del Horno de Reverbero por un reactor continuo y la instalación de una tercera planta de ácido entre otros cambios.

La modificación de la Normativa vigente, a valores por debajo de 365 como media diaria, introduce un cambio significativo en los parámetros del proyecto, implica una revisión de los objetivos planteados y no resulta factible evaluar dentro de la fecha solicitada.

Nos ponemos a su disposición y la saludamos atentamente,

MW Petersmeyer

Mark Petersmeyer
Gerente General

MWP/ECJ
c.c.: Archivo G.G.

000609

CODELCO-CHILE

CHUQUICAMATA EL SALVADOR ANDINA EL TENIENTE

CORPORACION NACIONAL DEL COBRE DE CHILE

Huérfanos 1270 - Cables CODELCO-CHILE - Casilla 150-D-Télex 240672/ Cupru CL - 441039 Cupru CZ

GMA-259/00

Santiago, 09 de Junio de 2000-06-09 21731

COMISION NACIONAL DEL MEDIO AMBIENTE
OFICINA DE PARTES Y ARCHIVO
Nº INGRESO: 6219 / 5388
FECHA:
DESPACHADO: 14 JUN 2000
OBS.: 15 JUN 2000

Sra.
Patricia Matus C.
Jefe Depto. Descontaminación
Planes y Normas
Comisión Nacional del Medio Ambiente
PRESENTE

Ref: **Revisión de Normas Primarias de Calidad del Aire**

Estimada Sra. Matus:

Damos respuesta a su Of. Ord N°001905, del 15.05.00, en el que nos solicita información fundada respecto a la factibilidad de reducir emisiones y el plazo requerido para alcanzar en áreas poblacionales un nivel máximo de concentración de SO_2 de 250 ugr/Nm3 y niveles intermedios en el rango comprendido entre el anteriormente señalado y 365 ugr/Nm3, como media de 24 hrs.

Nuestras fundiciones se encuentran analizando distintos escenarios al respecto y haremos llegar a Ud. esta información tan pronto dispongamos de ella. Sin embargo, en forma preliminar, podemos anticipar a Ud. la siguiente:

División Chuquicamata: mientras se mantenga el campamento habitado, no existe posibilidad de dar cumplimiento integral a los niveles antes señalados. No obstante, una vez evacuado el campamento, no existirán problemas al respecto, dado que la incidençia de los gases de la fundición sobre Calama son mínimos. La evacuación total del campamento se espera para el año 2003.

División Salvador: habiéndose ya evacuado el campamento de Potrerillos, no habría problemas en dar cumplimiento a dichos niveles en áreas poblacionales.

División El Teniente: las aplicaciones del modelo de difusión para 250 ugr/Nm3 han dado resultados negativos para el cumplimiento del valor señalado en la localidad de Coya Club de Campo. Para niveles superiores, 300 ugr/Nm3 por ejemplo, es posible esperar un mejor cumplimiento, asociado a un percentil de 98%.

Esperamos contar en un período breve de información más completa al respecto.

Atentamente,

p. Santiago Torres E.
Gerente de Medio Ambiente

Comisión Nacional del Medio Ambiente
Departamento de Descontaminación Planes y Normas

Revisión Normas Primarias de Calidad de Aire para SO2, CO, O3, NO2 y PTS

ACTA DE REUNIÓN DE COMITÉS OPERATIVO Y AMPLIADO

Fecha Reunión: 20 de junio de 2000-06-20
Lugar: CONAMA, Obispo Donoso 6. Santiago

Tabla:

1. Valores que definen situaciones de emergencia ambiental para NO2 y O3, Fernando Farías E., CONAMA
2. Valores que definen situaciones de emergencia ambiental para SO2 y CO, Rodrigo Lucero Ch., CONAMA.

La Reunión:

- En relación al punto 1, Fernando Farías presenta los antecedentes disponibles a la fecha tanto a nivel nacional como internacional relacionados a los valores críticos de contaminación para NO2 y O3, estableciendo claramente la diferencia entre los índices de calidad del aire y los niveles que definen situaciones de emergencia ambiental.
- Respecto de los antecedentes presentados Alejandro Diez (ENAMI) consulta si se debe realizar un control de episodios críticos de contaminación si no existe un Plan de Descontaminación. F.Farías (CONAMA) señala que en el País la forma en que se ha abordado el control de episodios críticos es mediante Planes operacionales insertos en Planes de Descontaminación.
- En relación a los antecedentes presentados respecto de valores críticos en Estados Unidos en donde para declarar un episodio crítico se toman, además de la superación de los niveles establecidos, criterios complementarios referidos al pronóstico meteorológico, Carlos Salvo (SONAMI) consulta si existen criterios complementarios hacia la comunidad. Al respecto F.Farías (CONAMA) señala que allí funcionan en paralelo los índices de calidad de aire, mediante el cual se mantiene informada a la comunidad y las medidas asociadas a niveles de episodios críticos de contaminación.
- En relación a este criterio complementario (predicción de condiciones meteorológicas) utilizado en Estados Unidos para declarar un episodio, Walter Folch del Ministerio de Salud, consulta como se puede compatibilizar esto en el País, considerando que aquí existen, a diferencia de Estados Unidos, muy pocos modelos predictivos. CONAMA señala, que si bien es cierto lo que se señala, en el caso del Ozono, a partir de la información disponible no se observa que existan problemas de episodios críticos en ninguna parte del país, de acuerdo a las redes de monitoreo actuales, incluyendo a la red de la Región Metropolitana. Respecto de esto último, Pablo Ulriksen (CENMA) señala que hay que tener precaución dado que no existe monitoreo de ozono en áreas más

lejanas, a las fuentes de precursores de ozono, donde se podrían encontrar valores máximos de Ozono muy superiores a los registrados. Al respecto C.Santana (CONAMA) señala que, en relación a la disponibilidad de modelos, a la fecha se encuentra en elaboración y en etapa de pruebas, un modelo predictivo para Ozono en la Región Metropolitana, realizado con expertos del South Coast Air Quliaty Mangament Office (California) el que se espera esté operativo en el corto plazo. Respecto a los valores que se registran en las estaciones pertenecientes a la red MACAM, F.Farias (CONAMA) indica que éstas se encuentran localizadas bajo un criterio principal de representatividad poblacional, siendo concordantes los resultados de tales estaciones con las condiciones de contaminación, en este caso por ozono, a las que estaría expuesta la mayoría de la población de Santiago

- En relación al punto 2, Rodrigo Lucero (CONAMA) realiza una presentación que incluye los principales elementos en el ámbito de los valores que definen las situaciones de emergencia ambiental principalmente para el contaminante SO2.

- Al respecto A.Diez (ENAMI) consulta si en forma similar a como se definió en el DS 59 (norma diaria de material particulado PM10) el concepto de Estación Monitora con Representatividad Poblacional (EMRP), existe algo similar para el caso del SO2. R.Lucero (CONAMA) señala que la legislación actualmente vigente en el país para este contaminante no lo considera, no obstante, será materia de evaluación su inclusión dentro del proceso actual de revisión de norma primaria.

- A.Diez, también informa que en el caso de la refinería de Paipote, al presente año ya se han registrado dos (2) superaciones del nivel de alerta establecido en el DS.185.

- W.Folch consulta si los niveles que definen las situaciones de emergencia, se pudiesen asociar a un "daño comprobado asociado", y si así fuese en qué se basaría tal definición. R.Lucero indica que el concepto que se encuentra en la literatura es el de "nivel significativo de daño" y que éste esta asociado a los efectos del contaminante sobre la población, señala además, que se encuentra en búsqueda de información precisa a este respecto.

- W.Folch también consulta cuáles son los fundamentos que estable la US EPA para tener niveles que definen las situaciones de emergencia ambiental para el SO2 en períodos de 24horas, y no horarios. Respecto a este mismo punto, el Dr.A.Tchernitchin (U.Chile y Colegio Médico) indica que la literatura reporta daños a la población a niveles de exposición de 24 horas de 250 ug/m3N, por lo que debieran fijarse valores cercanos a esa cifra a efectos de evitar tal daño. Respecto a ambos temas, R.Lucero indica que una vez identificada una situación base de primeros efectos en la salud de la población, se deben buscar niveles que protejan adecuadamente a la población. Indica además, que de acuerdo a información en reuniones con expertos de USEPA y antecedentes de la literatura, en los EE.UU. no se ha definido una norma horaria ni valores que determinen situaciones de emergencia ambiental de carácter horario porque se considera que con la norma diaria y la definición de valores críticos para 24 horas se protege adecuadamente a la población. Además, ante situaciones eventuales, la población sensible expuesta a este contaminante es muy baja.

- S.Carstens (ENAMI) consulta si a través de los temas que se están tratando en esta oportunidad (contaminante SO2 y valores horarios) puede inferirse algo respecto a la norma secundaria para SO2, que considera valores horarios a diferencia de la norma primaria vigente, que considera valores diarios. Señala que el no cumplimiento de esta norma secundaria, ha implicado para la refinería de Ventanas que el año pasado hayan tenido 7 episodios de superación del valor horario, y que en el presente año, a la fecha, ya tienen 8 episodios. Las medidas que han debido tomar por tales episodios le han reportado a la empresa costos por (US$286 mil) a la fecha. Por otra parte indica que esta Fundición no pueden certificarse por ISO 14000, por el no cumplimiento de esta norma secundaria, y propone que se revise a la brevedad tal norma secundaria.

- C.Salvo informa que este año, se registró una excedencia horaria en las mediciones que realiza la fundición de Chagres del valor establecido en la norma secundaria que es de 1000 ug/m3 en 1-h.

- O.Salazar (CONAMA) consulta en que consiste el "sistema de aviso a la población". R.Lucero (CONAMA y A.Diez (ENAMI) indican que las medidas que se toman son 2: por un parte se realizan avisos a la población más sensible (vía fax a medios de difusión por ejemplo), y por otra existen acciones operacionales tal como la disminución de fusión.

- Por último, se realiza la presentación de los antecedentes disponibles par el contaminante CO, no existiendo consultas respecto a este tema, salvo la razón de por que en EE.UU. los niveles que definen situaciones de emergencia están definidos para intervalos de 8-h si es que existe norma tanto para un periodo de 1-h como de 8-h. Al respecto R.Lucero informa que esto se puede deber a que se consideraría que el cumplimiento de un nivel de 8-h aseguraría también el cumplimiento de un valor más breve.

Rodrigo Lucero Ch.

GOBIERNO DE CHILE
COMISION NACIONAL DEL MEDIO AMBIENTE

Reunión "Revisión Normas Primarias de Calidad de Aire para SO2, PTS, CO, NO2 Y O3"
Santiago, 20 de junio 2000

Nº	NOMBRE	DIRECCION	FONO	FAX	E - MAIL
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14.	CECILIA GODOY GONZALEZ.	S. Salud O'Higgins Bueras 555	72-238686 - 227040	72-226902	D.PA6@ENTELCHILE.NET
15.	[illegible] Figueroa C	Seminario 774	2234483	225 8909	
16.	Christian Santana O	Obispo Donoso Nº 6	2405600	—	csantana@conama.cl
17.	MIGUEL ESCOBAR C	MIRAFLORES 222 4º PISO	6068399	(32)794012	mescobar@[illegible]
18.					
19.					
20.					
21.					
22.					
23.					
24.					

000613

GOBIERNO DE CHILE
COMISION NACIONAL DEL MEDIO AMBIENTE

Reunión "Revisión Normas Primarias de Calidad de Aire para SO2, PTS, CO, NO2 Y O3"
Santiago, 20 de junio 2000

Nº	NOMBRE	DIRECCION	FONO	FAX	E - MAIL
1.	Sergio Carstews	Enami Ventanas	32-933411	32-933449	scarstews@enami.cl
2.	Cecilia Fernald H.	Cemento Polpaico	3376500 3376510	3376501	cfernald@polpaico.cl
3.	Carlos Salvo P.	SONAMI	230-8686	230-8666	—
4.	Aníbal Mege	SOFOFA	3913130	3913210	amege@sofofa.cl
5.	Alejandro Diez V.	ENAMI	6375357	6375452	adiez@enami.cl
6.	Oriana Soleza	CONAMA	—	-	osoleza@conama.cl
7.	Pablo Ulriksen	CENMA	2751455	2751688	pulriksen@cenma.uchile.cl
8.	Carlos Saavedra	UTMA - M.O.P.	3612835	3612749	utma@mop.cl
9.	I. [illegible]	[illegible]	[illegible]	[illegible] -	—
10.	Pedro Santic C.	COCHILCO	3828213	3828100	psantic@cochilco.cl
11.	Walter Folch	MINSAL	6641244	6397110	wfolch@netline.cl
12.	Santiago Sanhueza R.	RENACE	223 4483	225.8908	renace@[illegible].cl

000614

Valores críticos que determinan las situaciones de emergencia ambiental

CONAMA
Depto. Descontaminación, Planes y Normas

Reglamento para la Dictación de Normas de calidad ambiental y emisión

Artículo 28:

"Toda norma primaria deberá señalar los valores críticos que determinen las situaciones de emergencia ambiental"

Indices de la calidad del aire

Canadá: Indice de la Calidad del Aire (IQUA)

Este índice está diseñado para ayudar a las agencias regionales a informar mejor al público acerca de las condiciones generales o prevalecientes de calidad del aire en su comunidad

Fuente: *Guideline for the index of the quality of the air, Report EPS1 AP3, 1996*

EE.UU.: Indice de calidad del aire (AQI)

Es una herramienta que simplifica el reporte de información de calidad del aire al público general. El AQI incorpora dentro de un índice único las concentraciones de 5 contaminantes criterio. La escala del índice se divide en categorías generales que se asocian con mensajes asociados a la salud.

Fuente: *40 CFR Part 58, Air Quality Index Reporting; Final Rule (4.8.99)*

Cuando este contaminante tenga un valor de índice superior a 100	**Reportar a estos grupos sensibles**
Ozono	Niños y asmáticos son los grupos con mayor riesgo
Dióxido de Nitrógeno	Niños y aquellos con enfermedades respiratorias son los grupos con mayor riesgo

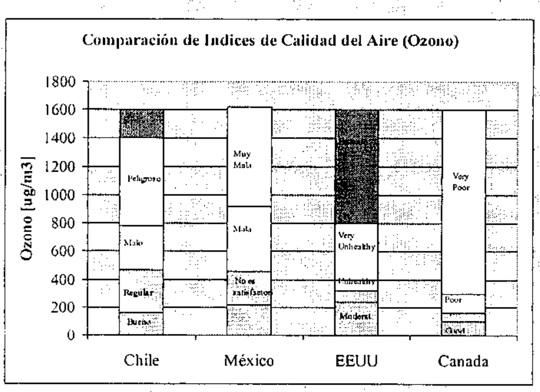
000617

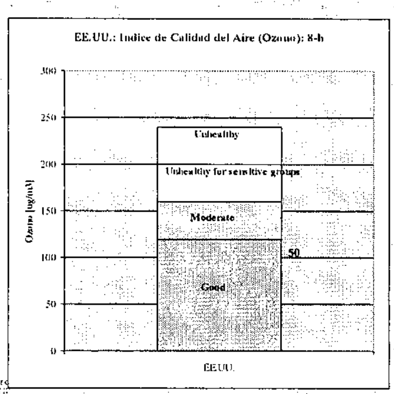
Chile: Indice de Calidad del Aire para Gases (ICA)

GOBIERNO DE CHILE

"La necesidad que tanto las autoridades como la población estén informados de los niveles de contaminación atmosférica de la Región Metropolitana"

Fuente: *Considerando de la Resolución 369/88 del Ministerio de Salud*





GOBIERNO DE CHILE

Valores Críticos que determinan las situaciones de emergencia ambiental: Antecedentes

Chile: Valores críticos

GOBIERNO DE CHILE

"Los establecimientos regulados en funcionamiento localizados en zonas saturadas deberán, además disponer de un Plan de Acción Operacional para ser aplicado en caso de episodios críticos."

Fuente: *Artículo 19 del DS 185/82 del Ministerio de Minería*

Concentración horaria (ppm)	Situación	Medidas de Precaución
	Aviso de Alerta	Ancianos y personas con enfermedades cardíacas y respiratorias deberán permanecer en sus casas. En ellas se deberán cerrar puertas y ventanas
	Aviso de Advertencia	Adicionalmente a lo anterior los escolares deberán suspender las clases de gimnasia y las actividades en el exterior
	Aviso de Emergencia	Adicionalmente a lo anterior, todas las personas deberán permanecer en sus casas minimizando las actividades físicas, desplazándose solo para concurrir a su trabajo o por razones de fuerza mayor

GOBIERNO DE CHILE

Decreto Supremo N°59/98, Artículo 3°.

Defínanse como niveles que originan situaciones de emergencia ambiental para Material Particulado Respirable MP10, aquellos de acuerdo a los cuales el valor calculado para la calidad del aire, en concentración de 24 horas, se encuentre en el respectivo rango señalado en la tabla siguiente:

Nivel	Material Particulado Respirable MP10 (ug/m3N) en 24 horas
Nivel 1°	195 – 239
Nivel 2°	240 – 329
Nivel 3°	330 o superior

Valores Críticos que determinan las situaciones de emergencia ambiental: *Ozono*

000620

EE.UU.: Valores críticos (O3 1-h)

EE.UU: recomendación Federal (*)	EE.UU: recomendación Federal (calificación)	EEUU: Los Angeles	EEUU: Los Angeles (calificación)
[ug/m3]		[ug/m3]	
400	*Alert*	400	*Alert*
800	*Warning*	700	*Warning*
1000	*Emergency*	1000	*Emergency*

GOBIERNO DE CHILE

EE.UU.: Condición Adicional (O3 1-h)

"En caso de episodios, para la declaración de uno de los niveles indicados, adicionalmente a la superación de los niveles establecidos, las condiciones meteorológicas deben ser tales que la situación pueda ocurrir de nuevo en las siguientes 24 horas, a menos que se tomen acciones de control"

GOBIERNO DE CHILE

Chile: Propuesta SGA Valores Críticos

Propuesta Estudio SGA (*) O3 en 1 hora (ug/m3):	**Propuesta Estudio SGA (*calificación*)**
[ug/m3]	
160	***Bueno***
400	***Alerta***
800	***Peligro***
1000	***Emergencia***

(*) Estudio: Generación de información para la revisión de las normas primarias contenidas en la Resolución 1215. SGA-Ibersis para CONAMA (1998)

GOBIERNO DE CHILE

Otros países: Valores Críticos (O_3)

Francia	Francia (*calificación*)	CE	CE (*calificación*)	México	México (*calificación*)
[ug/m3] 1-h		[ug/m3] 1-h		[ug/m3] 1-h	
180	*Seuil d'Information*	180	*Information*		
360	*Seuil d'Alerte*	240	*Alert*	580	*Fase I, Prog.Contingencia*
				830	*Fase II, Prog.Contingencia*

GOBIERNO DE CHILE

Chile: máximos 1-h Ozono

Localidad	1997	1998	1999
Santiago	350	408	358
Quillota			126
Huasco			76
Vallenar			72
Copiapó			68

valores en [ug/m3]

GOBIERNO DE CHILE

Chile: máximos 8-h Ozono

Localidad	1997	1998	1999
Santiago	226	240	216
Quillota			88

valores en [ug/m3]

GOBIERNO DE CHILE

Valores Críticos que determinan las situaciones de emergencia ambiental: Dióxido de Nitrógeno

EE.UU.: Valores críticos (NO2 1-h)

EE.UU: recomendación Federal (*)	**EE.UU:** recomendación Federal (calificación)
[ug/m3]	
1130	*Alert*
2260	*Warning*
3000	*Emergency*

EEUU: *Condición Adicional* (NO2 1-h)

"En caso de episodios, para la declaración de uno de los niveles indicados, adicionalmente a la superación de los niveles establecidos, las condiciones meteorológicas deben ser tales que la concentración del contaminante se espere permanezca en tales niveles superiores (o aumente) para las siguientes 12-horas al menos"

Chile: Propuesta SGA Valores Críticos

Propuesta Estudio SGA (*) NO2 en 1 hora	Propuesta Estudio SGA (*calificación*)
[ug/m3]	
1130	***Alerta***
2260	***Peligro***
3000	***Emergencia***

(*) Estudio: Generación de información para la revisión de las normas primarias contenidas en la Resolución 1215. SGA-Ibersis para CONAMA (1998)

GOBIERNO DE CHILE

Otros países: Valores Críticos (NO2)

Francia	Francia (*calificación*)	CE	CE (*calificación*)	México	México (*calificación*)
[ug/m3] 1-h		**[ug/m3] 3-h consecutivas**		**[ug/m3] 1-h**	
200	*Seuil d'Information*				
400	*Seuil d'Alerte*	400	*Alert*	1660	*Fase I, Prog.Contingencia*
				2540	*Fase II, Prog.Contingencia*

GOBIERNO DE CHILE

Chile: máximos 1-h NO2

Localidad	1997	1998	1999
Huasco	83	96	280
Vallenar			215
Copiapó			118

valores en [ug/m3]

GOBIERNO DE CHILE

VALORES CRITICOS QUE DETERMINAN SITUACIONES DE EMERGENCIA AMBIENTAL POR SO2

CONAMA
Depto. Descontaminación
Planes y Normas

CHILE

- El D.S N°93/95, Reglamento para la Dictación de Normas de Calidad Ambiental y de Emisión.
  - Establece que una norma primaria de calidad de aire debe contener los valores criticos que definen situaciones de emergencia ambiental.

CHILE

- La Res. 1215 del Ministerio de Salud que establece las normas primarias de calidad de aire para SO2 y otros contaminantes, no señala para este contaminante, valores criticos que definen situaciones de emergencia ambiental.

CHILE

- El D.S 185/91, Ministerio Minería, establece valores que definen situaciones de emergencia ambiental y las medidas a adoptar, según la siguiente clasificación:
  - Alerta : 1965 ug/Nm3 (0,75ppm), hora
  - Advertencia : 2620 ug/Nm3 (1,0 ppm), hora
  - Emergencia : 3930 ug/Nm3 (1,5 ppm), hora

CHILE

- La ocurrencia de episodios críticos por SO2 se regula a través de la aplicación de planes operacionales para el control de episodios críticos insertos en los planes de descontaminación (D.S N° 185, D.S N°94/95)
  - Chuquicamata
  - Paipote
  - Potrerillos
  - Ventanas
  - Caletones

CHILE

- La Resolución N° 369 Ministerio de Salud establece un indice de calidad de aire (ICA) referido a gases, que incluye el SO2, cuyo objetivo es mantener informada a la autoridad y la población de los niveles de contaminación atmosférica en la Región Metropolitana.
- El ICA no establece valores críticos que definen situaciones de emergencia ambiental.

CHILE

- Puntos de quiebre establecidos para el ICA

ICA	SO_2 (ug/Nm3) 24 Horas
0	0
100	365
500	2620

Valores Criticos de SO2 Otros Países

País	Clasificación	Concentración ug/Nm3			
		1 hora	2 horas	3 horas	24 horas
Estados (1) Unidos	Alerta Advertencia Emergencia				800 1600 2100
UE	Alerta			500 durante 3 hrs.	

(1) Recomendación Federal.
Episodios se regulan mediante un plan de contingencia estatal para evitar nivel de 2620 ug/Nm3 en 24 horas.
Episodio se declara teniendo en cuenta condiciones meteorológicas adversas

Valores Críticos de SO2 Otros Países

País	Clasificación	Concentración ug/Nm3			
		1 hora	2 horas	3 horas	24 horas
México	Fase 1 Prog. Contingencia Faes 2 Prog. Contingencia				1050 1700
Japón	Aviso Alerta Emergencia	1300	 1300 durante 2 hrs. 1820 durante 2 hrs.	 1300 durante 3 hrs.	
Francia	Aviso Alerta	300 600			
Chile	Alerta Advertencia Emergencia	1965 2620 3930			

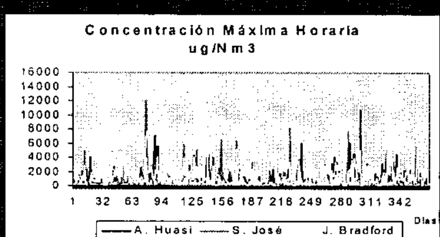
VALORES CRITICOS SO2
Propuesta Estudio SGA

Concentración ug/Nm3 1 hora	Clasificación
1300	Alerta
1965	Advertencia
2620	Emergencia

Valores Máximos Horarios de SO2
ug/Nm3

Localidad	Año		
	1997	1998	1999
Chuquicamata			13454
Calama			911
Tocopilla			550
Antofagasta			682
Paipote			7520
Copiapó			855
Huasco			780
Chagres		946	711
Quillota		232	344
Ventanas	10199	6977	4883
Caletones	6166	7201	4673
R. Metropolitana		629	695

CHUQUICAMATA
SO2 (1999)

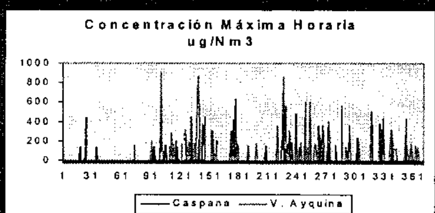


CHUQUICAMATA

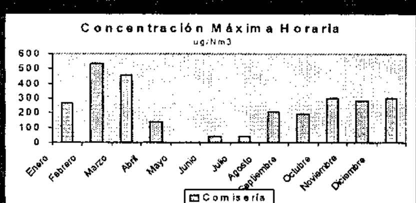
Episodios Críticos SO2
Valores > 1965 ug/Nm3 (D.S 185)

Año	N° Valores
1994	221
1995	116
1996	125
1997	95
1998	114
1999	127

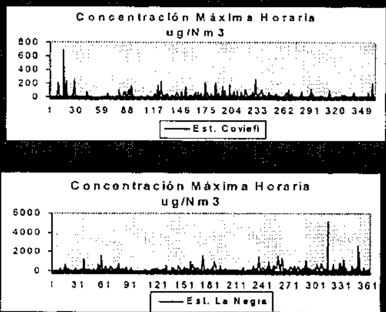
CALAMA
SO2 (1999)



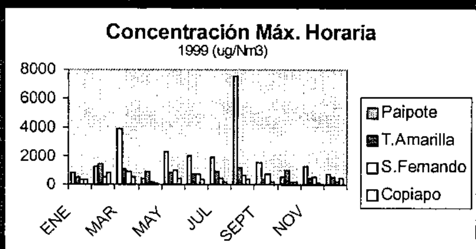
TOCOPILLA
SO2 (1999)



ANTOFAGASTA
SO2 (1999)



PAIPOTE
SO2

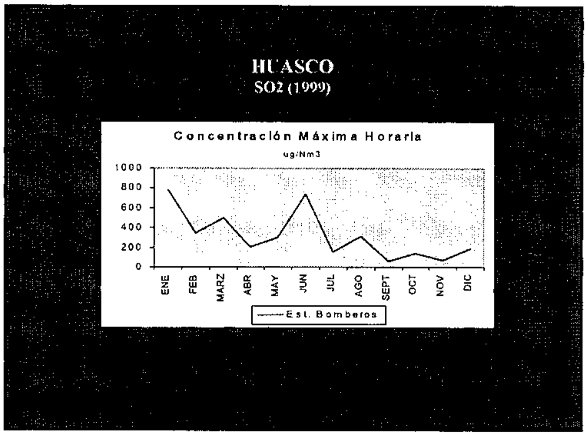


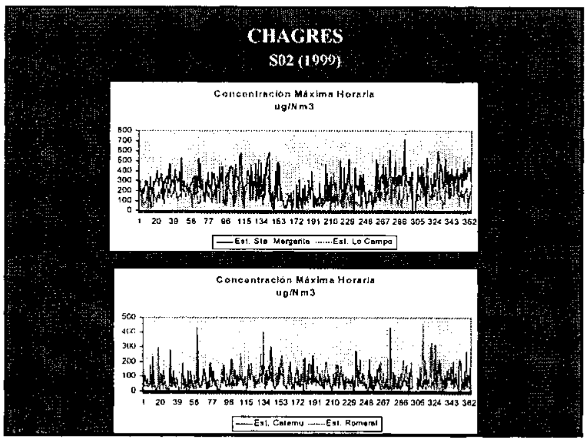
PAIPOTE

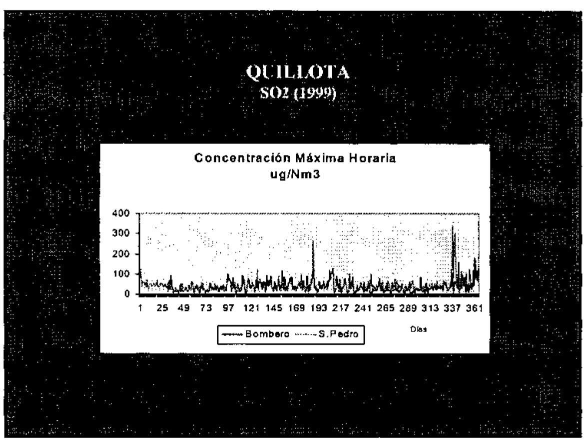
Episodios Criticos SO2
Valores > 1965 ug/Nm3 D.S 185

RESULTADOS REDUCCION EPISODIOS CRITICOS SEGÚN AÑO

AÑO	Nº TOTAL DE EPISODIOS CRITICOS SEGÚN LOCALIDAD			
	E. PAIPOTE	COPIAPO	T. AMARILLA	SAN FERNANDO
1993	283	15	88	58
1994	216	7	67	31
1995	57	7	67	7
1996	26	0	16	0
1997	10	1	7	2
1998	11	0	2	1
1999	7	0	0	0

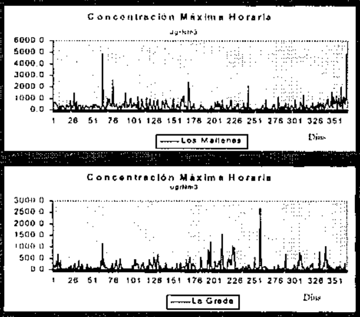

HUASCO
SO2 (1999)
Concentración Máxima Horaria
ug/Nm3
Est. Bomberos


CHAGRES
S02 (1999)
Concentración Máxima Horaria
ug/Nm3
Est. Sta. Margarita
Est. Lo Campo
Concentración Máxima Horaria
ug/Nm3
Est. Catemu
Est. Romeral

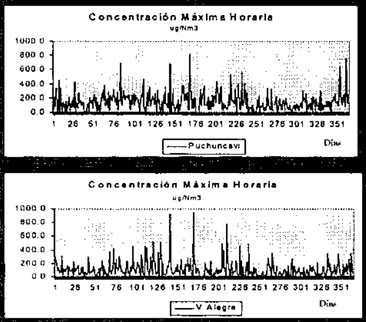

QUILLOTA
SO2 (1999)
Concentración Máxima Horaria
ug/Nm3
Bombero
S.Pedro
Días

000631

VENTANAS
SO2 (1999)



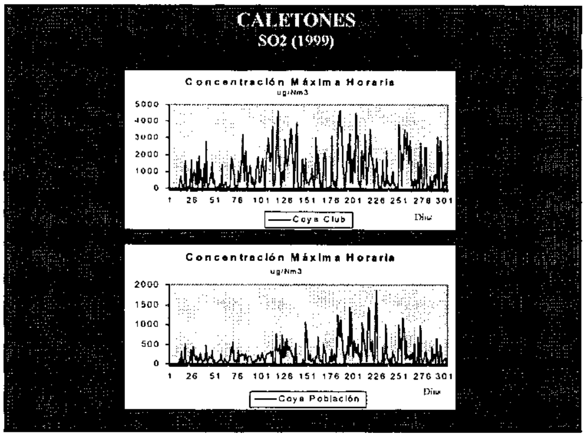
VENTANAS
SO2 (1999)



VENTANAS
Episodios Críticos SO2 (D.S 185)

Año	Alerta	Advertencia	Emergencia	**Total**	Puchuncavi	La Greda	Valle Alegre	Sur	Maitenes
1995	109	83	23	216	7	47	15	53	94
1996	239	150	62	451	26	38	30	143	214
1997	57	35	17	109	4	8	10	34	53
1998	22	14	5	41	1	1	2	19	18
1999	4	2	1	7*	0	2	0	0	5

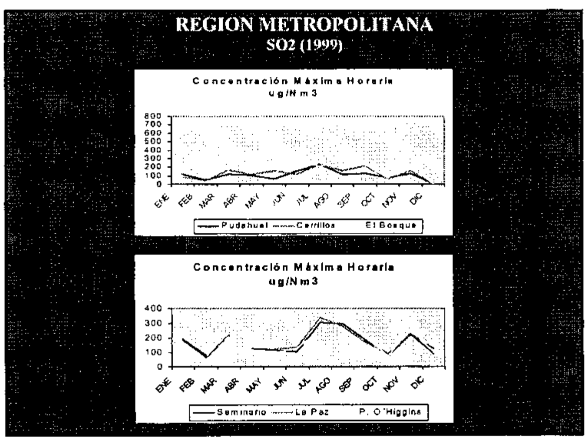
Alerta: 1965 ug/Nm3
Advertencia: 2620 ug/Nm3
Emergencia: 3930 ug/Nm3



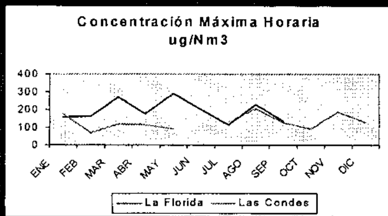
CALETONES

Episodios Críticos SO2
Valores > 1965 ug/nm3 (D.S 185)

Estación	Año 1998	Año 1999
Club de campo Coya	299	171
Coya Población	6	0
Total	305	171



REGIÓN METROPOLITANA
SO2 (1999)



VALORES CRITICOS QUE DETERMINAN SITUACIONES DE EMERGENCIA AMBIENTAL POR CO

CONAMA
Depto. Descontaminación
Planes y Normas

CHILE
Valores Críticos CO

- Chile no cuenta con valores que definan situaciones de emergencia ambiental para CO
- Chile cuenta con un índice de calidad de aire, referido a gases, que incluye CO, pero es solo para información de la población y autoridades, no para adoptar medidas.

ESTADOS UNIDOS
Valores Críticos

Concentración ug/Nm3 8 hrs	Clasificación
17000	Alerta
34000	Advertencia
46000	Emergencia

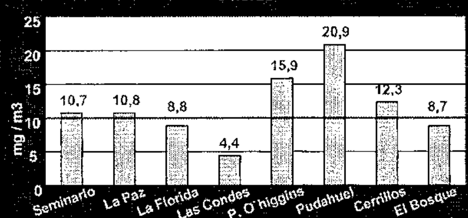
Recomendación Federal

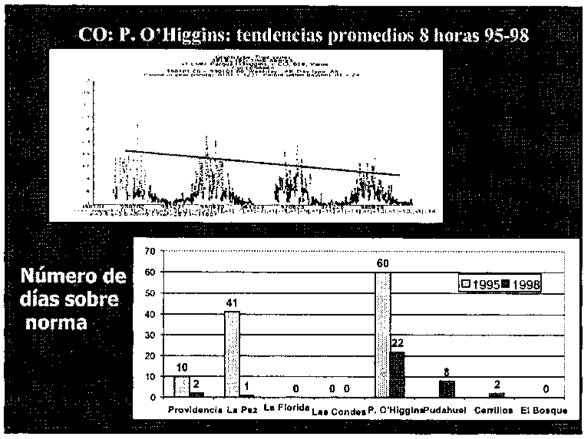
VALORES CRITICOS
Propuesta Estudio SGA

Concentración ug/Nm3 8 hrs	Clasificación
10000	Bueno
17000	Alerta
34000	Peligro
40000	Emergencia

CO 1998

Máx. media
8 horas




CO: P. O'Higgins: tendencias promedios 8 horas 95-98
Número de días sobre norma
1995
1998
10
2
41
1
0
0 0
60
22
8
2
0
Providencia
La Paz
La Florida
Las Condes
P. O'Higgins
Pudahuel
Cerrillos
El Bosque

000636

ENAMI OFICINA DE PARTES
06751 23.6.00
SANTIAGO

ENAMI

Vicepresidencia Ejecutiva Nº 66

Santiago, 22 de Junio de 2000

COMISION NACIONAL DEL MEDIO AMBIENTE
OFICINA DE PARTES Y ARCHIVO
Nº INGRESO: 6202/5859
FECHA: 28 JUN 2000
DESPACHADO:
OBS.: A. Hoffmann
Por Correo. 13
21859

Señora:
Adriana Hoffmann J.
Directora Nacional
Comisión Nacional del Medio Ambiente
Presente

At. Sra. Patricia Matus C.

Ref: Revisión Resolución Nº 1215 de Salud

De mi consideración:

En atención a su carta Nº1905, en la cual se consulta sobre la factibilidad técnica para reducir emisiones asociadas a un nivel de concentración de calidad de aire de SO2 desde el valor actual de 365 a 250 ugr/Nm3 o niveles intermedios entre estos valores, como índice para 24 horas, tengo a bien exponer las siguientes consideraciones:

En 1990 la Empresa Nacional de Minería asumió abiertamente su compromiso ambiental, enfrentando esta problemática principalmente en fundiciones, a través de Planes de Descontaminación, con una serie de inversiones tendientes a recuperar el atraso tecnológico de las instalaciones. Dichas inversiones se orientaron preferentemente a dar cumplimiento a la normativa Primaria de Anhídrido Sulfuroso y Material Particulado, de acuerdo a lo expresado en el Decreto Supremo Nº185 del Ministerio de Minería.

Los Planes de Descontaminación diseñados para dar cumplimiento al decreto mencionado significaron para la Empresa, en las fundiciones en conjunto, una inversión de alrededor de US$ 160 millones, los proyectos fueron terminados en el año 1999.

Como resultado de lo anterior, las fundiciones de ENAMI, como se indica en los documentos adjuntos a la presente, se encuentran cumpliendo la norma primaria de SO2. Sin embargo, el nivel de cumplimiento actual de la norma, involucra un delicado manejo operacional de los procesos, a través de una disminución de producción frente a altos niveles de SO2 en los alrededores de las fundiciones.

ENAMI

Cualquier rebaja de los niveles de concentración diaria de Anhídrido Sulfuroso y niveles de emisión que definen episodios críticos, implicaría a la Empresa aplicar nuevas rebajas en los niveles de emisión actuales de las fundiciones (captación de 88% promedio), cuyo costo involucraría montos de inversión, según estimaciones preliminares, superiores a US$ 55 millones, que la Empresa debido a su alto endeudamiento, no está en condiciones de asumir.

A este respecto, la consideración de no restringir los criterios actuales de la normativa es fundamental en el manejo y sustentabilidad de las fundiciones del país, motivo por el cual sugerimos mantener los estándares de calidad ambiental actuales, con un criterio de superación de norma que considere la transgresión de la norma actual, en aquellos de situaciones de meteorología adversa, como el criterio aplicado en otras normativas ambientales, tal como el D.S. Nº59 que regula la calidad de aire por PM-10.

Se adjuntan los antecedentes correspondientes que indican la situación actual de las fundiciones de ENAMI.

Le saluda atentamente

EMPRESA NACIONAL DE ... Vice Presidente Ejecutivo

Jaime Pérez de Arce Araya
Vicepresidente Ejecutivo

ENAMI-SANTIAGO
DESPACHADO
23 JUN 2000
OFICINA DE PARTES

CUMPLIMIENTO DE METAS AMBIENTALES FUNDICIONES ENAMI

1 ANTECEDENTES GENERALES

1.1 Antecedentes Históricos

En 1990, la Empresa Nacional de Minería incorporó la variable ambiental a su gestión habitual como un factor determinante para asegurar el desarrollo sustentable de sus actividades de fomento y productivas. Es así como a partir de 1990, ENAMI asumió decididamente una estrategia ambiental destinada a solucionar los problemas generados por el atraso tecnológico de sus planteles productivos, en especial de sus fundiciones.

Con la promulgación del Decreto Supremo N°185 del ministerio de Minería en Enero de 1992 ambas Fundiciones instalaron redes de monitoreo del aire, en los sectores poblados de los alrededores de las faenas.

Basado en las mediciones de la red de monitoreo de Fundición y Refinería Ventanas y en un protocolo de acuerdo entre la Empresa y el Ministerio de Minería, ENAMI presentó en 1992 un Plan de Descontaminación de su fundición en Ventanas, el cual fué aprobado por el Presidente de la República en el Decreto Supremo N°252, decreto mediante el cual ENAMI adquirió los siguientes compromisos:

- Cumplimiento de la Norma de Calidad de aire por Anhídrido Sulfuroso a más tardar el 30 de Junio de 1999 y, en forma conjunta con la Termoeléctrica Ventanas de Gener S.A., la norma de Material Particulado Respirable PM10 a más tardar el 1 de Enero de 1995.

- Cumplir el calendario de reducción de emisiones que se muestra a continuación.

Año	Emisiones de Azufre Ton S/ año	Emisiones Material Particulado Ton/año
1993	62.000	3.400
1994	62.000	3.400
1995	62.000	3.400 / Cumple Norma
1996	62.000	3.400
1997	62.000	3.400
1998	45.000	2.000
1999	Cumple Norma	1.000

- Contar con un plan de Acción Operacional, aprobado por el Servicio de Salud Viña del Mar Quillota con el objeto de controlar los episodios de críticos de anhídrido sulfuroso.

- Informar a los Servicios Fiscalizadores mensualmente las emisiones de Azufre y semestralmente las de Material Particulado determinadas por muestreo isocinético.

Por su parte la Fundición Hernán Videla Lira presenta su plan de Descontaminación en Noviembre de 1993, el cual fué aprobado en el D.S. N°180 de Octubre de 1994, estableciéndose lo siguientes compromisos.

- Cumplimiento de la Norma de Calidad de aire por Anhídrido Sulfuroso a más tardar el 30 de Diciembre de 1999.

- Cumplir el calendario de reducción de emisiones que se incluye a continuación.

Año	Emisiones de Azufre Ton S/ año
1995	40.000
1996	40.000
1997	40.000
1998	30.000
1999	20.000
2000	Cumple Norma

- Contar con un plan de Acción Operacional, aprobado por el Servicio de Salud de Atacama con el objeto de controlar los episodios de críticos de anhídrido sulfuroso.

Los planes de descontaminación fueron desarrollados por ENAMI, Estudiando distintas alternativas centradas principalmente en descontaminar sin ampliación de capacidades, concluyéndose que la alternativa Tecnica-economica más adecuada, considerando las restricciones presupuestarias, lo constituia la implementación de la Tecnología de Fusión en Convertidores Teniente, es decir, el reemplazo de los Hornos de Reverbero como unidad principal de Fusión por los convertidores mencionados. Un Diagrama de los procesos de ambas fundiciones y los cambios realizados con los respectivos planes se presenta en el Anexo N°1.

El hecho de que los proyectos no consideraron ampliación de capacidades, sino que en el caso de Ventanas se redujo la fusión de concentrado en más de un 10 %, no solo afecto el endeudamiento de la empresa sino que también su rentabilidad.

Para implementar los Planes de Descontaminación de las Fundiciones, ENAMI debió realizar una inversión total de 160 Millones de Dolares en las Fundiciones de Paipote y Ventanas.

1.2 Cumplimiento Normativo

Como Resultado del esfuerzo de inversión realizado, la Empresa se encuentra actualmente cumpliendo la norma primaria de SO2 dictaminada por el Decreto Supremo N°185. Los gráficos que se presentan en las páginas siguientes, muestran los resultados de calidad del aire detectados por las redes de monitoreo ambiental de los alrededores de ambas fundiciones.

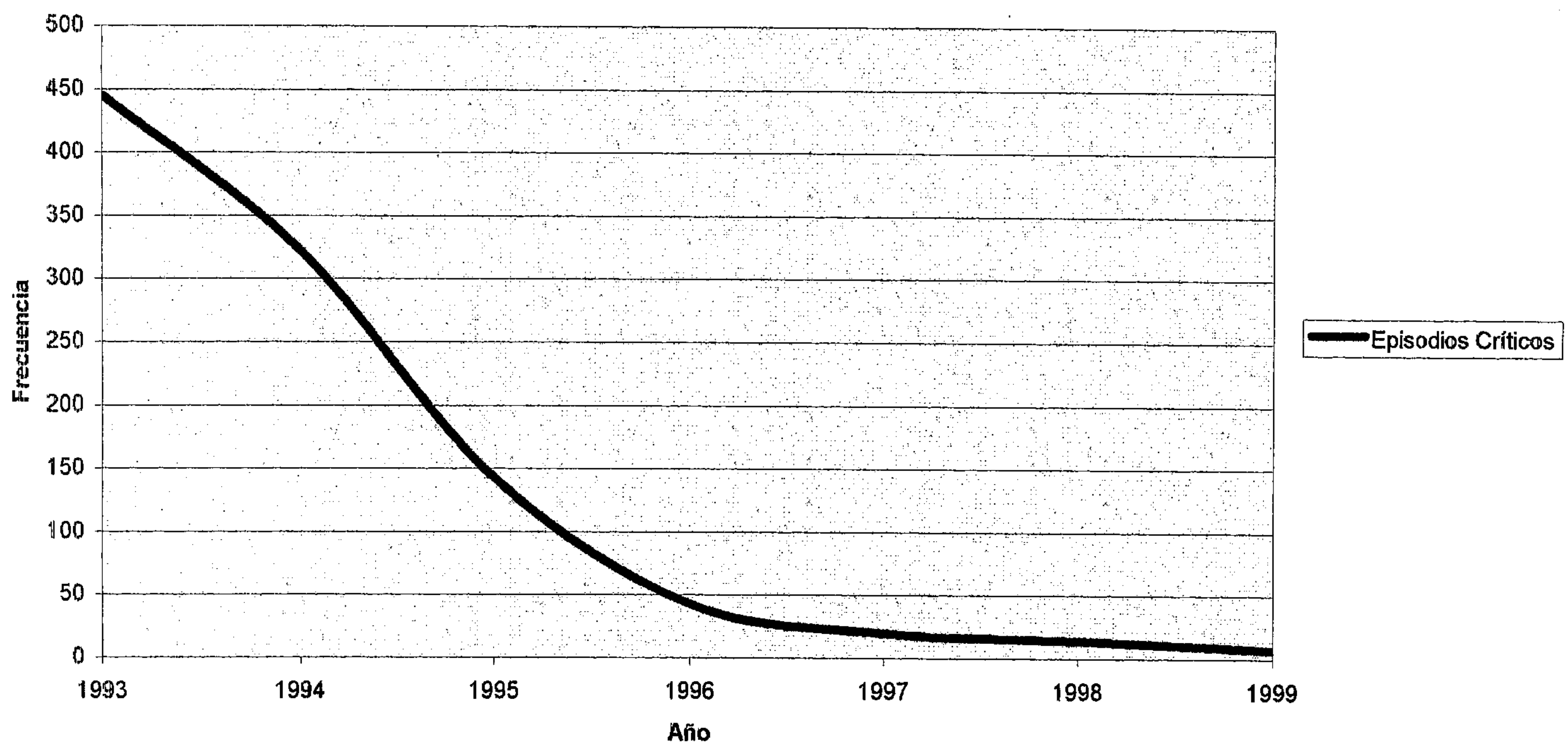
La Empresa no solo se ha preocupado en resolver los problemas de contaminación atmosférica por SO2 de las fundiciones, sino que ha realizado otras inversiones ambientales destinadas a dar cumplimiento a otros tópicos de índole ambiental, tales como emisiones de Arsénico y Plomo, Riles, Manejo de Residuos Sólidos, regularización de Permisos Sectoriales, Ambiente Laboral e implementación de Sistemas de Gestión Ambiental. Estas acciones, sumadas a otros proyectos de descontaminación de la Empresa, ha comprometido sobre el 60% del presupuesto para inversiones de los últimos 10 años, ascendiendo la inversión ambiental total en fundiciones a un monto superior a US$ 215 millones, reflejando con ello la preponderancia del tema en la administración superior de ENAMI.

1.3 Estrategias Operativas

Debido a que las condiciones de transporte atmosférico de emisiones no son variables posibles de manejar por la operación de la fundición, las inversiones realizadas han sido complementadas con un plan de estrategias operativas para el adecuado cumplimiento de la norma de calidad del aire. Estos planes operativos son contemplementados con disminución de los niveles de producción cada vez que se presentan elevados niveles de calidad del aire en alguna de las estaciones de monitoreo ambiental, o bien si las condiciones de transporte atmosférico determinadas por un equipo de expertos meteorólogos, puede ser estimada como alto riesgo de impacto ambiental.

Con todo, el manejo estricto de algunas situaciones no logra impedir el impacto en alguna de las estaciones sobrepasándose los valores normados como diarios y/o horarios, prueba de ello lo constituye el análisis de casos realizado en al Anexo N°2.

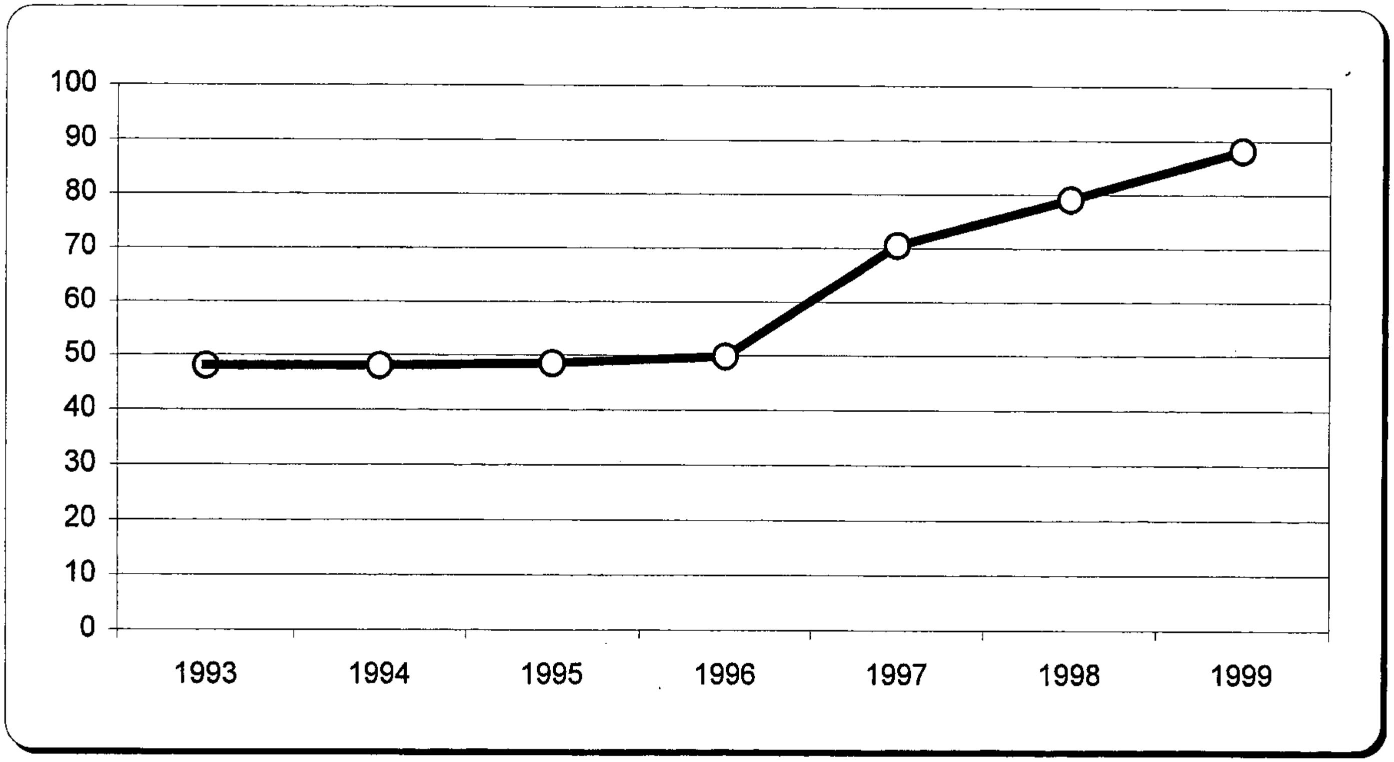
Episodios Críticos por SO2



EMISIONES Y CAPTACIONES DE AZUFRE

Fundición Paipote

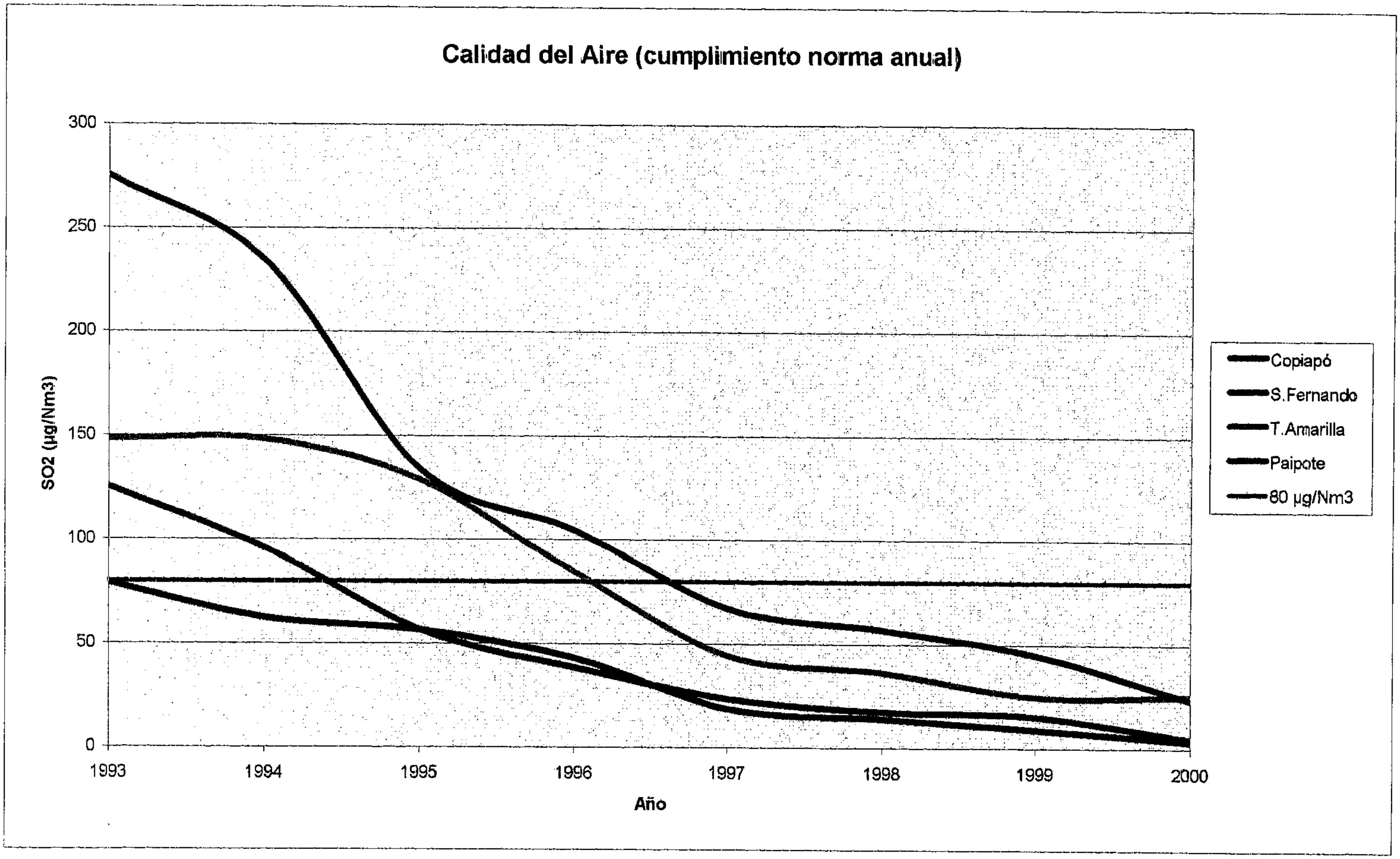
	1993	1994	1995	1996	1997	1998	1999
Emisión (ton)	32.888	33.000	31.895	30.006	18.541	17.753	10.655
Captación (%)	48,0	48,0	48,5	49,8	70,5	79,1	88,2



Calendario Emisiones de Azufre (ton/año)

Autorizado por D.S. N°180 v/s Real

Año	D.S. N°180	Real
1995	40.000	31.893
1996	40.000	30.006
1997	40.000	18.541
1998	30.000	17.753
1999	20.000	10.656
2000	Cumple Norma	


Calidad del Aire (cumplimiento norma anual)
SO2 (µg/Nm3)
300
250
200
150
100
50
0
1993
1994
1995
1996
1997
1998
1999
2000
Año
Copiapó
S.Fernando
T.Amarilla
Paipote
80 µg/Nm3

2.- SITUACIÓN FINANCIERA DE LA EMPRESA

La deuda de ENAMI desde el año 1995 a la fecha ha alcanzado un valor de US$ 450 millones, de los cuales más de US$ 215 millones derivan de los programas de inversión implementados para superar los problemas ambientales en las Fundiciones de Ventanas y Paipote. Los programas de inversión de ambas fundiciones corresponden principalmente a los Planes de Descontaminación. Con anterioridad a estos planes, se realizaron inversiones en Plantas de Acido, en ambas fundiciones.

La recuperación de las inversiones realizadas en descontaminar que finalizaron en Ventanas y en Paipote en 1999, no ha sido posible de materializar debido a la reducción significativa de los cargos de tratamiento entre los años 1998 y 1999, cuyo impacto negativo en los ingresos de la Empresa asciende a US$ 40 millones. Se agrega al impacto negativo citado, el efecto de deterioro del tipo de cambio real, el que desde 1987 a la fecha, ha experimentado una disminución real frente al peso de un 44%. Es importante señalar que el patrimonio de ENAMI, a diciembre del año 1999, alcanzaba un valor de US$ 273 millones, monto inferior a su deuda total.

Bajo estas condiciones, acceder a nuevos créditos para incorporar un nuevo plan de descontaminación, asociado a las mayores restricciones ambientales, es imposible de sustentar

3.- ESCENARIOS POSIBLES ANTE NUEVAS RESTRICCIONES

3.1 Escenarios de Restricción

De acuerdo al desarrollo de las reuniones del comité ampliado de normas en la CONAMA, los escenarios de modificación de la normativa de SO_2 analizados son los siguientes :

Norma Primaria
- Anual de 80 $\mu g/Nm^3$
  - Se mantiene
- Diaria de 365 $\mu g/Nm^3$
  - Se mantiene
  - Rebaja a 340
  - Rebaja a 320
  - Rebaja a 300
  - Rebaja a 250

Episodios Críticos
- Se mantiene
- Se rebaja promedio horario para nivel de Alerta a 1300 $\mu g/Nm^3$

3.2 Situación Actual

Bajo los escenarios de restricciones presentados en el punto actual se efectuó un ejercicio de cumplimiento para los últimos 12 meses, encontrándose los siguientes resultados:

Fundición y Refineria Ventanas

Análisis Estadístico Cumplimiento Potenciales Normas de SO_2

Marzo 1999 - Marzo 2000

Norma Diaria	Niveles de SO_2 en µg/Nm^3						
Estaciones	**veces > 250**	**veces > 280**	**veces > 300**	**veces > 320**	**veces > 340**	**veces > 365**	**peak**
Puchuncavi	0	0	0	0	0	0	
La Greda	1	1	0	0	0	0	283,22
Los Maitenes	2	2	1	1	1	1	424,3
Valle Alegre	0	0	0	0	0	0	
Sur	2	2	1	1	0	0	332,6
TOTAL	**5**	**5**	**2**	**2**	**1**	**1**	

Norma Hora	SO_2 en µg/Nm^3	
Estaciones	**veces > 1300***	
Puchuncavi	0	
La Greda	2	
Los Maitenes	5	
Valle Alegre	0	
Sur	2	
TOTAL	**9**	

Promedio 2 horas

Fundición H. Videla Lira

Resumen Análisis Estadístico Cumplimiento Potenciales Normas de SO2

Abril 1999 - Marzo 2000

Norma Diaria	Niveles de SO_2 en µg/Nm^3					
	Nº de veces	Nº de veces	Nº de veces	Nº de veces	Nº de veces	peak
Estaciones	> 250	>300	>320	>340	>365	
Copiapó	0	0	0	0	0	54
S. Fernando	0	0	0	0	0	146
Paipote	3	2	2	2	2	560
T. Amarilla	0	0	0	0	0	160
TOTAL	**3**	**2**	**2**	**2**	**2**	

Norma Hora	SO_2 en µg/Nm^3
Estaciones	**veces > 1300***
Copiapó	0
S. Fernando	0
Paipote	5
T. Amarilla	0
TOTAL	**5**

Promedio 2 horas

3.2 Escenarios de Solución

3.2.1 Fundición Ventanas

Según estudios de cálculo de procesos internos las distribuciones de las emisiones generadas por fundición y refinería la distribución de emisiones de esta es la siguiente (Anexo N°3):

Distribución de Emisiones	
Convertidor Teniente	50.30 %
Convertidores Pierce Smith	33.90 %
Sangrías CT	5.01 %
Sangrias CPS	3.51 %
Otras Emisiones	7.25 %

Como es posible ver, las emisiones de azufre no captadas se generan en las campanas de convertidores. Lo anterior se relaciona con las limitaciones del sistema de manejo de gases y en particular con la capacidad de tratamiento de gases de planta de ácido, que restringe el flujo de gases en campana. En estas condiciones no es posible inducir una mayor extracción de gases por los ventiladores determinándose una menor eficiencia de campanas.

En general, los eventos de operación que implican giros de reactores y/o apertura de compuertas, si bien es cierto, tienen una incidencia menor en el balance de azufre, representando un 10% del azufre no captado, implican elevadas tasa de emisiones instantáneas y en condiciones metereológicas adversas pueden conducir a excedencias en la calidad del aire.

Basado en lo mencionado anteriormente, una posible disminución de emisiones pasa necesariamente por una mayor captación de gases fugitivos, dicha mayor captación requeriría de la implementación de campanas secundarias y sistemas de tratamiento de los gases captados. Para efectuar un proyecto de tal naturaleza es necesario realizar estudios de ingeniería detallados, pero una estimación gruesa indica que la implementación de captación secundaria de gases, requiere de modificaciones menores a la nave de conversión, montaje de nuevos sistemas de captación (campanas secundarias), manejo de gases (tuberías, limpieza de gases y otros), y equipos de tratamiento de gases. Dicha inversión no sería inferior a US$ 35 millones para Ventanas.

3.2.1 Fundición Hernán Videla Lira

Por su parte, Fundición Hernán Videla Lira tiene una configuración de emisiones tales que una ampliación de su planta de ácido permitiría reducir sus emisiones desde un nivel actual de 88% hasta un nivel de captación de gases levemente superior al 91 %. El aumento de nivel de captación de gases contempla la adecuación de ductos e implementación de doble catálisis en la Planta de Acido N°2, el valor de inversión asociada se estima en alrededor de US$ 20 millones.

Analizada la factibilidad de captación de los gases secundarios emitidos directamente por el Convertidor Teniente y los convertidores tradicionales (Pierce Smith), se estima que el proyecto requiere de montos de inversión fuera del alcance de la Empresa, pues para implementarlo se requiere realizar modificaciones mayores en la nave de conversión y la instalación de campanas secundarias, lo cual involucra adicionalmente interferencias de producción de varios meses, con la consecuente pérdida económica.

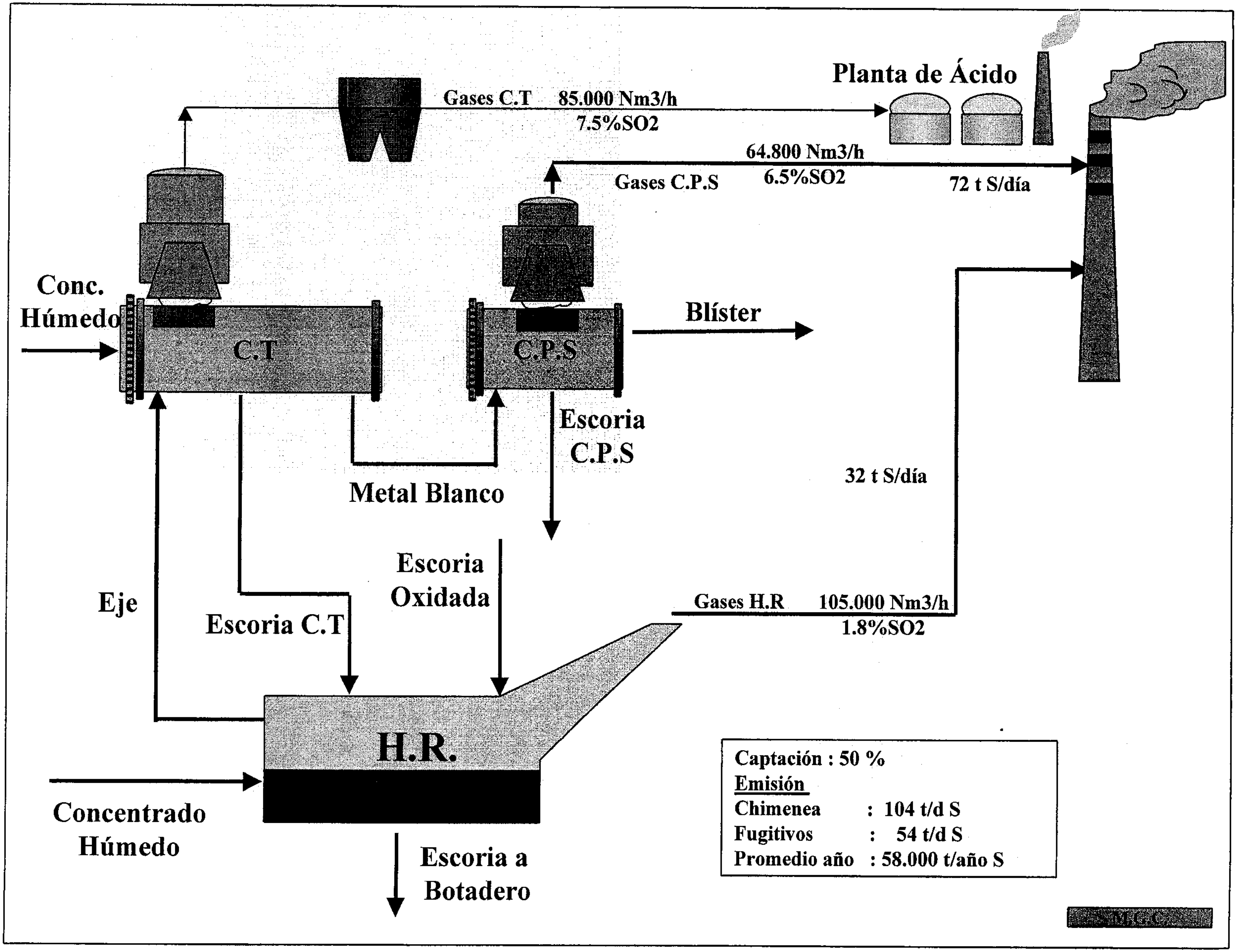
ENAMI

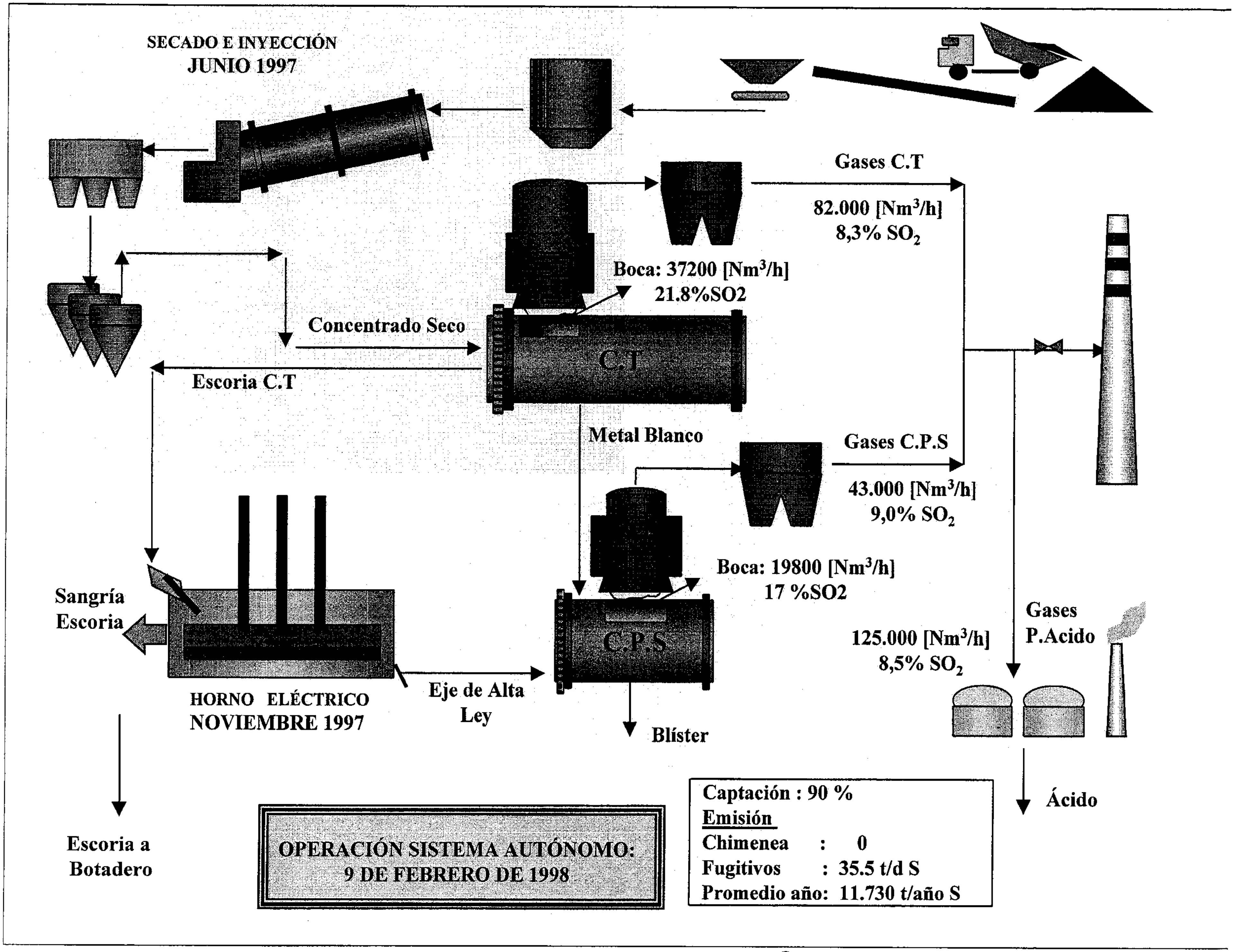
DIAGRAMA PROCESO FUNDICIÓN PERIODOS SIN Y CON PROYECTO MODERNIZACIÓN

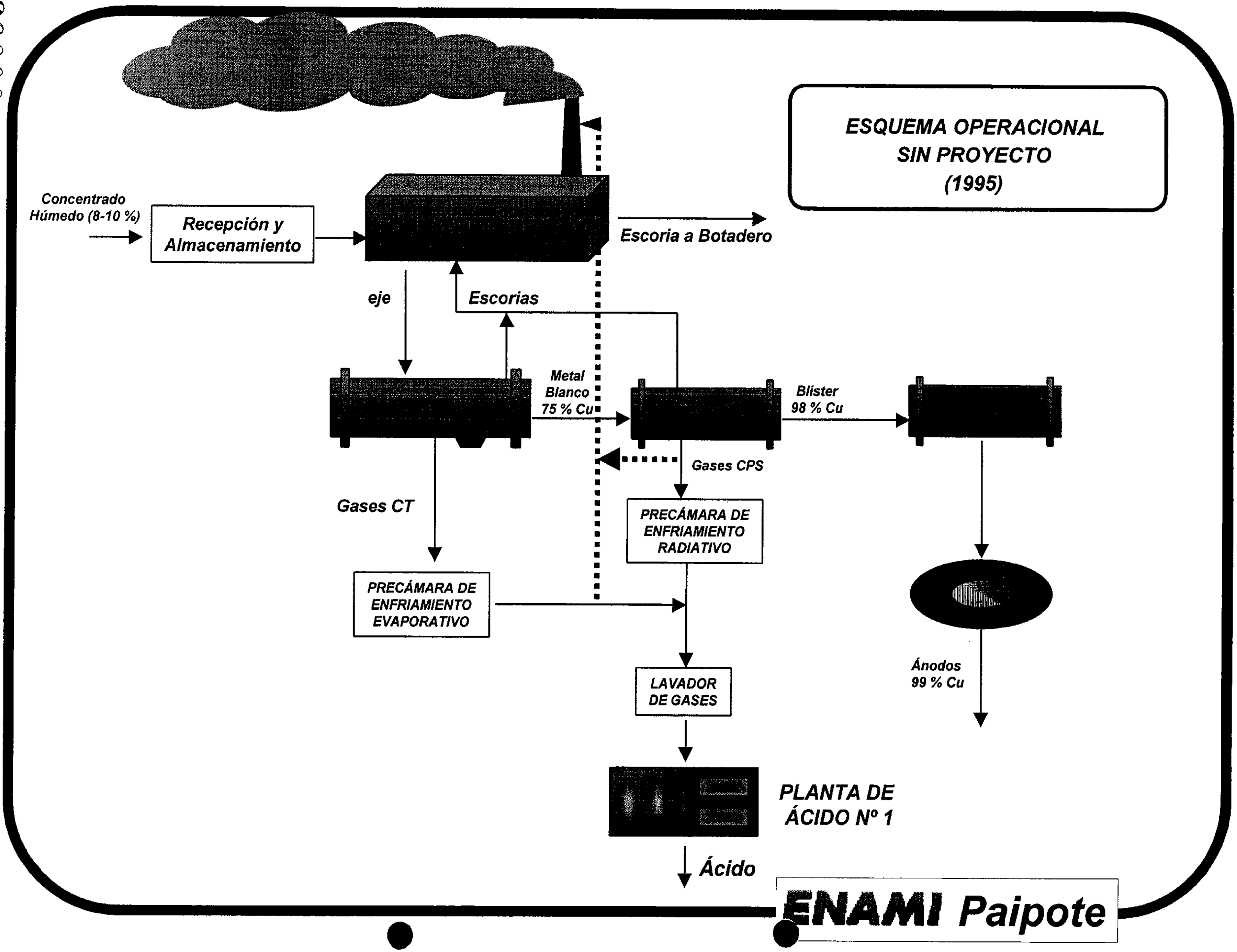
PREPARADO POR:

INGENIERÍA DE PROCESOS FUNDICIÓN
SUPERINTENDENCIA FUNDICIÓN

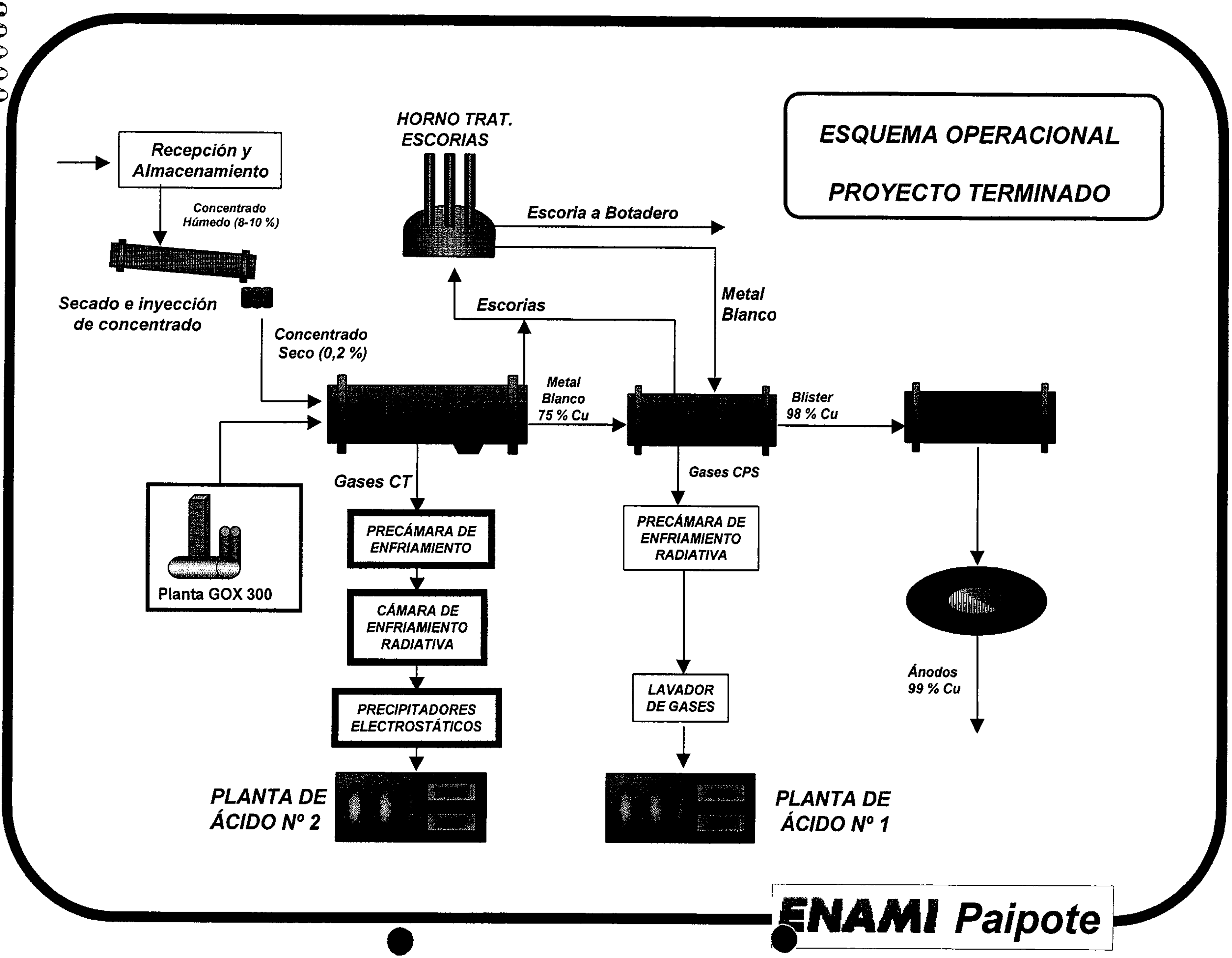
SANTIAGO, JUNIO 2000


Planta de Ácido
Gases C.T 85.000 Nm3/h
7.5%SO2
64.800 Nm3/h
6.5%SO2
Gases C.P.S
72 t S/día
Conc.
Húmedo
C.T
C.P.S
Blíster
Escoria
C.P.S
Metal Blanco
32 t S/día
Escoria
Oxidada
Eje
Escoria C.T
Gases H.R 105.000 Nm3/h
1.8%SO2
H.R.
Concentrado
Húmedo
Escoria a
Botadero
Captación : 50 %
Emisión
Chimenea : 104 t/d S
Fugitivos : 54 t/d S
Promedio año : 58.000 t/año S


SECADO E INYECCIÓN
JUNIO 1997
Gases C.T
82.000 [Nm³/h]
8,3% SO₂
Boca: 37200 [Nm³/h]
21.8%SO2
Concentrado Seco
C.T
Escoria C.T
Metal Blanco
Gases C.P.S
43.000 [Nm³/h]
9,0% SO₂
Boca: 19800 [Nm³/h]
17 %SO2
Gases
P.Acido
125.000 [Nm³/h]
8,5% SO₂
Sangría
Escoria
C.P.S
HORNO ELÉCTRICO
NOVIEMBRE 1997
Eje de Alta
Ley
Blíster
Ácido
Escoria a
Botadero
OPERACIÓN SISTEMA AUTÓNOMO:
9 DE FEBRERO DE 1998
Captación : 90 %
Emisión
Chimenea : 0
Fugitivos : 35.5 t/d S
Promedio año: 11.730 t/año S



ESQUEMA OPERACIONAL
SIN PROYECTO
(1995)
Concentrado Húmedo (8-10 %)
Recepción y Almacenamiento
Escoria a Botadero
eje
Escorias
Metal Blanco 75 % Cu
Blister 98 % Cu
Gases CPS
Gases CT
PRECÁMARA DE ENFRIAMIENTO RADIATIVO
PRECÁMARA DE ENFRIAMIENTO EVAPORATIVO
LAVADOR DE GASES
Ánodos 99 % Cu
PLANTA DE ÁCIDO Nº 1
Ácido
ENAMI Paipote


ESQUEMA OPERACIONAL
PROYECTO TERMINADO
Recepción y Almacenamiento
Concentrado Húmedo (8-10 %)
Secado e inyección de concentrado
Concentrado Seco (0,2 %)
Planta GOX 300
HORNO TRAT. ESCORIAS
Escoria a Botadero
Escorias
Metal Blanco
Metal Blanco 75 % Cu
Blister 98 % Cu
Gases CT
PRECÁMARA DE ENFRIAMIENTO
CÁMARA DE ENFRIAMIENTO RADIATIVA
PRECIPITADORES ELECTROSTÁTICOS
PLANTA DE ÁCIDO Nº 2
Gases CPS
PRECÁMARA DE ENFRIAMIENTO RADIATIVA
LAVADOR DE GASES
PLANTA DE ÁCIDO Nº 1
Ánodos 99 % Cu
ENAMI Paipote

ENAMI

MANEJO OPERACIONAL
vs
COMPORTAMIENTO METEOROLÓGICO

SANTIAGO, JUNIO 2000

MANEJO OPERACIONAL vs COMPORTAMIENTO METEORÓLOGICO

1._ INTRODUCCIÓN.

Bajo el esquema actual de operación del sistema Fundición y Planta de Ácido en las fundiciones de ENAMI, el impacto ambiental es función del comportamiento meteorológico que transportan las emisiones fugitivas de la nave fundición. Este informe entrega algunos ejemplo de la premisa anterior, siendo comparado las operaciones del día 02 y 05 de abril del presente año (2000) para Fundición Ventanas y analizado el episodio del día 23 de Marzo de 1999 en estación Paipote de la fundición Hernán Videla Lira.

2._ DESARROLLO.

En ambos casos las operaciones de las fundiciones corresponden a un día de operación normal, siendo sus emisiones atmosféricas las promedio.

EN Fundición Ventanas el día 02 de abril corresponde a un día de operación normal sin impacto ambiental, y el día 05 de abril, también de operación normal, pero con ocurrencia de un episodio crítico de calidad de aire en la Estación Sur a las 04 horas.

2.1 Fundición Ventanas

2.1.1.-Operación de Fundición.

Los resultados de captación y emisión de azufre de la Fundición Ventanas para los días indicados entregan los siguientes valores:

Condición Operacional	Día 02/04/2000	Día 05/04/2000
• CNU (ton)	1310	1240
• Ley azufre (%)	30.1	30.4
• Acido producido (ton)	1036.8	999
• Azufre ingresado (ton)	394.31	376.96
• Azufre captado (ton)	338.71	326.2
• Captación (%)	85.91	86.53
• Azufre emitido (ton)	55.6	50.75

Como es posible apreciar las emisiones generadas durante el dia del episodio son menores a las del día 2

En los Gráficos N°1 y N°2 se indica el comportamiento de la concentración de SO_2 detectada por la Estación Sur de monitoreo, para los días 02 y 05 de abril de 2000, respectivamente.

Flujo de gases Fundición – Planta Ácido

El comportamiento del flujo de gases de la Fundición para los días 02 y 05 de abril de 2000, respectivamente funcionó normalmente en ambos días.

2.1.2. Comportamiento Meteorológico

Velocidad del viento

Basados en la información meteorológica recopilada para los días 02 y 05 de abril de 2000, de la intensidad de vientos bajo y sobre nivel de chimenea, se observa lo siguiente:

El día **02 de abril**, la intensidad de vientos bajo y sobre nivel de chimenea, presenta un comportamiento similar, con un promedio sobre los 2 m/s entre las 00:00 y 09:00 horas aumentando progresivamente, alcanzando un máximo valor de 6 m/s en la hora de máximo calentamiento diurno. Ver gráfico N°3.

El día **05 de abril**, la intensidad de vientos bajo nivel de chimenea, presenta una notable disminución desde el inicio del día señalado, aumentando desde las 12:00 horas. El comportamiento del viento por sobre el nivel de chimenea se mantiene sobre los 2 m/s hasta las 11:00 horas. Ver gráfico N°4.

En ambos días, entre las 00:00 y 23:00 horas, la dirección predominante del viento era hacia la Estación Sur de monitoreo. Ver gráficos N°5 , N°6.

Estabilidad atmosférica

Basados en la información meteorológica recopilada para los días 02 y 05 de abril de 2000, de la estabilidad atmosférica bajo y sobre chimenea, se observa lo siguiente:

El día **02 de abril**, la atmósfera se presenta estable (índice 2) hasta las 05:00 horas. Posteriormente tiene un comportamiento entre neutro (índice 3) e inestable (índice 4) hasta las 17:00 horas, período de calentamiento diurno, volviendo a ponerse estable por ausencia del calentamiento diurno, que hace que se generen movimientos convectivos, favorables para la dispersión. Ver gráfico N°7.

El día **05 de abril**, la atmósfera se presenta estable (índice 1) y muy estable (índice 2) en todo el período de 00:00 a 06:00 horas. Tal característica es consecuencia directa del predominio de Vaguada Costera en la zona, asociada además de una notable disminución de vientos, de componente norte. Ver gráfico N°8.

2.2. Fundición Hernán Videla Lira

2.2.1. Condiciones de Operación

El día 23 de Marzo de 1999 ocurrió un episodio crítico de Contaminación por S02 en estación Paipote, alcanzándose un valor promedio horario de 3915.1 ugr/Nm3. Las condiciones de Operación de la Fundición correspondieron a la detalladas en el siguiente cuadro:

Condición Operacional	Día 23/03/99
• CNU (ton secas)	825.0
• Ley azufre (%)	30.96
• Acido producido (ton)	737.0
• Azufre ingresado (ton)	279.0
• Azufre captado (ton)	251.8
• Captación (%)	91.1
• Azufre emitido (ton)	24.6

Como es posible apreciar el nivel de captación de gases del día en cuestión corresponde a uno de los niveles de captación más altos alcanzados por la fundición, ya que el promedio del año 1999 fue de 88 %.

2.2.2. Comportamiento Meteorológico

Debido a la presencia de un Vaguada Costera sobre la zona, se produjo una fortificación de la componente SE con intensificación de la inversión térmica, llegando a ser en ocasiones inversión de superficie.

Lo anterior, según datos de ecosonda, se comprobó al decaer la intensidad del viento a partir de las 5:00 hrs (bajo 1 m/s) girando de NW a S-SE. Desde las 6:00 Hrs y hasta las) 9:30 Hrs, aproximadamente, esta componente mantuvo magnitudes mayores a 1 m/s, lo cual tuvo alzas en las concentraciones de SO2 en forma puntual. Desde las 9:30 hrs nuevamente decae la intensidad de viento, esta vez, para ocasionar el retorno de la dirección a NNW. Así, lentamente el gas acumulado durante la madrugada retorna desde Copiapó hacia San Fernando (Alzas puntuales) y Estación Paipote.

Seguramente, por la ubicación de esta localidad en el valle (eje Central entre quebrada Paipote y el Cauce del río) el viento en ella tendió a la calma por un par de horas (promedio de la intensidad del viento entre 10 y 11 am de 0,17 m/s), lo cual produjo la inmobilidad de los gases y el alza de las concentraciones.

Una vez fortificada la componente NW, salen los gases desde el sector Paipote desplazándose hacia tierra amarilla. Cuando llegan a este lugar, por incidencia de la radiación solar, la inversión térmica ya quebrada y la ventilación mejorada se presentan solo ascensos puntuales de concentración ambiental de SO2 sin mayores consecuencias

Para mayor detalle se presentan los gráficos de Calidad del Aire por SO_2 en estación Paipote, junto a la radiación solar y humedad relativa (Grafico Nº 9); Reporte de operación de equipos de Fundición; Altura de la capa de inversión (Gráfico Nº 10).

Nota :
Fuente : Informe de Auditoría de Episodo Crítico Nº 2 1999, entregada aL servicio de Salud y SAG Atacama.

3._ CONCLUSIONES

De los episodios analizados es posible obtener las siguientes conclusiones:

1. La operación de plantas de ácido y de los sistemas de manejo de gases en los días analizados se comportó en forma normal, confinándose los gases en los ductos.

2. Para Fundición Ventanas la captación de azufre el día 02/04 fué un 0,7% menor que la del día 05/04, y a pesar de la similitud de las variables operacionales en ambos días, el día 05/04 se registró un episodio crítico de calidad de aire.

3. Los episodios se debieron exclusivamente a las emisiones fugitivas.

4. Puede observarse claramente que el factor preponderante para la ocurrencia de impactos en la calidad de aire es el factor climático, ligado a condiciones meteorológicas de altísima estabilidad atmosférica. En todos los casos se tomó las acciones operacionales para el control de los episodios críticos establecidas en el Plan de Episodios, pero la estabilidad atmosférica evitó la dispersión provocando el impacto.

5. La Fundiciones de ENAMI operan bajo las condiciones determinadas por el proyecto de descontaminación, sin embargo existe una variabilidad en las leyes de los concentrados producto de un abastecimiento heterogéneo, por lo que las emisiones de éstas pueden variar día a día.

6. Los impactos ambientales debido a las emisiones fugitivas, obligarían a fuertes inversiones para captarlas y mejorar la calidad del aire de la zona.

7. Las Fundiciones no tienen la flexibilidad necesaria que le permita impedir la ocurrencia de un episodio crítico cuando las condiciones meteorológicas en la zona son adversas. Cuando las Estaciones de Monitoreo detectan concentraciones de SO2 que obligan a tomar acciones operacionales, estas medidas, que llegan incluso a tener que detener todos los equipos (convertidores) de la línea de producción, no aseguran que el impacto ambiental no ocurrirá.

   Adicionalmente, es necesario hacer notar que debida a las condiciones de la dinámica del transporte y dispersión de los gases en la atmósfera, las acciones operativas tomadas no garantizan una rápida disminución de las concentraciones de SO2 en el aire, dándose incluso algunos casos en que tomadas todas las acciones correspondientes, los valores detectados en las redes de monitoreo siguen elevándose y provocando el impacto, por lo que resulta muy complejo predecirlos con efectividad y tomar acciones oportunas.

FUNDICION Y REFINERIA VENTANAS
CONCENTRACIÓN DE SO2 ESTACIÓN SUR DÍA 02 DE ABRIL 2000

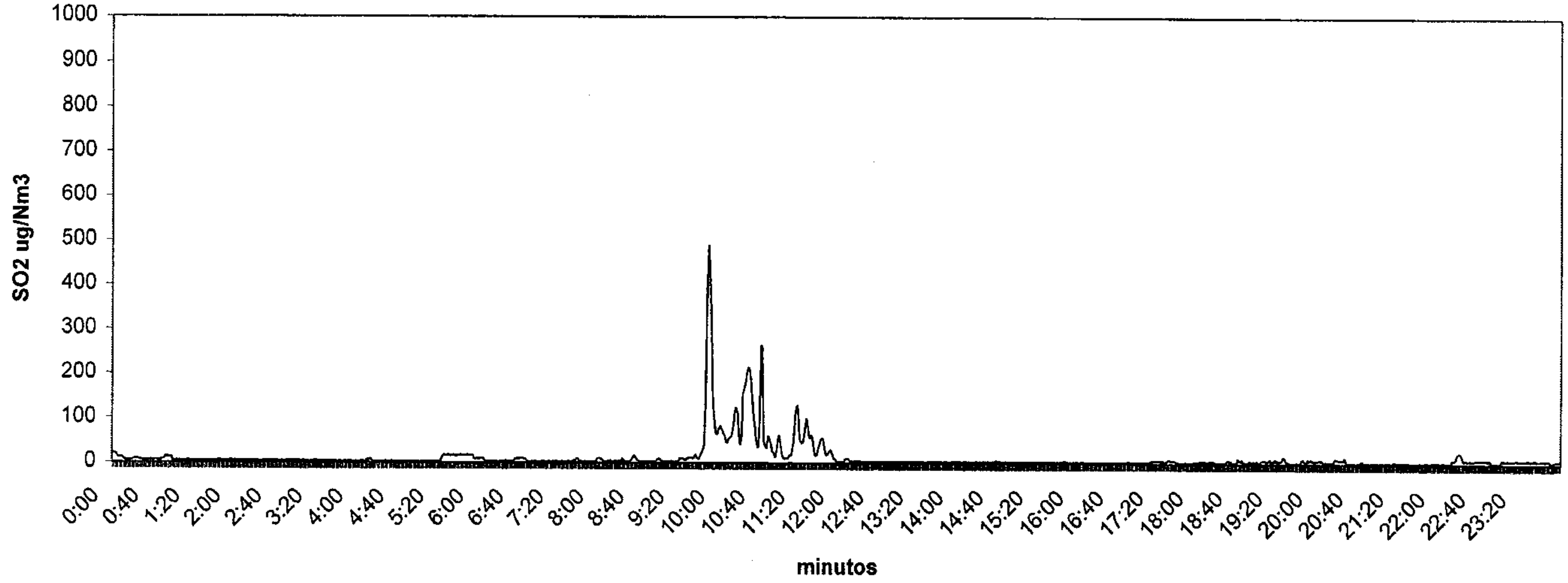
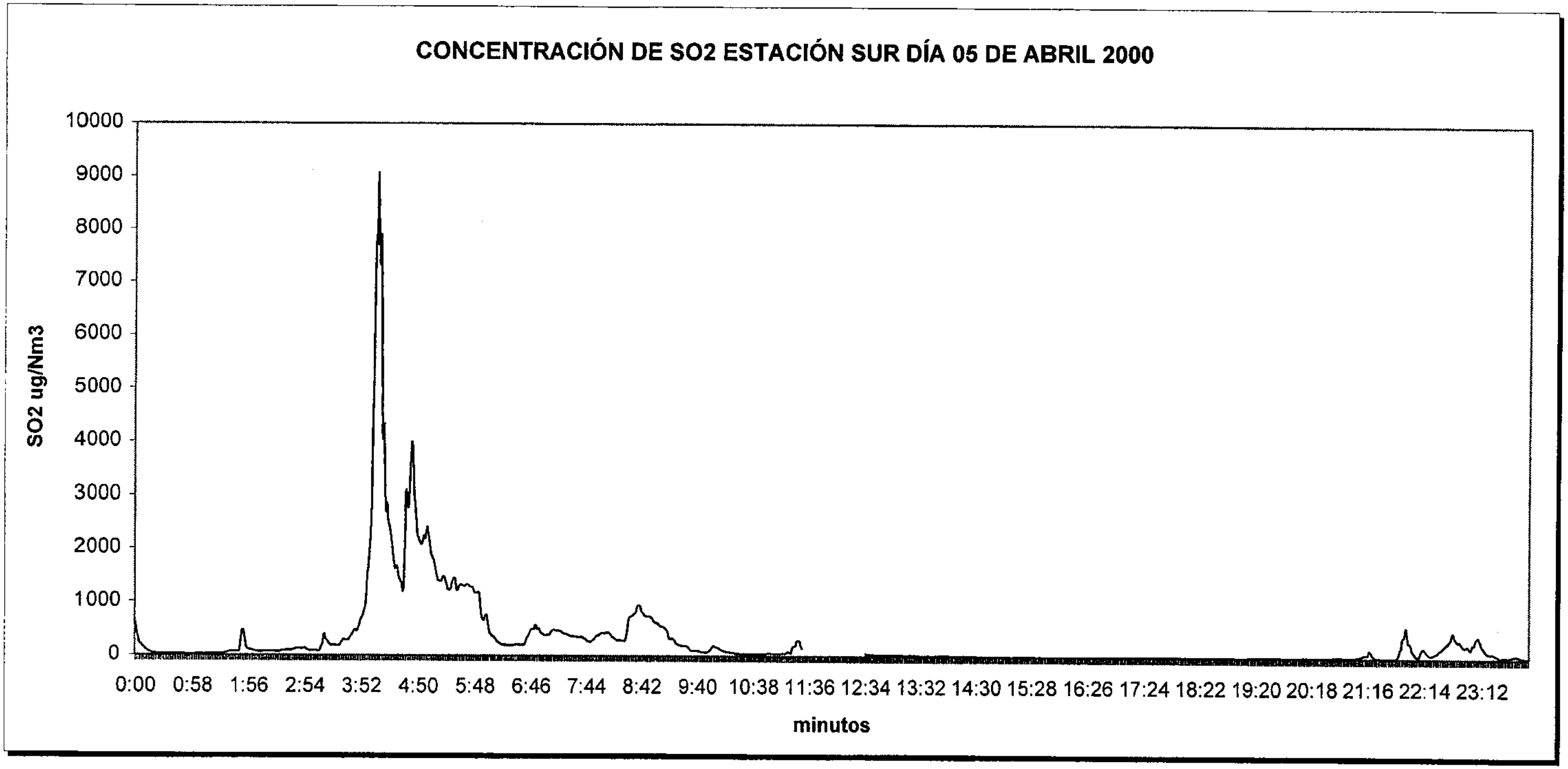


GRÁFICO N°1

000660



CONCENTRACIÓN DE SO2 ESTACIÓN SUR DÍA 05 DE ABRIL 2000
SO2 ug/Nm3
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
0:00 0:58 1:56 2:54 3:52 4:50 5:48 6:46 7:44 8:42 9:40 10:38 11:36 12:34 13:32 14:30 15:28 16:26 17:24 18:22 19:20 20:18 21:16 22:14 23:12
minutos

GRÁFICO Nº2

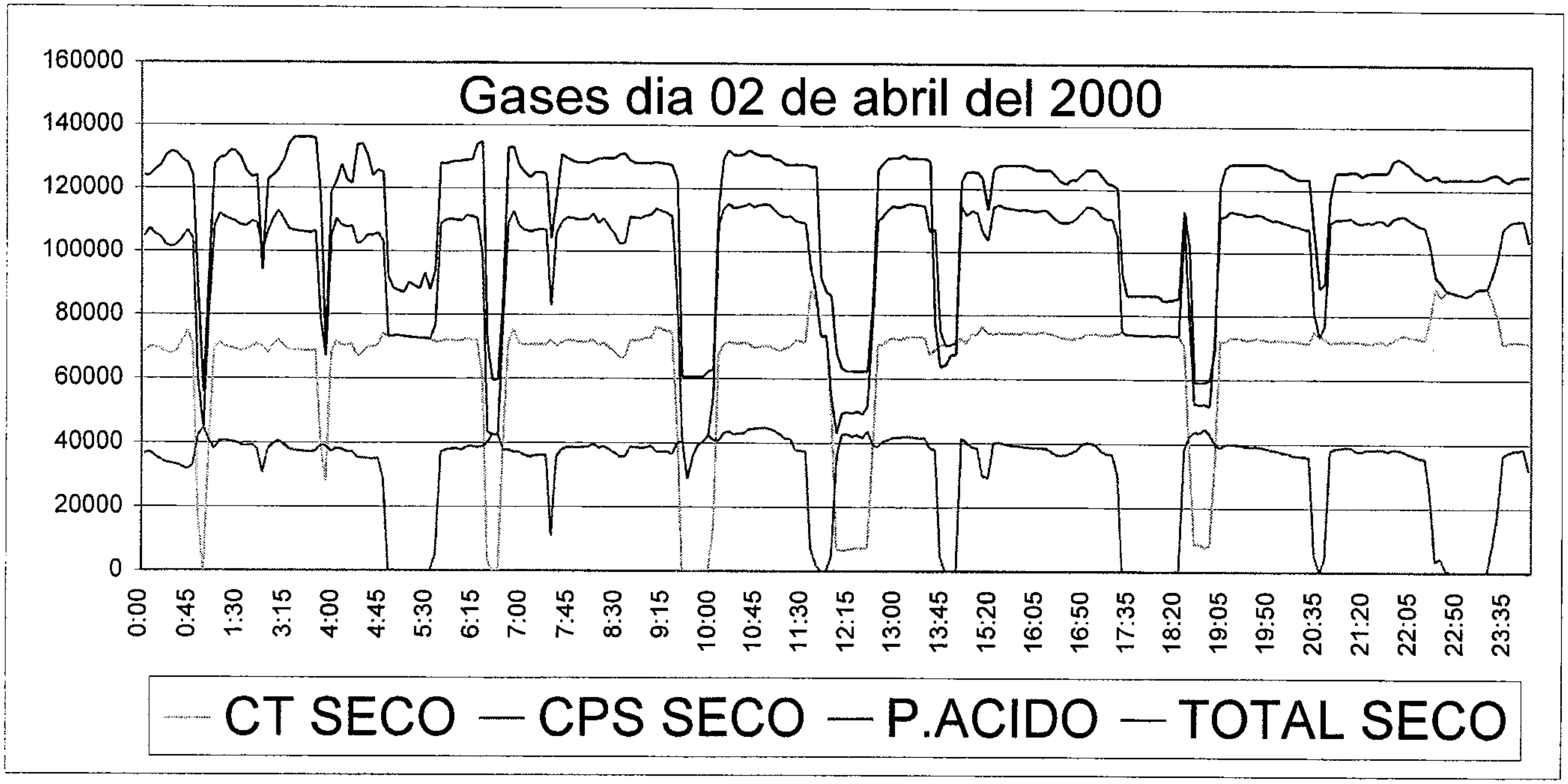
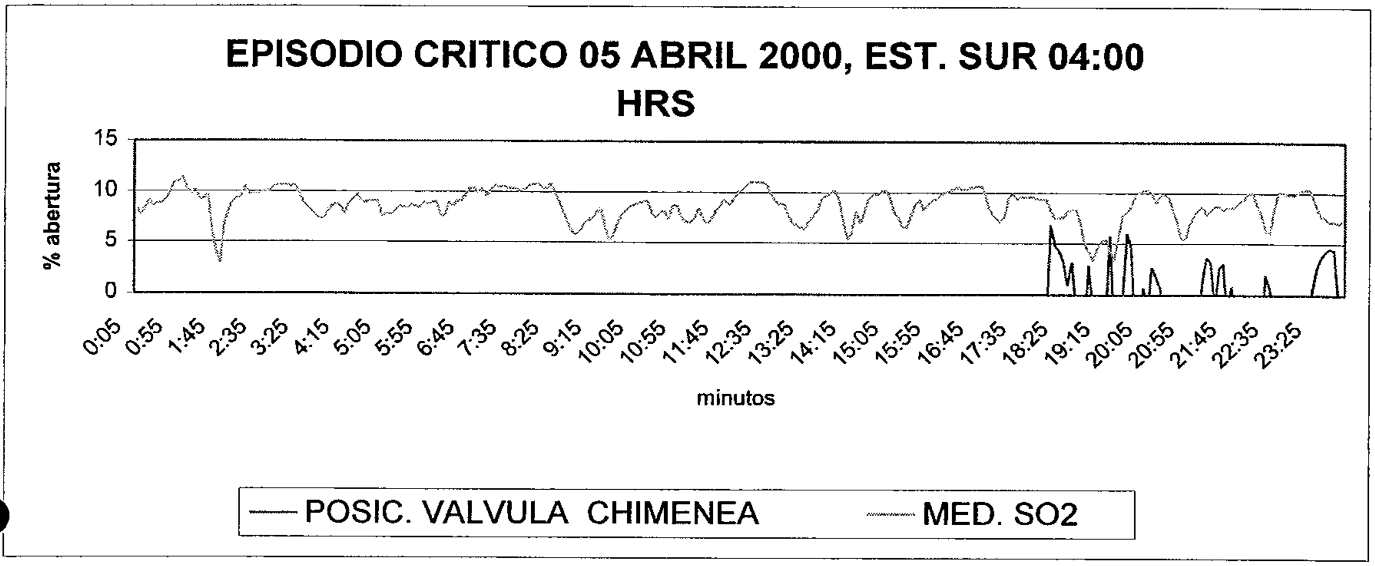


GRÁFICO Nº3

GASES	CT	CPS	TOTAL
HDAD %	11	6	8,5
SO2			9
HUMEDOS	73947	34014	107960
SECOS	65812	31973	97786
PROMEDIO PLANTA ACIDO			115103

000662



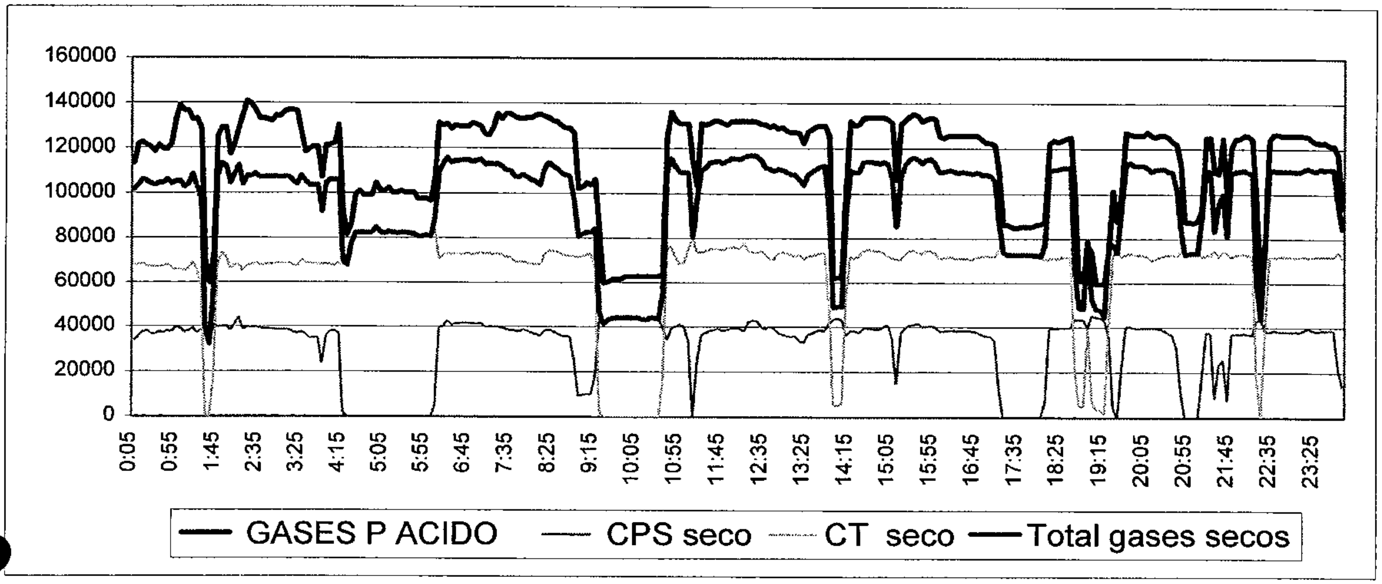


GRÁFICO Nº4

GASES	CT	CPS	TOTAL
HDAD %	11	6	8,5
SO2			9
HUMEDOS	77356	32199	109555
SECOS	68847	30267	99114
PROMEDIO PLANTA ACIDO			115971

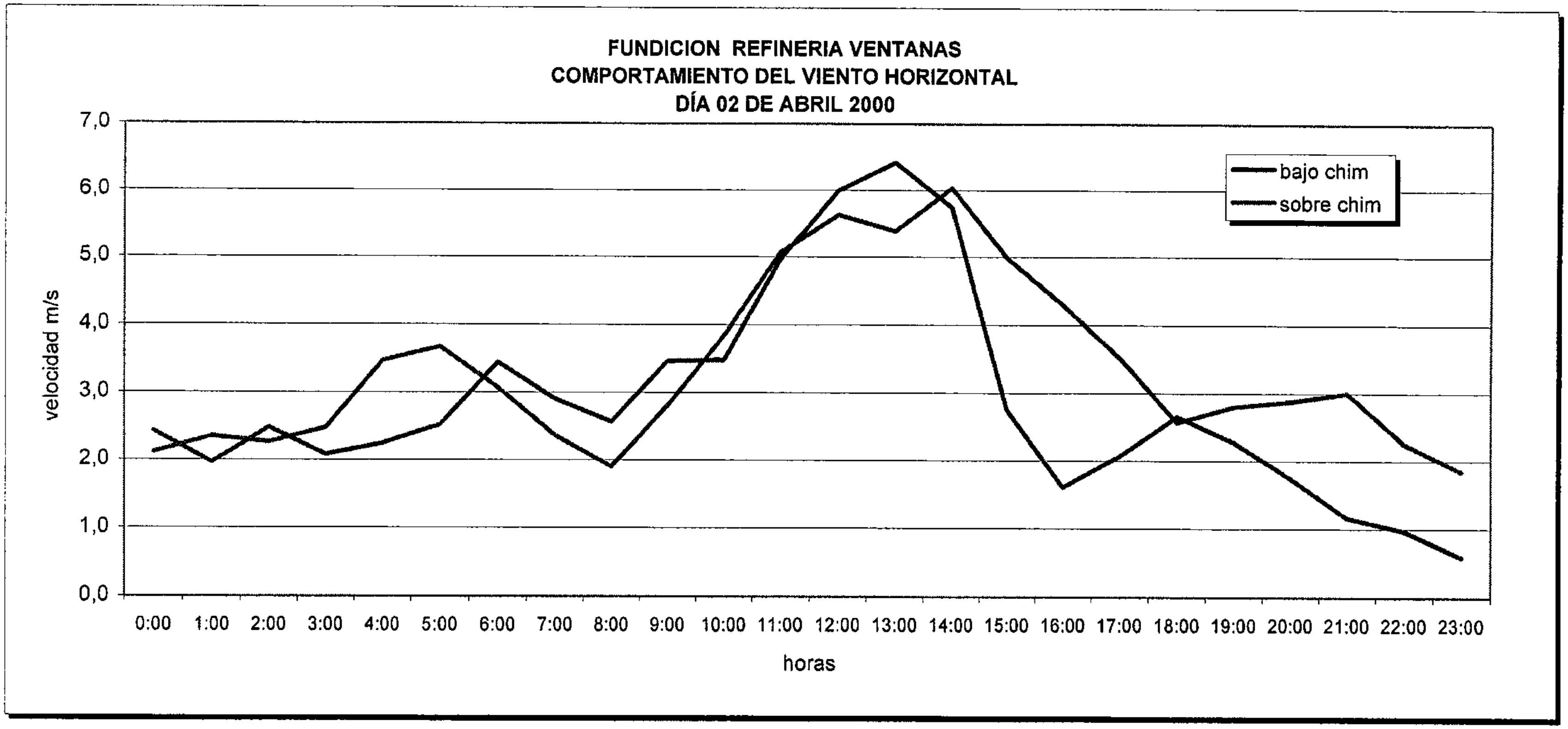


GRÁFICO Nº5

La intensidad de vientos bajo y sobre nivel de chimenea, presenta un comportamiento similar, con un promedio sobre los 2 m/s de 00:00 a 09:00 aumentando progresivamente, alcanzando un maximo valor de 6 m/s en la hora de maximo calentamiento diurno.

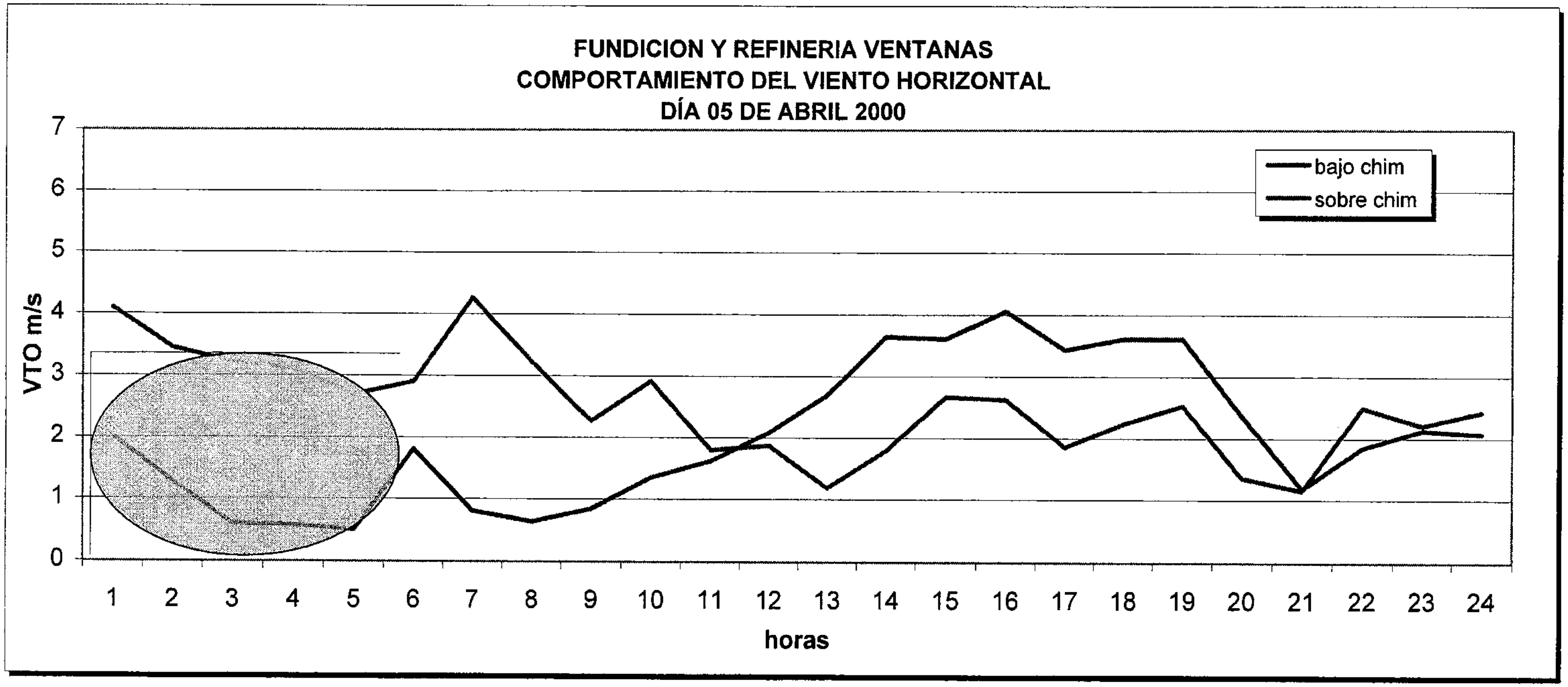


GRÁFICO Nº6

La intensidad de vientos bajo nivel de chimenea, presenta una notable disminución desde el inicio del día 05, aumentando desde las 12:00 horas. El comportamiento del viento por sobre el nivel de chimenea se mantiene sobre los 2m/s hasta las 11:00 horas.

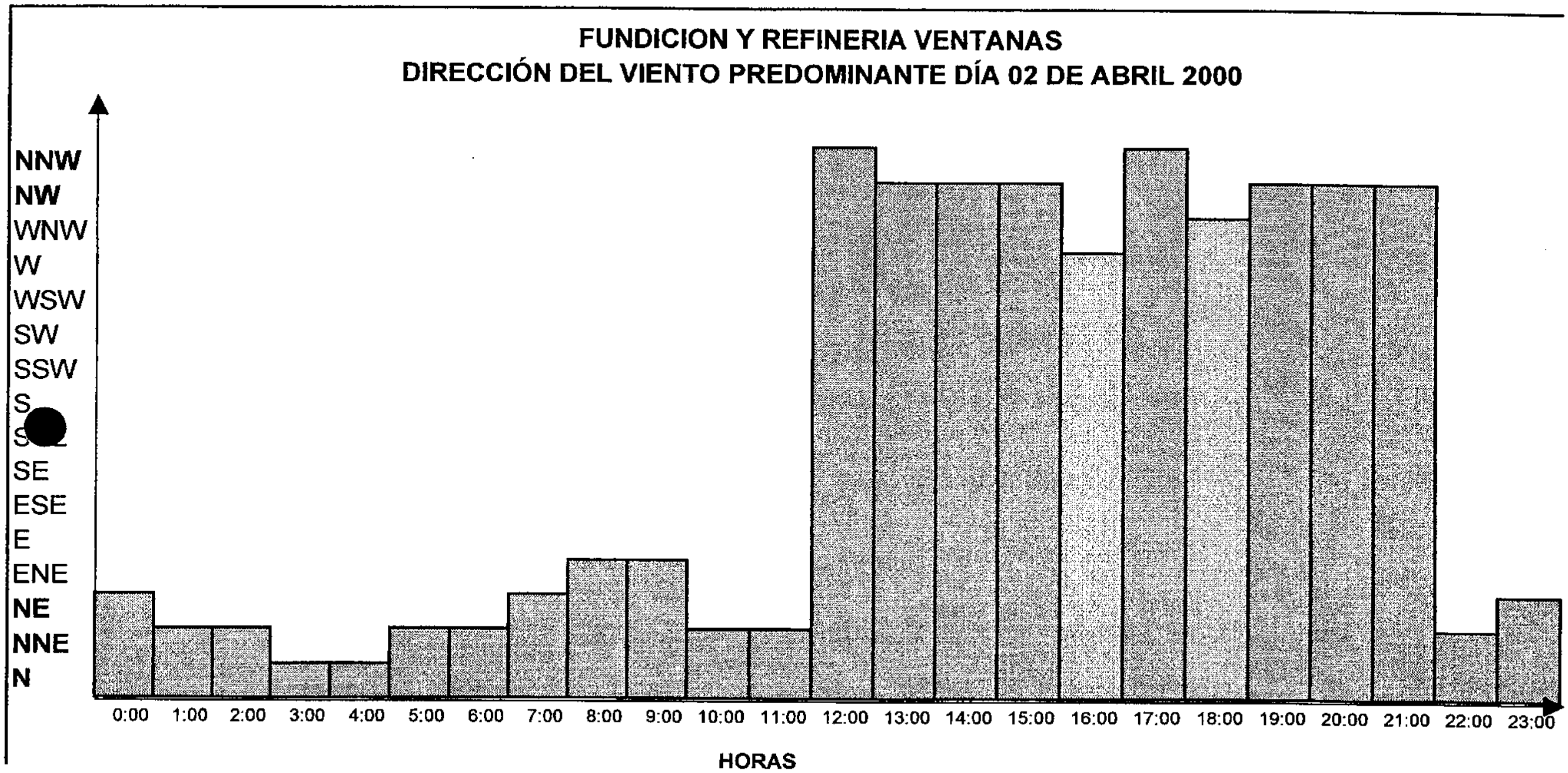
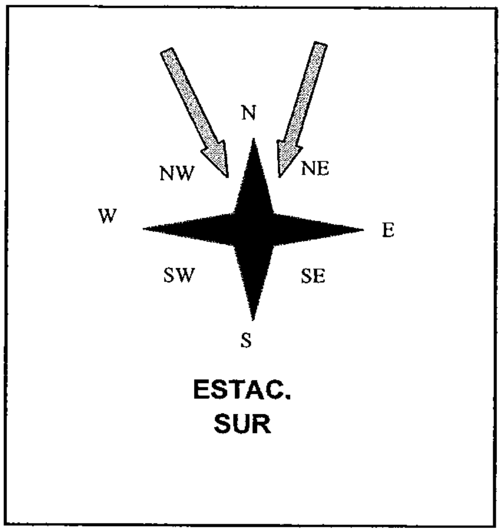


GRÁFICO Nº7



La dirección predominante del viento se mantiene de componente norte desde las 00:00 horas del día 02 de abril, específicamente NNW a NNE, dirección en que se encuentra ubicada la estación SUR.

FUNDICION Y REFINERIA VENTANAS
DIRECCIÓN DEL VIENTO PREDOMINANTE DÍA 05 DE ABRIL 2000

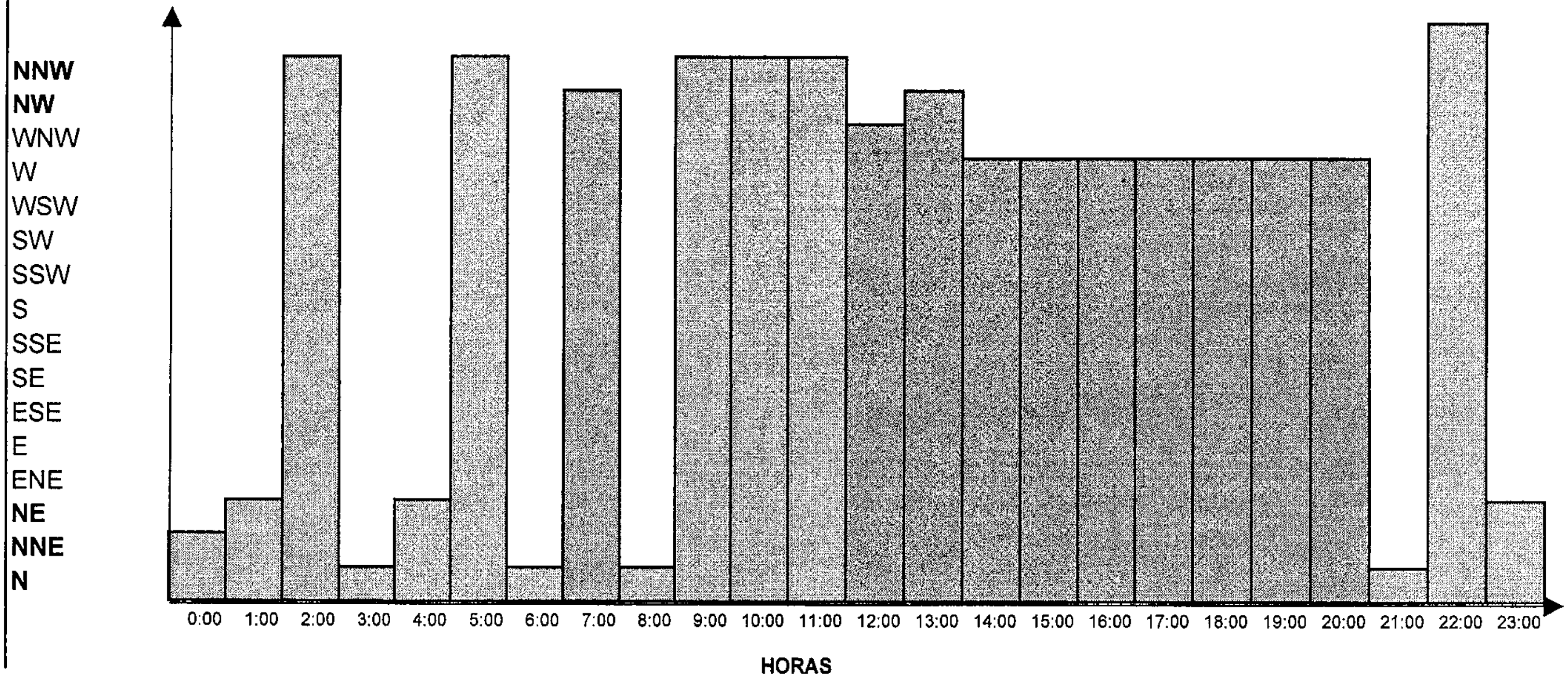
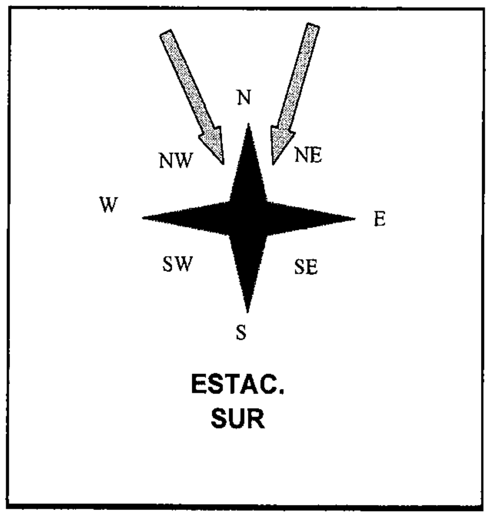


GRÁFICO Nº8



La dirección predominante del viento se mantiene de componente norte desde las 00:00 horas del día 05 de abril, específicamente NNW a NNE, y es precisamente la dirección en que se encuentra ubicada la estación SUR. Desde las 12:00 hrs. el viento varía a la dirección W, hasta las 21:00 horas donde nuevamente se produce una variación a vientos del Norte.

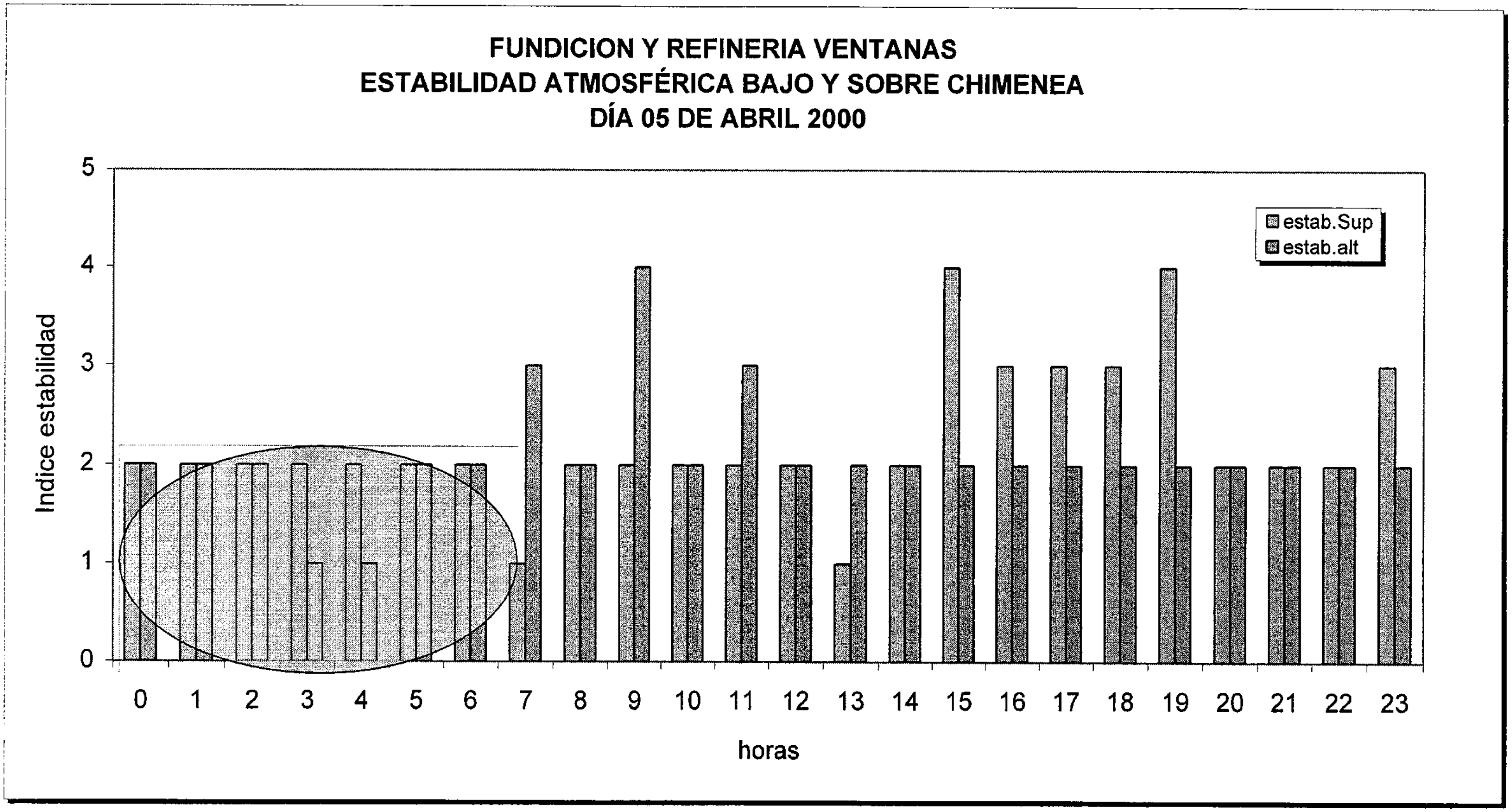
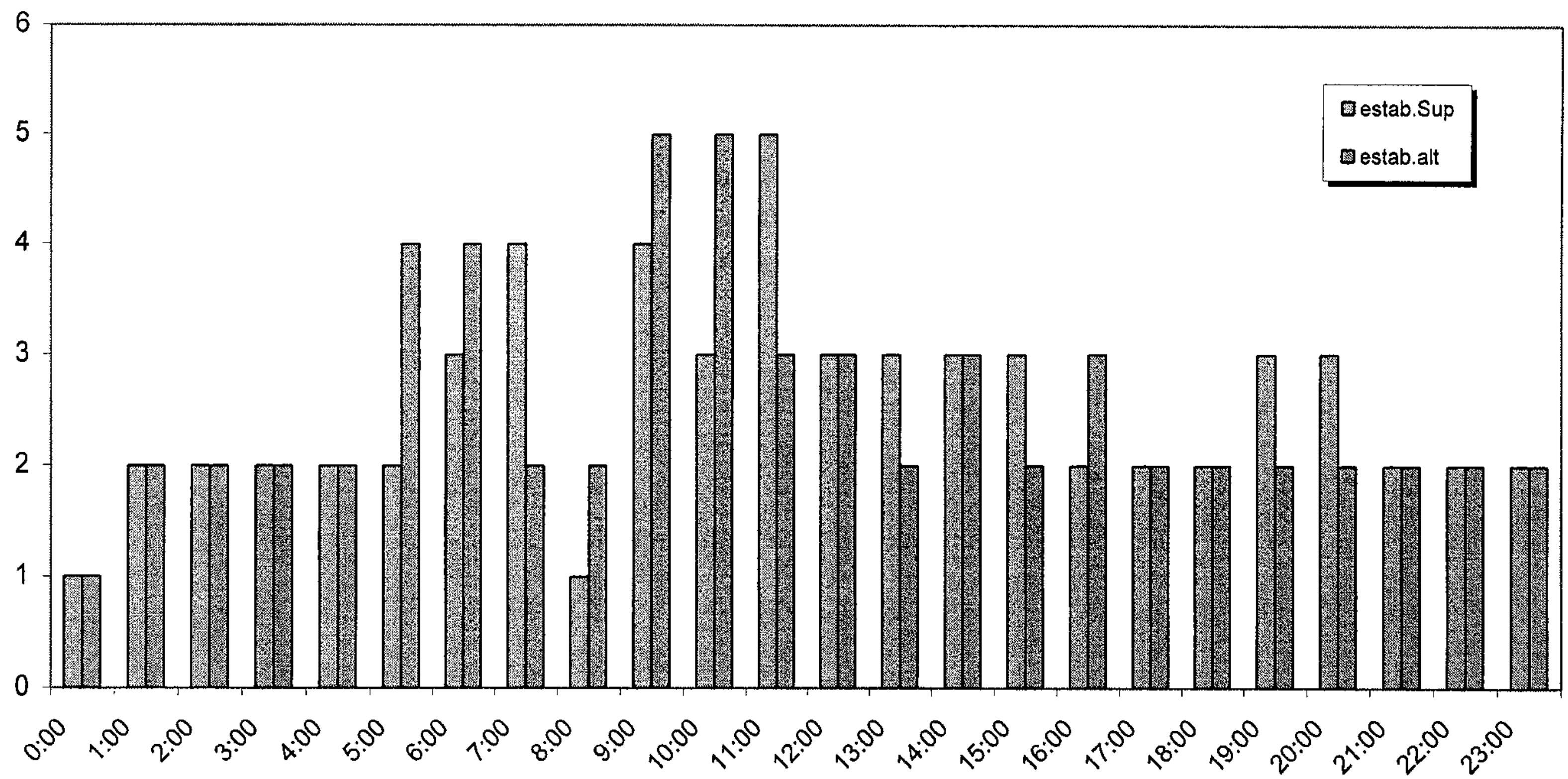


GRÁFICO N°10

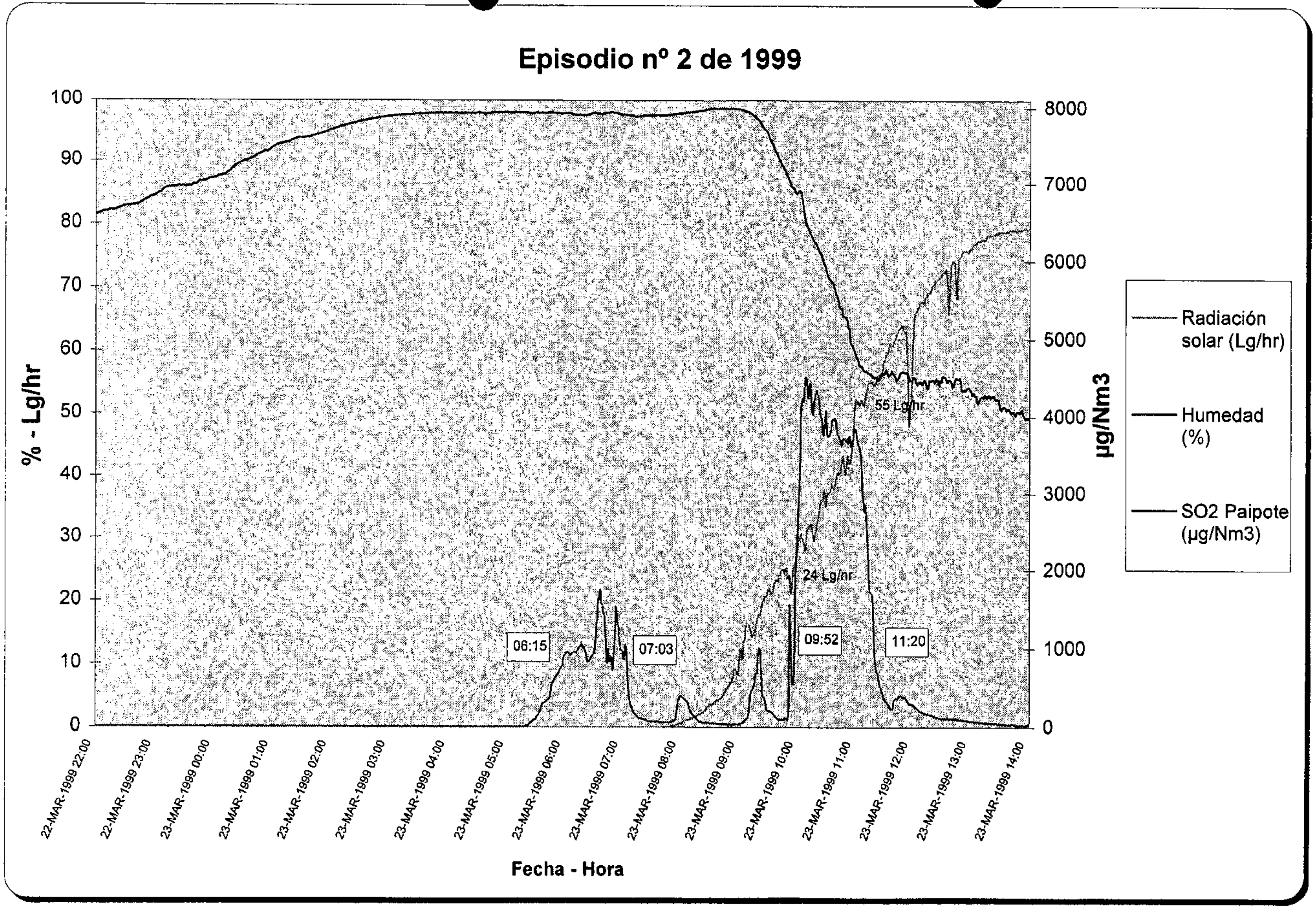
La atmósfera se presenta estable (índice 1) y muy estable (índice 2) en todo el período de 00:00 a 06:00 horas. Tal característica es consecuencia directa del predominio de Vaguada Costera en la zona, asociada además de una notable disminución de vientos, y vientos de componente norte.

FUNDICION Y REFINERIA VENTANAS
ESTABILIDAD ATMOSFÉRICA BAJO Y SOBRE
CHIMENEA DÍA 02 DE ABRIL 2000



La atmósfera se presenta estable (índice 2) hasta las 05:00 horas. Posteriomente tiene un comportamiento entre neutro (indice 3) e inestable (indice 4) hasta las 17:00 horas, periodo de calentamiento diurno. Volviendo a ponerse estable por ausencia del calentamiento diurno, que hace que se generen moviemientos convectivos, favorables para la dispersión.

PAIPOTE


Episodio nº 2 de 1999
% - Lg/hr
µg/Nm3
Radiación solar (Lg/hr)
Humedad (%)
SO2 Paipote (µg/Nm3)
06:15
07:03
09:52
11:20
24 Lg/hr
55 Lg/hr
22-MAR-1999 22:00
22-MAR-1999 23:00
23-MAR-1999 00:00
23-MAR-1999 01:00
23-MAR-1999 02:00
23-MAR-1999 03:00
23-MAR-1999 04:00
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ENAMI

FUNDICIÓN Y REFINERÍA VENTANAS

DEBILIDADES SISTEMA DE MANEJO DE GASES FUNDICIÓN

PREPARADO POR:

INGENIERÍA DE PROCESOS FUNDICIÓN
SUPERINTENDENCIA FUNDICIÓN

VENTANAS, MAYO 2000

DEBILIDADES SISTEMA MANEJO DE GASES FUNDICION.

INTRODUCCION:

En el marco del plan de mejoramiento del sistema de manejo de gases Fundición y Planta de ácido, se definieron diversas acciones, entre ellas la determinación y cuantificación de las emisiones fugitivas en la nave de fundición y que inciden en los resultados de captación de azufre del sistema. En este informe, se presenta una caracterización preliminar de dichas emisiones, sobre la base de los mejores antecedentes disponibles.

DESARROLLO:

Balance de azufre Fundición:

Los resultados oficiales de captación y emisión de azufre de la Fundición Ventanas, emitidos por la Unidad Medio Ambiente, entregan los siguientes valores para el período enero a abril de 1999:

• Azufre ingresado	:	100%
• Azufre en ácido	:	88,5%
• Azufre en polvos	:	0,25%
• Azufre en escorias	:	0,75%
Captación total:	:	89,5%
Azufre no captado	:	10,5%

De acuerdo con lo indicado, un 10,5% del azufre ingresado a la Fundición en los concentrados no es captado y fijado en productos, asumiendo entonces que es emitido a la atmósfera como emisión gaseosa secundaria. En el anexo Nº1, se entrega el resumen del balance de azufre del año 1999.

Emisiones secundarias de azufre.

Las causas de emisión atmosférica se muestran en la figura N°1, la que incluye una estimación preliminar expresada en toneladas/día de azufre emitido en cada fuente.

Como se desprende de la figura N°1, la campana de captación de gases del convertidor Teniente es la fuente física que ocasiona el mayor impacto e incidencia en las emisiones secundarias. En este contexto y a modo de ejemplo, se identificaron 4 causas relevantes de emisiones en campana CT:

- Captación inferior a 100% durante soplado normal del CT
- Giro del CT para revisiones de rutina
- Puesta en servicio del CT después de giros

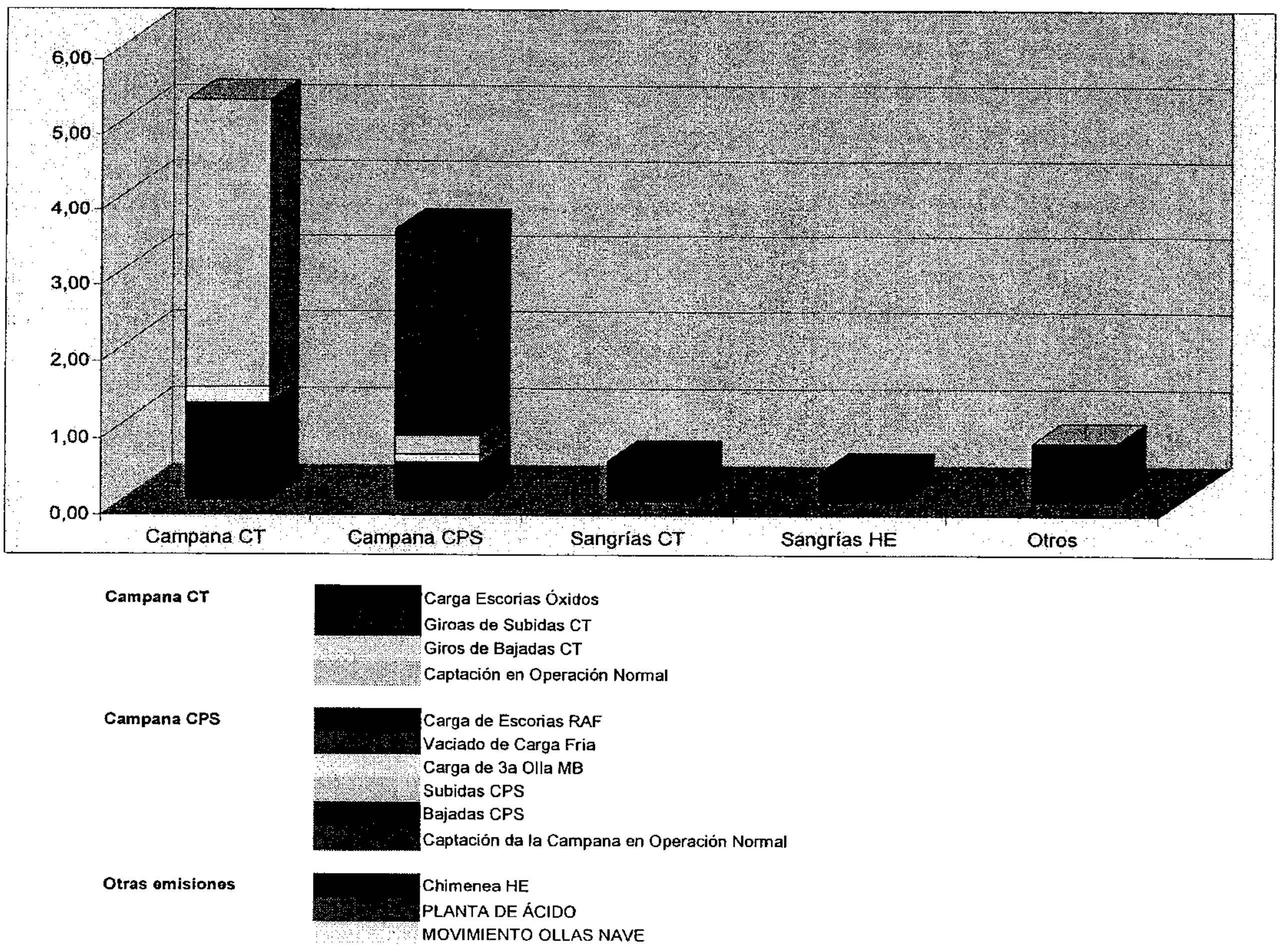
- Apertura de compuerta para retorno de escorias de CPS a CT

Un análisis análogo se realiza para los convertidores Peirce-Smith, en los cuales aparecen también otras operaciones similares como el carguío de la tercera olla de metal blanco con el CPS soplando y especialmente la adición de carga fría.

Otras fuentes identificadas de emisiones secundarias son las chimeneas de la planta de ácido, correspondiente al SO2 no convertido por menor eficiencia de conversión y a los gases del horno eléctrico, por la contribución a la reducción de magnetita realizada por el FeS contenido en circulantes y escoria del CT, que genera algo de SO2.

La emisión en canaletas de sangría, particularmente de metal del CT y HE, como también las emisiones por movimiento de ollas, se estimó en bases a trabajos anteriores (CIMM 1994).

Como se observa en la figura N°1, la mayor incidencia en las emisiones de azufre corresponde a la menor captación de las campanas del CT y CPS, que de acuerdo a las últimas mediciones de gases efectuadas resultaron 96,2% y 93,3%.



Cuantificación de emisiones secundarias:
En el cuadro N°1, se presenta el balance general de azufre de la Fundición, incluyendo la estimación de emisiones de cada una de las fuentes.

Balance de azufre Fundición, t/día

Emisiones menores:							
Campana CT	4,16	0,50	0,75	13,95			19,36
Campana CPS	0,92	0,92	0,37	0,92	1,38	8,53	13,06
Sangrías CT	1,93						1,93
Sangrías HE	1,35						1,35
Otras emisiones	0,87	1,88	0,04				2,79
Escoria Final	2,80						2,80
Polvos	0,85						0,85

Fusión de CNU	[ts/día]	1224
Ley de azufre CNU	[%]	30,00%
Azufre ingresado en CNU	[tf/día]	367,2
Emisión atmosférica	[tf/día]	38,48
Confinado en sólidos	[tf/día]	3,65
Azufre en ácido	[tf/día]	325,06
Emisión anual estimada	[tf/día]	12700
Captación total de azufre	[%]	89,5%
Azufre emisión atmosférica	[%]	10,5%

Emisiones Secundarias Fundición, %

Campana CT	1,13	0,14	0,20	3,80			5,27
Campana CPS	0,25	0,25	0,10	0,25	0,38	2,32	3,56
Sangrías CT	0,53						0,53
Sangrías HE	0,37						0,37
Otros	0,24	0,51	0,01				0,76
Total	[%]						10,5

CONCLUSIONES:

- Las emisiones de azufre no captadas se generan mayoritariamente en las campanas del Convertidor Teniente y de los convertidores Peirce-Smith. Bajo régimen normal de operación, la eficiencia de captación inferior a 100%, implica una emisión de gases permanente hacia la nave.

- Lo anterior se relaciona con las limitaciones del sistema de manejo de gases, particularmente la capacidad de tratamiento de gases de planta de ácido, que restringe a flujos máximos de gases de 82.000 Nm3/h para CT y de 43.000 Nm3/h para CPS.

- En estas condiciones, no es posible inducir un mayor tiro con los ventiladores, determinando una menor captación efectiva en campanas. Las últimas mediciones realizadas indican una captación de 93% para CPS. En el caso del CT, la mejor estimación es 96,2%.

- Directa relación con este fenómeno tiene la falta de hermeticidad del sistema, debido a la pérdida gradual de eficiencia durante la campaña de los nuevos componentes, como guillotinas de aislación, dampers, cortinas posteriores de CT y CPS, cilindros neumáticos de CPS.

- Los eventos de operación que implican giro de reactores y/o apertura de compuertas de las campanas de captación de gases, tienen una incidencia menor en el balance de azufre y representan una fracción menor del 10,5% del azufre no captado.

- Sin embargo, dichos eventos implican elevadas tasas de emisión instantánea, que afectan las concentraciones medidas en la red de monitoreo y constituyen un importante impacto visual de gases alrededor de la nave de Fundición. La concentración de este tipo de eventos durante períodos con condiciones meteorólogicas adversas, puede conducir a episodios críticos de calidad del aire.

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SANTIAGO

COMISION NACIONAL DEL MEDIO AMBIENTE
OFICINA DE PARTES Y ARCHIVO
Nº INGRESO: 6987/5961
FECHA:
DESPACHADO: 03 JUL 2000
OBS.: P. Matus
Por correo
04/07/00 - 930
ID # 22232

MEDIO AMBIENTE CORPORATIVO Nº 133

Santiago, 29 de Junio de 2000

Señora
Patricia Matus C.
Jefe de Depto Descontaminación, Planes y Normas
Comisión Nacional del Medio Ambiente
Presente

Ref.: Revisión Resolución Nº 1215 de Salud

De mi consideración:

En atención al informe de efecto sobre la salud de las personas, presentado como antecedente para la revisión de la norma de la referencia, "Contaminación atmosférica y síntomas respiratorios en niños escolares del área de influencia del complejo industrial Las Ventanas-Puchuncaví, V Región de Chile". Tesis de grado para obtener Maestro en Ciencias en el Área Salud Ambiental, Instituto Nacional de Salud Pública, México. Sánchez, J. (1997)., tengo a bien exponer las siguientes observaciones:

Si bien el informe presentado constituye un importante aporte científico al proceso de revisión de la norma, y siendo conocido el efecto de broncoespasmo bronquial provocado por el SO_2 al ser estudiado en laboratorio con condiciones controladas de otras variables, es necesario hacer notar que dicho estudio consideró como grupo expuesto a escolares con antecedentes previos de patología bronquial tipo broncoespástico (asma bronquial), sin considerar un grupo de control sin antecedentes patológico previos.

La respuesta biológica se evaluó por mediciones de función pulmonar con un flujómetro (instrumento de terreno que se utiliza como screening, para control de pacientes en tratamiento con enfermedades con asma bronquial) y no con un espirómetro que es el instrumento adecuado para medir función pulmonar de acuerdo a las normas de la American Thoracic Society.

Adicionalmente, las diferentes condiciones de contaminación atmosférica por SO_2, se obtuvo usándose la información de las estaciones de monitoreo de Puchuncaví y no se realizó un monitoreo continuo de las condiciones existentes en la escuela

EMPRESA NACIONAL DE MINERIA
MAC-IVER Nº 459
TELEFONO : 6375000
CASILLA : 100-D
SANTIAGO
CHILE

u hogares donde se realizó el estudio. Además no se efectuaron mediciones de los niveles de PM-10 y monóxido de carbono, contaminantes que, dada la cercanía con la carretera y la utilización de calefacción en hogares con leña y parafina, pueden tener una influencia en la sintomatología presentada en el grupo de niños estudiados.

Como consecuencia de lo anterior, la conclusión que puede inferirse del estudio es que cuando las concentraciones de SO2 sobrepasan ciertos niveles en el ambiente, aumentaría la bronco constricción en los niños que padecen de patología bronquial espástica previa, no siendo posible concluir que en los niños que no padecen de dicha patología aparezcan síntomas o signos sugerentes de bronco espasmo bronquial en las concentraciones de SO2 a las que estuvieron expuestos durante el estudio, ni tampoco que la exposición prolongada a estos provoque alguna clase de patología pulmonar o de otro tipo.

Por último informo a usted que según nuestras indagaciones, existe a nivel nacional un segundo estudio del tema, realizado por el Doctor Lionel Gil en 1996 y cuyo título sería "Estudio preliminar sobre los efectos de la contaminación atmosférica en la función Pulmonar de niños de edad escolar y pre-escolar en la III región".

Sin otro particular, se despide atentamente,

ALEJANDRO DIEZ VALENCIA
JEFE DE MEDIO AMBIENTE

GOBIERNO DE CHILE
Comisión Nacional del Medio Ambiente
Región de Atacama

22873/7

COMISION NACIONAL DEL MEDIO AMBIENTE
OFICINA DE PARTES Y ARCHIVO
Nº INGRESO: 7673/6444
FECHA: 17 JUL 2000
DESPACHADO:
OBS.: P. Matus

ORD.: N° 00439/

ANT . Solicitudes telefónicas.

MAT: Remite información que indica.

COPIAPO, 14 JUL 2000

DE : DIRECTOR REGIONAL COMISION NACIONAL DEL MEDIO AMBIENTE REGION DE ATACAMA

A : DRA. PATRICIA MATUS CORREA JEFA UNIDAD DESCONTAMINACION PLANES Y NORMAS COMISION NACIONAL DEL MEDIO AMBIENTE

En atención a lo solicitado por el profesional de esa unidad, Sr. Rodrigo Lucero, adjunto remito a Ud. plano del sector de Paipote donde se encuentra el área poblada más expuesta a las emisiones de la fundición Hernán Videla Lira.

Además se adjunta los datos de población del área por grupo etáreo y un cuadro con la información referida a ocasiones en que durante el año 1999 se registraron eventos de superación de los niveles de concentración de anhídrido sulfuroso correspondientes a 250 y 300 Ug/Nm3.

La información remitida complementa otros antecedentes que se han estado enviando vía E-mail, y que corresponden a la calidad del aire en diferentes localidades de la Región de Atacama, a fin de aportar al proceso de revisión de la norma primaria de calidad del aire establecida en Resolución 1215/1978 del Ministerio de Salud.

Por otro lado, considerando que el proceso de revisión de la mencionada norma reviste especial importancia para la Región de Atacama, en particular para las localidades de Copiapó, Tierra Amarilla y Huasco y las megafuentes asociadas, me permito solicitar a Ud., si lo tiene a bien disponer los medios administrativos y económicos para que la Unidad de Planes y Normas de esta Dirección regional pueda participar de todas las instancias posibles de discusión de la norma señalada en la citada Resolución.

Sin otro particular, saluda atentamente a Ud.,

Comisión Nacional del Medio Ambiente
DIRECTOR

DANIEL ALVAREZ PARDO
DIRECTOR REGIONAL
COMISION NACIONAL DEL MEDIO AMBIENTE

DAP/RRD/rrd.
<u>DISTRIBUCION :</u>

- Destinatario.
- Sr. Pedro Hernández G. Unidad de Coordinación Regional.
- Archivos Planes y Normas .

COMISION NACIONAL DEL MEDIO AMBIENTE
REGION DE ATACAMA
UNIDAD DE PLANES Y NORMAS

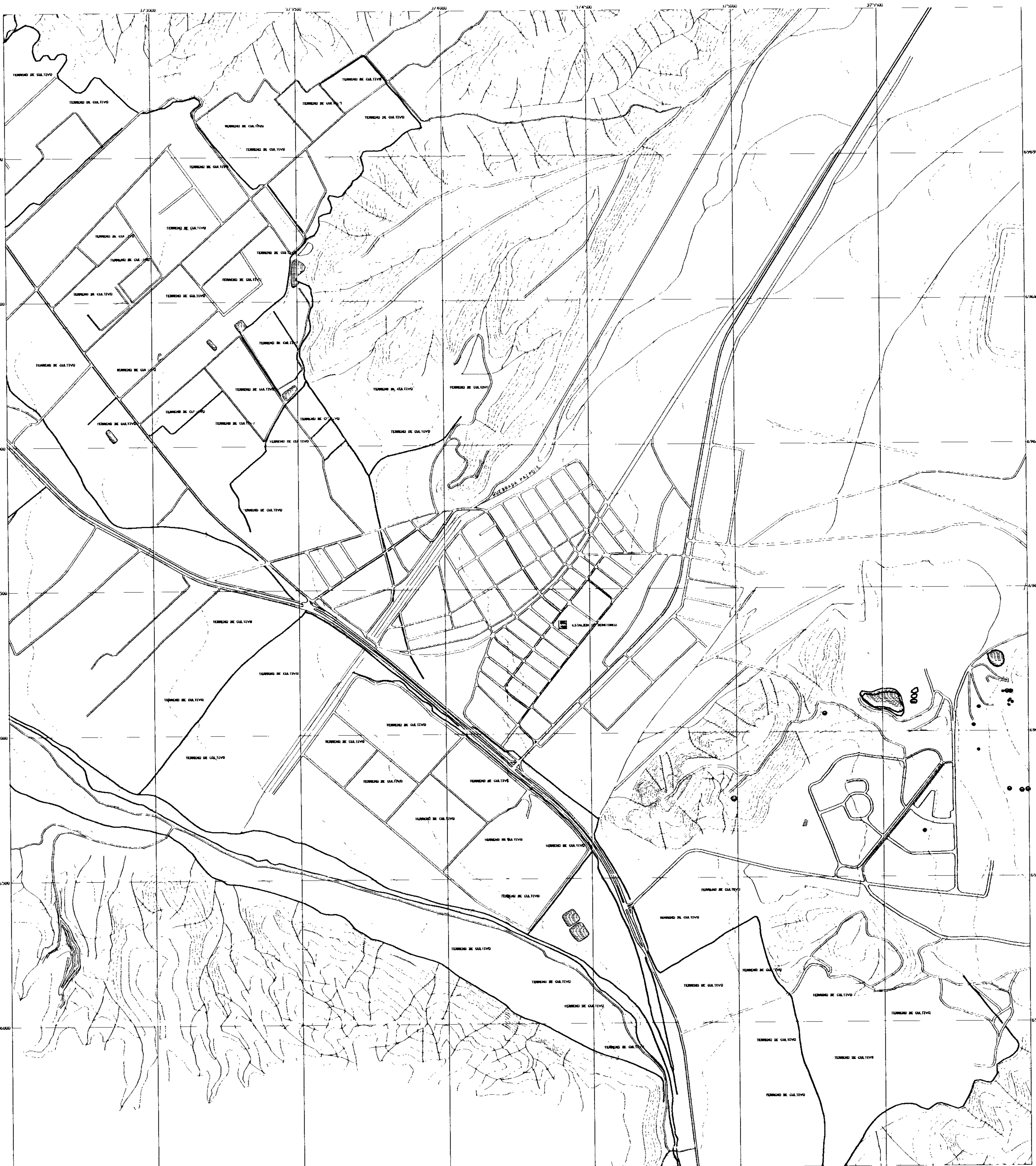
CALIDAD DEL AIRE POR SO2 EN ESTACION PAIPOTE AÑO 1999 CONCENTRACION DIARIA EN LOS RANGOS DE 250 - 300 Ug/ Nm3 Y SUPERIOR

MES	EVENTOS CONCENTRACION ENTRE 250 Y 300 Ug/Nm3	EVENTOS CONCENTRACION MAYOR A 300Ug/ Nm3
ENERO	0	0
FEBRERO	0	0
MARZO	0	1
ABRIL	0	0
MAYO	0	1
JUNIO	1	0
JULIO	0	0
AGOSTO	0	1
SEPTIEMBRE	0	0
OCTUBRE	0	0
NOVIEMBRE	0	0
DICIEMBRE	0	0
TOTAL	1	3

POBLACIÓN POR GRUPO ETAREO SECTOR PAIPOTE

	POBL. TOTAL	POBL. INFANTIL	POBL. ADULTA	POBL. ADULTA MAYOR
POBL. PAIPOTE	4.630	1.364	2.992	274
FUNDICIÓN	153	50	83	20
TOTAL	4.783	1.414	3.075	294

000682



PLANO SECTOR PAIPOTE

ESCALA 1/10.000

SISTEMA DE INFORMACION TERRITORIAL DE ATACAMA

UNIDAD DE ANALISIS TERRITORIAL SERPLAC ATACAMA

GOBIERNO DE CHILE
COMISION NACIONAL
DEL MEDIO AMBIENTE

Con fecha 17 de julio de 2000 se archivó el documento que a continuación se indica sobre antecedentes para la Revisión de las Normas Primarias de Calidad de Aire para CO, O3, NO2, SO2 y PTS:

1. Dispersión de azufre oxidado en Chile central y escenarios de emisiones, Laura Gallardo, Ariel Aguayo, Gustavo Olivares.

RODRIGO LUCERO CH.
Depto. Descontaminación, Planes y Normas
Comisión Nacional del Medio Ambiente

DISPERSIÓN DE AZUFRE OXIDADO EN CHILE CENTRAL Y ESCENARIOS DE EMISIONES: APOYO A LA REVISIÓN DE LA NORMATIVA AMBIENTAL VIGENTE

Laura Gallardo*, Ariel Aguayo y Gustavo Olivares
Comisión Nacional del Medio Ambiente
Obispo Donoso 6, Providencia, Santiago Chile

RESUMEN

Se aplica un modelo de escala regional a la dispersión de compuestos oxidados de azufre en la macrozona central de Chile. El sistema de modelación aplicado consta de un modelo meteorológico (HIRLAM) y de un modelo de dispersión (MATCH). Hasta la fecha se cuenta con resultados validados correspondientes a los escenarios de Enero y Mayo de 1998 para compuestos oxidados de azufre. Los resultados antes señalados se aplican ahora a evaluar dos escenarios de emisiones de dióxido de azufre (SO_2): uno actual y otro proyectado. Ambos se evalúan respecto del cumplimiento de las normas ambientales vigentes y en estudio. Para los fines de esta aplicación se considera como escenario actual aquel correspondiente a las emisiones de SO_2 estimadas para 1998. El escenario futuro corresponde a las emisiones proyectadas para el año 2002 según los planes de descontaminación de las grandes fundiciones mineras de Chile central. Se presenta una estimación de la contribución relativa de las fundiciones de cobre en Chile central al azufre oxidado. También se muestra una estimación de los cambios esperables en las contribuciones relativas y las cantidades absolutas a partir de los cambios proyectados para el año 2002 en las tasas de emisión de las fuentes mineras. En lo principal, se concluye que la disminución de las emisiones de las grandes fundiciones ubicadas en Chile central tendrá como efecto una disminución substantiva de los impactos en sus inmediaciones y viento abajo de las mismas. Sin embargo, aún en un escenario de emisiones reducidas al 2002, se estima que habrá importantes extensiones afectadas por altas concentraciones de azufre oxidado.

1. INTRODUCCIÓN

Desde 1999 se encuentra en ejecución el proyecto '*Fortalecimiento del sistema de información ambiental – Aplicación de un modelo de escala regional para Chile Central*'(Ver http://tralka.dcc.uchile.cl/match y http://www.swe-chile.com/ para más detalles). Este es un proyecto conjunto entre la Comisión Nacional del Medio Ambiente (CONAMA) y el Instituto Sueco de Meteorología e Hidrología (SMHI). El proyecto tiene como objetivo general implementar y validar un modelo de dispersión de escala regional, el sistema HIRLAM-MATCH, para determinar la influencia de varias fuentes sobre la calidad del aire en Chile central (Regiones Metropolitana, V y VI). El sistema de modelación consta de dos partes:

- HIRLAM (*High Resolution Limited Area Model*): Un modelo de pronóstico numérico del tiempo
- MATCH (*Multiscale Atmospheric Transport and Chemistry Modelling System*): Un modelo de dispersión de contaminantes atmosféricos

MATCH se alimenta con los campos meteorológicos calculados con modelos como HIRLAM o con datos meteorológicos analizados para transportar a los contaminantes atmosféricos. Los datos analizados corresponden a observaciones de la red meteorológica

* Autor quien se debe dirigir la correspondencia o correos electrónicos (lgallardo@conama.cl).

global, dependiente de la Organización Mundial de Meteorología (OMM), que han sido interpoladas con la ayuda de modelos globales de la atmósfera. El modelo de dispersión describe las emisiones, transformaciones físicas y químicas y deposición de los contaminantes transportados por los sistemas meteorológicos. El modelo pronóstico numérico del tiempo (HIRLAM) es ejecutado en Suecia por SMHI y el modelo de dispersión (MATCH) es ejecutado por CONAMA en Chile.

Hasta la fecha se cuenta con los resultados correspondientes a los escenarios de Enero y Mayo de 1998 para compuestos oxidados de azufre, esto es, dióxido de azufre (SO_2) y sulfato (Gallardo et al., 1999; Olivares et al., 2000). Nuestro esfuerzo se ha centrado hasta ahora en la validación sistemática de los módulos de meteorología y dispersión para situaciones de verano y otoño. Las primeras son relevantes para eventos de contaminación fotoquímica y las segundas para eventos de contaminación por partículas. Cabe destacar que Enero y Mayo de 1998 representan situaciones extremas en cuanto a condiciones de ventilación de Chile central.

Los resultados antes señalados se aplican ahora a evaluar dos escenarios de emisiones de SO_2: uno actual y otro proyectado. Ambos se evalúan respecto del cumplimiento de las normas ambientales vigentes y en estudio (Nor_1215, 2000). Para los fines de esta aplicación se considera como escenario actual aquel correspondiente a las emisiones de SO_2 estimadas para 1998. El escenario futuro corresponde a las emisiones proyectadas para el año 2002 según los planes de descontaminación de las grandes fundiciones mineras de Chile central (DS. 81 y DS. 179) que corresponden a las principales fuentes de SO_2 a escala regional. Esto es, para la fundición Ventanas de la Empresa Nacional de Minería (ENAMI) y la fundición Caletones de la División El Teniente de la Corporación Nacional del Cobre (CODELCO). Por simplicidad y teniendo en cuenta la contribución relativa de estas fuentes al contenido de azufre a escala regional, en esta aplicación no se han considerado los cambios proyectados respecto de las emisiones de Santiago y otras zonas urbanas de la macrozona central de Chile.

En la sección siguiente se describe el modelo aplicado. Luego se discute brevemente la validación del modelo y su grado de confiabilidad para los fines de esta aplicación. En la Sección 4 se describen los escenarios de emisión considerados. Los resultados se presentan en la Sección 5. Finalmente las conclusiones se entregan en la Sección 6.

2. DESCRIPCIÓN Y CONFIGURACIÓN DEL MODELO

a) Procesos

La dispersión a escala regional de contaminantes, como es el caso de los compuestos oxidados de azufre, involucra un rango amplio de escalas espaciales y temporales (Seinfeld & Pandis, 1998). Las escalas espaciales van desde decenas a cientos de kilómetros en la horizontal y abarcan unos pocos kilómetros en la vertical. Las escalas temporales van desde unas pocas horas a varios días. Por tanto, los patrones locales, de mesoescala y de escala sinóptica deben ser considerados al evaluar la dispersión regional de los contaminantes. Teniendo esto en consideración, a través de un esfuerzo conjunto con el Instituto de Hidrología y Meteorología de Suecia (SMHI) hemos aplicado el sistema de modelación HIRLAM-MATCH a la dispersión de compuestos oxidados de azufre. Como se indicó antes, el sistema consta de un modelo meteorológico (HIRLAM) y un modelo de dispersión (MATCH). Para más detalles acerca de este sistema de modelación se recomienda ver Robertson et al. (1999). A continuación se describen brevemente los procesos físicos y químicos representados en esta versión del sistema HIRLAM-MATCH, su configuración e implementación computacional.

Como ya se señaló, varias escalas espaciales y temporales están involucradas en la dispersión regional de los contaminantes. De la misma manera, una variada gama de procesos físicos y químicos afectan la dispersión de los contaminantes. Adicionalmente, la distribución temporal y espacial de las fuentes de contaminantes primarios también afecta la dispersión y distribución de los contaminantes. El modelo de dispersión (MATCH) representa con variado grado de detalle tales procesos, es decir, las emisiones, transformaciones físicas y químicas y deposición de los contaminantes transportados por los sistemas meteorológicos. HIRLAM, a su vez, representa una variada y compleja gama de procesos meteorológicos que incluyen la circulación de vientos, la propagación de altas y bajas presiones, nubosidad y precipitaciones, etc.. Para mayor detalle respecto de la modelación de los aspectos meteorológicos se recomienda ver Gallardo et al. (1999) y las referencias allí contenidas (También http://www.knmi.nl/hirlam/).

En la Figura 2.1 se muestran esquemáticamente los procesos de emisión, deposición y transformación que están considerados en MATCH según la configuración aplicada. Si bien MATCH cuenta con módulos químicos más complejos, incluyendo un completo módulo fotoquímico (Langner et. al. 1998), en esta aplicación se usa un módulo simple. En él la oxidación SO_2 a ácido sulfúrico y sulfato se parametriza a través de una tasa global de oxidación (KT) propuesto para EMEP (European Monitoring and Evaluation Program) por Tarrason & Iversen (1998). KT representa la oxidación en fase gaseosa por radical hidroxilo (OH) y en fase húmeda por agua oxigenada y ozono. En este esquema se supone, además, que el 95% de las emisiones ocurren en la forma de SO_2 y que el resto lo hace en forma de sulfato. Por último se representa la remoción de los compuestos por procesos de deposición húmeda y seca (Ver Robertson et al. 1999 para detalles). Hay que notar que la deposición húmeda sólo involucra la remoción por efecto de lluvia y no por neblina.

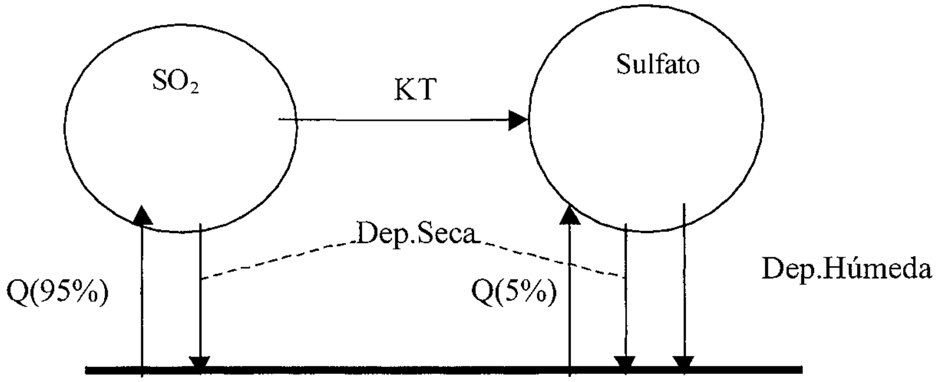


Figura 2.1. Esquema químico considerado en MATCH para esta aplicación. Q denota emisión.

b) Configuración

Varios parámetros deben seleccionarse al aplicar MATCH. Ellos tienen que ver con las tasas de remoción por lluvia y por deposición seca. Otros parámetros tienen que ver con la resolución temporal y espacial en que se representan los diversos procesos. La selección de estos parámetros no es trivial. En virtud de la falta de información más específica, para los fines de estas simulaciones hemos seguido las recomendaciones de Langner et al. (1998).

El modelo de dispersión se ejecuta con una resolución horizontal de 0.05°x0.05° de latitud y longitud (aproximadamente 5x5 km^2) y 15 niveles verticales. El dominio corresponde a un área de 200x400 km^2 centrada en Santiago y alrededor de 5.5 km en la vertical. El modelo meteorológico se ejecuta con una resolución horizontal de 0.1° x 0.1° de latitud y longitud (aproximadamente 11x11 km^2) y 31 niveles en la vertical desde la superficie hasta la estratósfera baja. El dominio del modelo meteorológico para la simulación de 1998 tiene 126x152 puntos de grilla.

Los campos meteorológicos son actualizados cada tres horas e interpolados para cada hora. El tiempo de integración para el proceso de transporte por advección es 150 s y los resultados de MATCH son guardados para cada hora de simulación. Los parámetros de deposición elegidos se especifican en la Tabla 2.1.

Tabla 2.1. Velocidades de deposición seca para SO_2 y sulfate sobre diferentes superficies en cm/s y coeficientes de remoción por lluvia en $(s^{-1} \cdot (mm \cdot hour^{-1})^{-1}$.

Traza	Deposición seca			Deposición húmeda
	Rural diurno	Rural nocturno	Mar	
SO_2	0.8	0.3	0.80	$6.95 \cdot 10^{-5}$
SO_4	0.1	0.1	0.05	$2.78 \cdot 10^{-4}$

Las concentraciones de fondo de SO_2 y sulfato se supusieron nulas. No conocemos mediciones de concentraciones de fondo de estas trazas que verifiquen nuestra suposición. Sin embargo, las mediciones disponibles indican un decaimiento suficientemente rápido de las concentraciones viento abajo de las grandes fuentes. Además, siendo la magnitud de las emisiones muy grande, resulta razonable despreciar los valores de fondo. Un error mayor pudiera cometerse en zonas costeras donde existen emisiones naturales de azufre. Sin embargo, en las zonas costeras de interés también existen emisiones significativas que aminoran este posible error.

Los detalles de la implementación del modelo meteorológico exceden el marco de este trabajo. Para más detalles se sugiere ver Olivares et al. (2000) y las referencias allí citadas o la página de HIRLAM en internet (http://www.knmi.nl/hirlam/). Detalles de la implementación computacional del modelo son entregados en el Anexo 1.

3. VALIDACIÓN DEL MODELO

La validación se ha hecho a través de una comparación sistemática de las simulaciones con las observaciones disponibles. En el caso del modelo meteorológico se compara con los datos recabados en las estaciones meteorológicas instaladas en la cuenca de Santiago (Ver Figura 3.1) y en las estaciones sinópticas de la red global de la OMM ubicadas en el cono sur de América. En el caso del modelo de dispersión se compara con los datos recabados por las redes de monitoreo de los grandes complejos industriales (fundiciones y termoeléctricas) y la red de monitoreo de Santiago (Ver Figura 3.2). La Figura 3.2 muestra también la topografía según la resolución del modelo meteorológico. Hay que destacar que la mayoría de las estaciones monitoras disponibles en la macrozona central de Chile han sido diseñadas para evaluar efectos locales, particularmente efectos sobre la salud. Por lo tanto, no se puede esperar que un modelo regional como HIRLAM-MATCH pueda reproducir todos los detalles de las observaciones. En las subsecciones siguientes se muestran algunos resultados que indican el nivel de confiabilidad y la precisión de los resultados.

a) Aspectos meteorológicos

Los datos meteorológicos producidos por la actual configuración de HIRLAM se estiman como suficientemente precisos para la simulación de la dispersión regional de contaminantes en Chile central durante condiciones veraniegas. Durante esta época del año, las condiciones sinópticas son relativamente invariables y caracterizadas por el predominio de la alta del Pacífico con condiciones de cielo despejado. Asimismo se observa un marcado ciclo diario en vientos, temperatura, etc. en superficie como producto del calentamiento diferencial entre las laderas de los cerros y los valles y de la costa y el mar. Durante el verano se intensifican las circulaciones de entre valle y montaña y la brisa marina y terral (circulaciones radiativas). Las simulaciones capturan, salvo efectos locales, estas variaciones. Simulaciones más detalladas para zonas urbanas como Santiago requieren la inclusión de los efectos meteorológicos de la ciudad, por ejemplo, efectos derivados de la isla calórica y la rugosidad provocados por la ciudad. Una mayor resolución horizontal también se hace necesaria para simular efectos topográficos locales como los que se dan en las inmediaciones de las grandes fundiciones. En la Figura 3.3 se muestra la comparación entre los valores simulados y observados en dos estaciones de la cuenca de Santiago (Aeropuerto de Pudahuel y La Platina).

En el caso otoñal las condiciones sinópticas son más variables que en verano destacándose el paso de frentes y la configuración de perturbaciones subsinópticas como las bajas o vaguadas costeras descritas por Rutllant y Garreaud (1995). Para la simulación de Mayo de 1998 hay ocasiones en que errores en la representación de la cobertura nubosa sobre Los Andes provocan la sobreestimación de los vientos en superficie, especialmente en la primera mitad del mes. Sin embargo, el modelo captura las principales características de la circulación atmosférica, incluyendo las bajas costeras más intensas y la advección de nubes bajas del tipo estratiforme (Episodios tipo A según Rutllant y Garreaud, 1995). Lo anterior se ilustra en las Figura 3.4. La Figura 3.4 es análoga a la Figura 3.3, sólo que para Mayo de 1998.

En suma, simulaciones de dos meses usando el modelo HIRLAM para Chile central han sido evaluadas hasta ahora: Enero y Mayo de 1998. Enero es un mes estival con poca nubosidad y caracterizado por circulaciones radiativas. Las simulaciones para Enero son precisas y se juzgan como suficientemente buenas para simular la dispersión regional de contaminantes. La simulación de Mayo de 1998, que es un mes de otoño y/o invierno seco, no es tan precisa como la de Enero. La temporadas de otoño e invierno están caracterizadas por tiempo nublado y vientos débiles en superficie. HIRLAM simula bien las condiciones meteorológicas asociadas a una baja costera en Chile central que se propaga por la costa al sur (Configuración tipo A, según Rutllant y Garreaud, 1995). Las condiciones prefrontales que preceden a un frente débil u ocluido que se tiende a detener o a hacerse estacionario (Configuración BPF, según Rutllant y Garreaud, 1995) no son tan bien simuladas. Al menos durante la primera mitad de Mayo 1998. Las discrepancias se asocian a una subestimación de la cobertura nubosa que induce una sobrestimación de las circulaciones radiativas. No obstante las discrepancias descritas, los resultados de HIRLAM indican que este modelo es capaz de reproducir muchos de los patrones meteorológicos relevantes para describir la dispersión de contaminantes en la macrozona central de Chile.

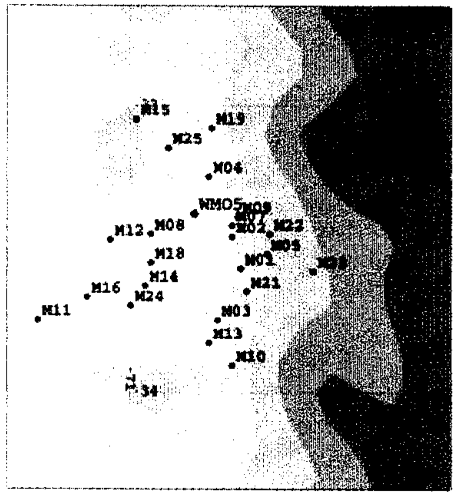


Figure 3.1 Mapa de las estaciones ubicadas en la cuenca de Santiago. También se indica la estación de Pudahuel (WMO5). La topografía es aquella considerada en HIRLAM.

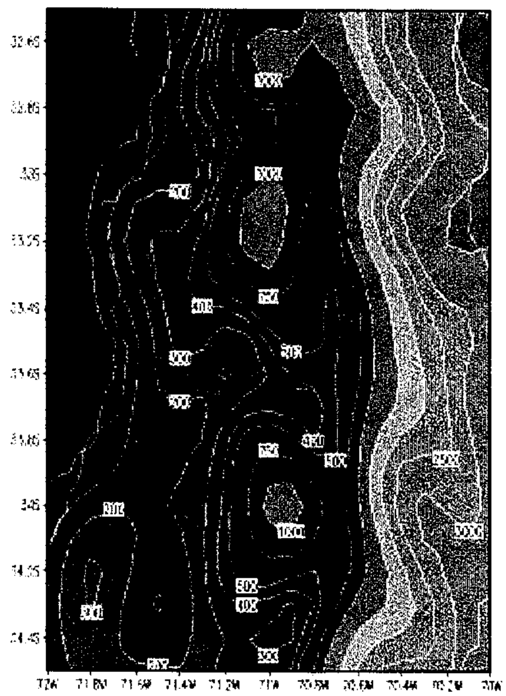
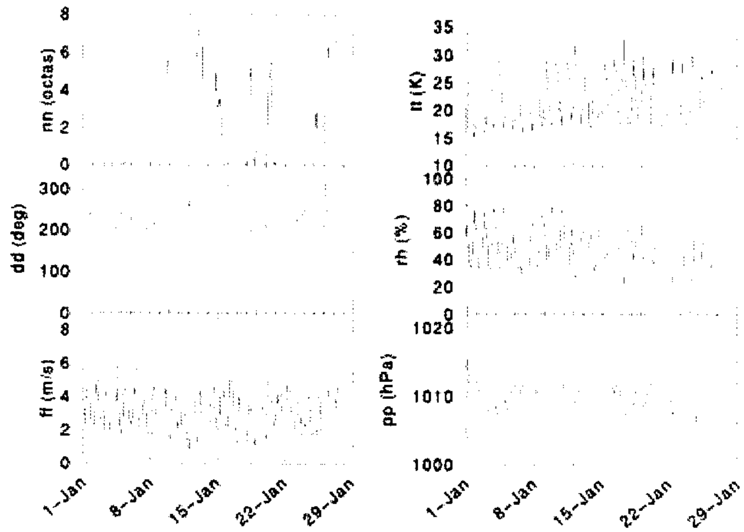


Figura 3.2. Ubicación de las estaciones de monitoreo consideradas en la validación del modelo. Las cruces indican las estaciones en Santiago; los círculos muestran las estaciones dependientes de CODELCO en la VI región; los círculos llenos denotan las estaciones de Quillota en la V región; los cuadrados abiertos indican las estaciones dependientes de ENAMI y los triángulos las de la fundición Chagres en la V región; el cuadrado relleno muestra la estación de Talagante. También se muestran las cotas de altura correspondientes a 200, 300, 400, 500, 750, 1000, 2500 y 3000 m. La topografía es aquella resuelta por el modelo.

Pudahuel



La Platina

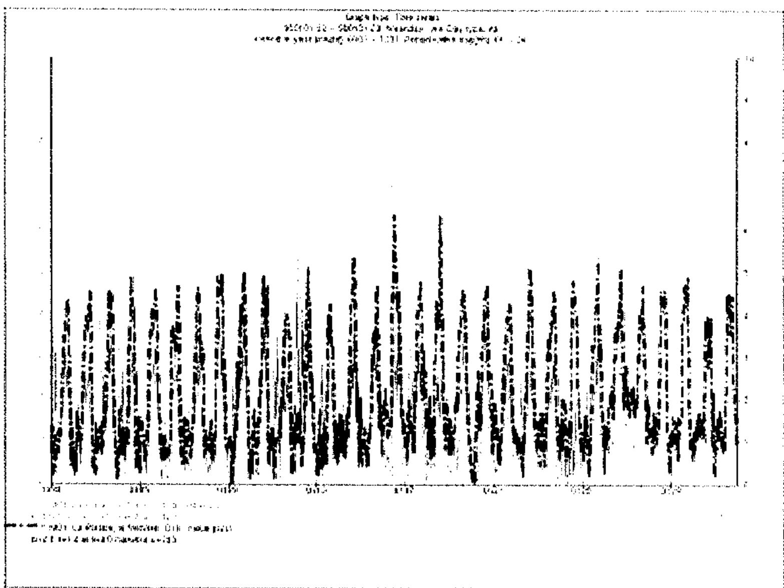
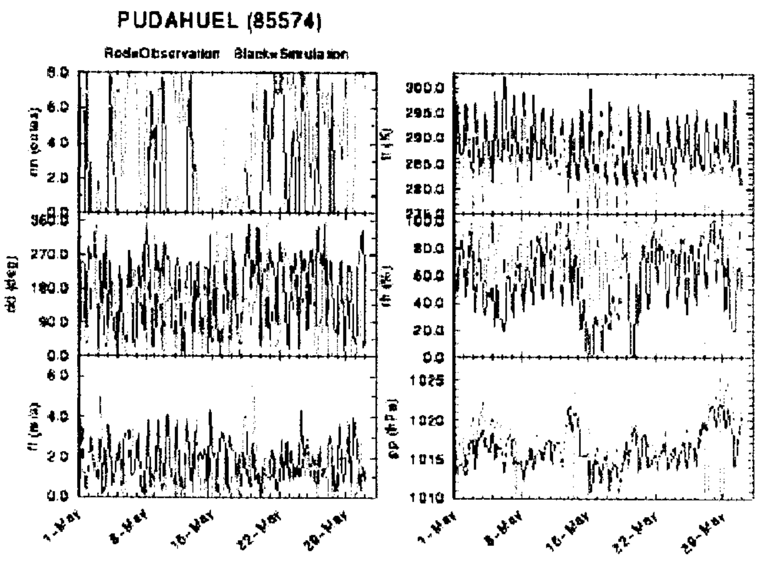


Figura 3.3. El panel superior muestra la comparación entre las simulaciones de HIRLAM (línea gruesa) y las observaciones (línea fina) en la estación de Pudahuel para Enero de 1998. Los subpaneles muestran: cobertura nubosa en octas (cc); dirección del viento en grados (dd); rapidez del viento en m/s (ff); temperatura en ºC (tt); humedad relativa en % (rh); y presión en hPa (pp). El panel inferior muestra el viento en superficie (10 m) según el modelo (línea continua fina) y según lo observado (línea discontinua gruesa) en la estación de La Platina para Enero de 1998. Unidad: m/s. Pudahuel y La Platina corresponden a las estaciones WMO 5 y MO1 en la Figura 3.1

Pudahuel



La Platina

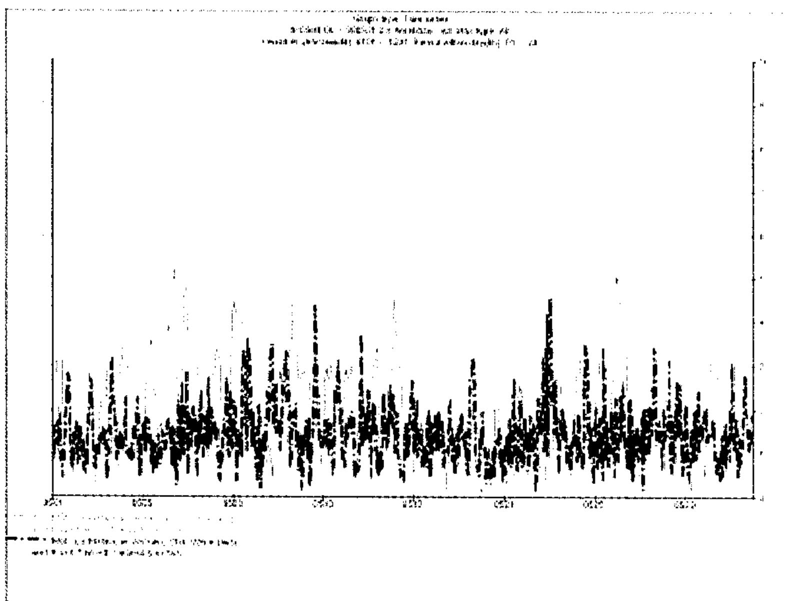


Figura 3.4. El panel superior muestra la comparación entre las simulaciones de HIRLAM (línea gruesa) y las observaciones (línea fina) en la estación de Pudahuel para Mayo de 1998. Los subpaneles muestran: cobertura nubosa en octas (cc); dirección del viento en grados (dd); rapidez del viento en m/s (ff); temperatura en ºC (tt); humedad relativa en % (rh); y presión en hPa (pp). El panel inferior muestra el viento en superficie (10 m) según el modelo (línea continua fina) y según lo observado (línea discontinua gruesa) en la estación de La Platina para Mayo de 1998. Unidad: m/s. Pudahuel y La Platina corresponden a las estaciones WMO 5 y MO1 en la Figura 3.1.

b) Aspectos de dispersión

Las Figuras 3.5 y 3.6 muestran la comparación de los promedios diarios y ciclos diarios simulados y observados para Enero y Mayo de 1998 en dos estaciones: Parque O'Higgins en el centro de Santiago y Coya Club de Campo en las inmediaciones de la fundición de Caletones. Los escenarios de emisiones corresponden al caso base especificado en la Sección 4.

En el caso de Santiago centro, el modelo simula generalmente bien las variaciones interdiarias. Las mayores discrepancias ocurren durante la primera mitad de Mayo cuando en algunas ocasiones la ventilación de la cuenca de Santiago es sobrestimada y las concentraciones son subsecuentemente subestimadas. Es notable cómo el modelo logra simular el episodio del 15 al 20 de Mayo asociado a una baja costera del tipo A. Sólo hacia el final del episodio el modelo tiende a sobrestimar las concentraciones pues aún no contempla una representación del sumidero de SO_2 debido a la neblina. El modelo "ve" la irrupción de aire húmedo desde la costa (advección de nubes estratiformes) pero no así un sumidero por neblina. Los ciclos diarios en Santiago muestran una sobreestimación del máximo matinal asociado a las emisiones de fuentes móviles y las condiciones meteorológicas típicamente estables de esas horas. El máximo de las tardes no es simulado o bien aparece desfasado en las simulaciones. Nosotros atribuimos esta discrepancia principalmente a algunas falencias en el inventario de emisiones empleado. No obstante, como se dijo antes, una mejor simulación de efectos locales, como los que trasluce el ciclo diario, requiere de datos locales más precisos relativos a emisiones y topografía como los aplicados por Flores et al. (2000). Con todo, juzgamos que Parque O'Higgins, estando lejos de fuentes puntuales importantes y ubicada en una parte relativamente plana de la cuenca de Santiago, resulta ser representativa de las condiciones regionales de dispersión.

La estación Coya Club de Campo está ubicada a aproximadamente 1000 m sobre el nivel del mar a los pies de la Cordillera de Los Andes. Los ciclos diarios observados indican que esta estación está expuesta al impacto relativamente directo del penacho de la fundición Caletones. Durante horas de la noche, el aire, al enfriarse, desciende por las laderas andinas y lleva aire rico en SO_2 hacia la estación. Durante horas del día ocurre lo contrario disminuyendo las concentraciones. Estas características son reproducidas por el modelo. Sin embargo, especialmente durante el verano, cuando la circulación de valle-montaña es más intensa, y debido a la representación topográfica empleada, el impacto nocturno tiende a ser sobrestimado por el modelo. La variación interdiaria es mejor capturada.

Para estaciones representativas de los patrones regionales de dispersión, el modelo logra simular las concentraciones promedio de 24 horas con, generalmente, no más de un 25% de error. Este valor es considerado típico para simulaciones de escala regional (Seinfeld & Pandis, 1998).

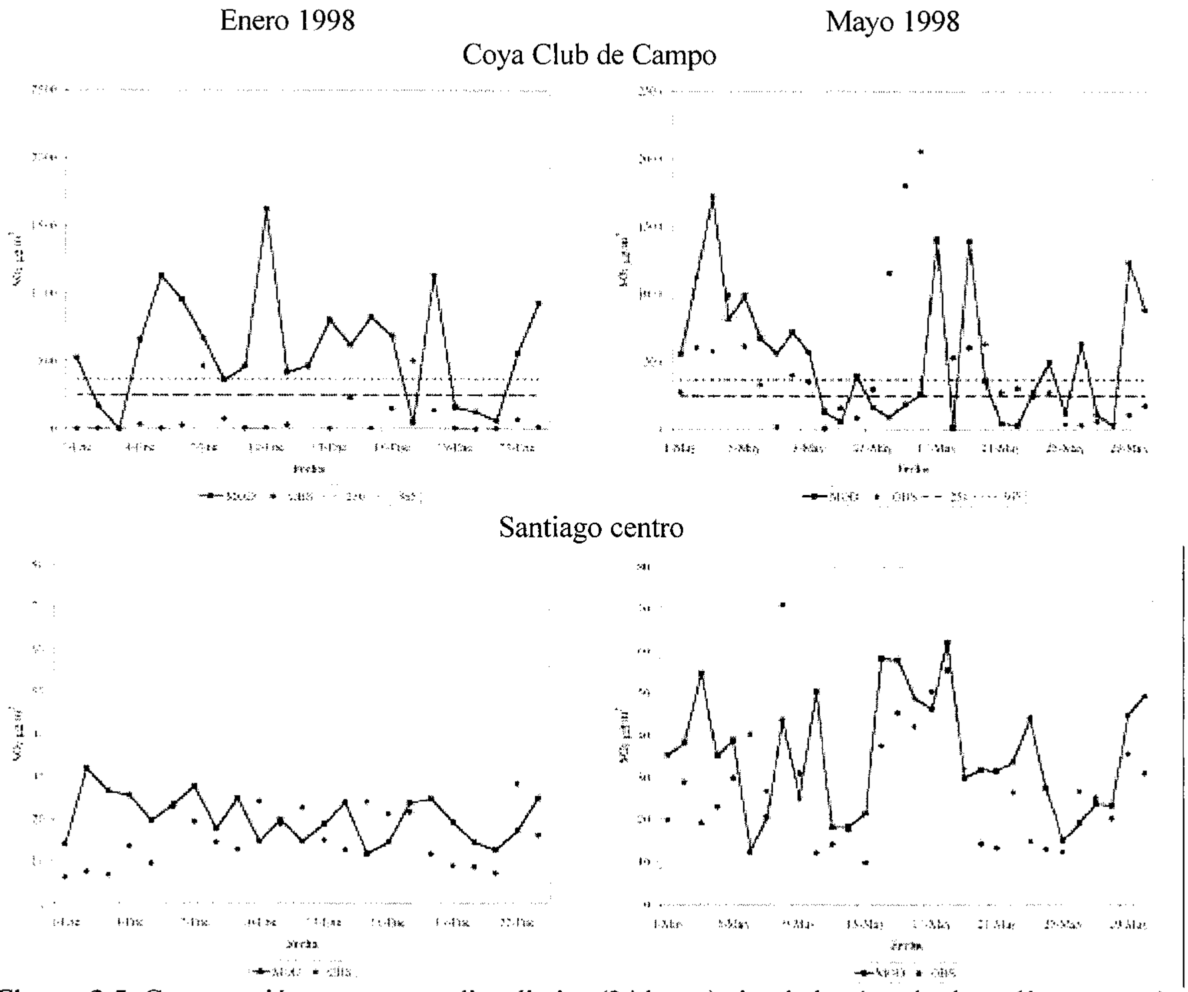


Figura 3.5. Comparación entre promedios diarios (24 horas) simulados (cuadrados y línea gruesa) y observados (círculos y línea tenue) en dos lugares (Ver detalles en el texto) para los meses de Enero y Mayo de 1998. También se indican los valores de 250 $\mu g/m^3$ (línea discontinua) y 365 $\mu g/m^3$ (línea punteada) de SO_2 correspondientes a los valores de norma en discusión y vigente respectivamente.

En general, se puede concluir que el sistema de modelación HIRLAM-MATCH es apto para describir los patrones regionales de dispersión en Chile central. El modelo captura los principales rasgos derivados de los cambios en las condiciones a escala sinóptica y los ciclos diarios y estacionales típicos. Por supuesto, hay que insistir en que la validación de un modelo complejo como este es un proceso siempre perfectible y dinámico que se verá beneficiado de las mejoras en la implementación de inventarios de emisiones más completos y redes de monitoreo a escala regional en Chile central.

Enero 1998 Mayo 1998

Coya Club de Campo

Santiago centro

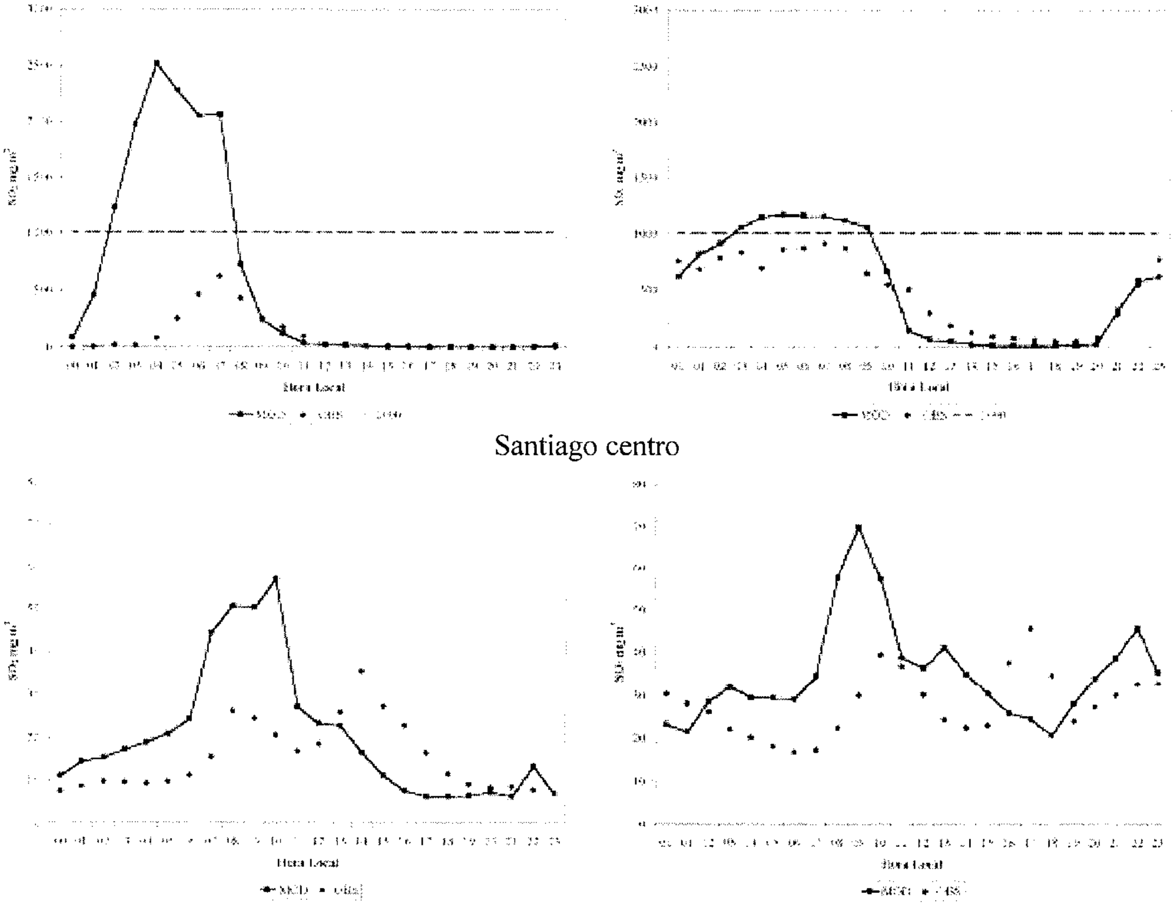


Figura 3.6. Comparación entre ciclos diarios simulados (cuadrados y línea gruesa) y observados (círculos y línea tenue) en dos localidades (Ver detalles en el texto) para los meses de Enero y Mayo de 1998. También se indica el valor de 1000 $\mu g/m^3$ (línea punteada) de SO_2 correspondiente a la norma secundaria vigente.

4. ESCENARIOS DE EMISIONES ACTUALES Y PROYECTADOS

La información acerca de las tasas de emisión dentro del dominio del modelo fue compilada para dos escenarios: uno base o actual correspondiente a 1998 y otro proyectado o futuro correspondiente al año 2002. La base de datos de emisiones más completa es la de la Región Metropolitana de Santiago. Nosotros usamos el inventario correspondiente a 1997 (CONAMA-RM, 1997). Las fuentes principales de información en otras áreas del dominio son el llamado proyecto "COSUDE" (Jadrijevic et al., 1999) y las empresas mineras ubicadas en la región a través de su participación en la formulación de normas ambientales (Por ejemplo, REF_As, 1998) y en los planes de descontaminación. La información recopilada y usada en las simulaciones se entrega en la Tabla 4.1.

Tabla 4.1. Emisiones actuales y proyectadas de dióxido de azufre (SO_2). Unidad: ton SO_2 por mes o año.

Fuentes	**Actuales**			**Proyectadas**		
	Verano	**Otoño**	**Anual**	**Verano**	**Otoño**	**Anual**
Fundiciones						
Caletones	60320	57230	710350	19531	18530	230000
Ventanas	3733	3733	44800	2561	2561	30732
Chagres	984	984	11926	929	929	11144
Santiago	**1125**	**1259**	**21110**	**1125**	**1259**	**21110**
Otras	**268**	**268**	**2873**	**268**	**268**	**2873**
Totales	**66430**	**63474**	**791059**	**24414**	**23547**	**295859**

Salvo en el caso de las emisiones de Santiago y de Caletones, sólo se dispone de estimaciones sobre una base anual. En el caso de Caletones se ha supuesto para el escenario futuro será la misma que la variación de mes a mes reportada para 1998 (Ver Tabla 4.2). Variaciones diarias y horarias se consideran sólo para las emisiones de Santiago.

Tabla 4.2. Emisiones de la fundición Caletones reportadas para 1998.

Mes	**Emisión ton SO_2**
Enero	60320
Febrero	59182
Marzo	54188
Abril	62730
Mayo	57230
Junio	59552
Julio	59028
Agosto	53794
Septiembre	61544
Octubre	56262
Noviembre	62120
Diciembre	64400
Total Anual	**710350**

5. Resultados

De la aplicación del sistema de modelación antes descrito hemos obtenido dos resultados principales para los fines de este trabajo. Primero, una estimación de la contribución relativa de las fundiciones de cobre en Chile central al azufre oxidado. Y segundo, una estimación de los cambios esperables en las contribuciones relativas y las cantidades absolutas a partir de los cambios proyectados para el año 2002 en las tasas de emisión de dichas fuentes. El caso actual o base es aquel correspondiente a las emisiones reportadas para 1998.

Las estimaciones se hacen para tres situaciones: verano (Enero), otoño/invierno (Mayo) y anual. La estimación de valores anuales se hace promediando los valores correspondientes a los meses de Enero y Mayo. Dos razones justifican esto. Por una parte, al momento de escribir este reporte no contamos con más meses de corridas meteorológicas (HIRLAM) lo que nos impide simular una año continuado. Por otra parte, siendo Enero y

Mayo de 1998, es decir, los meses para los cuales contamos con simulaciones meteorológicas, dos meses extremos en cuanto a condiciones de ventilación en Chile central, su promedio debiera entregar una buena aproximación de un promedio anual calculado convencionalmente.

A escala regional, las emisiones de las fundiciones de cobre dominan el contenido de azufre oxidado en la atmósfera de Chile central. El predominio de las fundiciones aparece tanto en las distribuciones horizontal como vertical de los campos de azufre oxidado. Las emisiones urbanas tienen un impacto menor, inferior al 10%, sobre los contenidos de azufre fuera de las zonas urbanas y por sobre la capa de mezcla atmosférica. Los campos correspondientes, es decir, la contribución relativa de las grandes fundiciones al contenido de azufre oxidado en los meses de Enero y Mayo de 1998 respectivamente, se muestran en la Figura 5.1. La Figura también muestra que la distribución mensual de SO_2 para Mayo de 1998 es similar a la de Enero de 1998. Sin embargo, las concentraciones simuladas son mayores en Mayo que en Enero. La razón principal de ello es que las condiciones meteorológicas son típicamente más estables en otoño, especialmente en Mayo de 1998, que durante el verano. Esto, a su vez, resulta en mayores concentraciones de azufre oxidado cerca de la superficie.

Hay que destacar que, adicionalmente a lo antes señalado, las fundiciones contribuyen episódicamente a los contenidos de azufre de las urbes. Esto es, a veces, bajo ciertas condiciones meteorológicas, la contribución de las megafuentes mineras se torna más importante que lo indicado por el promedio mensual. En el verano esto parece ocurrir en conexión con la fuerte mezcla vertical típica de las tardes estivales. En el otoño, la contribución de las fundiciones aparece en conexión con la fuerte subsidencia (descenso de aire) asociada a las bajas costeras. Adicionalmente, los cálculos del modelo indican que hay una conexión entre el impacto episódico de las fundiciones y la aparición de masas de aire envejecidas, con tasas de sulfato sobre dióxido de azufre (SO_2) más altas, esto es, asociadas a aerosoles secundarios (Olivares et al., 2000). Este es un resultado consistente con los análisis de material particulado respirable realizados para Santiago (Artaxo, 1998), Rancagua, Valparaíso y Viña del Mar (Koutrakis, 1999). Todos estos estudios muestran la existencia de una contribución de las megafuentes mineras a las concentraciones de material particulado en las urbes estudiadas. Las simulaciones aquí discutidas ayudan a cuantificar este impacto. Dada su relevancia, estos aspectos serán abordados en más detalle en un informe próximo del proyecto de modelación regional para un período (Junio-Julio de 1999) para el cual se cuenta con mediciones de varias cantidades relevantes con mayor resolución temporal (Oyola, com. pers.).

La Figura 5.2 muestra, sobre una base anual, la contribución relativa de las emisiones de SO_2 de cada de una de las fundiciones de cobre sobre la concentración de SO_2 a nivel de superficie. Dos características se evidencian allí. Primero, la contribución relativa sigue el orden de la magnitud de las emisiones (Ver Tabla 4.1), esto es, Caletones, Ventanas y Chagres. Y segundo, cada fuente tiene un impacto de alcance regional si bien el impacto más intenso ocurre en las inmediaciones de cada una.

Enero 1998 Mayo 1998

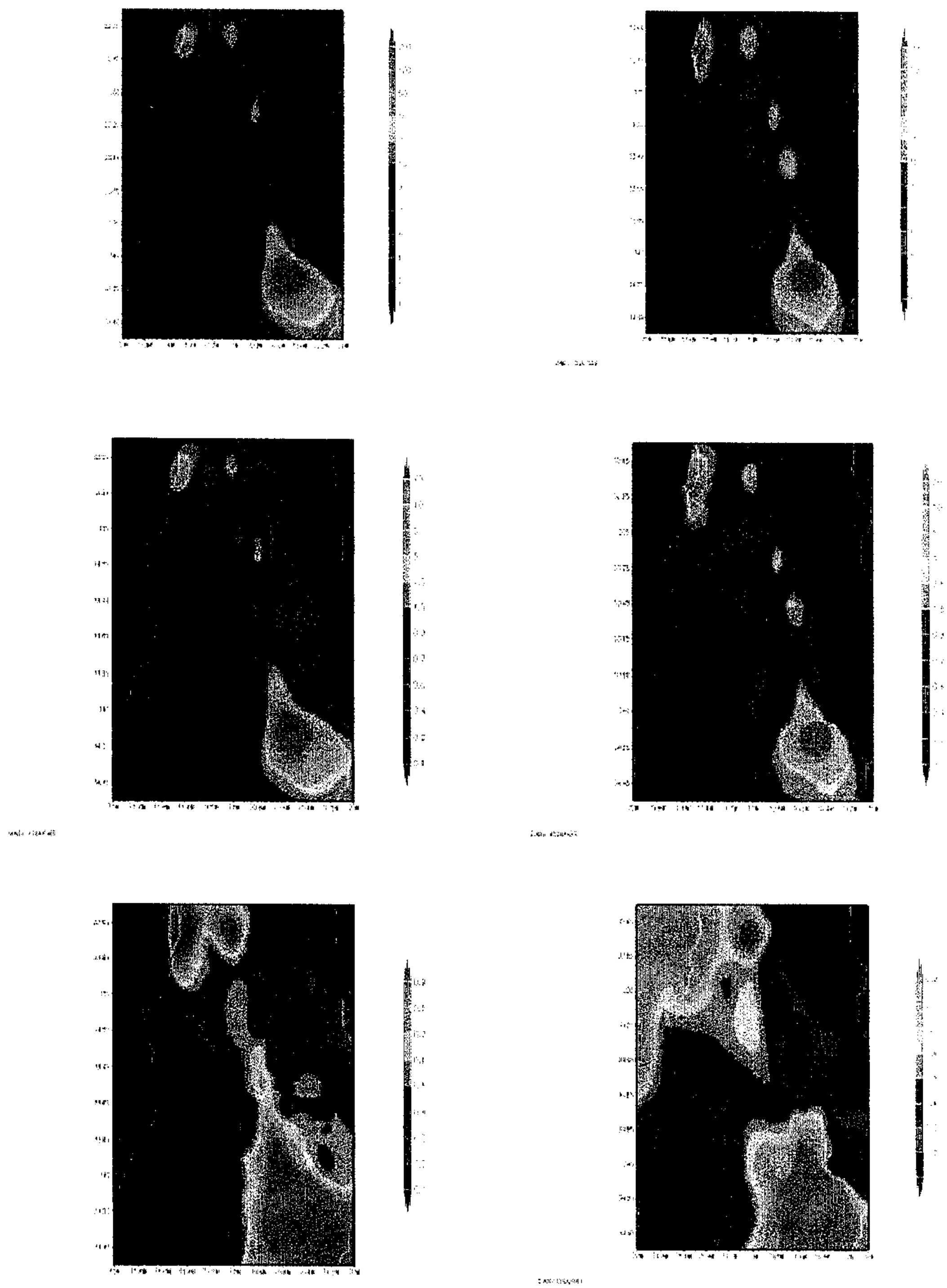


Figure 5.1. Distribuciones promedio mensuales de azufre oxidado. SO_2, SO_4 ($\mu g/m^3$) y contribución relativa de las fundiciones a S-SO_2 + S-SO_4 en los paneles superior, medio e inferior respectivamente.

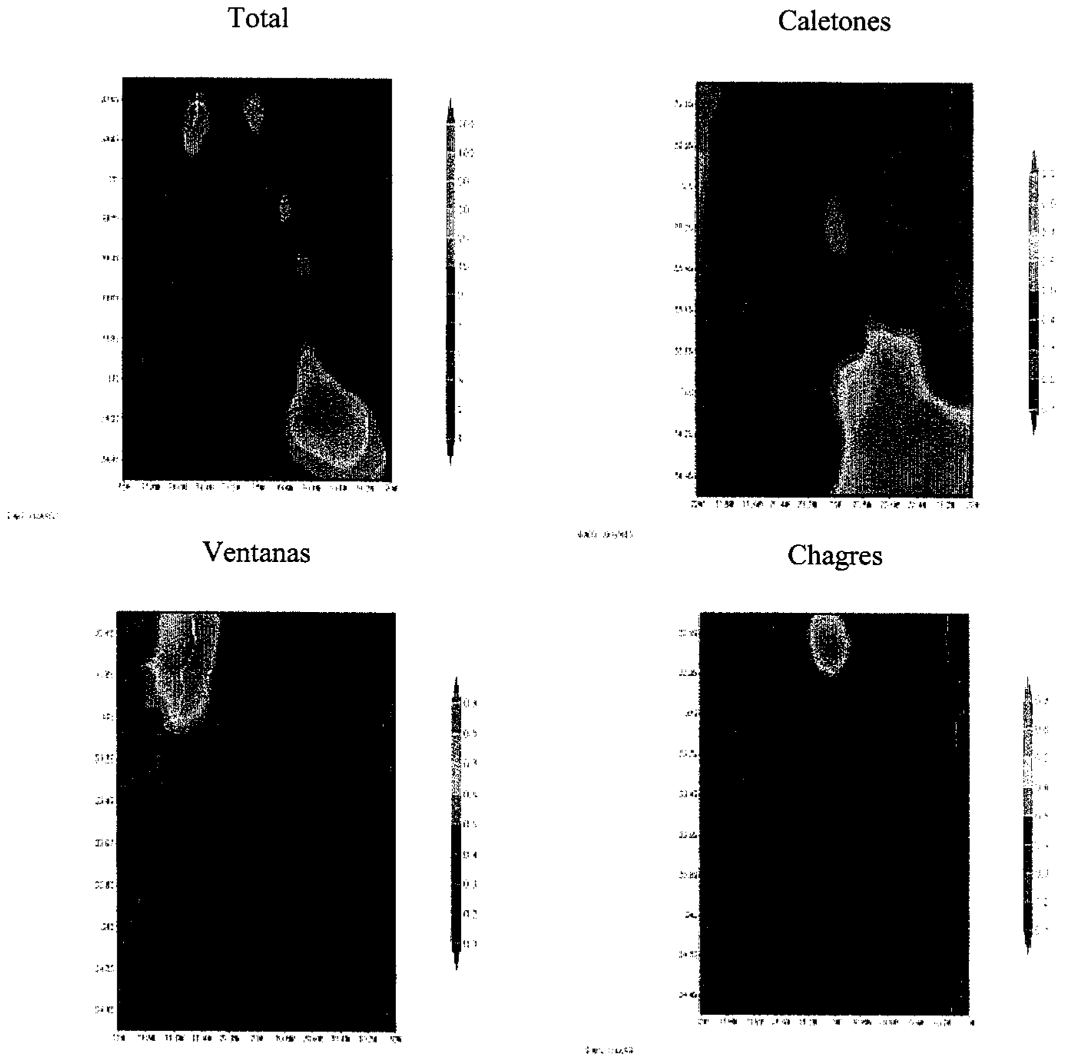


Figure 5.2 Distribución promedio anual de SO_2 en $\mu g/m^3$ a nivel de superficie y contribución relativa de las fundiciones de cobre en Chile central para el caso de base.

Otro aspecto que vale considerar es la excedencia de normas ambientales, en particular de normas primarias de SO_2. Existen dos normas primarias de SO_2 vigentes en Chile. Una norma anual de 80 $\mu g/m^3$ y una norma diaria de 365 $\mu g/m^3$. En la Figura 5.3 se indican zonas con concentraciones promedios anual superiores e inferiores la norma para el escenario base y el proyectado. También, a modo de referencia, se indican las zonas que exceden 50 $\mu g/m^3$ promedio anual que es el valor recomendado por la Organización Mundial de la Salud (OMS, 1999). Además, se indica el nivel crítico de 30 $\mu g/m^3$ respecto del cual se ha identificado la aparición de efectos crónicos en la vegetación (Sanders et al., 1995). Para mayor claridad se han agrandado los mapas para tres áreas: región norte que abarca las zonas de impacto de Ventanas y Chagres; región centro que abarca la zona de impacto de las fuentes en Santiago; y región sur que comprende las inmediaciones de Caletones. Sólo en el entorno de las dos mayores fundiciones, Caletones y Ventanas, se observan zonas extensas en las que el promedio anual de 80 $\mu g/m^3$ es superado. Al disminuir las emisiones (caso proyectado), como es de esperar, la extensión de las mismas disminuye. Algo análogo ocurre respecto de los límites de 30 $\mu g/m^3$ y 50 $\mu g/m^3$ antes indicados. La mayor disminución se observa en el entorno de Caletones ya que allí el cambio en la tasa de emisiones es mayor. Las emisiones de 2002 son alrededor de un tercio de las emisiones de 1998. En la zona centro no hay excedencia de la norma en ninguno de los escenarios. Los cambios estimados para la zona centro son menores y se deben a la menor contribución de las fuentes lejanas, especialmente de Caletones. En el caso del entorno de Chagres sólo se estima una disminución marginal al 2002. Lo anterior también se puede ilustrar a través de los cambios en las contribuciones relativas de cada una de las fuentes a las concentraciones superficiales de azufre oxidado (Ver Figura 5.4). La Figura 5.4 es análoga a la Figura 5.2 sólo que par el caso proyectado de emisiones (2002). En general, disminuye el impacto relativo de mayores fundiciones (Caletones y Ventanas) y crece el impacto relativo de las otras fuentes.

Vale notar que el nivel crítico de 30 $\mu g/m^3$ es sobrepasado en extensas áreas en el entorno de todas las grandes fundiciones en la macrozona central de Chile. Si bien no se dispone de los antecedentes suficientes para juzgar la aplicabilidad del nivel crítico de 30 $\mu g/m^3$ a los cultivos de las regiones V y VI, hay que tener presente tales riesgos (García-Huidobro, 1999). Dichos antecedentes deben ser especialmente contemplados a la hora de planificar y establecer estrategias de desarrollo regional en estas zonas y al tiempo de diseñar redes de monitoreo de escala regional.

Caso Base (1998) **Caso Proyectado (2002)**

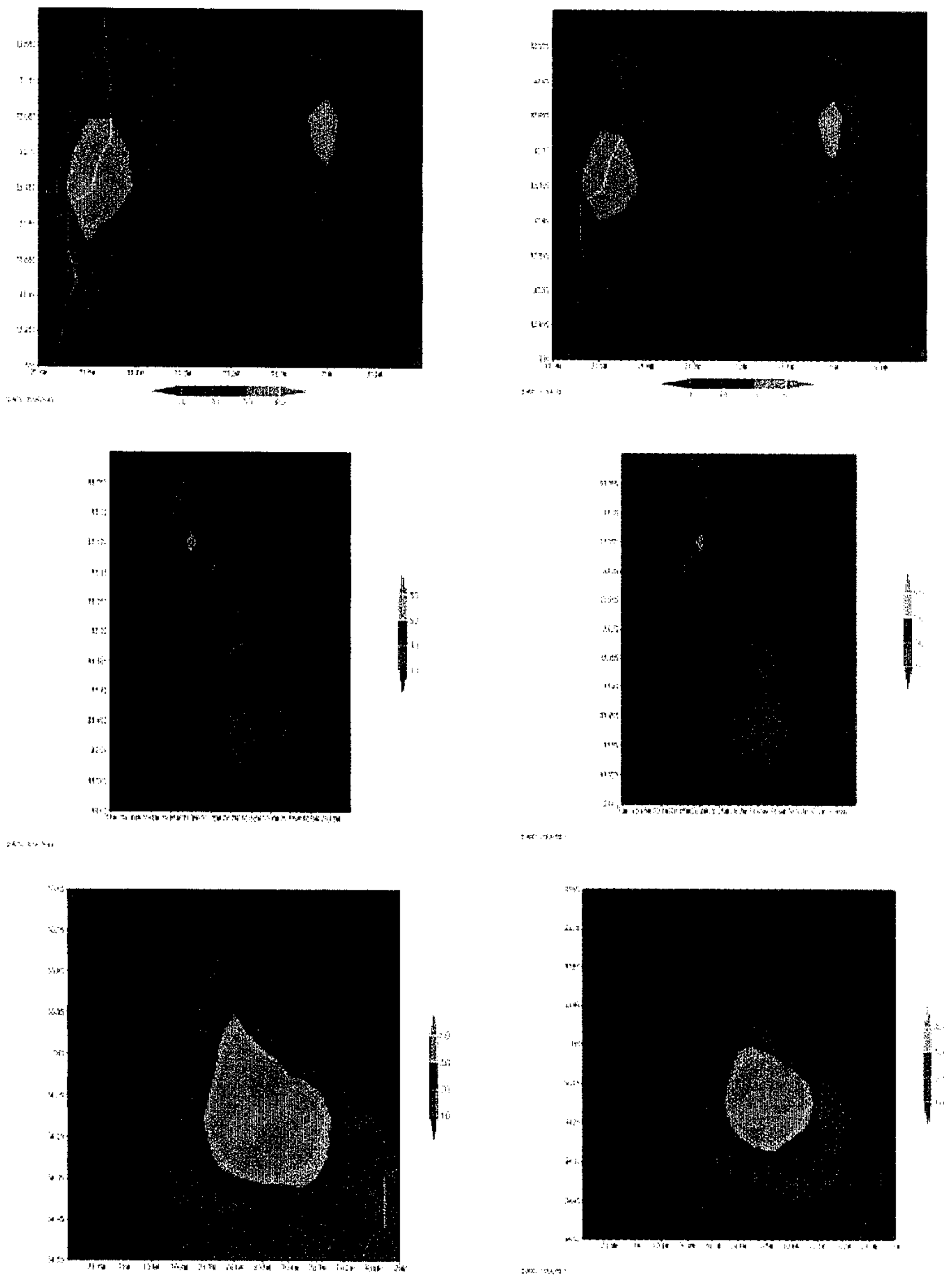


Figure 5.3 Distribución promedio anual de SO_2 en $\mu g/m^3$ a nivel de superficie para el caso base y el caso proyectado de emisiones. Se indican las zonas con valores mayores y menores a la norma primaria vigente (80 $\mu g/m^3$). Los paneles superior, intermedio e inferior muestran las regiones norte, centro y sur respectivamente.

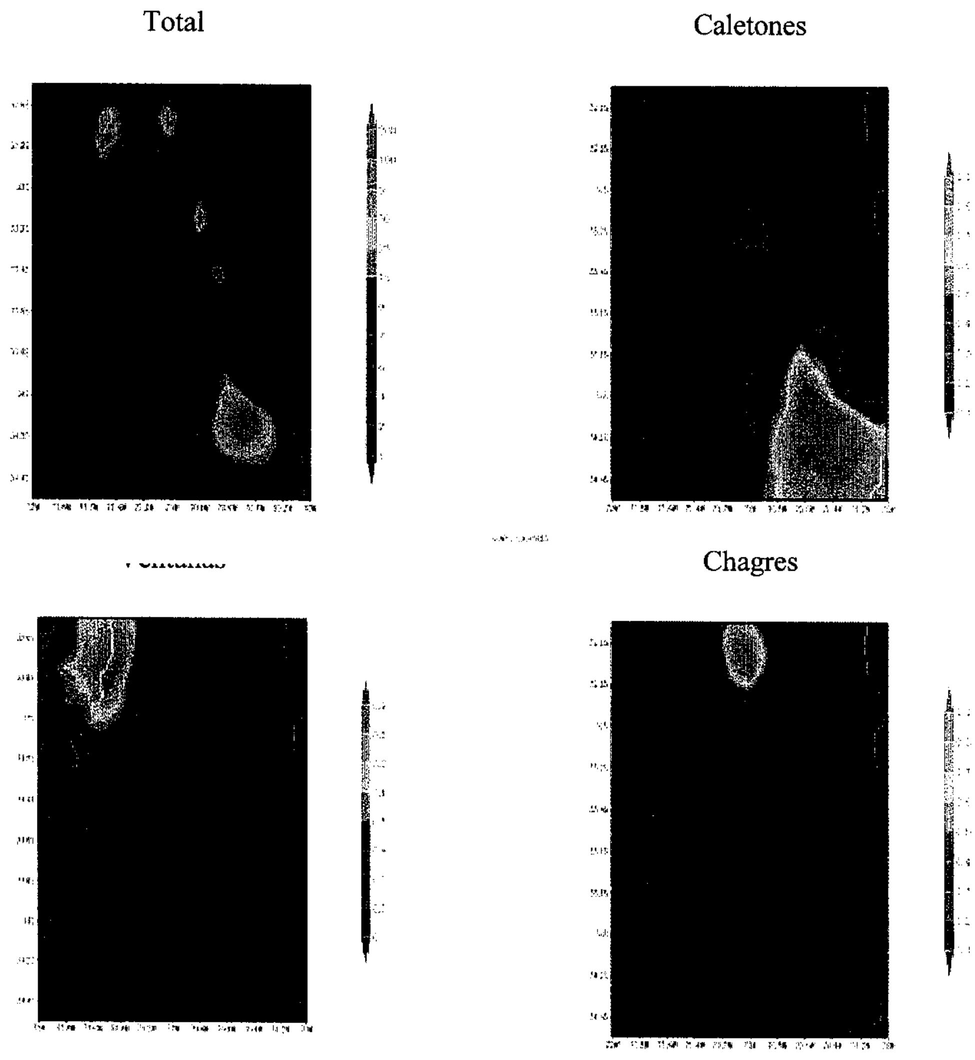


Figure 5.4 Distribución promedio anual de SO_2 en $\mu g/m^3$ a nivel de superficie y contribución relativa de las fundiciones de cobre en Chile central para el caso proyectado (2002).

El carácter regional del modelo impide hacer una estimación precisa respecto del cumplimiento o excedencia de las normas diaria y horaria de SO_2 en las estaciones de monitoreo dependientes de las empresas mineras. Como ya se discutió, dichas estaciones fueron diseñadas para dar cuenta de efectos primarios locales que no son simulados con suficiente precisión por un modelo regional. Particularmente aquellas variaciones derivadas de las circulaciones atmosféricas locales asociadas a un relieve complejo no logran ser bien capturadas. No obstante, algunas estaciones pueden dar cuenta de características regionales de la dispersión de azufre oxidado en la macrozona central de Chile. Al menos, para estas estaciones el modelo logra reproducir una parte significativa de las variaciones diarias e interdiarias de las observaciones de SO_2 disponibles. Tal es el caso de la estación Coya Club de Campo en las inmediaciones de la fundición de Caletones y de la estación Parque O'Higgins en Santiago centro. Para estas estaciones de carácter relativamente más regional revisamos el cumplimiento o excedencia de las normas diaria y horaria de SO_2 para ambos escenarios de emisiones y para cada época del año. Esto se muestra en las Figuras 5.5 y 5.6.

De las Figuras 5.5 y 5.6 se desprende que los cambios en las concentraciones derivados de los cambios en las emisiones son, grosso modo, lineales en las inmediaciones de cada fuente. Además, en esos lugares, la magnitud de los cambios en las concentraciones está en relación directa con la tasa de disminución de las emisiones. Sin embargo, lejos de las fuentes, si bien se observan cambios en las concentraciones, éstos no se relacionan linealmente con los cambios en las emisiones. En Santiago Centro por ejemplo, los cambios se evidencian en conexión con procesos de transporte. En los promedios de 24 horas el cambio mayor ocurre durante la vaguada costera del 15 al 20 de Mayo cuando, como ya se indicó, el modelo muestra una mayor contribución de las fuentes mineras. De la misma manera, el ciclo diurno estival en Parque O'Higgins muestra la mayor diferencia a horas de máxima insolación y mezcla vertical.

La mayor probabilidad de sobrepasar las norma diaria de SO_2 se halla en las inmediaciones de las mayores fuentes. Particularmente en Caletones donde aún para el caso de emisiones reducidas, el modelo muestra una tendencia a sobrepasar la norma diaria de 365 $\mu g/m^3$ y el valor estudiado de 250 $\mu g/m^3$. Esto ocurre especialmente en la época de otoño e invierno que, por cierto, es el período con mejor coincidencia entre las simulaciones y las observaciones de acuerdo a la evaluación presentada en la Sección 3.

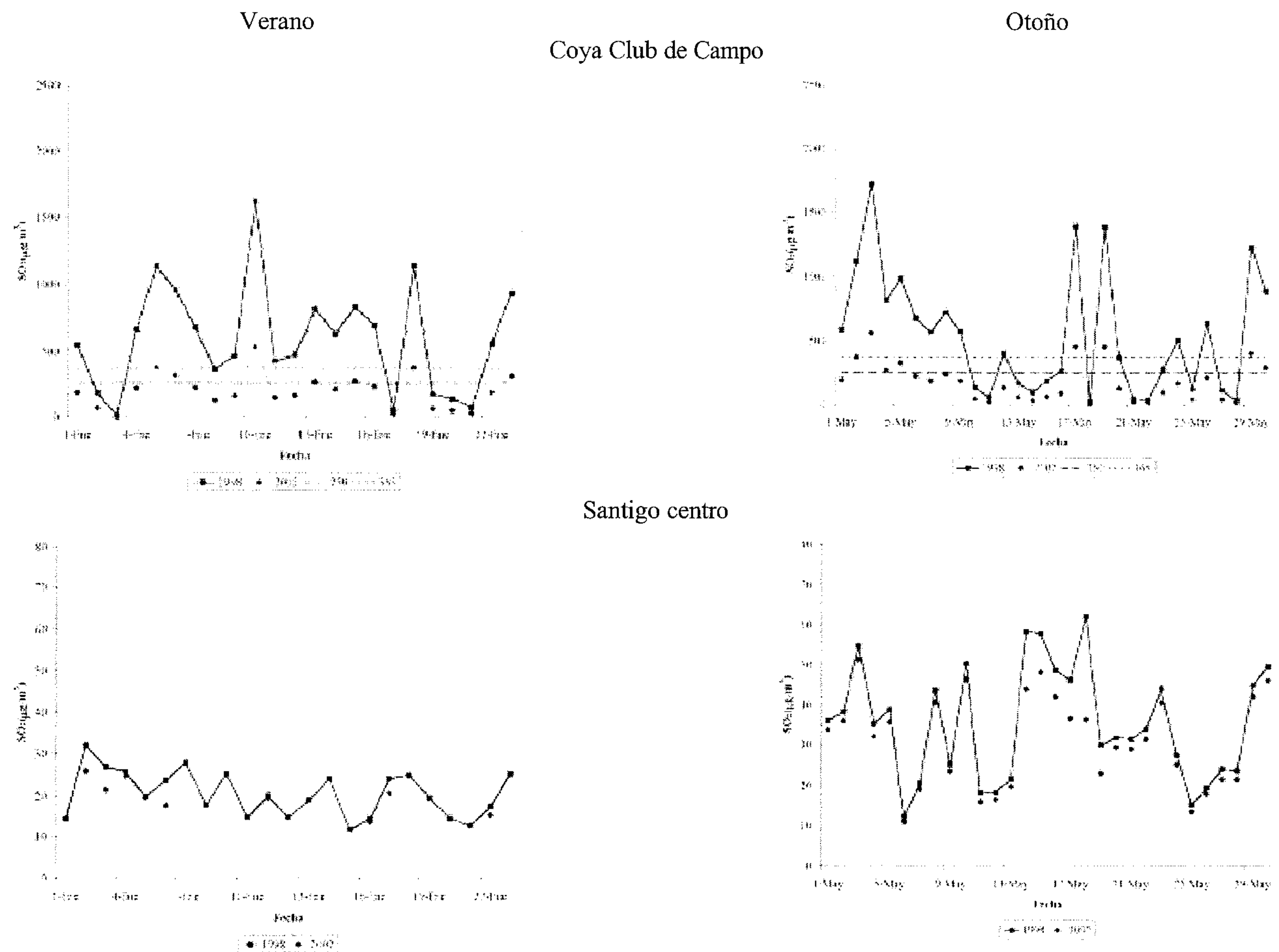


Figura 5.5 Comparación entre promedios diarios (24 horas) simulados para 1998 o caso base (cuadrados y línea gruesa) y simulados para 2002 o caso proyectado (círculos y línea tenue) en cuatro localidades. También se indica la norma vigente (365 $\mu g/m^3$) y en discusión (250 $\mu g/m^3$).

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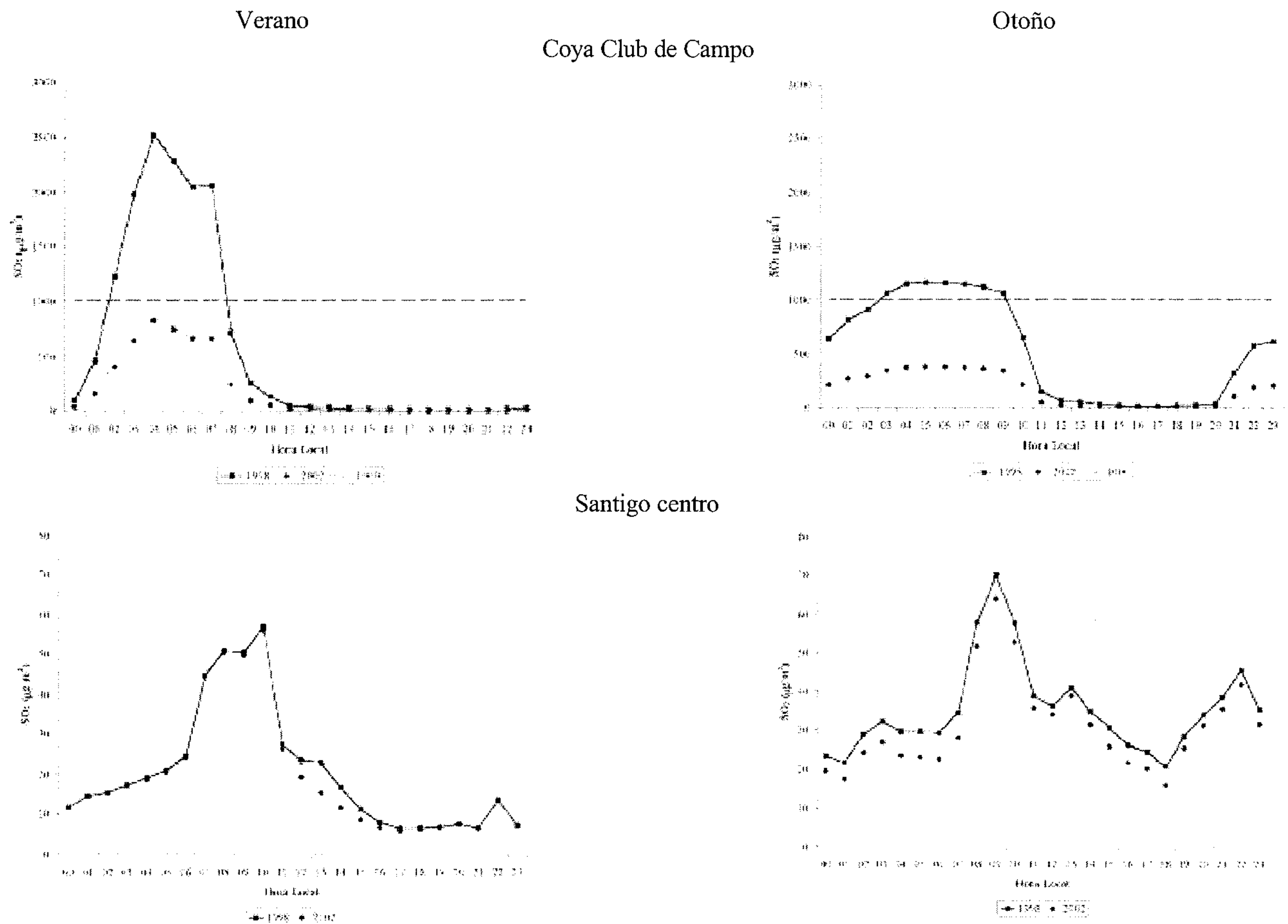

Figura 5.6. Comparación entre ciclos diarios simulados para el caso base de 1998 (cuadrados y línea gruesa) y simulados para el caso proyectado de 2002 (círculos y línea tenue) en cuatro localidades.

6. CONCLUSIONES

Como parte de un proyecto de cooperación entre CONAMA y SMHI, un modelo de escala regional (HIRLAM-MATCH) ha sido aplicado a la dispersión de compuestos oxidados de azufre en la macrozona central de Chile (Regiones V, VI y Metropolitana). El modelo ha sido validado para dos situaciones extremas respecto de las condiciones de ventilación: Enero y Mayo de 1998 (Gallardo et al., 1999; Olivares et al., 2000). Esta evaluación se ha hecho a través de una comparación sistemática entre las simulaciones y las observaciones meteorológicas y de calidad del aire disponibles en la zona. Dicha validación indica que el sistema de modelación HIRLAM-MATCH es apto para describir los patrones regionales de dispersión en Chile central. El modelo captura los principales rasgos derivados de los cambios en las condiciones a escala sinóptica y los ciclos diarios y estacionales típicos.

Como parte de la aplicación de HIRLAM-MATCH antes indicada, se ha obtenido una estimación de la contribución relativa de las fundiciones de cobre en Chile central al azufre oxidado. También se han estimado los cambios esperables en las contribuciones relativas y las cantidades absolutas a partir de los cambios proyectados para el año 2002 en las tasas de emisión de dichas fuentes. El caso actual o base es aquel correspondiente a las emisiones reportadas para 1998.

Los resultados de las simulaciones para los casos base y proyectado de emisiones de SO_2 muestran que la distribución regional de azufre oxidado en Chile central está dominada por la contribución de las grandes fundiciones mineras. Además, hay un impacto episódico de las fuentes mineras sobre las urbes asociado a la aparición de masas de aire envejecidas y aerosoles secundarios. En otoño esto parece ocurrir en combinación con bajas costeras intensas (Tipo A). En verano, la contribución de las fuentes mineras se asocia a la fuerte mezcla vertical en horas de máxima insolación.

Sobre una base anual, la contribución relativa a las concentraciones en superficie de SO_2 de las grandes fuentes mineras sigue el orden de la magnitud de las emisiones, esto es, Caletones, Ventanas y Chagres. Todas las fuentes tienen un impacto de alcance regional pero el impacto más intenso ocurre en las inmediaciones de cada una.

En el entorno de las dos mayores fundiciones, Caletones y Ventanas, se observan zonas extensas en las que el promedio anual de 80 $\mu g/m^3$ es superado. Al disminuir las emisiones (caso proyectado) la extensión de las zonas afectadas por estas altas concentraciones disminuye. La mayor disminución se observa en el entorno de Caletones ya que allí el cambio en la tasa de emisiones es mayor (ca. 60% de reducción). En la zona centro no hay excedencia de la norma en ninguno de los escenarios. Los cambios estimados para la zona centro son menores y se deben a la menor contribución de las fuentes lejanas, especialmente de Caletones. En el caso del entorno de Chagres sólo se estima una disminución marginal al 2002. En todas las zonas aledañas a las fundiciones se observan amplias áreas con concentraciones anuales promedio que exceden el nivel de 30 $\mu g/m^3$, para el cual hay indicaciones de la aparición de efectos crónicos en la vegetación (Sanders et al., 1995). Estos antecedentes, si bien muy preliminares, debieran ser considerados al planificar y establecer estrategias de desarrollo regional en estas zonas y al tiempo de diseñar redes de monitoreo de escala regional.

El carácter regional del modelo impide hacer una estimación precisa respecto del cumplimiento o excedencia de las normas diaria y horaria de SO_2 en las estaciones de monitoreo dependientes de las empresas mineras pues dichas redes de monitoreo fueron diseñadas para dar cuenta de efectos primarios locales. Sin embargo, de modo indicativo, para aquellas estaciones juzgadas como más representativas de los patrones regionales de dispersión hemos estimado los cambios esperados en las concentraciones promedio horarias y de 24 horas. Se concluye que los cambios en las concentraciones derivados de los cambios en las emisiones son, grosso modo, lineales en las inmediaciones de cada fuente. Además, en esos lugares, la magnitud de los cambios en las concentraciones está en relación directa con la tasa de disminución de las emisiones. Sin embargo, lejos de las fuentes, si bien se observan cambios en las concentraciones, éstos no se relacionan linealmente con los cambios en las emisiones.

En suma, de acuerdo a las simulaciones de HIRLAM-MATCH, se estima la disminución de las emisiones de las grandes fundiciones ubicadas en Chile central tendrá como efecto una disminución substantiva de los impactos en sus inmediaciones y viento abajo de las mismas. Sin embargo, aún en un escenario de emisiones reducidas al 2002, se estima que habrá importantes extensiones afectadas por altas concentraciones de azufre oxidado.

AGRADECIMIENTOS

Este proyecto es parte de un acuerdo de cooperación entre la Intendencia Metropolitana de Santiago y el Gobierno Regional de Västra Götaland en Suecia. El trabajo se financia a través de la Comisión Nacional del Medio Ambiente (CONAMA) y la Agencia Sueca de Cooperación para el Desarrollo (ASDI).

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ANEXO 1: IMPLEMENTACIÓN COMPUTACIONAL

El modelo MATCH ha sido implementado en Chile en una estación de trabajo Hewlett Packard. Las características técnicas de dicha máquina se especifican en la Tabla A.1.

Tabla A.1 Características técnicas de la plataforma computacional de MATCH

Propiedad	Especificación
Modelo	HP Visualize C360
Unidad central de procesos (CPU)	1 Procesador PA-8500
Frecuencia de Reloj	367 MHz
Instr. Cache	512 Kb.
Data Cache	1 Mb.
Memoria	512 Mb.
Capacidad en disco (HDD)	18 Gb.
Sistema Operativo	HP-UX 10.20
Lenguajes	CC, GCC, Fortran 77.
Software	Airviro, Grads, Vis5D, MATCH y herramientasUnix.

El conjunto de herramientas proporcionadas por SMHI como parte del proyecto tienen como objeto permitir la obtención y visualización de resultados a partir de la información existente sobre emisiones, topografía y meteorología para Chile Central. AIRVIRO es el portador de la base de datos de emisiones, la cual es completamente manejada ya sea por un módulo interno llamado EDB o por comandos a nivel del *shell*[†]. MATCH recibe mediante un *script* todos los parámetros que se necesitan para llevar a cabo la modelación. Los archivos con las grillas de emisiones, topografía y meteorología deben estar en el formato *Grib*[‡], al igual que los resultados que MATCH genera al terminar el proceso. MATCH puede ser compilado y ejecutado prácticamente en cualquier plataforma *Unix* que posea los compiladores de *Ansi C* y *Fortran 77*. Finalmente AIRVIRO debe recibir los resultados del modelo y desplegarlos en pantalla mediante una interfaz gráfica que permita visualizar los resultados obtenidos para cada intervalo de tiempo y altura definidos. Nosotros usamos aplicaciones de libre acceso capaces de desplegar archivos en formato *Grib*, como son Grads y Vis5D.

El modelo HIRLAM es corrido en un supercomputador en la Universidad de Linköping en Suecia bajo la supervisión y responsabilidad de SMHI. Los resultados de HIRLAM son transferidos a Chile en cintas o a través de internet.

† Interprete de comandos que provee el sistema operativo como interfaz con el usuario.
‡ Formato estándar de almacenamiento de información meteorológica.

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EMPRESA NACIONAL DE MINERIA
Medio Ambiente corporativo N° 157

Santiago, 18 de Julio de 2000

Señora:
Patricia Matus
Jefe Departamento de Descontaminación Planes y Normas
Comisión Nacional del Medio Ambiente
Presente

Ref: Revisión Resolución N° 1215 de Salud

De mi consideración:

Por medio de la presente, adjunto minuta de una reunión sostenida con don Rodrigo Lucero a fín de entregar mayores antecedentes para la revisión de la norma de la referencia

Sin otro particular se despide atentamente

Alejandro Diez Valencia
Jefe de Medio Ambiente Corporativo

Minuta Reunión CONAMA
Antecedentes de Episodios Críticos

En atención al proceso de revisión de la Resolución Nº 1215, que se encuentra en revisión de los valores de norma diaria de Calidad de Aire por Dióxido de Azufre y sus respectivos niveles de episodios críticos, se ha decidido presentar a CONAMA los siguientes antecedentes:

- El Estado de Chile ha otorgado a La Empresa Nacional de Minería la Misión Estratégica de desarrollar la pequeña y mediana minería de Chile, realizando dentro de sus actividades de sustentación de este sector la compra y procesamiento de minerales y concentrados de cobre de las pequeñas y medianas empresas mineras, empresas que de otra forma no podrían acceder a un mercado para sus productos.

  Las Fundiciones de cobre de la empresa se consideran una componente fundamental de la misión de ENAMI, ya que son ellas las que completan la cadena del valor del negocio minero, otorgando a los productos mineros proveniente de las pymes un producto que puede ser transado en el mercado internacional, cuya labor también es realizada por ENAMI.

  Ante una normativa ambiental que signifique descontinuar el accionar de ENAMI, es necesario considerar que la actividad que se genera en el contexto laboral, directamente involucra un empleo de 6.770 trabajadores, e indirectamente agrega 12.200 empleos adicionales. Considerando los grupos familiares correspondientes, con un promedio de 5 personas por trabajador, determina una dependencia de ENAMI, de más de 90.000 personas.

- La difícil situación financiera de la empresa contempla un endeudamiento de US$ 450 millones, 1,7 veces sobre su patrimonio. Dicho endeudamiento se compone en un alto porcentaje (alrededor de un tercio) de los créditos obtenidos para financiar los planes de descontaminación implementados.

  Adicionalmente, la deuda incluye créditos derivados de la política de Estado de adelantar utilidades para financiar el fomento minero, además se han debido financiar los intereses derivados del servicio de la deuda.

  La empresa durante el ejercicio de los años 1998 y 1999 ha tenido por primera vez en su trayectoria pérdidas por US$ 17,65 Millones y 24,35 millones respectivamente. Por otra parte, las proyecciones financieras indican que la situación de pérdidas en el estado de resultados, se mantendría negativa durante este año y el próximo, con US$ 25 y US$ 18 millones respectivamente, esperando sólo para el año 2002 un leve nivel de utilidades.

- En lo que respecta a la situación Operacional, las fundiciones pertenecientes a la Empresa actualmente realizan procedimientos operacionales para prevenir la ocurrencia de estos episodios, los cuales incluyen la disminución de los niveles de fusión cada vez que se detectan valores altos como promedio de un minuto en alguna de las estaciones de monitoreo atmosférico de sus alrededores.

  Dicho procedimiento ha determinado que Fundición y Refinería Ventanas haya activado en 1999 un número total de 150 alarmas que activan el procedimiento y Fundición Paipote tuvo para el mismo período un total de 1300 horas con algún nivel de restricción operacional.

- Con todo lo anterior las Fundiciones no lograron evitar la ocurrencia de episodios durante dicho período llegándose a tener un total de 7 episodios críticos en cada una de las faenas de ENAMI. Es necesario mencionar que fundición Ventanas ha tenido en los 6 meses corridos durante este año 2000 un total de 8 episodios críticos.

- Según estimaciones realizadas, los menores ingresos directos derivados de los planes operacionales para prevenir la ocurrencia de episodios críticos en Fundición Ventanas ascendió a un monto aproximado de US$ 7 Millones en el período 1993-1999 y anualmente el menor ingreso de Fundición Paipote ascendería a un valor estimado de US$ 790.000. Lo anterior no incluye aquellos costos provenientes de mayor generación de circulantes e interferencias operacionales, los cuales son de difícil cuantificación.

- En consideración a los valores de episodios críticos sugeridos por los estudios preliminares realizados por CONAMA (SGA-Ibersis), nuestras estimaciones indican que el número de episodios críticos para un valor de 1300 ugrNnm3 sería de 17 en 1999 en fundición Ventanas y 16 para Paipote, lo cual disminuiría los ingresos sólo en esta última fundición en US$ 2.100.000 anualmente. Se estima que para Fundición Ventanas el valor de menor ingreso sería similar o superior, toda vez que las restricciones operacionales de ella contemplan un nivel de baja de producción mayor. (sin capacidad disponible)

- Lo anterior constituye un aspecto de relevancia para la Empresa, ya que debido a su delicada situación financiera, las fuertes pérdidas económicas esperadas serían profundizadas por los menores ingresos percibidos por la depresión de la fusión a fin de prevenir el mayor número de episodios generados.

- Cabe hacer notar que la alternativa de efectuar inversiones para disminuir la tasa de emisión anual requiere del otorgamiento de créditos por sobre los US$ 55 millones, lo que según lo ya expresado en el Oficio N° 66 de la Vicepresidencia de ENAMI, resulta imposible de alcanzar.

REPUBLICA DE CHILE

MINISTERIO
DE MINERIA

COMISION NACIONAL DEL MEDIO AMBIENTE
OFICINA DE PARTES Y ARCHIVO
Nº INGRESO: 7970/6662
FECHA:
DESPACHADO: 24 JUL 2000
P. Matus

23/133

000713

Santiago, 20 de julio de 2000
UAMM/88/2000

Señora
Patricia Matus
Jefe Dpto de Descontaminación Planes y Normas
CONAMA
Presente

De mi consideración:

Informo a Ud., que esta Secretaría de Estado en conjunto con la Comisión Chilena del Cobre, ha realizado un análisis de los antecedentes de respaldo que dieron orígen a la revisión de la Resolución N° 1215, específicamente en lo que se refiere a la norma de calidad primaria de anhídrido sulfuroso.

En relación a ello y considerando que:

1) El estudio realizó una exhaustiva revisión de los antecedentes disponibles a nivel mundial, acerca del impacto en la salud por exposición a SO_2.

2) El estudio no consideró en su análisis, los Planes de Descontaminación de las fundiciones estatales de concentrados de cobre, elaborados de acuerdo al D.S. N° 185 del Ministerio de Minería.

3) En virtud de ello, las decisiones tomadas por las empresas respecto de las tecnologías de fusión y las inversiones asociadas, se evaluaron económicamente en un horizonte de 25 años, no teniendo en cuenta que las normas ambientales que se irían implementando fuesen cada vez más estrictas.

4) La mayoría de las fundiciones aún no concluyen sus Planes de Descontaminación, de manera que lentamente se ha ido integrando a la operación de las fundiciones las “consideraciones atmosféricas y ambientales”.

5) La experiencia en el desarrollo de modelos de dispersión de contaminantes atmosféricos en el país, ha demostrado tener bajos niveles de confiabilidad en cuanto a ser una herramienta predicitiva.

6) El cobre es un "commodity" transado en los mercados internacionales, donde las exigencias de certificación están siendo un requisito indispensable si se quiere ser un actor relevante en el mercado, por lo que al momento de generar una normativa nacional hay que tener presente el impacto que puede tener ésta en la comercialización del producto. La certificación exige el cumplimiento de la normativa nacional y cambios demasiado seguidos dificultan su satisfacción.

Se propone:

1) Mantener el nivel actual de la norma de calidad promedio anual de anhídrido sulfuroso equivalente a 80 $\mu g/Nm^3$.

2) Establecer una reducción en la norma primaria de SO_2 desde 365 a 250 $\mu g/Nm^3$ asociada a un porcentaje de excedencia, estimado en el rango de 3-6%.

3) No establecer una norma horaria como lo sugiere el estudio de respaldo.

4) Mantener los niveles actuales a los espisodios críticos en el entendido que para el caso de las fundiciones, cuyos planes de descontaminación se encuentran terminados, muestran que la ocurrencia de estos eventos es casi completamente independiente de las condiciones operacionales de la fundición (niveles de fusión, niveles de emisión, equipos en operación, etc.) y más bien obedecen y responden a variables de meteorología local inmanejables por los operadores. En este ámbito se estima conveniente que la CONAMA defina criterios y conceptos generales para la generación de los Planes Operacionales destinados a enfrentar los episodios críticos, de manera de que los distintos servicios fiscalizadores regionales actúen en forma homogénea.

5) Que se generen criterios comunes, que permitan a los diferentes servicios fiscalizadores regionales, actuar en forma homogénea en materias tales como:

- representatividad poblacional de cada monitor en que se verifica la norma de calidad primaria; tamaño de la red de monitoreo;
- plazo en el cual se hace exigible la operación de la red por parte del ente regulado;

- definición de la responsabilidad respecto de la mantención y operación de la red de monitoreo y los costos asociados a la misma, en un régimen normal de cumplimiento de la norma de calidad.

6) Establecer mecanismos jurídicos claros con respecto al término de los planes de descontaminación o al procedimiento que deje sin efecto la declaración de zona saturada.

Finalmente, se adjunta minuta de información preparada por la Comisión Chilena del Cobre complementaria a lo ya expresado a través de la presente, con el fin de respaldar las propuestas aquí descritas.

Sin otro particular, saluda atentamente a Ud.,

REPUBLICA DE CHILE - UNIDAD AMBIENTAL - MINISTERIO DE MINERIA

María de la Luz Vásquez M.
Coordinadora Unidad Ambiental
Ministerio de Minería

REVISION RESOLUCIÓN N°1215-NORMA CALIDAD DEL AIRE ANHIDRIDO SULFUROSO

Situación de CODELCO- Chile

Chuquicamata: La Fundición de Chuquicamata se encuentra en la actualidad en proceso de reformulación de su Plan de Descontaminación debido a que, habiendo dado cumplimiento a la reducción de emisiones establecida de acuerdo a la modelación aplicada para formular el plan, no ha podido dar cumplimiento a las normas de calidad del aire para SO_2 (esto reafirma la poca confiabilidad de los modelos de dispersión utilizados). Como se indica en el Anexo N°1 las inversiones asociadas al plan alcanzan a US$ 654,8 millones. En la actualidad la fundición de Chuqui está capturando el 80% del SO_2.

Los estudios realizados para sustentar la reformulación del plan señalan que es imposible dar cumplimiento a la normativa diaria de 365 $\mu g/Nm^3$, incluso realizando proyectos adicionales de inversión en la fundición de concentrado, de manera de llevar la captación de SO_2 a niveles en torno al 90%, por lo que la única solución es erradicar el Campamento de Chuquicamata. En este escenario, una reducción de la normativa como la propuesta no tendría impacto en Chuquicamata, puesto que al no existir población expuesta (el criterio definido por CONAMA, es que una norma primaria se fiscaliza donde existe "población expuesta") entendemos que la norma se fiscalizaría en la ciudad de Calama o en cualquier lugar donde exista población expuesta y con la información hoy disponible, se puede afirmar que no habría grandes problemas en cumplir una norma diaria con un valor entre 250 y 365 $\mu g/Nm^3$.

La inversión estimada para realizar la erradicación del Campamento de Chuquicamata se estima en una cifra que fluctúa entre US$ 100 y 300 millones, dependiendo de las acciones que deban adoptarse. Es imposible separar y atribuir montos de inversión al cumplimiento de una norma de SO_2 o arsénico, por lo que en términos globales ésta es una inversión ambiental para proteger la salud de las personas.

Potrerillos: La Fundición de Potrerillos ha completado con éxito los proyectos de inversión y las acciones asociadas al cumplimiento del Plan de Descontaminación, capturando actualmente del orden del 75% del SO_2, pudiendo llegar eventualmente en el futuro a niveles cercanos al 85%. Lo anterior ha significado una inversión de US$ 163,3 millones.

Una de las acciones más importantes realizadas fue la erradicación del Campamento de Potrerillos, por lo que, a partir del 1° de enero de 2000 no existe población expuesta, situación que a nuestro mejor entender significa que el Plan de Descontaminación está terminado, transformándose esta zona en un área laboral. No obstante lo anterior, el cronograma establecido en el Plan de Descontaminación establece la verificación del cumplimiento de la norma de calidad el año 2003.

Considerando lo anterior, la autoridad fiscalizadora debería controlar el cumplimiento de la norma de calidad primaria en la zona donde existe población expuesta, criterio que la autoridad fiscalizadora a la fecha no ha hecho suyo.

De aceptarse por la autoridad fiscalizadora el criterio planteado, la fundición de Potrerillos no tendría problemas en la zona del ex – campamento por ser éste área laboral.

Caletones: la Fundición de Caletones se encuentra en plena etapa de implementación de las acciones e inversiones asociadas a su Plan de Descontaminación. Se ha completado la erradicación del Campamento de Sewell y la construcción de la primera planta de ácido. En la actualidad está en construcción la segunda planta, se están implementando todas las acciones e inversiones para el sistema de transporte definitivo del ácido hacia el puerto de San Antonio y el proyecto "Cambio de Esquema Operativo Fundición", que conceptualmente significa operar en forma autónoma los dos convertidores Teniente. Todo lo anterior significará inversiones por US$ 192,7 millones.

Por el estado de desarrollo del Plan de Descontaminación, que significa que a la fecha sólo se esté abatiendo un 35% del SO_2 y considerando la debilidad de los modelos de dispersión como herramienta predictiva, las simulaciones realizadas para determinar el cumplimiento de distintos niveles de norma primaria diaria en los puntos donde existe población expuesta (Coya Club y Coya Población) indican que, para dar cumplimiento **sin excedencias** a la norma diaria sugerida sería necesario implementar la captación de los gases secundarios, con una inversión del orden de US$ 44 millones, para reducir el nivel de emisión a valores del orden de 64.000 TM/año de SO_2, sin garantizar que esto se cumpla, por cuanto la experiencia indica que, la captación de gases secundarios considera equipos y esquemas operacionales poco probados y de eficiencia dudosa, y la ocurrencia de eventos que signifiquen el no cumplimiento de una norma diaria obedecen a factores atmosféricos locales y geográficos, independiente del nivel de emisión que se tenga.

El Plan de Descontaminación establece el cumplimiento de la norma de calidad primaria en el año 2003, la cual se verificaría en las localidades de Sewell, Coya Club y Coya Población. Para el ejercicio anterior no se consideró la información del monitor de Sewell, por no existir población expuesta, ya que se completó con éxito el traslado.

Situación de ENAMI

Ventanas: La Fundición Ventanas terminó su Plan de Descontaminación a comienzos de 1999, lo que le significó invertir US$ 64,6 millones y se encuentra cumpliendo las normas de calidad primaria de SO_2 anual y diaria desde fines de 1998. El cumplimiento de la norma diaria se ha logrado con un difícil y costoso manejo operacional de la fundición, en relación con las condiciones meteorológicas imperantes, lo que también se ha visto reflejado en una menor fusión de concentrado por parte de la empresa. A modo de ejemplo, en el año 1999, cuando ya se encontraban todos los proyectos del Plan terminados, existieron más de 150 alarmas del Plan Operacional gatilladas por condiciones de excedencia del nivel definido por la empresa en cualesquiera de las estaciones de monitoreo o por condiciones atmosféricas que podían significar alto riesgo de impacto ambiental.

Las emisiones durante el año 1999 fueron del orden de 28.000 TM de SO_2, cifra significativamente menor que la estimada en el Plan de Descontaminación como necesaria para cumplir la norma, alcanzándose una captación del 88%, siendo las restantes emisiones fugitivas. Esto reitera nuevamente la debilidad de los modelos de dispersión que se han utilizado en el país y muestra el gran esfuerzo realizado por la fundición para dar cumplimiento a la norma diaria y la prevención de ocurrencia de episodios críticos.

Una reducción de la norma diaria a los niveles sugeridos por el estudio de respaldo le significaría a Ventanas, de acuerdo con las estimaciones realizadas por la empresa, un nivel de excedencia de alrededor de 5 veces por año, situación abordable por la empresa en el caso que se autorizara un cierto porcentaje de excedencias adecuado.

Una reducción en los niveles de alerta, advertencia y emergencia como la sugerida significaría que ENAMI debería realizar inversiones, que no está en condiciones de enfrentar, que superan los US$ 35 millones, para capturar y tratar parte de los gases fugitivos, elevando la captación a niveles del 92%, además de deprimir fusión a niveles muy difíciles de predecir, pero que significarían un importante costo para la empresa. Sin embargo, lo anterior no garantizaría el control de los episodios, por cuanto éstos corresponden a fenómenos de transporte atmosférico no manejables por los operadores de la fundición.

Hernán Videla Lira: la fundición se encuentra con su Plan de Descontaminación prácticamente terminado, faltando sólo la entrada en operación del horno eléctrico de tratamiento de escorias. Las inversiones realizadas ascienden a US$ 98,9 millones y el nivel de captación de SO_2 alcanza a un 88%, siendo las restantes emisiones fugitivas y gases de cola de la planta de ácido.

Desde el año 1997 la fundición se encuentra cumpliendo la norma anual y diaria actual, con un nivel de excedencia de 2 veces al año para la norma diaria. Durante el año 1999 se verificaron 7 episodios críticos considerando los niveles actualmente vigentes. Para lograr estos resultados la fundición debió bajar los niveles de fusión durante aproximadamente 1.300 horas.

En el caso de la norma diaria sugerida por el estudio, las estimaciones indican que sería posible cumplirla definiendo un cierto nivel de excedencias. Con los niveles sugeridos para episodios críticos se estima que éstos podrían llegar a 16 o más al año, lo que significaría reducir fusión en casi 3.500 horas. Lo anterior es insostenible desde el punto de vista operacional, puesto que significaría operar la fundición con capacidad reducida casi la mitad del año, o bien es necesario invertir alrededor de US$ 20 millones para transformar las plantas de ácido a doble catálisis y llevar el nivel de captación a 92%, situación que tampoco garantizaría la no ocurrencia de episodios críticos, porque las variables que los controlan son de carácter atmosférico.

Cabe hacer notar que la situación financiera de la empresa hace imposible poder abordar nuevas inversiones en descontaminación en el mediano plazo.

Situación de Altonorte – NORANDA

La fundición con su actual nivel de fusión de 400.000 TM/año tiene un nivel de captación del 82%, que le significa emitir del orden de 36.000 TM/año de SO_2. Para poder mantener los niveles actuales de emisión, cuando la empresa aumente su capacidad de fusión a 850.000 TM/año en el 2003, debería incrementar la captación a valores cercanos al 94%.

En general la fundición no tendría problemas para cumplir la norma diaria sugerida si se establece algún nivel de excedencias.

Situación de Chagres – Compañía Minera Disputada de Las Condes

En la actualidad la fundición emite del orden de 14.000 TM/año de SO_2, con un tratamiento de 400.000 TM/año de concentrado utilizando fusión Flash, y su nivel de captura del contaminante es superior al 96% (uno de los más altos a nivel mundial), siendo la diferencia emisiones fugitivas.

En los últimos dos años la fundición no ha tenido problemas con el cumplimiento de la norma anual y diaria.

Una reducción en la norma diaria a los niveles propuestos por el estudio probablemente no le generaría problemas de cumplimiento a la fundición. Sin embargo, por la ubicación geográfica de la operación, el control de episodios críticos es una variable de la mayor importancia y una reducción como la que se está planteando le significaría aumentar su nivel de captura a 99%, lo que sólo es posible lograr instalando conversión continua y doble catálisis en la planta de ácido, con una inversión estimada en US$ 200 millones.

Finalmente se adjunta el Anexo N° 1, donde se observan las inversiones realizadas por las fundiciones estatales en planes de descontaminación.

REPUBLICA DE CHILE

MINISTERIO DE MINERIA

ANEXO N° 1

INVERSIONES REALIZADAS EN LOS PLANES DE DESCONTAMINACION DE LAS FUNDICIONES ESTATALES DE CONCENTRADO DE COBRE

FUNDICION VENTANAS - ENAMI

Gastos de Ingeniería	**US$**
Secado, Transporte e Inyección de concentrado	376.869
Manejo Gases Convertidores	282.865
Planta de Acido	991.924
Horno Eléctrico	363.823
Manejo Gases Horno Eléctrico	74.323
Servicios	254.599
Ampliación Subestación Eléctrica N° 2	74.571
Total Gastos de Ingeniería	**2.418.974**
Gastos de Adquisición de Equipos	**US$**
Secado, Transporte e Inyección de concentrado	4.829.528
Manejo Gases Convertidores	2.720.351
Planta de Acido	6.942.391
Horno Eléctrico	6.200.613
Manejo Gases Horno Eléctrico	1.617.792
Servicios	1.032.979
Ampliación Subestación Eléctrica N° 2	635.579
Total gastos de Adquisición de Equipos	**23.979.233**

Gastos de Construcción	**US$**
Secado, Transporte e Inyección de concentrado	5.036.251
Manejo Gases Convertidores	9.184.584
Planta de Acido	3.247.890
Horno Eléctrico	6.223.920
Manejo Gases Horno Eléctrico	1.588.693
Servicios	3.871.342
Ampliación Subestación Eléctrica N° 2	419.935
Total Gastos de Construcción	**29.572.615**

Gastos Financieros y Otros	**US$**
Intereses Línea de Crédito Rotatorio	4.270.761
Estudios Preinversionales más gastos financieros	2.330.395
Gastos del Centro de Costos	2.042.958
Total Gastos Financieros y Otros	**8.644.114**

GASTO TOTAL DEL PROYECTO	**US$ 64.614.936**

FUNDICION HERNÁN VIDELA LIRA – ENAMI

Concepto	US$
Planta de Acido	21.664.421
Planta de Oxígeno	14.309.460
Manejo de Gases	16.770.324
Secado e Inyección de Concentrado	12.670.949
Servicios	2.212.055
Energía Eléctrica	6.051.552
Tratamiento Escorias	20.543.255
Ingeniería y Administración	4.665.721
INVERSION TOTAL	**US$ 98.887.737**

FUNDICION POTRERILLOS – División Salvador – CODELCO-Chile

Concepto	US$
Proyecto MALIGAS	48.000.000
Campanas para CT y CPS	9.500.000
Transformación Campamento en Zona Industrial	2.315.000
Ordenamiento Potrerillos	3.036.000
Planta de Acido Sulfúrico	98.000.000
TOTAL	**US$ 160.851.000**

Adicionalmente, como consecuencia del cambio de sistema de turnos se ha implementado una serie de proyectos orientados a mejorar el ambiente laboral en la Fundición

Proyecto	US$
Captación Gases Fugitivos Reverbero 1ª etapa	379.000
Captación Gases Fugitivos Reverbero 2ª etapa	250.000
Mejoras lugares descanso Fundición-Refinería	112.000
Control contaminación Polvos Nave Fundición	1.804.000
Casa Cambio N°2 Complejo Potrerillos	503.000
Control Ruido Nave Fundición	470.000
TOTAL	**US$ 2.518.000**

FUNDICION CHUQUICAMATA – División Chuquicamata - CODELCO-Chile

Proyectos	US$
Construcción Horno Flash y anexos	94.350.000
Planta de Acido N° 2 (Horno Flash)	91.820.000
Modificación y Mejoramiento Planta de Acido N° 1	14.670.000
Construcción Planta de Acido N° 3	22.670.000
Construcción Horno Reverbero N° 4 y anexos	15.720.000
Construcción Convertidor Teniente N° 1	10.390.000
Reemplazo Enfriador Evaporativo	1.590.000
Tercer Camión Escorias	880.000
Soplador Aire a Convertidores	3.150.000
Plan Control Contaminación Ambiental	1.580.000
Planta de Tratamiento de Polvos	8.730.000
Reemplazo Mantos y Campanas CPS's	3.510.000
Tercer Precipitador Convertidor Teniente N° 1	5.890.000
Segundo Secador de concentrado	15.500.000
Construcción Convertidor Teniente N° 2	56.080.000
Planta de ácido N° 4 (CT 2)	71.500.000
Reemplazo Convertidor Teniente N° 1	9.900.000
Adaptación instalaciones reverbero a Tren de Gases Flash	1.580.000
Módulos de Contacto y Limpieza de Gases	52.100.000
Refacción y puesta en marcha Planta Acido N° 1	3.000.000
Captación y Tratamiento de Gases CPS's	76.940.000
5° Módulo de Limpieza de Gases	41.020.000
Descontaminación Areas Laborales	25.418.000
Estudios e Ingeniería	4.885.000
Captación Gases Fugitivos Horno Flash y otros	13.876.000
Estudios de Fusión por Lanzas en CT	5.800.000
Ampliación Vertedero Montecristo	2.228.000
TOTAL	**US$ 654.777.000**

FUNDICION CALETONES – División El Teniente – CODELCO-Chile

Concepto	US$
Erradicación Campamento Sewell	1.930.000
Acondicionamiento Ambiental Edificio Campamento Sewell	236.000
Construcción Nuevo Camarín de Cambio Colón	1.266.885
Construcción Estación de Transbordo de Acido "La Junta"	160.000
Otras Obras	112.000
Subtotal	**3.704.885**

Planta de Limpieza de Gases N° 1	71.328.000
Planta de Limpieza de Gases N° 2	78.200.000
Transporte Definitivo Acido	21.312.000
Cambio Esquema Operativo Fusión	17.800.000
Red de Monitoreo – Tubos Pasivos – PC en línea	320.000
Subtotal	**188.960.000**
TOTAL	**US$ 192.664.885**

RESUMEN

Para dar cumplimiento a la normativa vigente de calidad del aire para anhídrido sulfuroso y material particulado, las fundiciones estatales de cobre han realizado una gran cantidad de proyectos que significaron fuertes inversiones, las que se resumen a continuación.

Fundición	US$
VENTANAS	**64.614.936**
HERNAN VIDELA LIRA	**98.887.737**
CHUQUICAMATA	**654.777.000**
POTRERILLOS	**163.369.000**
CALETONES	**192.664.885**
TOTAL	1.174.313.558

Es preciso destacar que, para los efectos de este trabajo se han considerado sólo las inversiones que han involucrado fondos del Estado, a través de sus empresas mineras, y no se incluyen los proyectos que se han externalizado y que han sido realizado por privados u otros entes estatales, como por ejemplo, la estación de transferencia de ácido de Los Lirios en Rancagua (alrededor de US$ 20 millones) y las soluciones habitacionales (realizadas por el MINVU) para aquellos que no eran empleados de Codelco al trasladar el Campamento de Potrerillos.

COMISION CHILENA DEL COBRE
Santiago, julio de 2000

GOBIERNO DE CHILE
COMISION NACIONAL
DEL MEDIO AMBIENTE

Con fecha 24 de Julio de 2000 se archivaron bajo los números que a continuación se indican los siguientes antecedentes para la Revisión de las Normas Primarias de Calidad de Aire para CO, O3, NO2, SO2 y PTS:

4-NOR-1/00 Latest Findings on National Air Quality: 1997 Status and Trends.

5-NOR-1/00 Antecedentes relativos a SO2:

- SO2 Position Paper (Final-June1997) European Communities.
- Guidelines for Air Quality SO2.
- Directiva 1999, Comunidad Europea (CE) del Consejo, relativa a los valores límite de dióxido de azufre, dióxido de nitrógeno y óxidos de nitrógeno, partículas y plomo en el aire ambiente.
- National Primary and Secondary Ambient air quality standards.
- Análisis Antecedentes y proposiciones sobre SO2, Estudio SGA.
- National Ambient Air Quality Standards for Sulfur Oxides, EPA-AIR.
- National Environmental Publications Information,1.600FP93002 Supplement to the 2nd Addendum (1986) to Air Quality Criteria for Particulate Matter and Sulfur Oxides (1982): Assessment of New Findings on Sulfur Dioxide Acute Exposure Health Effects in Asthmatic Individuals. http://www.epa.gov/cgi-bin/claritgw.
- National Environmental Publications Information, 1.600886020A Air Quality Criteria for Particulate Matter and Sulfur Oxides (1982): Assessment of Newly Available Health Effects Information (List of Authors/Contributors), 2nd Addendum http://www.epa.gov/cgi-bin/claritgw.
- Calidad del Aire Región Metropolitana para SO2, 1998.
- Norma Calidad de Aire, México.
- Index of the Quality of the Air (IQUA), Canadá.

6-NOR-1/00 Antecedentes relativos a NO2:

- NO2 Position Paper, (January 1997) European Communities.
- Guidelines for Air Quality NO2, WHO Geneva, 1999.
- Directiva 1999, Comunidad Europea (CE) del Consejo, para NO2
- Guidance Report on Preliminary Assesssment under EC Air Quality Directives, NO2, January, 1998.
- Norma oficial Mexicana NOM-023-SSA1-1993. "Salud ambiental criterio para evaluar la calidad del aire ambiente, con

respecto al bióxido de nitrógeno (NO2). Valor para la concentración de bióxido de nitrógeno (NO2) en el aire ambiente, como medida de protección a la salud de la población".

- OAR Policy and Guindance Metarecord.
- National primary and secondary ambient air quality standards for nitrogen dioxide.
- National Ambient air quality standards for nitrogen dioxide: proposed decision.
- United States Environmental Protection Agency, June 1, 1999.
- Management plan for Nitrogen Oxides (Nox) and Volatile Organic Compounds (VOCs), November 1990.
- Effect of the Fine Fraction of Particulate Matter versus the Coarse Mass and Other Pollutans on Daily Mortality in Santiago, Chile, August 2000.
- Análisis de antecedentes y proposiciones sobre dióxido de nitrógeno, estudio SGA.
- Análisis de la consistencia de los antecedentes para la revisión de las normas de calidad de aire contenidas en la Resolución N°1215/78 del ministerio de Salud, Claiss.
- Analysis of high 1 Hr NO2 values and associated annual averages using 1988-1992 data, (McCurdy, 1994).

7-NOR-1/00 Antecedentes relativos a O3:

- Guidelines for Air Quality Ozone, WHO Geneva, 1999.
- Federal register, National ambient air quality standards for Ozone; final rule, July 1997.
- Final revisions to the Ozone and Particulate Matter Air Quality Standards, July 1997.
- Summary of EPA's strategy for implementing new ozone and particulate matter air quality standards, July, 1997.
- Norma oficial mexicana NOM-020-SSA1-1993. "Salud ambiental, criterio para evaluar la calidad del aire ambiente, con respecto al ozono (O3). Valor normado para la concentración de ozono (O3) en el aire ambiente, como medida de protección a la salud de la población".
- Air and health, Taking actions to improve air quality.
- Communty legislation in force, Council directive 92/72/EEC of 21 september 1992 on air pollution by ozone.
- Principales reglamentaciones vigentes.
- Les procédures d'alerte.
- Federal register, Air quality index reporting; final rule.
- Classification of regions for episode plans.
- Análisis de antecedentes y proposiciones sobre ozono, SGA.
- Effect os the Fine fraction of Particulate Matter versus the Coarse Mass and other pollutants on Daily Mortality in Santiago, Chile.
- Guideline for the Index of the Quality of the Air.
- Comisión de Recursos Naturales, Bienes Nacionales y Medio Ambiente, El Impacto Urbano del Ozono y Fotooxidantes, Julio 2000.

- List of designated reference and equivalent methods, may, 2000.
- Testimony of Carol M. Browner administrator U.S. environmental protection agency before the committee on agriculture united states house of representatives, September, 1997.
- Regulating Smog and Particle Air Pollution, August, 1997.
- Assessing health effects of air pollution, November 1994.

8-NOR-1/00 Antecedentes relativos a CO:

- Guidelines for Air Quality CO, WHO Geneva, 1999.
- CO Position Paper (June1997) European Communities.
- Análisis Antecedentes y proposiciones sobre CO, Estudio SGA.
- Health Effects of carbon monoxide: implications of new discoveries for the National Ambient Air Quality Standards.

9-NOR-1/00 Antecedentes relativos a PTS:

- Análisis Antecedentes y proposiciones sobre PTS, Estudio SGA.
- Antecedentes para evaluar la contaminación por material particulado en zonas con aporte de fuentes naturales y antrópicas, enero 1999.
- Paper capítulo II.9, Inglaterra.

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COMENTARIO: ☐ Urgente ☐ Confirmar ☐ Para su revisión ☐ Por favor comentar

CONAMA
COMISION NACIONAL DEL MEDIO AMBIENTE

OF. ORD. N° 001690

MAT.: Revisión Normas Primarias de Calidad de Aire

Santiago, 28 de julio de 2000

DE : SRA. LORETO MADRID
JEFE AREA DESCONTAMINACION ATMOSFERICA
COMISION NACIONAL DEL MEDIO AMBIENTE
REGION METROPOLITANA

A : SRA. PATRICIA MATUS
JEFE DEPARTAMENTO DESCONTAMINACION, PLANES Y NORMAS
COMISION NACIONAL DEL MEDIO AMBIENTE

Por medio del presente, y de acuerdo a los antecedentes disponibles, nuestros comentarios a la revisión de las normas contenidas en la resolución N° 1215 son las siguientes:

- Se cree conveniente separar las normas de cada contaminante con el objeto de facilitar su posterior tratamiento.

- Se considera adecuada la propuesta de derogación de la norma para PTS.

- Se consideran adecuadas las propuestas para las normas del resto de los contaminantes, especialmente en relación con los efectos en salud demostrados para periodos mayores que los horarios en el caso de Ozono y en el caso de efectos agudos para dióxido de Nitrógeno. Los niveles horarios fijados para los casos de episodios parecen responder a los mejores antecedentes existentes, y bajo este punto de vista nos parecen convenientes.

- Desgraciadamente, permanece la incógnita acerca de los efectos sinérgicos de los contaminantes, lo cual en el futuro con mejores antecedentes podría llevarnos a modificar estos niveles.

- El caso de la Región Metropolitana, la condición de saturación por diversos contaminantes que la afecta, presenta leves variaciones bajo las nuevas normas propuestas. Por ejemplo, en el caso de monóxido de Carbono, el cambio del criterio de excedencia hacia el percentil 99 constituye una cierta relajación en nuestro caso, puesto que permite una mayor cantidad de días de superación de norma, lo que podría dejarnos al límite del "cumplimiento por decreto". En el caso de Ozono, la nueva norma de ocho horas se traduce en una reducción de los días sobre norma, aunque todavía se sobrepasa ampliamente el umbral de saturación. Por otra parte, en ambos casos, es decir, CO y O_3, habría antecedentes históricos de la ocurrencia de niveles 1, ante lo cual sería necesario dictar planes operacionales para episodios críticos.

- No obstante lo anterior, es posible abordar la regulación de las emisiones de monóxido de Carbono como parte de las estrategias de control de precursores de Ozono y de material particulado en las nuevas versiones del Plan de Prevención y Descontaminación Atmosférica, por lo que la nueva condición de excedencia no debería afectar el curso de la reducción de este contaminante.

- Aunque es materia de Plan, cabe destacar que habría diferencias sustanciales en el control de cada uno de estos contaminantes, y por lo tanto en la factibilidad del cumplimiento de la norma. El Ozono, al ser un producto fotoquímico, presenta mayores complejidades para su control.

- De lo anterior se desprende la necesidad futura de normar algunos precursores que no sean abordables por las estrategias de control contenidas en los Planes.

- También en relación con el problema fotoquímico que se desarrolla en la atmósfera de la Zona Central, la propuesta de norma horaria para NO_2 nos sitúa en una probable condición de latencia respecto de estos niveles horarios, además, por supuesto de la probable condición de latencia en la base anual (desgraciadamente no se dispone de información suficiente para probar esta condición). En todo caso, creemos que la existencia de esta norma horaria nos permitirá enfrentar mejor el problema de fotooxidantes que la norma anual.

- En el caso de que las nuevas normas propuestas de alguna manera fueran contradictorias con los Planes de Prevención y/o Descontaminación vigentes, en particular con aquel de la R.M., nos parecería preciso estipular en forma explícita las excepciones o variaciones en la norma misma.

- La ampliación de la normativa propuesta a nuevos períodos y condiciones de excedencia, plantea la inquietud acerca de la representatividad de las estaciones monitoras para los diversos casos. Dados los costos involucrados en la mantención de una red de monitoreo de calidad de aire, los nuevos diseños de redes deberán ser todavía más cuidadosos en su elaboración para responder adecuadamente sobre la condición en la que se encuentra un determinado lugar.

- Finalmente, producto de la discusión acerca de las normas primarias, ha quedado manifiesta la importancia de elaborar pronto normas secundarias que protejan la vegetación, la agricultura y eventualmente algún patrimonio histórico de interés. Especialmente importante parece ser el caso de Ozono para la Zona Central dada su gran actividad agrícola.

Sin otro particular, le saluda atentamente

LORETO MADRID F.
Jefe Area Descontaminación Atmosférica
Comisión Nacional del Medio Ambiente
Región Metropolitana

LMF/rsc/bl

c.c.: Señor Gianni López R., Director CONAMA R.M.

COMISIÓN NACIONAL DEL MEDIO AMBIENTE
DEPARTAMENTO DE DESCONTAMINACIÓN, PLANES Y NORMAS

Revisión Norma de Calidad Primaria contenidas en la Resolución Nº 1215/78

ACTA DE REUNION DE COMITÉ OPERATIVO Y AMPLIADO

FECHA REUNION : 31 de julio de 2000
LUGAR : CONAMA. Obispo Donoso 6. Santiago
ASISTENCIA : Se adjunta hoja de asistencia

Tabla :

1. Presentación de propuesta de normas de CONAMA (CONAMA, Depto. Descontaminación, Planes y Normas)
2. Discusión

Discusión :

Ozono:

- **G.Muñoz** *(CODELCO)* consulta sobre cómo se entiende el percentil 99 y qué implicancias tiene el valor de norma propuesto en la Región Metropolitana en comparación con la norma vigente. **F.Farías** (*CONAMA*) aclara que en el caso de la norma de ozono el percentil 99 se refiere a aquel calculado sobre la base de los máximos diarios para un año calendario. Respecto al número de veces proyectado en el cual se de superaría la norma en la RM, señala que con el nivel propuesto, éste disminuiría.

NO2

- **G.Muñoz** *(CODELCO)* consulta sobre cuál sería la situación con el nivel de norma horario propuesto. **F.Farías** (*CONAMA*) señala que se está empezando a medir NO2 horario y que aún no se cuenta con datos oficiales.

SO2

- **M.Alday** *(JIACons.)* propone evaluar la dictación de una norma horaria por las implicancias que ésta pudiese traer al país en vías de desarrollo. Señala que esta norma restringiría la inversión de proyectos nuevos. **R.Lucero** (*CONAMA*) señala que de acuerdo a los antecedentes disponibles la normativa propuesta se cumpliría en la mayoría del país. **R.Pedrero** (*CODELCO*) sostiene que la norma horaria no tiene mayor utilidad práctica por cuanto las medidas se tomarían a destiempo. **A.Tchernitchin** *(Colegio Médico)* recuerda que la norma propuesta es más permisiva que lo recomendado por la OMS, lo cual significa que podrían generarse efectos en la salud. **S. Pimentel** (*COCHILCO*) hace hincapié en que el estudio realizado por SGA indica que no hay antecedentes a nivel nacional sobre efectos en salud por SO2, por cuanto es difícil establecer los beneficios asociables a la norma, en especial dada la poca población afectada. Solicita hacer una evaluación costo-beneficio de la norma horaria propuesta. **R.Lucero** (*CONAMA)* afirma que el estudio de SGA propone no fijar una norma horaria, considerando los resultados de su evaluación económica y tomando un determinado criterio de población. No obstante, existe un consenso a nivel internacional sobre los efectos en 5-10 minutos que genera el SO2, y que en Chile se alcanzan valores altísimos en períodos cortos. **C.Salvo** (*SONAMI*) aclara que en relación a los antecedentes nacionales en salud, aquel realizado en Puchuncaví arrojó sólo un efecto menor por pérdida de capacidad respiratoria. Por otro lado, sostiene que en relación al cumplimiento de una norma horaria éste es complejo dada la aleatoriedad de la meteorología que no permite tomar acción de tal forma de evitar la superación de la norma, o que las acciones pueden significar detenciones de la actividad con sus altos costos asociados. Menciona el caso de la fundición Chagres que tiene que reducir considerablemente su fusión para alcanzar los niveles de la norma secundaria de 1000 ug/m3. **G.Muñoz** *(CODELCO)* señala que los antecedentes en salud del SO2 son de carácter irritante, no asociados a cáncer. Consulta qué sucede en casos donde la población expuesta no hay niños o población sensible. Por otro lado insiste en la necesidad de realizar una evaluación de costo beneficio. **M.Alday** *(JIACons.)* sostiene que la norma propuesta podría significar la reformulación de los Planes de Descontaminación a los cuáles actualmente están sujetos algunas fundiciones de cobre. **S.Sanhueza** (*RENACE*) sostiene que los valores de normas no se deben fijar para ser cumplidas sino que para proteger la salud de las personas o de los recursos naturales.

Rodrigo Lucero Ch.
Depto. Descontaminación, Planes y Normas
CONAMA

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COMISION NACIONAL DEL MEDIO AMBIENTE
DEPTO. DESCONTAMINACION, PLANES Y NORMAS

Reunión "Revisión Normas Primarias de Calidad de Aire para SO2, PTS, CO, NO2 Y O3"
Santiago, 31 de Julio 2000

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Propuesta de norma de calidad primaria y niveles que definen situaciones de emergencia para el Contaminante Dióxido de Nitrógeno

CONAMA

Depto. Descontaminación, Planes y Normas

31 DE JULIO 2000

En base a los antecedentes presentados y recopilados durante el proceso de preparación del anteproyecto de norma, se presenta para discusión de los Comités Operativo y Ampliado de la norma, la siguiente *Propuesta*.

1. Norma para efectos agudos: corto plazo

Intervalo de evaluación corto plazo:
1-hora

(actualmente no hay norma)

Intervalo propuesto por estudios en salud:
- Guía OMS (Organización Mundial de la salud) de 1999 y aplicado en norma por la Comunidad Europea

Nivel de corto plazo:

400 ug/m3

Nivel guía propuesto por la OMS en 1999 sin aplicar Factor de Incertidumbre

Excedencia de la norma:

Percentil 99, base anual sobre los máximos diarios

Propuesta homogénea de percentil para la revisión de las normas de corto plazo contenidas en la Res.1215.

Valores que definen situaciones de emergencia ambiental:

Nivel	Dióxido de Nitrógeno (ug/m3N) en 1 hora
Nivel 1°	1130 – 2259
Nivel 2°	2260 – 2999
Nivel 3°	3000 o superior

Antecedentes:

Niveles federales que utiliza la USEPA para episodios por NO2 en EE.UU.

OMS reporta en su Guía de 1999 que "para exposiciones agudas, solamente concentraciones muy altas (>1990 ug/m3) afectan a individuos saludables".

2. Norma para efectos crónicos: largo plazo

Intervalo de evaluación largo plazo:

1-año

(norma actual: 1-año)

Intervalo propuesto por estudios en salud:

- Guía OMS (Organización Mundial de la Salud) de 1999 y aplicado en norma por la Comunidad Europea
- Comité Técnico Asesor a la US EPA lo mantiene en su última revisión de 1996. Norma vigente en EE.UU. desde 1971

Nivel de largo plazo:

100 ug/m3

(norma actual: 100 ug/m3)

- Valor de norma vigente en los EE.UU. y que se mantuvo en la última revisión de la norma de 1996.

Excedencia de la norma:

Evaluación anual

(norma actual: anual)

Propuesta homogénea para la revisión de las normas de largo plazo contenidas en la Res.1215.

Métodos de medición:

- Quimiluminiscencia
- Los que se basen en el método modificado de Griess-Saltzmann

Son métodos de medición aprobados por US EPA

Se cuenta con método estandarizado por la ISO

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Propuesta de norma de calidad primaria y niveles que definen situaciones de emergencia para el Contaminante OZONO

GOBIERNO DE CHILE

CONAMA
Depto. Descontaminación, Planes y Normas
31 DE JULIO 2000

En base a los antecedentes presentados y recopilados durante el proceso de preparación del anteproyecto de norma, se presenta para discusión de los Comités Operativo y Ampliado de la norma, la siguiente *Propuesta.*

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Intervalo de evaluación:
8-horas
(norma actual: 1-hora)

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Intervalo propuesto por estudios en salud más recientes:

- Guía OMS (Organización Mundial de la salud) de 1999 y aplicado en norma por la Comunidad Europea
- Comité Técnico Asesor a la US EPA en 1996 y aplicado en norma por EE.UU.

Nivel:

120 ug/m3

(norma actual: 160 ug/m3)

Nivel guía propuesto por la OMS en 1999 y aplicado en norma por la CE para ser usado conjuntamente con el intervalo de 8-horas

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Excedencia de la norma:

Percentil 99, base anual sobre los máximos diarios

(norma actual: hasta 1-vez por año)

Propuesta homogénea de percentil para la revisión de las normas de corto plazo contenidas en la Res.1215.

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Valores que definen situaciones de emergencia ambiental:

Nivel	Ozono (ug/m3N) en 1 hora
Nivel 1°	400 – 799
Nivel 2°	800 – 999
Nivel 3°	1000 o superior

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Antecedentes:

- Niveles federales que utiliza la USEPA para episodios por Ozono en EE.UU.
- OMS reporta en su Guía de 1999 que "se produce efectos agudos sustanciales cuando se realiza ejercicio con exposiciones de 1-h de 500ug/m3 o superior, particularmente en individuos susceptibles o sub-grupos".

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Métodos de medición:

- Quimiluminiscencia con etileno
- Fotometría de absorción ultravioleta
- Cromatografía líquida Gas/Sólido

- Son métodos de medición aprobados por US EPA
- Se cuenta con método estandarizado por la ISO

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PROPUESTA
DE NORMA DE CALIDAD PRIMARIA
PARA
PARTICULAS TOTALES EN
SUSPENSION

CONAMA
Depto. Descontaminación, Planes y Normas
31 DE JULIO 2000

GOBIERNO DE CHILE

La Resolución 1215 de 1978 regula los efectos en salud que se generan por el material particulado en suspensión (PTS) mediante una norma promedio 24 horas de 260 ug/m3 y una norma anual de 75 ug/m3.

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Históricamente se creía que todas las partículas suspendidas en el aire (PTS) afectaban a la salud de la misma forma.

Sin embargo, recientemente se ha demostrado que las partículas que más afectan la salud son aquellas con diámetro aerodinámico menor a 10 um (MP10) y más aún, aquellas con diámetro aerodinámico menor a 2.5 um (MP2.5).

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De hecho, la fracción del PTS mayor a 10 micrones se deposita en la traquea y las partículas son limpiadas por los cilios a través de la formación de mucus y expulsadas a través de la tos o tragar, por lo que no causa los riesgos a la salud comprobados en el MP10.

La OMS, Comunidad Europea o EEUU no establecen ningún tipo de guías para aquella fracción del material particulado mayor a 10 um.

No se cuenta con una evaluación de riesgo que evidencie alguna relación entre la exposición a PTS (> 10um), y en particular a los compuestos tóxicos contenidos en éste y la ocurrencia de alguna enfermedad.

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Con el D.S. 185 de 1991 y posteriormente con el D.S. 59 de 1998 se regulan los efectos en salud generados por la fracción respirable del material particulado, a través de una norma para PM10 promedio de 24 horas (150 ug/m3).

Actualmente, este Decreto está en proceso de revisión e incluye una propuesta para incorporar un valor de norma anual

GOBIERNO DE CHILE

En base a los antecedentes presentados y recopilados durante el proceso de preparación del anteproyecto de norma, se presenta para discusión de los Comités Operativo y Ampliado de la norma, la siguiente *Propuesta*.

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Se propone derogar la actual norma de PTS

GOBIERNO DE CHILE

PROPUESTA
DE NORMA DE CALIDAD PRIMARIA
PARA EL
MONÓXIDO DE CARBONO

CONAMA
Depto. Descontaminación, Planes y Normas
31 DE JULIO 2000

GOBIERNO DE CHILE

La Resolución 1215 de 1978 regula los efectos en salud que se generan por el *CO* mediante una norma de 10 mg/m3 para promedio de 8 horas, no debiendo sobrepasarse este valor más de una vez por año, o 40 mg/m3 para 1 hora, no debiendo sobrepasarse este valor más de una vez por año.

GOBIERNO DE CHILE

En base a los antecedentes presentados y recopilados durante el proceso de preparación del anteproyecto de norma, se presenta para discusión de los Comités Operativo y Ampliado de la norma, la siguiente *Propuesta*.

GOBIERNO DE CHILE

Intervalo de evaluación
1 -hora

Guía OMS (Organización Mundial de la salud) de 1999 y aplicado en norma por EE.UU

Nivel
40 mg/m3

Nivel guía propuesto por la OMS en 1999

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Intervalo de evaluación
8 - horas

Guía OMS (Organización Mundial de la salud) de 1999 y aplicado en norma por EE.UU

Nivel
10 mg/m3

Nivel actual
Nivel guía propuesto por la OMS en 1999

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Excedencia de la norma

Percentil 99, base anual sobre los máximos diarios

Propuesta homogénea de percentil para la revisión de las normas de corto plazo contenidas en la Res. 1215.

Valores que definen situaciones de emergencia ambiental (8 horas):

Nivel 1: 17 mg/m3
Nivel 2: 34 mg/m3
Nivel 3: 40 mg/m3.

•Niveles federales que utiliza la USEPA para episodios por CO en EE.UU.

Métodos de medición

Fotometría infraroja no dispersivo

Método actual
Son métodos de medición aprobados por US EPA
Se cuenta con método estandarizado por la ISO

COMISION NACIONAL DEL MEDIO AMBIENTE
CONAMA

Proceso Revisión Normas Primarias de Calidad de Aire para CO, PTS, NO2, O3 y SO2

31 julio 2000

OBJETIVO REUNION:

Presentar al Comité Operativo y Ampliado la propuesta de norma CONAMA de los contaminantes en revisión.

CALENDARIO REUNIONES:

- Lunes 7/08/00: SO2, PTS y CO
- Lunes 14/08/00: O3, NO2
- Lunes 28/08/00: Presentación Anteproyecto

Anteproyecto de Norma : 8/09/2000

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PROPUESTA NORMA PRIMARIA DE CALIDAD DE AIRE PARA ANHIDRIDO SULFUROSO

CONAMA

Depto. Desc. Planes y Normas

31 JULIO 2000

- En base a los antecedentes presentados y recopilados durante el proceso se propone para discusión del Comité Operativo y Ampliado la siguiente propuesta:

EFECTOS CRONICOS:

- Mantener norma vigente de 80 ug/Nm3 para un intervalo de evaluación de un año.

Corresponde al 80% del valor guía recomendado por la OMS sin aplicar factor de incertidumbre (100 ug/Nm3).

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EFECTOS AGUDOS:

- **Disminuir nivel actual de 365 ug/Nm3 para un intervalo de evaluación de 24 horas a 250 ug/Nm3.**

Corresponde al valor guía recomendado por la OMS sin aplicar factor de incertidumbre.

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EFECTOS AGUDOS:

- **Incorporar norma para un intervalo de evaluación de una hora:**

  Nivel : 1.050 ug/Nm3

Valor de norma más alto a nivel internacional a excepción de Argentina (sobre información disponible).

EXCEDENCIA NORMA :

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- Norma para intervalo de evaluación de 24 horas
  - Percentil 99, base anual.
- Norma para intervalo de evaluación de 1 hora
  - Percentil 99, base anual, sobre máximos diarios.

Propuesta homogénea de percentil para la revisión de las normas de corto plazo contenidas en la Res.1215.

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NIVELES QUE DEFINEN SITUACIONES DE EMERGENCIA AMBIENTAL:

Nivel 1	1.960 ug/Nm3, hora
Nivel 2	2.620 ug/Nm3, hora
Nivel 3	3.930 ug/Nm3, hora

Niveles actualmente vigentes en el país

GOBIERNO DE CHILE

METODO DE MEDICION

- Método de la pararosanilina
- Método de la Fluorescencia Ultravioleta
  - Métodos utilizados por USEPA
  - Métodos estandarizados por norma ISO
  - Métodos utilizados actualmente

PROPUESTA DE NORMATIVA DE CALIDAD PRIMARIA: **MONOXIDO DE CARBONO**

Resumen

En base a los antecedentes analizados, se presenta para discusión de los Comités Operativo y Ampliado de la norma, la siguiente Propuesta. Entre paréntesis se indica el origen de cada elemento propuesto de la norma.

Nivel: 30 mg/m3 (nivel guía propuesto por la OMS en 1999)
Intervalo de evaluación: 1-hora (intervalo guía propuesto por OMS en 1999)
Excedencia de la norma: con percentil 99 de las concentraciones máximas diarias durante un año igual o mayor de norma o con más de 4 excedencias del nivel de norma en un mismo año.

Nivel: 10 mg/m3 (nivel norma vigente en Chile, nivel guía propuesto por la OMS en 1999)
Intervalo de evaluación: 8-horas promedio móvil (intervalo guía propuesto por OMS en 1999)
Excedencia de la norma: percentil 99 de las concentraciones máximas diarias registradas durante un año igual o mayor de norma o con más de 4 excedencias del nivel de norma en un mismo año.

Valores que definen las situaciones de emergencia ambiental:
Nivel 1: 17 mg/m3
Nivel 2: 34 mg/m3
Nivel 3: 40 mg/m3.
Todos estos niveles evaluados en base promedio 8 horas. (propuesta de estudio preparado por SGA, basada en los niveles federales norteamericanos).

Además incluir un párrafo indicando que dentro de cada Plan de Descontaminación o Prevención se establezcan condiciones dentro del plan de manejo de episodios críticos, como las indicadas en la regulación federal de EEUU acerca del uso de modelos predictivos, o bien condiciones meteorológicas, otorgando la flexibilidad particular según el desarrollo que tenga localmente para aplicar esta parte de la norma en distintas partes de Chile.

Métodos de medición:
-Fotometría infrarroja no dispersivo

ANTECEDENTES RECOPILADOS PARA LA REVISIÓN DE LA NORMA CO

La Resolución 1215 de 1978 regula los efectos en salud que se generan por el monóxido de carbono mediante una norma de 10.000 ug/m3 como concentración media aritmética máxima de 8 horas consecutivas, no debiendo sobrepasarse este valor más de una vez por año o 40.000 ug/m3 como concentración media aritmética de una hora, no debiendo sobrepasarse este valor más de una vez por año. Para su determinación establece que se deberá utilizar el método de radiación infrarroja no dispersivo o equivalente.

EFECTOS EN SALUD

Las propiedades tóxicas del CO están relacionadas con su gran afinidad por las proteínas del grupo Hem-Fe (relacionadas con el transporte de oxígeno a las células) como la hemoglobina y la mioglobina. De hecho, la afinidad de la hemoglobina al CO es aproximadamente 220 veces mayor que al oxígeno. Por lo tanto, los efectos del CO se manifiestan en aquellos órganos más sensibles a la falta de oxígeno. Por otro lado, cuando baja la tensión del 02, el CO también se une a la mioglobina en músculo cardíaco y esquelético, disminuyendo la entrega de oxígeno a los procesos intracelulares involucrados en la contracción muscular.

La exposición al CO se puede evaluar a través de los niveles de carboxyhemoglobina (COHb) que se expresan como porcentaje de la hemoglobina (Hb) total que está unida al CO. En individuos sanos, no fumadores, estos niveles están en un rango de 0,3% - 0,7%. La Tasa de producción endógena puede aumentar por fiebre, hemólisis, trastornos de la eritropoyesis y algunas drogas. El CO inhalado aumenta los niveles de Cohb a prox. 1% en individuos normales. Sin embargo, un porcentaje de la población tiene niveles por sobre 1,5%, relacionado directamente con el hábito tabáquico, y la exposición a otras fuentes de CO en ámbito intradomiciliario.

El pulmón es la principal ruta de excresión y absorción de CO. La tasa de HbCO depende de la concentración de CO en aire inspirado, la tasa de difusión aire-sangre, el contenido de Hb en la sangre, la tensión capilar de O2 y el nivel de COHb en lo capilares pulmonares.

La afinidad de la hemoglobina al CO es aproximadamente 220 veces mayor que al oxígeno. Por otro lado, cuando baja la tensión del O2, el CO también se une a la mioglobina en músculo cardíaco y esquelético, disminuyendo la entrega de oxígeno a los procesos intracelulares involucrados en la contracción muscular.

Durante una exposición a una concentración fija de CO, la concentración de COHb crece rápidamente hasta situarse en los niveles de la exposición, después de 3 horas comienza a decaer y alcanza su condición estable después de 6-8 horas de exposición.

Los resultados de diversos estudios recientes son consistentes en cuanto a que el CO aparece asociado a incrementos en las admisiones hospitalarias respiratorias. Sin embargo, es importante destacar que los efectos de CO y de material particulado se encuentran muchas veces confundidos, ya que éstos tienen fuentes comunes y se encuentran correlacionados.

El estudio de SGA realizó una recopilación de estudios nacionales. En relación a la mortalidad, existen 2 estudios que aplicaron el diseño de análisis de series de tiempo o cohorte dinámica, en el cual el efecto medido es la mortalidad diaria por causas médicas en Santiago en el período 1988-1993. El CO resultó estadísticamente significativo, incluso en presencia de otros contaminantes. En los estudios de morbilidad SGA incluye el realizado por Ilabaca, el cual analizó efectos del CO en las consultas infantiles de urgencia en un hospital de Santiago, no reportando efectos sobre esta variable.

Algunos estudios internacionales recientes han mostrado, entre otros, los siguientes efectos asociados al CO:

Efectos respiratorios:

- Disminución de capacidad de ejercicio en pacientes con enfermedad pulmonar obstructiva crónica a niveles de alrededor de 4% de COHb.

Efectos cardiovasculares:

- Disminución tiempo máximo de ejercicio y consumo máximo de O2, 1% por cada 1% de aumento sobre 4% de COHb en sujetos normales
- Aparición precoz de dolor (angina) y alteraciones del electrocardiograma (depresión del segmento ST) en enfermos con angina estable. En resumen se ha observado una disminución del tiempo para desarrollar angina a niveles de COHb entre 2% y 6%
- Aumento de probabilidad de depresión del ST de 1,5% veces para niveles entre1 y 2% y de 2,1 veces para niveles mayores que 2% en sujetos anginosos dsarrollando actividad normal
- Aumento de mortalidad diaria especialmente asociada a enfermos cardiovasculares en numerosos análisis de series de tiempo

NORMATIVA INTERNACIONAL

Según la OMS (1999), para proteger a la población no fumadora, de mediana y mayor edad con enfermedad de la arteria coronaria latente o reportada de ataques de isquemia miocárdica aguda, y para proteger al feto en madres no fumadoras de efectos hipóxicos adversos, el nivel de COHb en la sangre de las personas expuestas a CO no debiera ser excedido.

Sobre esa base, la OMS definió los valores guía para CO recomendados que se presentan en el cuadro 3. Este cuadro indica los niveles de CO por encima de los cuales se han observado efectos en la salud, los efectos observados, el factor de incertidumbre proveniente del juicio y consenso científico y los valores guía para diferentes tiempos promedio de exposición.

Cuadro 3: Valores guía para CO recomendados por la OMS

Efectos sobre la salud	Nivel de efecto observable ($\mu g/m^3$)	Factor de incertidumbre	Valor guía ($\mu g/m^3$)	Tiempo promedio de exposición

Nivel crítico de COHb <2.5%	n.a.	n.a	100.000	15 minutos
			60.000	30 minutos
			30.000	1 hora
			10.000	8 horas

n.a.: no aplicable

El Cuadro 4 presenta los valores límite para la protección de la salud pública, tiempos promedio de muestreo y frecuencias de excedencia permitida para las normas de CO en América Latina y el Caribe, Canadá, China, Estados Unidos, Japón y la Unión Europea.

Cuadro 4

País	**Valor límite ($\mu g/m^3$)[1]**	**Tiempo promedio de muestreo[2]**	**Frecuencia de excedencia permitida**
Argentina[3]	57.250	1 hora	El valor límite no podrá superarse en ninguna ocasión
	11.450	8 horas	
Belice[4,5]	1.000 (I) 2.000 (II) 5.000 (III)		El valor límite no podrá superarse en ninguna ocasión
Bolivia	40.000	1 hora	El valor límite no podrá superarse en ninguna ocasión
	10.000	8 horas	
Brasil	40.000	1 hora	El valor límite no podrá superarse en más de una ocasión por año
	10.000	8 horas	
Chile	40.000	1 hora	El valor límite no podrá superarse en más de una ocasión por año
	10.000	8 horas	
Colombia	50.000	1 hora	El valor límite no podrá superarse en ninguna ocasión
	15.000	8 horas	
Costa Rica	40.000	1 hora	El valor límite no podrá superarse en ninguna ocasión
	10.000	8 horas	
Cuba			
Ecuador[6]			
Guatemala			
Jamaica			
México	12.595	8 horas	El valor límite no podrá superarse en más de una ocasión por año
Perú			
Venezuela	10.000 – 40.000	8 horas	El valor 10.000 $\mu g/m^3$ no podrá superarse en más de 50% de las mediciones y el valor 40.000 $\mu g/m^3$ no podrá superarse en más de 0.5% de las mediciones por año.
Canadá[7]	15.000 (deseable) 35.000 (aceptable)	1 hora	
	6.000 (deseable) 15.000 (aceptable) 20.000 (tolerable)	8 horas	
China[4]	10.000 (I) 10.000 (II) 20.000 (III)	1 hora	El valor límite no podrá superarse en ninguna ocasión
	4.000 (I) 4.000 (II) 6.000 (III)	24 horas	
Estados Unidos	40.000	1 hora	El valor límite no podrá superarse en más de una ocasión por año
	10.000	8 horas	El valor límite no podrá superarse en más de una ocasión por año sin traslape entre los promedios
Japón	22.800	8 horas	El valor límite no podrá superarse en ninguna ocasión
	11.400	24 horas	
Unión Europea[6]			

1 Las concentraciones de los contaminantes se calculan para condiciones de 1 atmósfera y 298 K.
2 El tiempo promedio de muestreo de 8 horas es un promedio móvil
3 Valores de las norma son aproximados: 50 ppm (1 hora) y 10 ppm (8 horas)
4 (I) áreas sensibles de protección especial; (II) áreas urbanas y rurales típicas y (III) áreas industriales especiales.
5 El tiempo promedio de muestreo no esta estipulado en la norma
6 No tiene normas primarias de CO.
7 El nivel máximo deseable define una meta a largo plazo y provee una base para las políticas de prevención del deterioro de la calidad del aire en áreas no contaminadas. El nivel máximo aceptable intenta proveer una adecuada protección contra los efectos adversos en humanos, animales, vegetación, suelos, agua, materiales y visibilidad. El nivel máximo tolerable indica concentraciones de contaminantes por encima de las cuales se deben tomar medidas inmediatas para proteger la salud de la población en general.

El método de referencia para el muestreo y análisis de CO establecido en las normas es generalmente el método automático basado en la espectrometría de infrarrojo no dispersivo.

La comunidad Europea aún no establece una norma de calidad primaria para CO. Sin embargo, en el Position Paper de 1997 respecto de este contaminante establece algunas propuestas al respecto. Como valor límite propone un valor promedio máximo de 8 horas de 10 o de 3,5 mg/m3, con 7 días de excedencia permitidos por año calendario.

En relación a los valores guía de la OMS para 15 y 30 minutos el documento de la CE establece que éstos no entregan una protección adicional comparada a los valores para 1 y 8 horas. De hecho, si la concentración promedio de 30 minutos está por sobre el valor guía de 60 mg/m3, la concentración horaria matemática debería estar sobre 30 mg/m3 (valor límite horario). Consecuente al valor guía no es útil como base para un valor límite. En cuanto al valor guía de 15 minutos, para exceder los 100 mg/m3 sin exceder el valor horario se requiere que en los 45 minutos restantes en la misma hora, la concentración promedio estuviera por debajo de los 7 mg/m3, lo cual pareciera ser improbable en situaciones normales. Adicionalmente, a la baja probabilidad de darse situaciones en que el valor guía de 15 minutos pudiese ser más estricto que el valor horario, el cumplimiento de una norma de 15 minutos sería extremadamente complicado de evaluar. Consecuentemente tampoco propone fijar un umbral sobre la base de 15 minutos.

A su vez, la CE analizó la información empírica disponible en la CE para comparar la severidad de los valores para 1 y para 8 horas. Como resultado obtuvo que el valor guía de 8 horas es usualmente más estricto que aquel para 1 hora, y consecuentemente el más adecuado para la fijación de un valor límite. Sin embargo, el valor para 8 horas no es en todos los casos más estricto que el de 1 hora, por lo que no se puede a priori excluir como segundo valor límite.

FUENTES DE EMISION

El CO es un gas incoloro e inodoro que se produce por la combustión incompleta de combustibles fósiles como gas, gasolina, kerosene, carbón, petróleo o madera. Los automóviles con motores de ignición a chispa son unas de las principales fuente de emisión de CO. Las chimeneas, las calderas, los calentadores de agua o calefones y los aparatos domésticos que queman combustible, como las estufas u hornillas de la cocina o los calentadores a Kerosene, también pueden emitir CO. El humo de cigarrillo puede ser una fuente significativa de CO en interiores.

El CO presente en la atmósfera proviene de la oxidación de metano (CH4) y otros alcanos, de compuestos orgánicos emitidos por la vegetación y de la combustión incompleta de combustibles fósiles y de biomasa. Esta última fuente es muy importante en las ciudades.

El CO en áreas urbanas es resultado en casi un 90% de emisiones de tráfico de calles y las concentraciones están más altas cerca de las calles decreciendo a medida que uno se aleja de éstas.

En Chile sólo se cuenta con un inventario de emisiones para CO en Santiago, el cual se adjuntó en el Anexo (1997). De este se desprende para el CO que casi un 90% de las emisiones provienen de fuentes móviles en ruta, con un total aproximado de 208.000 t/año de CO. De estas emisiones, a lo menos, el 50% provenía de los vehículos particulares no catalíticos, con un aporte aproximado de 107.000 t/año de CO.

PRINCIPALES RESULTADOS EN MONITOREO DE CO EN CHILE

Región Metropolitana

En la RM, los niveles anuales de concentración de CO tienen una marcada estacionalidad, siendo los meses de invierno aquellos que presentan las concentraciones más altas.

Tal como se puede apreciar en la tabla siguiente, en 1998, en 5 de las 8 estaciones de la red se superó la norma para 8 horas, siendo la estación Parque O'Higgins aquella con mayor número de superaciones. En total, en esta estación se registraron 22 días con superación de norma. En la estación de Pudahuel, se superó 8 días.

CO, Red MACAM2, 1998
Concentraciones promedios móviles 8 hrs.

Estación	Máx (mg/m3N)
Seminario	10
La Paz	10
La Florida	8
Las Condes	4
P. O'Higgins	15
Pudahuel	20
Cerrillos	12
El Bosque	8

En 1999, en 4 de las 8 estaciones se registraron valores sobre la norma para 8 horas, aumentando el número de días con excedencia en la estación Pudahuel, en comparación al año anterior. La estación Parque O'Higgins registró una disminución en los días con excedencia de norma, según se puede apreciar en la siguiente tabla.

CO, Red MACAM 2, 1999
Concentraciones promedios móviles 8 hrs.

Estación	**Máx (mg/m3N)**	**N° días > 10 mg/m3N**
Seminario	7.9	0
La Paz	9.8	0
La Florida	8.7	0
Las Condes	5.9	0
P. O'Higgins	15.8	15
Pudahuel	20.4	11
Cerrillos	11.2	2
El Bosque	10.8	2

En 1998 y 1999 las mayores concentraciones de CO se registraron en la estación de Pudahuel, coincidiendo con situaciones de emergencia para el material particulado.

En cuanto, a la norma horaria, ésta está incluso por debajo del valor guía establecido por la OMS de 30 mg/m3.

Otras regiones

Para otras regiones del país sólo se cuenta con información para las ciudades de Viña del Mar, Valparaíso, Rancagua, Copiapó, Vallenar y Huasco cuyos resultados se presentan a continuación:

Ciudad	**CO máx. horaria (mg/m3N)**	**CO máx. Promedio 8 hrs.**
Viña del Mar (jul-oct93)	13	
Viña del Mar (feb-mar94)	20.2	
Valparaíso (jul-oct93)	12.3	
Valparaíso (feb-marzo94)	12.6	
Rancagua (ago-sep96)	29.5	23.8 (33 superaciones)
Copiapó (may98-jun99)	12	5.4
Vallenar (may98-jun99)	11	5.8
Huasco (may98-jun99)	4	2

De estos antecedentes se puede concluir que no hubo en los periodos de medición, en ninguna de las ciudades, superación de la norma horaria, estando en todos los casos las concentraciones máximas por debajo del valor guía de la OMS. En cuanto al valor de norma para 8 horas, éste se superó reiteradamente en la ciudad de Rancagua entre agosto y septiembre de 1996.

VALORES QUE DEFINEN SITUACIONES DE EMERGENCIA

Chile no cuenta con valores que definan situaciones de emergencias ambiental para CO. Sólo cuenta con un índice de calidad de aire, referido a gases, que incluye CO, pero es solo para información de la población y autoridades, no para adoptar medidas. Los valores asociados son:

ICA	CO ug/m3 (8 hrs.)
100	10.000 (9 ppm)
500	55.550 (50 ppm)

En EEUU existen niveles de daño significativo definidos para cinco contaminantes, entre ellos el CO. Estos son: 57,5 mg/m3 para 8 horas, 86.3 mg/m3 para 4 horas y 144 mg/m3 para 1 hora. Por otra parte, la Ley de Control de la Contaminación Atmosférica obliga a los Estados a elaborar planes de emergencia para tomar medidas que impidan alcanzar los niveles que causen daño significativo (que ponen en peligro inminente y substancial la salud de las personas), en todas las regiones de Prioridad I (CO: Máx 1 Hora: 55ug/m3, Anual: 14 mg/m3).

Se establece en EEUU la siguiente recomendación federal:

Concentración 8 hrs (mg/m3)	Situación
17	Alerta
34	Adventencia
46	Emergencia

La CE, en su position paper, propone no definir un valor de alerta, pero sí introducir un umbral de información a la población de 10 mg/m3 como promedio de 8 horas, basado en lo valores de la OMS. La excedencia de umbral de información obligaría a los países miembros a informar a la población lo antes posible, pero no requiere informar a la Comisión en un período corto. Esta proposición se basa en que pese a que pueden ocurrir niveles muy altos de CO bajo condiciones meteorológicas adversas simultáneamente en distinta calles de alto tráfico en un área grande, las concentraciones altas siempre serían de carácter local. Si bien el valor de umbral de información sería el mismo válido como valor límite (norma) la diferencia radicaría en el tamaño del área considerada relevante para la aplicación del umbral de información.

Considerando los valores del ICA, así como las exigencias en EEUU la empresa consultora SGA propone definir los siguientes valores de emergencia:

Concentración 8 hrs (mg/m3)	Situación
17	Alerta
34	Adventencia

40	Emergencia

DOCUMENTO TECNICO PARA DISCUSIÓN INTERNA

PROPUESTA DE NORMATIVA DE CALIDAD PRIMARIA: OZONO

Resumen

- *PROPUESTA DE NORMA DE CALIDAD PRIMARIA PARA OZONO*

En base a los antecedentes presentados, se presenta para discusión de los Comités Opertivo y Ampliado de la norma, la siguiente *Propuesta*. Entre paréntesis se indica el origen de cada elemento propuesto de la norma.

Nivel: 120 ug/m3 (nivel guía propuesto por la OMS en 1999)
Intervalo de evaluación: 8-horas (intervalo guía propuesto por OMS en 1999)
Excedencia de la norma: 99%, evaluado en condición anual sobre los máximos diarios (propuesta homogénea de percentil para las normas de corto plazo contenidas en la Res.1215).

Valores que definen las situaciones de emergencia ambiental:
Nivel 1: 400 ug/m3
Nivel 2: 800 ug/m3
Nivel 3: 1000 ug/m3. Todos estos niveles evaluados en base horaria.
(propuesta del Estudio preparado por SGA, basada en los niveles federales norteamericanos, habida cuenta de lo indicado por la OMS, respecto a efectos sensibles a partir de 500ug/m3 en 1-hora).
Además incluir un párrafo indicando que dentro de cada Plan de Descontaminación o Prevención se establezcan condiciones dentro del plan de manejo de episodios críticos, como las indicadas en la regulación federal de EEUU acerca del uso de modelos predictivos, o bien condiciones meteorológicas, otorgando la flexibilidad particular según el desarrollo que tenga localmente para aplicar esta parte de la norma en distintas partes de Chile.

Métodos de medición:
- Quimiluminiscencia con etileno;
- Fotometría de absorción ultravioleta
- Cromatografía Líquida Gas /Sólido (método de medición aprobados por US EPA).

- EFECTOS EN SALUD

a) Experiencia Internacional

Los efectos dañinos del ozono provienen de su gran capacidad oxidante lo cual le hace reaccionar con toda clase de sustancias biológicas. El ozono puede penetrar a todos los tejidos de la región pulmonar pero la dosis máxima de contaminante la recibe la región entre los bronquios y la región alveolar. La rapidez de la penetración depende de la concentración de ozono en la tráquea y de la frecuencia respiratoria. Parte del ozono inhalado se absorbe en la sangre. Los efectos típicos del ozono en la salud son cambios en la función pulmonar que van precedidos por irritación de ojos y síntomas del pecho y de las vías respiratorias en poblaciones sensibles[1]. Además, estudios en animales han mostrado efectos sobre la bioquímica del pulmón (Estudio SGA, pag.7/1).

A este respecto la Organización Mundial de la Salud indica que en el caso del Ozono, "los problemas de salud de mayor preocupación son: aumento en las admisiones hospitalarias, exacerbación del asma, inflamaciones pulmonares y alteraciones estructurales del pulmón" ("Guidelines for Air Quality", WHO, 1999. pp.36).

En EE.UU. la EPA reporta en su Ozone Final Rule: 40CFR, part 50 de julio de 1997, que existe clara evidencia a partir de estudios clínicos (respuestas estadísticamente significativas) que los efectos del ozono se asocian con exposiciones de una duración entre 6 a 8 horas. Frente a ejercicio moderado, a concentraciones de 0.08ppm de O3 en tales periodos de exposición se encuentran decrementos en la función pulmonar, síntomas respiratorios tales como tos o dolor al realizar inspiraciones profundas, respuestas bronquiales no específicas e indicadores bioquímicos de inflamación pulmonar. Estudios de campo proveen evidencia similar de síntomas y efectos, a concentraciones ambientales de ozono que son consistentes con las conclusiones de los estudios clínicos (Ozone Final Rule: 40CFR, part 50, pp 38864).

En términos cuantitativos, la Organización Mundial de la Salud (OMS) reporta efectos en la salud, estadísticamente significativos, a concentraciones de 160 ug/m3 para exposiciones de 6,6-h en un grupo de adultos saludables, experimentando los sujetos más sensitivos más de un 10% de decremento en la función pulmonar a las 4-5 horas. También que, a valores de 240 ug/m3 por 2-horas se producen disminuciones en la función pulmonar en niños y adultos realizando ejercicio físico intenso. Por último, indica que se producen efectos agudos sustanciales cuando se realiza ejercicio con exposiciones de 1-h de 500ug/m3 o superior, particularmente en individuos susceptibles o sub-grupos: "El balance de las evidencias indica que disminuciones de FEV1[2] de más de un 10% ocurren a niveles de 160 ug/m3 y superior. Se acepta generalmente que la duración en la exposición a Ozono es importante en el control de la respuesta. Sobre esta base, un valor guía de 120 ug/m3 por un período máximo de 8-horas se establece como un nivel al cual los efectos agudos sobre

[1] US EPA, la Agencia Ambiental de EE.UU. considera como poblaciones sensibles para el contaminante criterio Ozono a los niños y aquellos que padecen de asma.

[2] Volumen Expiratorio Forzado en 1 segundo.

la salud pública son factibles que sean pequeños ("Guidelines for Air Quality, WHO, Geneva, 1999, pp32 y 33).

b) Efectos de contaminante en la salud: Experiencia Nacional
Existe un número reducido de estudios locales en ese ámbito. La mayoría de los estudios realizados en Chile no encuentran efectos entre mortalidad total y exposición a ozono. Solo dos estudios mostraron un leve efecto significativo en mortalidad: Sanhueza,Vargas (período analizado ´89 al ´93) y Ostro (periodo analizado: veranos de los años ´89 al ´91). El estudio de Ilabaca muestra un aumento en las consultas de urgencia infantil de hasta un 23% con niveles de ozono del orden de 106 ug/m3. El estudio de Belmar (´88) encontró un resultado inesperado, ya que el ozono resultó ser una un agente protector respecto a la tasa de consultas de Atención Primaria en Salud. (Estudio SGA pp 7/2).

Un último estudio realizado con información de Santiago para el periodo 1988-1996 encuentra relaciones estadísticamente significativas entre mortalidad diaria y ozono (máximos de 1-h en estación con mayor valor de la red), pero solo en meses cálidos. (Cifuentes, Lave, Vega y Kopfer, en paper del año 2000 aún no publicado).

- METODOS DE MEDICIÓN PARA OZONO TROPOSFÉRICO

En Chile la normativa vigente se refiere a equipos basados en principios de medición por *Quimiluminiscencia*, lo cual es consecuente con lo establecido al respecto en EE.UU. No obstante, en EE.UU. también es posible utilizar métodos basados en:
- *Fotometría de absorción ultravioleta;*
- *Cromatografía Líquida Gas /Sólido.*

ISO tiene 2 métodos aprobados para medir ozono:
ISO 10313:1993 Ambient Air –Determination of the mass concentration of ozone—Chemiluminiscence method;
ISO 13964: 1998 Air Quality –Determination of ozone in ambient air—Ultraviolet photometric method.

La red MACAM de Santiago utiliza equipos basados en el principio de Fotometría de absorción ultravioleta.

- PRINCIPALES RESULTADOS EN MONITOREO DE OZONO EN CHILE

Aunque los esfuerzos más importantes de monitoreo de contaminación atmosférica en el país han estado orientados al material particulado y el dióxido de azufre, a partir de 1998 han existido esfuerzos de monitoreo sistemático para el contaminante Ozono -aparte de Santiago- principalmente en zonas urbanas.

Analizando la información de monitoreo a partir de ese año, las mediciones de ozono realizadas corresponden a localidades con una población estimada en su conjunto al año 2000 de más de 6,4 millones de habitantes, según las cifras que estima el Instituto Nacional de Estadísticas de Población. Este valor correspondería aproximadamente a un 42% del total de población de chilenos estimada al año 2000. Si se considerara que los resultados de la red MACAM fuesen representativos de la situación de Ozono para la Región Metropolitana completa, el porcentaje sube a un 51%.

a) Regiones
Se hicieron mediciones horarias durante 1999 en Vallenar, Copiapó y Huasco. El mayor valor medido en esas 3 localidades en esta condición fue de 76ug/m3.

Existen mediciones horarias y de 8-horas para la ciudad de Quillota para todo el año 1999. Los valores máximos respectivamente son: 126 y 88 ug/m3.

El Estudio de 5 ciudades monitoreó ozono con técnicas pasivas durante 1998. Al respecto, se encontraron valores semestrales inferiores a 60ug/m3 en Viña del Mar; ligeramente superior a 50ug/m3 en Iquique, Rancagua y Valparaíso; e inferiores aún en Temuco.

b) Santiago
Se tienen datos de monitoreo de ozono (nueva red de Santiago: MACAM-2) en esta ciudad para los años 1997 (solo a partir del día 1 de abril), ´98 y ´99 (series completas).

Los valores son los más altos registrados en el país. En el caso de valores de 1-hora, el año 1998 se registraron 177 días sobre el valor vigente en Chile (160 ug/m3) y el año 1999, 154 días.

En cuanto a valores de concentraciones medidas de ozono, la concentración máxima horaria registrada el año 1998 fue de 408 ug/m3y el año 1999, 352 ug/m3. Tomando promedios de 8 horas, los valores máximos registrados son de 235ug/m3 el año 1998 y 212ug/m3 para el año 1999.

A manera de ejercicio comparativo, considerando que para el año 1997 se tiene información a partir del día 1 de abril, y que en dicho periodo de ese año se registraron 120 días con superación del valor 160 ug/m3, si se considera el mismo periodo (abril-diciembre) para los años ´98 y ´99 se encuentra una disminución progresiva en los días con superación de tal valor: 103 y 88 días respectivamente.

- INVENTARIOS DE EMISIONES PARA PRECURSORES (PRESENTE Y TENDENCIAS FUTURAS) Y PRINCIPALES AFECTADOS POR LA NORMA

El problema de contaminación de ozono a comunidades se concentra -de acuerdo a la información de monitoreo disponible- en la ciudad de Santiago. Es en esta ciudad que se tiene también más avanzado el tema de identificación de fuentes emisoras de contaminantes o precursores. Las principales fuentes de precursores para el ozono serían de acuerdo al Inventario 1997 de la Región Metropolitana:
i) en el caso de los NOx, las fuentes móviles en ruta (aproximadamente el 80% del total de emisiones);

ii) en el caso de los COV, las fuentes areales que aportan cerca de un 60% y las fuentes móviles en ruta, con cerca de un 35% del total de emisiones locales de COV.

En el caso de Santiago, de acuerdo a información presentada por CONAMA RM, se hubiese esperado un aumento entre los años 1997 y 2005 de entre un 20 y un 30% en las emisiones de los precursores NOx y COV en el caso que no se implementara el Plan de Descontaminación de la RM. De acuerdo al cronograma de reducción de emisiones del Plan, al año 2005 se esperan reducciones a un 75% de la situación de emisiones del año 1997.

- PRINCIPALES BENEFICIARIOS

Con la aplicación de esta norma, se protegería principalmente a la salud de la población localizada en centros urbanos.
Por la reducción de este contaminante, también se generarían beneficios –secundarios- a recursos naturales (cosechas y vegetación natural) cercanos a las comunidades a proteger, así como indirectamente a ecosistemas.

- NORMATIVA EN OTROS PAÍSES

En este caso se consideran, independientemente en forma inicial y posteriormente en su conjunto los siguientes elementos constitutivos de una norma: a) Intervalo de Evaluación de la Norma; b) Nivel de la norma y c) Evaluación de la excedencia de la norma.

Los países o conjuntos de países que se utilizan para estudio y comparación son EE.UU., la Comunidad Europea (CE) y México. Los dos primeros, teniendo en cuenta que corresponden a los procesos normativos más recientes, y México porque tienen un problema importante de ozono urbano en su capital.

a) Intervalo de Evaluación de la Norma
Las normas más recientemente discutidas en el mundo para el ozono primario (EE.UU: y la CE) consideran intervalos de 8 horas para la evaluación de la concentración de este contaminante.

En efecto, en el caso de EE.UU. el "Clean Air Scientific Advisory Committee" (CASAC), basado en la información proporcionada por variados estudios epidemiológicos, recomendó en forma unánime a EPA cambiar el tiempo de evaluación del estándar de 1-hora a 8-horas. En base a tal antecedente, la conclusión de EPA fue que "un estándar primario de 1-h no protege adecuadamente a la gente de efectos adversos en la salud, por lo que EPA reemplaza el estándar previo por un estándar de 8-horas" (EPA´s Revised Ozone Standard Fact Sheet, USEPA, OAQPS, Julio 17, 1997).

Por su parte, la CE siguiendo las recomendaciones de la OMS, también definió un intervalo de 8-horas para su norma. Al respecto, OMS indica que los problemas de salud de mayor preocupación "son abordados más apropiadamente por un valor objetivo (guideline) que limite exposición diaria, y consecuentemente dosis de inhalación antes que tomar en cuenta situaciones de corta duración de deterioro de la calidad del aire las que pueden estar asociadas con condiciones meteorológicas inusuales. Un valor objetivo evaluado en intervalos de 8-h protegería contra exposiciones agudas en el rango ambiental de lo que se concluye que un valor objetivo de 1-hora no sería necesario" (Guidelines for Air Quality, WHO, 1999, pp.36).

b) Nivel de la norma
Respecto al nivel o valor de la norma se pueden encontrar diferencias entre las normativas recientemente generadas a nivel internacional.

En el caso de EE.UU. el CASAC indica que "reconociendo que individuos sensibles pueden experimentar efectos adversos con un estándar de 0,08 ppm pero tales efectos son de naturaleza transiente, ningún miembro del panel del CASAC apoya la selección del nivel 0,07ppm como el nivel de un estándar primario (Ozone Final Rule: 40CFR, part 50 de julio de 1997, pp38864). Con esta información, US EPA fijó como valor para su norma un nivel de 0,08 ppm (aprox.160 ug/m3).

La CE, en tanto, basada en las recomendaciones hechas por la OMS y presentadas en el primer punto de este documento, propone un valor de 120 ug/m3, con fecha de cumplimiento posible para el año 2010.

La norma primaria mexicana para el ozono (NOM 020-SSA1-1993) publicada en el año 1993, considera un valor máximo horario de 0,11 ppm (216 ug/m3).

c) Evaluación de la excedencia de la norma
Este es el tercer elemento clave a considerar en una norma, en conjunto con el intervalo de evaluación de la norma y su valor o nivel.
En el caso de esta norma, en la práctica se han identificado 3 maneras de evaluar la superación de la norma:

i) considerar el número de veces en que puede superarse el valor definido en la norma en un período determinado (1 vez en un año que es lo que indica la Resolución 1215, 1 vez cada tres años como se establece en México, 20 días en un año como propone la CE, como ejemplos);
ii) considerar un promedio de los valores asociados a periodos determinados (promedio de los 4tos mayores valores para tres años consecutivos, que es la opción seleccionada en EE.UU);
iii) considerar un valor único o promediado seleccionado a partir del conjunto de valores medidos en un período determinado (percentil).

Ninguno de ellos es determinado a priori como más o menos estricto. La estrictez del criterio de superación de la norma estará definida por la selección conjunta de los elementos que conforman la norma.

Sin embargo, el CASAC fundamenta que utilizar un criterio de promedio de 3 años, reduciría inherentemente las diferencias que de año en año se producen, así como eventos meteorológicos extremos inusuales que son conducentes a la formación de O3 (Ozone Final Rule: 40CFR, part 50, pp38868).

d) Comparaciones integradas de los elementos de las normas internacionales
A manera ilustrativa, aplicando los tres elementos citados previamente a diferentes normas internacionales y la propuesta presentada por el Estudio de SGA, según los resultados de monitoreo de Ozono en Santiago, en promedio para los años ´97, ´98 y ´99, se encuentra lo siguiente:
- En el caso de la norma de la CE (valor: 120 ug/m3 8-h, hasta una superación de 20 días al año): 47% excedida;
- En el caso de la norma de EEUU (valor: 0,08 ppm 8-h, promedio de los 4tos mayores valores de 3 años consecutivos): 27% excedida;
- En el caso de la norma de México (valor: 0,11 ppm 1-h, hasta una superación cada tres años): 63% excedida;
- En el caso de la norma chilena vigente (Res.1215, valor 160 ug/m3 1-h, hasta una superación anual): 101% excedida.
- En el caso de la norma propuesta por el Estudio de SGA (valor 160 ug/m3 1-h, percentil 98): 74% excedida.

- VALORES QUE DEFINEN LAS SITUACIONES DE EMERGENCIA AMBIENTAL

Los valores que definen las situaciones de emergencia ambiental establecen los niveles a los cuales deben tomarse las medidas que se indican en el Plan Operacional para enfrentar Episodios Críticos de Contaminación según se definan particularmente para cada Plan de Descontaminación o de Prevención.

El principal elemento que se considera a este respecto es la indicación de la OMS, en el sentido que "se produce efectos agudos sustanciales cuando se realiza ejercicio con exposiciones de 1-h de 500ug/m3 o superior, particularmente en individuos susceptibles o sub-grupos". Guidelines for Air Quality, WHO, Geneva, 1999. (pp32)

También es un elemento valioso a considerar la forma en que aborda este tema la Agencia Ambiental de EEUU, al indicar además de un conjunto de niveles que son los que definen las situaciones de emergencia ambiental que: "En caso de episodios, para la declaración de uno de los niveles indicados, adicionalmente a la superación de los niveles establecidos, las condiciones meteorológicas deben ser tales que la situación pueda ocurrir de nuevo en las siguientes 24 horas, a menos que se tomen acciones de control" (51 FR Subpart H, Appendix L).

- *PROPUESTA DE NORMA DE CALIDAD PRIMARIA PARA OZONO*

En base a los antecedentes presentados, se presenta para discusión de los Comités Opertivo y Ampliado de la norma, la siguiente *Propuesta*. Entre paréntesis se indica el origen de cada elemento propuesto de la norma.

Nivel: 120 ug/m3 (guía de la OMS)
Intervalo de evaluación: 8-horas (guía de la OMS)
Excedencia de la norma: 99%, evaluado en condición anual sobre los máximos registrados diariamente.

Valores que definen las situaciones de emergencia ambiental:
Nivel 1: 400 ug/m3
Nivel 2: 800 ug/m3
Nivel 3: 1000 ug/m3. Todos estos niveles evaluados en base horaria.
(propuesta de SGA, basada en los niveles federales norteamericanos, habida cuenta de lo indicado por la OMS, respecto a efectos sensibles a partir de 500ug/m3 en 1-hora).
Además incluir un párrafo indicando que dentro de cada Plan de Descontaminación o Prevención se establezcan condiciones dentro del plan de manejo de episodios críticos, como las indicadas en la regulación federal de EEUU acerca del uso de modelos predictivos, o bien condiciones meteorológicas, otorgando la flexibilidad particular según el desarrollo que tenga localmente para aplicar esta parte de la norma en distintas partes de Chile.

Métodos de medición:
- Quimiluminiscencia con etileno;
- Fotometría de absorción ultravioleta
- Cromatografía Líquida Gas /Sólido (método de medición aprobados por US EPA).

- COMENTARIOS A LA *PROPUESTA* PRESENTADA

La *Propuesta* recoge las recomendaciones más recientes basadas en estudios en salud, en cuanto al uso de promedios de 8 horas.

De acuerdo a información de monitoreo en Santiago, existirían 97, 171 y 145 días respectivamente sobre el nivel indicado en la *Propuesta (*120 ug/m3 en 8-h) en los años 1997, ´98 y ´99. Considerando la norma vigente actualmente (160 ug/m3 en 1-h) para tales años en Santiago se registraron respectivamente: 120, 177 y 154 días con superación.

Para el caso de la fijación del valor de la norma y el percentil asociado, el efecto de la *Propuesta* presentada en su conjunto es comparable con la situación normativa existente de saturación actual para Santiago. Con la norma horaria actualmente vigente en Chile (Res.1215), Santiago se encuentra excedido por ozono en un 113% y en un 79% evaluando los resultados de monitoreo en la capital para los años 1998 y 1999. Con la P*ropuesta*, Santiago se habría encontrado excedido en un 72% y un 52% para tales años.

Comparando con las normas de EEUU y la CE, y considerando los datos del monitoreo de Santiago, la *Propuesta* resultaría ser más estricta. Es comparable con la norma Mexicana en términos de estrictez.

Considerar otra alternativa de valor para un promedio de 8-horas, como la norma de EEUU, en la práctica significaría mantener el valor actual de la norma chilena, pero extender su plazo de evaluación a 8-horas. Esto implicaría reducir drásticamente el número de días con superación del valor de la norma: desde 120 a 38 para los días con que se cuenta información del año 1997, de 177 días a 55 para el año 1998 completo, y de 154 a 27 días para el año 1999.

Está pendiente la fijación de un plazo para el inicio de la aplicación de la presente norma primaria de ozono, diferenciando la situación de aquellas zonas del país que ya se encuentran saturadas y con Plan de Descontaminación vigente (la Región Metropolitana) con el resto del país. En el primer caso habría que considerar las nuevas metas cuando corresponda la revisión del Plan.

/FFE

COMISION NACIONAL DEL MEDIO AMBIENTE
DEPTO.DESCONTAMINACIÓN, PLANES Y NORMAS

DOCUMENTO TECNICO PARA DISCUSIÓN INTERNA

PROPUESTA DE NORMATIVA DE CALIDAD PRIMARIA: DIOXIDO DE NITROGENO

<u>Resumen</u>

En base a los antecedentes que se indican, se presenta para discusión de los Comités Operativo y Ampliado de la norma, la siguiente *Propuesta*. Entre paréntesis se indica el origen de cada elemento propuesto de la norma.

Efectos agudos:
Nivel: 400 ug/m3 (valor indicado en OMS sin incluir factor de incertidumbre)
Intervalo de evaluación: 1-hora (intervalo indicado en la guía de la OMS y en México)
Excedencia de la norma: percentil 99, evaluado en condición anual sobre los máximos diarios.

Efectos crónicos:
Nivel: 100 ug/m3 (valor vigente en Chile y EE.UU.)
Intervalo de evaluación: Anual (intervalo indicado en la guía de la OMS, intervalo vigente en Chile, la CE y EE.UU.)

Valores que definen las situaciones de emergencia ambiental:
Nivel 1: 1130 ug/m3
Nivel 2: 2260 ug/m3
Nivel 3: 3000 ug/m3. Todos estos niveles evaluados en base horaria.
(propuesta del Estudio preparado por SGA, basada en los niveles federales norteamericanos).
Además incluir un párrafo indicando que dentro de cada Plan de Descontaminación o Prevención se establezcan condiciones dentro del plan de manejo de episodios críticos, como las indicadas en la regulación federal de EEUU acerca del uso de modelos predictivos, o bien condiciones meteorológicas, otorgando la flexibilidad particular según el desarrollo que tenga localmente para aplicar esta parte de la norma en distintas partes de Chile.

Métodos de medición:
- Quimiluminiscencia;
- Los que se basen el método Modificado de Griess-Saltzmann.

- EFECTOS EN SALUD

a) Experiencia Internacional

Los tipos principales de efectos en la salud de mayor preocupación a concentraciones ambientales o cercanas a ambientales del NO2 son:

(1) Aumentos en la reactividad de las vías respiratorias en individuos asmáticos después de una exposición de corto plazo; y
(2) Mayor frecuencia de enfermedades respiratorias en niños como consecuencia de exposiciones a NO2 de mayor duración.

También se ha detectado una tercera categoría de efectos del NO2, el enfisema, pero aparentemente reviste problemas únicamente a exposiciones muy superiores a los niveles ambientales del NO2. (Estudio SGA, pag.8/1).

US EPA reconoce como grupos sensitivos al NO2 a "niños y aquellos con enfermedades respiratorias (40CFR, Part 58, pp 42548).

A este respecto la Organización Mundial de la Salud indica para el Dióxido de nitrógeno: "Efectos a exposiciones de corto plazo: Seres humanos saludables expuestos, en descanso o con ejercicio liviano por menos de 2 horas a concentraciones sobre los 4700 ug/m3 (2,5 ppm) experimentan reducciones pronunciadas en la función pulmonar; generalmente, sujetos normales no son afectados por concentraciones menores que 1880 ug/m3 (1ppm). Se ha reportado un amplio rango de efectos en asmáticos. Ellos son probablemente los más sensitivos, aunque existen algunas incertezas en las bases de datos de salud. La concentración más baja que causaría efectos en la función pulmonar se reportó en dos estudios de laboratorio que expusieron a asmáticos leves por 30-110 minutos a 565 ug/m3 (0,3ppm) de NO2 durante ejercicio intermitente. Sin embargo, ninguno de estos estudios lograron replicar tales respuestas con un grupo más grande de sujetos asmáticos.
Efectos de exposiciones en el largo plazo: Estudios con animales han mostrado claramente que exposiciones de varias semanas a meses con concentraciones menores a 1880 ug/m3 (1ppm) de NO2 ya causan una variedad de efectos, primeramente en el pulmón, pero también en otros órganos tal como el bazo e hígado, y en la sangre. Se han observado efectos reversibles e irreversibles en pulmones. No hay estudios epidemiológicos que puedan ser usados en forma confiable para cuantificar una exposición de largo plazo de NO2 o una concentración capaz de ser asociada con la inducción de riesgos inaceptables a la salud de niños o adultos. Los resultados de estudios en extramuros indican en forma consistente que niños expuestos por largo plazo a concentraciones ambientales de NO2 exhiben síntomas respiratorios de larga duración y muestran un descenso en la función pulmonar. Sin embargo, estudios epidemiológicos intra y extramuros proveen poca evidencia que exposiciones de largo plazo de NO2 están asociadas con efectos en la salud de adultos" ("Guidelines for Air Quality", WHO, 1999. pp.30).

En EE.UU. la EPA reporta en su NO2 Final Rule review, que la exposición a dióxido de nitrógeno puede irritar los pulmones y disminuir la resistencia ante infecciones respiratorias (ej. influenza), particularmente en individuos con enfermedades respiratorias pre-existentes, tales como asma. Los efectos de exposiciones de corto plazo a dióxido de nitrógeno aun no están claros, pero exposición continuada o frecuente al dióxido de nitrógeno más altas que aquellas encontradas normalmente en el aire ambiente pueden incrementar la incidencia de enfermedades respiratorias agudas en niños" (US EPA NO2/Fact Sheet 16 de septiembre de 1996).

En términos de definición de "guidelines", la Organización Mundial de la Salud (OMS) indica que en el caso del corto plazo, basado en pequeños cambios en las funciones pulmonares -menor que 5% de disminución en VEF1- y cambios en respuestas respiratorias en estudios con asmáticos y pacientes con enfermedades pulmonares crónicas, un rango de 365-565 ug/m3 (0,20 a 0,30ppm) es un claro LOEL (lowest-observed-effect-level). Sobre este último valor, OMS propone el uso de un margen de seguridad de 50% porque se han reportado aumentos estadísticamente significativos en respuestas a un broncoconstrictor con exposiciones a 188ug/m3, y porque un meta-análisis sugiere respuestas bajo los 365 ug/m3. Sin embargo, la significancia en la respuesta a 188ug/m3 se ha cuestionado. Con un valor doble respecto a la guía recomendada (400ug/m3) hay evidencia que sugiere posibles pequeños efectos en la función pulmonar de asmáticos. Si un asmático fuera expuesto simultáneamente o secuencialmente a NO2 y a un aero-alergeno, el riesgo de una respuesta exagerada al alergeno se incrementaría.

Para el caso de valores anuales, OMS reporta que basado en los estudios revisados, no es posible en la actualidad seleccionar un valor bien sustentado para la selección de un valor específico de guía como promedio anual. Sin embargo, una revisión previa de NO2 recomendó un valor anual de 40 ug/m3 (WHO 1997c[1]). En la ausencia de un valor alternativo, se reconoce este valor como el valor guía ("Guidelines for Air Quality", WHO, 1999. pp.31).

b) Efectos de contaminante en la salud: Experiencia Nacional
Existe un número reducido de estudios locales para este contaminante. Los estudios realizados en Chile no encuentran efectos entre mortalidad total y exposición a NO2: Ostro, Sanchez (período analizado ´89 al ´93) y Salinas, Vega (periodo analizado: años ´88 al ´91). El estudio de Ilabaca muestra un exceso de riesgo de 11% para consultas de urgencia infantil, esto equivaldría a un exceso de 4617 consultas anuales atribuibles a NO2. El estudio de cohorte de Belmar (´88) asocia la presencia de sibilancias a una aumento de este contaminantes, pero no describe el aumento en la tasa de consultas de Atención Primaria en Salud. (Estudio SGA pp 8/2).

Un último estudio realizado con información de Santiago para el periodo 1988-1996 encuentra relaciones estadísticamente significativas entre mortalidad diaria y dióxido de nitrógeno en modelos de contaminantes únicos así como en modelos que evalúan contaminantes en parejas (Cifuentes, Lave, Vega y Kopfer, en paper del año 2000 aún no publicado).

- METODOS DE MEDICIÓN PARA DIÓXIDO DE NITROGENO

[1] La que a su vez se basó en una recomendación realizada por OMS en 1987.

En Chile la normativa vigente se refiere a equipos basados en principios de medición por *Quimiluminiscencia*, lo cual es consecuente con lo establecido al respecto en EE.UU.

ISO tiene 2 método aprobados para medir NO2:
ISO 7996:1985 Ambient Air –Determination of the mass concentration of nitrogen dioxide—Chemiluminiscence method (el método de referencia elegido por la CE);
ISO 6768: 1998 Ambient Air –Determination of the mass concentration of nitrogen dioxide—Modified Griess-Saltzmann method.

La red MACAM de Santiago utiliza equipos basados en el principio de *Quimiluminiscencia.*

- PRINCIPALES RESULTADOS EN MONITOREO DE DIÓXIDO DE NITROGENO EN CHILE

Aunque los esfuerzos más importantes de monitoreo de contaminación atmosférica en el país han estado orientados al material particulado y el dióxido de azufre, a partir de 1996 y con mayor intensidad desde 1998, han existido esfuerzos de monitoreo sistemático para el contaminante NO2 principalmente en zonas urbanas. Para ese período sin embargo, SESMA no tiene resultados oficiales de monitoreo, y solo reporta que a partir del presente año 2000 está recopilando información para este contaminante en su Red MACAM-2.

Analizando la información de monitoreo, las mediciones de dióxido de nitrógeno realizadas en el país corresponden a localidades con una población estimada en su conjunto al año 2000 de aproximadamente 1,65 millones de habitantes, según las cifras que estima el Instituto Nacional de Estadísticas de Población. Este valor correspondería aproximadamente a un 10,8% del total de población de chilenos estimada al año 2000. Esta cifra considera todo tipo de monitoreo, en particular técnicas pasivas de evaluación de largo plazo. En el caso de mediciones de NO2 con métodos horarios (automáticos), se tiene cubierta población aun menor: cerca de 260 mil hab, que cuenta por un 1,7% del total de población de chilenos estimada al año 2000.

a) Regiones

Se hicieron mediciones horarias durante 1999 en Quillota, Vallenar, Copiapó y Huasco. El mayor valor medido en esas 4 localidades en esta condición fue de 280ug/m3 en Huasco.

Existen mediciones anuales con métodos automáticos para las ciudades de Tocopilla, Mejillones, Quillota, Vallenar, Copiapó y Huasco para todo el año 1999. El valor máximo registrado fue de 38ug/m3 en Huasco.

El Estudio de 5 ciudades monitoreó dióxido de nitrógeno con técnicas pasivas durante 1998. Al respecto, se encontraron valores anuales en el orden de 80ug/m3 en Valparaíso y Viña del Mar; casi 60ug/m3 en Rancagua y Temuco, y ligeramente superior a 30ug/m3 en Iquique. Todos estas cifras corresponden al punto con valor mayor del conjunto de puntos de monitoreo utilizados, lo que no necesariamente reflejan que sean estos valores representativos de exposición comunitaria sistemática en estas ciudades.

b) Santiago

No existen datos validados para los últimos años. Sin embargo, de acuerdo al inventario de emisiones de la Región Metropolitana, se puede suponer que valores importantes de NO2 son esperables.

- INVENTARIOS DE EMISIONES PARA EL NO2 Y PRINCIPALES AFECTADOS POR LA NORMA

Las estaciones monitoras de NO2 localizadas fuera de Santiago o de las 5 Ciudades, responden básicamente a la existencia de desarrollos industriales locales (centrales termoeléctricas principalmente). Para estas actividades industriales no se tienen tasas estimadas de emisiones asociadas.

En el caso de la Región Metropolitana, en base al Inventario de 1997 para emisiones de NOx, de un total cercano a las 60 mil ton/año de NOx que serían emitidos, las fuentes móviles en ruta aportan aproximadamente el 80% del total en tanto que alrededor de un 10% provendría de emisiones puntuales. En el caso de las fuentes móviles en ruta, aproximadamente el 40% de los NOx emitidos corresponden a buses, y más de un 20%, de camiones. Autos particulares, taxis y comerciales aportan el resto.

De acuerdo a información presentada por CONAMA RM, se hubiese esperado un aumento entre los años 1997 y 2005 cercano a un 30% en las emisiones de los NOx en el caso que no se implementara el Plan de Descontaminación de la Región Metropolitana. De acuerdo al cronograma de reducción de emisiones del Plan, al año 2005 se esperan reducciones a un 75% de la situación de emisiones en 1997.

Por ultimo, para el caso de las 5 Ciudades, no se cuenta con Inventarios consolidados de emisiones de NO2.

- PRINCIPALES BENEFICIARIOS

Con la aplicación de esta norma, se protegería principalmente a la salud de la población localizada en centros urbanos con aportes relevantes de emisiones por fuentes móviles, así como localidades que se encuentran afectas por la presencia de desarrollos industriales con fuentes emisoras de NO2 en sus cercanías.

Es importante indicar que los óxidos de nitrógeno también contribuyen como precursores a la formación de Ozono y aumentan los problemas de Lluvia ácida por lo que reducciones en sus emisiones tendrían efecto positivo también en tales problemas ambientales.

- NORMATIVA EN OTROS PAÍSES

En este caso se consideran, independientemente en forma inicial y posteriormente en su conjunto los siguientes elementos constitutivos de una norma: a) Intervalo de Evaluación de la Norma; b) Nivel de la norma y c) Evaluación de la excedencia de la norma.

Los países o conjuntos de países que se utilizan para estudio y comparación son la Comunidad Europea (CE), EE.UU., y México. El primero teniendo en cuenta que corresponden a un proceso normativo reciente, EE.UU. porque es la base para la norma vigente en Chile, y México porque dispone de una norma para efectos agudos.

a) Intervalo de Evaluación de la Norma

Las normas más comunes para el caso del NO2 son aquellas asociadas a efectos crónicos (normas anuales), aunque también existen normas asociadas a efectos de corto plazo (normas horarias y en menor medida, diarias).

En el caso de EE.UU. en la última revisión de esta norma el año 1996, US EPA indicó que el actual estándar (0.053ppm, anual) era adecuado para proteger la salud de la población de los efectos directos del NO2 y que revisiones a este estándar no eran por tanto apropiadas en tal oportunidad (Fact Sheet, OAR Policy and Guidance Metarecord, 16.9.96).

Por su parte, la CE siguiendo las recomendaciones de la OMS, definió norma anual y norma horaria. (Directiva 1999/30/CE, Diario Oficial de las Comunidades Europeas, 29.6.99).

Por último, México dispone solamente de norma horaria.

b) Nivel de la norma

Respecto al nivel o valor de la norma se pueden encontrar diferencias entre las normativas recientemente generadas a nivel internacional.

En el caso de la norma anual, como se indicó previamente EE.UU. tiene una norma de nivel 0,053ppm, equivalente a 100ug/m3, en tanto la CE fijó un nivel de 40ug/m3. Este último valor es la recomendación guía hecha por la OMS en 1999, que se basa en una recomendación previa hecha por la misma institución. No obstante, como se indicó previamente, OMS reporta que basado en los estudios revisados no es posible en la actualidad seleccionar un valor bien sustentado para la selección de un valor específico de guía como promedio anual.

En el caso de valores de corto plazo, EE.UU. no la considera necesaria al existir una norma anual. La CE, en tanto, basada en las recomendaciones hechas por la OMS y presentadas en el primer punto de este documento, fija un valor de 200ug/m3. OMS deriva este valor desde resultados de estudios que en el rango 365-565 ug/m3 encuentran efectos (pequeños cambios en función pulmonar de asmáticos).

La norma primaria mexicana para el dióxido de nitrógeno (NOM 023-SSA1-1993) publicada en el año 1993, considera un valor máximo horario de 0,21 ppm (395 ug/m3).

c) Evaluación de la excedencia de la norma

Este es el tercer elemento clave a considerar en una norma, en conjunto con el intervalo de evaluación de la norma y su valor o nivel.

Para la norma anual, se plantean dos alternativas:

i) Evaluar cada año si el valor correspondiente al año anterior se ha superado el nivel fijado (caso norma de EE.UU.)
ii) Permitir un margen de tolerancia que año tras año se reduzca, de modo de cumplir el año 2010 con el valor fijado para la norma (desde un 50% de tolerancia hasta un 0%, caso norma de la CE).

En el caso de una norma horaria, en la práctica se han identificado 3 maneras de evaluar la superación de la norma:

i) considerar el número de veces en que puede superarse el valor definido en la norma en un período determinado (para el caso del NO2, 1 vez en un año que es lo que se establece en México, 18 días en un año como propone la CE, como ejemplos);
ii) considerar un promedio de los valores asociados a periodos determinados;
iii) considerar un valor único o promediado seleccionado a partir del conjunto de valores medidos en un período determinado (percentil).

Ninguno de ellos es determinado a priori como más o menos estricto. La estrictez del criterio de superación de la norma estará definida por la selección conjunta de los elementos que conforman la norma.

d) Comparaciones integradas de los elementos de las normas internacionales
Considerando que existen escasos resultados de monitoreo para el NO2, en el caso de la norma anual puede indicarse que ninguno de los puntos monitoreados en el país se acerca a la norma vigente en Chile. Los puntos donde se registraron los valores más altos en Valparaíso y Viña del Mar están fuertemente impactados por emisiones vehiculares, no correspondiendo a localizaciones con representatividad de exposición poblacional de largo plazo.

En el caso de monitoreos de corto plazo (horarios), los valores máximos y mínimos registrados corresponden a Huasco (280ug/m3) y Quillota (79 ug/m3), con valores respectivos en percentil 98 de 201ug/m3 y 70ug/m3. En el caso de Huasco, para efectos de comparar los valores con la norma de la CE, su percentil 95 es de 124 ug/m3. Estos valores no exceden ni la norma mexicana ni la norma de la CE.

- VALORES QUE DEFINEN LAS SITUACIONES DE EMERGENCIA AMBIENTAL

Los valores que definen las situaciones de emergencia ambiental establecen los niveles a los cuales deben tomarse las medidas que se indican en el Plan Operacional para enfrentar Episodios Críticos de Contaminación según se definan particularmente para cada Plan de Descontaminación o de Prevención.

Un elemento que se considera a este respecto para el NO2 es la indicación de la OMS, en el sentido que "para exposiciones agudas, solamente concentraciones muy altas (>1000ppb; 1990 ug/m3) afectan a individuos saludables" (Guidelines for Air Quality, WHO, Geneva, 1999. pp31).

También es un elemento valioso a considerar la forma en que aborda este tema la Agencia Ambiental de EEUU, al indicar además de un conjunto de niveles que son los que definen las situaciones de emergencia ambiental que: "En caso de episodios, para la declaración de uno de los niveles indicados, adicionalmente a la superación de los niveles establecidos, las condiciones meteorológicas deben ser tales que se espere que se permanezca en niveles altos por 12 o más horas a menos que se tomen acciones de control" (51 FR Subpart H, Appendix L).

En el caso de valores, se definen los siguientes niveles en regulación para EE.UU.:

Calificación	Valor 1-h (ug/m3)	Valor 24-h (ug/m3)
Alert	1130	282
Warning	2260	565
Emergency	3000	750

- *PROPUESTA DE NORMA DE CALIDAD PRIMARIA PARA DIÓXIDO DE NITRÓGENO*

En base a los antecedentes que se indican, se presenta para discusión de los Comités Operativo y Ampliado de la norma, la siguiente *Propuesta*. Entre paréntesis se indica el origen de cada elemento propuesto de la norma.

Efectos agudos:
Nivel: 400 ug/m3 (valor indicado en OMS sin incluir factor de incertidumbre)
Intervalo de evaluación: 1-hora (intervalo indicado en la guía de la OMS y en México)
Excedencia de la norma: percentil 99, evaluado en condición anual sobre los máximos registrados diariamente.

Efectos crónicos:
Nivel: 100 ug/m3 (valor vigente en Chile y EE.UU.)
Intervalo de evaluación: Anual (intervalo indicado en la guía de la OMS, intervalo vigente en Chile, la CE y EE.UU.)

Valores que definen las situaciones de emergencia ambiental:
Nivel 1: 1130 ug/m3
Nivel 2: 2260 ug/m3
Nivel 3: 3000 ug/m3. Todos estos niveles evaluados en base horaria.
(propuesta de SGA, basada en los niveles federales norteamericanos).
Además incluir un párrafo indicando que dentro de cada Plan de Descontaminación o Prevención se establezcan condiciones dentro del plan de manejo de episodios críticos, como las indicadas en la regulación federal de EEUU acerca del uso de modelos predictivos, o bien condiciones meteorológicas, otorgando la flexibilidad particular según el desarrollo que tenga localmente para aplicar esta parte de la norma en distintas partes de Chile.

Métodos de medición:
- Quimiluminiscencia;
- Los que se basen el método Modificado de Griess-Saltzmann.

- COMENTARIOS A LA *PROPUESTA* PRESENTADA

La *Propuesta* de norma horaria en forma principal y también la anual, aunque en menor medida, se basan en conocimiento limitado de la situación de monitoreo en el país al no contarse con un porcentaje relevante de población con monitoreo asociado de NO2.

La evidencia de efectos en salud por NO2 es más reducida en términos cuantitativos que para otros contaminantes, teniendo por lo tanto la *Propuesta* un carácter de preventivo respecto a la exposición de la población a este contaminante.

En base a estos antecedentes y que no existe nueva evidencia asociada a la guía presentada por OMS desde 1987, se propone mantener la norma vigente anual, considerando que la fuente original de esta norma (US EPA) no ha cambiado.

Comparando con las normas de EEUU y México, la *Propuesta* resulta más estricta al abordar simultáneamente efectos de corto y largo plazo. En forma individual, los valores son equivalentes por separado, estableciendo México un margen estricto de excedencia (hasta 1 vez por año).

En el caso de la norma de la CE, es difícil establecer una comparación dado el balance conjunto de nivel, la excedencia permitida y el margen de tolerancia que presenta esta norma. No se consideró realizar un ejercicio de comparación con el monitoreo horario existente por la poca representatividad de las ciudades con este tipo de monitoreo.

La *Propuesta* es congruente con lo propuesto por el Estudio de SGA.

Está pendiente la fijación de un plazo para el inicio de la aplicación de la presente norma primaria de dióxido de nitrógeno, pero debe tomarse en consideración que la Región Metropolitana se encuentra en condición de latencia por este contaminante.

/FFE

ANTECEDENTES TECNICOS PARA PROPUESTA NORMA PRIMARIA DE CALIDAD DE AIRE PARA SO2

Resumen

- **Propuesta de Norma Primaria de Calidad de Aire para Anhidrido Sulfuroso, SO2**

En base a los antecedentes presentados, se presenta para discusión de los Comités Operativo y Ampliado de la norma, la siguiente propuesta :

- Norma:
  - 80 ug/Nm3 para un periodo de evaluación de un año.
  - 250 ug/Nm3 para un periodo de evaluación de 24 horas.
  - 1050 ug/Nm3 para un periodo de evaluación de una hora.

- Valores que Definen Situaciones de Emergencia Ambiental:
  - Nivel1: 1965 ug/Nm3
  - Nivel 2: 2620 ug/Nm3
  - Nivel 3: 3930 ug/Nm3

- Métodos de Medición:
  - Pararosanilina
  - Fluorescencia Ultravioleta

1. **Efectos en Salud.**

a) Antecedentes Generales:

El Anhídrido Sulfuroso es un gas irritante cuando es inhalado a altas concentraciones que principalmente afecta la función respiratoria. El grupo más sensible lo constituyen las personas asmáticas o aquellas que tienen un decrecimiento crónico de la función pulmonar.

Los efectos producidos por el contaminante se dividen en aquellos de corto plazo (efectos agudos) y aquellos de largo plazo (efectos crónicos). Al respecto, los estudios mas recientes, se centran en los efectos agudos para periodos cortos de exposición menores a una hora.

b) Antecedentes Internacionales:

Efectos de Corto Plazo (< a una hora)

La Organización Mundial de la Salud OMS (Guidelines for Air Quality, WHO, 1999) señala que la información de efectos agudos proviene de experimentos controlados en cámaras con voluntarios expuestos a SO2 por periodos que van desde unos pocos minutos a una hora. Los efectos observados están asociados a una disminución del volumen medio expiratorio forzado del primer segundo (FEV1), incremento de la resistencia aérea específica (RAW) y síntomas tales como silibancia o falta de aire.

Se señala también, que la respuesta aguda ocurre muy rápidamente después de comenzada la exposición, a los pocos minutos, y que la exposición a un tiempo mayor no incrementa los efectos observados. Además, se señala que existe un amplio rango de sensibilidad a la exposición al SO2, tanto en individuos sanos como en aquellos con asma. La población mas sensible a los efectos producidos por altas concentraciones de SO2 son los asmáticos.

En términos cuantitativos, y basado en los resultados obtenidos mediante estudios controlados con asmáticos expuestos a SO2, la OMS señala que para evitar que se produzcan estos efectos, el nivel de concentración de SO2 no debe exceder 500 ug/Nm3 en un periodo de evaluación de10 minutos.

En relación a periodos mas largos de exposición, por ejemplo de una hora, no hace referencia a un valor determinado, debido a que señala que la exposición a peak agudos de concentración depende de la naturaleza local de las fuentes emisoras, por lo cual un único factor no puede ser aplicado para estimar la relación entre el valor guía recomendado para 10 minutos y un valor para un periodo de una hora.

La EPA (Estudio SGA, EPA Final Desición,Vol 61, Number 100, 1996), en general coincide con los antecedentes señalados por la OMS en cuanto a los efectos observados y la población más sensible a esos efectos. En base a la evaluación de la información mas reciente indica que un porcentaje relativamente pequeño (< 10 al 20 %) de los asmáticos leves y moderados expuesto a un rango de concentración entre 524 ug/m3 y 1310 ug/m3 de SO2, durante un esfuerzo moderado, experimentaron cambios en la función pulmonar que son claramente superiores a los que experimentan normalmente. Más aún, señala que solo individuos excepcionalmente sensibles podrían experimentar cambios en la función pulmonar lo suficientemente graves y/o síntomas respiratorios de una gravedad tal, que se conviertan en un problema en términos de salud y que provoquen la interrupción de las actividades en curso, el uso de medicamentos broncodilatadores y la necesidad de buscar atención médica.

Por el contrario, se espera que un porcentaje considerable (> 20 a 25 %) de individuos asmáticos leves o moderados expuestos entre 1.572 ug/Nm3 y 2.620 ug/Nm3 durante actividad física, sufra cambios en la función respiratoria y agravamiento de los síntomas respiratorios que excedan claramente aquellos que experimentan normalmente.

Señala también, que individuos sanos no se ven afectados por exposiciones agudas a SO2 en niveles inferiores a 5.000 ug/Nm3 (Estudio SGA, 1998)

En el documento base (Position Paper, Final 1997) utilizado para la revisión de la directiva de la Unión Europea (EU) se hace mención a la reevaluación efectuada por la OMS (WHO – European Center for Environment and Health-Update and Revisiom of WHO Air Quality Guidelines for Europe-Volume 6 Classical-1996) señalándose la dificultad de dibujar un cuadro consistente de relaciones exposición-respuesta y que la mínima concentración a la que se evidencian cambios en la función pulmonar en individuos asmáticos expuestos a SO2 durante ejercicio, es del orden de 1144 ug/Nm3, aunque se han encontrado efectos a niveles inferiores.

En el mismo documento se hace referencia a los efectos agudos observados para distintos niveles de concentración de SO2 (anexo 1, tabla 1). En este se puede apreciar la diferente sensibilidad, en cuanto a los efectos observados a la exposición al SO2, entre una persona normal y una asmática. Por ejemplo, mientras en una persona asmática sometida a ejercicio se evidencia algún tipo de efecto a partir de un nivel de concentración de 1.148 ug/Nm3, en una persona normal los efectos comienzan a percibirse recién a partir de un nivel de 2.840 ug/Nm3.

Efectos Sobre 24 Horas.

La OMS (Guidelines for Air Quality WHO 1999) señala que los efectos observados en la salud de la población para periodos exposición de 24 horas, derivan principalmente de estudios epidemiológicos sobre los cambios diarios en, morbilidad, mortalidad o cambios en la función pulmonar, en los cuales se ha tenido en consideración los efectos del SO2, el material particulado en suspención y otros contaminantes.

Los resultados de estos estudios con grupos sensibles indican que a partir de un nivel de concentración de 250 ug/Nm3 y en presencia de material particulado en suspención, existe un aumento en los síntomas de la población expuesta..

La OMS basado en el nivel mas bajo al cual se han observado efectos sobre la salud, recomienda aplicando un factor de incertidumbre de 2, un nivel de 125 ug/Nm3 para un periodo de 24.

Sin embargo, señala también que estudios mas recientes indican que efectos con una importancia significativa en la salud de la población han sido observados, aún, a niveles mas bajo de exposición, pero que todavía existe incertidumbre respecto si el SO2 es el contaminante responsable de los efectos observados o si es un indicador de los efectos que pudiera causar otro contaminante tal como el material particulado en suspensión con diámetro inferior a 10 um o 2,5 um., o alguna otra sustancia correlacionada.

La UE en su última revisión ha acogido el valor recomendado por la OMS, no así Estados Unidos (Estudio SGA, Final Decisión; Vol 61; number 100, 1996), quien ha mantenido un valor de 350 ug/Nm3 por considerar que este resguarda adecuadamente la salud de la población.

Efectos de Largo Plazo (anual)

La OMS (Guidelines for Air Quality WHO 1999), en base a los antecedentes de los resultados aportados por estudios, señala que el valor mas bajo al cual se han observado efectos sobre la salud de la población cuando se estaba en presencia de material particulado en suspención, corresponde a un nivel de 100 ug/Nm3 como promedio anual. Sin embargo y sin especificar un nivel, señala que estudios mas recientes relacionados con fuentes emisoras industriales de SO2 o con cambios en las mezclas de contaminantes urbanos, han mostrado efectos adversos a niveles inferiores.

Al igual que para un periodo de 24 horas y aplicando un factor de incertidumbre de 2, la OMS recomienda un valor guía de 50 ug/Nm3 para un periodo anual, manteniendo de esta manera el valor recomendado en 1987.

Estados Unidos (Estudio SGA 1998, EPA Final Desición,Vol61 Number 100, 1996), basado en los datos científicos que sirvieron como respaldo cualitativo a la inquietud de que altas exposiciones al SO2 podrían causar potenciales efectos no observables en estudios a corto plazo mantiene la norma actualmente vigente de 80 ug/Nm3. Si bien no existe un solo estudio que proporcione conclusiones cuantitativas claras, la EPA descubrió que los datos epidemiológicos indicaban la posibilidad de efectos sobre la salud como resultado de la exposición permanente al SO2 en áreas con promedios a largo plazo que solo superan levemente el estándar anual. Sin embargo, los datos no son claros en relación a si máximas repetidas de SO2 a corto plazo u de otros contaminantes podrían ser tanto o mas responsable de dichos efectos.

Si bien la información disponible indica que el riesgo de un aumento en los efectos agudos y crónicos por transgredir el estándar anual son pequeños, la EPA ha decidido mantener el estándar anual como una opción de política pública prudente.

La UE, en su Directiva (1999/30/CE) no establece un valor de norma anual anual para SO2.

c) **Antecedentes Nacionales**:

Los estudios mas relevantes relacionados al SO2 son los realizados por Sanhueza, Belmar, Ilabaca, Sanchez y Oyarzún.

Los estudios muestran que la mortalidad no es estadísticamente significativa, es decir, no comprueban este efecto asociado al contaminante Los daños a la salud identificados y asociados a exposiciones al SO2 corresponden a un aumento de tos y un efecto en el flujo expiratorio forzado (FEV). No se encontró evidencia de efectos sinérgicos con otros contaminantes. En general en ninguno de los modelos de mortalidad el SO2 resulto estadísticamente significativo, en particular cuando el modelo incluía el PM10.

2. Normativa Internacional:

Las principales regulaciones a nivel internacional y por las cuales se guían la mayoría de los países son las establecidas por Estados Unidos (Code Federal Regulatión Part 50, EPA), la Unión Europea (Directiva 1999/30/Ce) y los valores guías recomendados por la Organización Mundial de la Salud (Guidelines for Air Quality, WHO, 1999).

Al respecto, como se menciono en el punto anterior, la OMS (Guidelines for Air Quality, WHO, 1999) basada en los niveles mínimos a los cuales se observan efectos sobre la salud en la población mas sensible, recomienda un nivel de 500 ug/Nm3 para un periodo de 10 minutos, 125 ug/Nm3 para un periodo de 24 horas y 50 ug/Nm3 para un periodo de un año.

La Unión Europea, recientemente revisó su normativa, recogiendo el nivel recomendado por la OMS para un periodo de 24 horas, pero otorgando plazo para su cumplimiento. Sin embargo, no recoge la recomendación para un periodo de 10 minutos, debido a las dificultades prácticas de gestión y evaluación que ello representa.

Sin embargo, reconociendo los efectos agudos de corto plazo, incorpora en su Directiva un estándar de 350 ug/Nm para un periodo de una hora. La Unión Europea no establece un estándar para un periodo de un año.

Estados Unidos posee estándares a nivel Federal para un periodo de un año (80 ug/Nm3) y para un periodo de 24 horas (365 ug/Nm3) (Code Federal Regulation, part 50).

La EPA, según lo estipula la Ley de Control de la Contaminación Atmosférica debe revisar cada cinco años los criterios científicos y médicos en que se basan los NAAQS y en caso necesario, modificar los estándares. En 1996 (EPA Final Decisión, Vol 61, Number 100) la EPA concluyó que los niveles de norma actualmente vigentes proporcionaban una adecuada protección a la salud de la población y que no era necesario incorporar un estándar para un periodo de mas corto plazo (una hora). Esto último, fundado en que los efectos a exposiciones agudas en periodos de 5 - 10 minutos, no constituyen un problema de salud pública a nivel nacional.

Estos efectos (Estudio SGA, 1998) se han cuantificado en revisiones anteriores y se ha encontrado un umbral alrededor de 1.300 ug/Nm3, pero bajo el cual aún se detectan efectos en asmáticos más sensibles.

El CASAC (The Clean Air Scientific Advisory Committe, EPA Final Decisión, Vol 61 number 100) concuerda con lo señalado por la EPA.

Es importante señalar que en Estados Unidos, si bien los estándares (NAAQS) son Federales, cada Estado puede independientemente establecer un estándar mas estricto si lo estima conveniente. Este es el caso por ejemplo, de los Estados de Washington y California, donde además de contar con estándares más estrictos para periodos de 24 horas y un año, han incorporado un estándar para un periodo de una hora (Anexo 1, tabla 2), 1050 ug/Nm3 y 655 ug/Nm3 respectivamente.

De la información disponible, el nivel de 1050 ug/Nm3 corresponde, a nivel internacional, al Estándar más alto para un periodo de 1 hora, a excepción de Argentina que posee un nivel de 2620 ug/Nm3 y del cual no se tienen los antecedentes que fundan dicho valor.

Chile posee los mismos niveles de norma que Estados Unidos, al igual que la mayoría de los países de América Latina, con excepción de Argentina.

En lo que respecta a la excedencia de los estándares ambientales (Anexo 1, tabla 2b), Estados Unidos establece que el estándar para un periodo de 24 horas no se debe sobrepasar en mas de una oportunidad durante un año. Sin embargo, la Unión Europea (UE) basada en un criterio de representatividad de las mediciones, permite que el estándar para el mismo periodo de evaluación, se pueda superar en tres oportunidades durante un año. El estándar establecido por la Unión Europea es mucho mas estricto que el de Estados Unidos a nivel Federal, 125ug/Nm3 y 365 ug/Nm3 respectivamente.

En relación al estándar para un periodo de una hora, la UE permite que este pueda ser sobrepasado en un máximo de 24 oportunidades.

En el anexo 1, tablas 2 y 2b se presenta un resumen con información de normativa internacional para SO2 y las excedencias permitidas para la norma.

3. Monitoreo de Calidad de Aire para SO2

En el país se cuenta con gran cantidad de información de monitoreo de calidad de aire para SO2, destacándose la red MACAM en la Región Metropolitana, las redes asociadas a las Fundiciones de Cu, las redes incorporadas como resultados de los proyectos aprobados en el marco del Sistema de Evaluación de Impacto Ambiental y los nuevos antecedentes que se estan generando a nivel regional , a través del proyecto COSUDE (Proyecto 5 ciudades: Iquique, Viña, Valparaiso, Rancagua y Temuco).

En base a la información disponible, la cantidad de población asociada a localidades donde existe algún tipo de monitoreo de SO2 asciende a más de 8,3 millones de habitantes (según las cifras estimadas por el Instituto Nacional de Estadísticas), la que corresponde a un 54% de la población total del país.

Los resultados de monitoreo para el año 1999 indican que la norma de 80 ug/Nm3 para el periodo de un año, se cumple en la mayoría de las zonas urbanas del país, a excepción de Talcahuano donde la norma ha sido superada por un estrecho margen (81 ug/Nm3). En las áreas circundantes a la fundiciones de Cu, la norma se superó en las localidades de Chuquicamata, II Región (153 ug/Nm3) y Coya Club de Campo, VI Región (203 ug/Nm3). No se hace referencia al caso de la Fundición de Potrerillos, debido a que actualmente en dicha localidad no existe población residente, y las normas primarias de calidad de aire, de acuerdo a lo establecido en el D.S N°94/95 del Ministerio Secretaría General de la Presidencia, se deben verificar donde existen asentamientos humanos.

En relación a la norma diaria, esta se superó en las mismas localidades señaladas anteriormente. La norma se superó en mas de 100 ocasiones en la localidad de Chuquicamata, 74 veces en Coya Club de Campo y en 2 oportunidades en la ciudad de Talcahuano.

En el caso de Coya Club de Campo, es importante mencionar que este lugar corresponde a un centro recreacional en donde existe muy poca población expuesta y por periodos de tiempo intermitentes.

Teniendo en consideración los antecedentes en salud señalados en el punto 1 anterior, un nivel de 250 ug/Nm3 para un periodo de 24 horas se superaría principalmente en las localidades cercanas a las Fundiciones de Cu y en Talcahuano. Durante el año1999, este nivel se supero 194 veces en la localidad de Chuquicamata, 3 veces en Paipote, 3 veces en Ventanas, 101 veces en Coya Club de Campo y 9 veces en Talcahuano.

Si se considera un escenario de 300 ug/Nm3 para el mismo periodo de evaluación, en general la norma se sigue sobrepasando en las mismas localidades, pero en un número inferior de veces.

En el anexo 1, tabla 3 se presenta el escenario de cumplimiento de la normativa para SO2 actualmente vigente en el país y la situación para un escenario de 250 ug/Nm3 y 300 ug/Nm3.

En el anexo 2 se presenta para el año 1999, la distribución anual de los niveles de concentración media diaria para distintas localidades del país.

4 Inventario de Emisiones

En base a la información disponible las principales fuentes emisoras de SO2 corresponden a las fundiciones de cobre que en conjunto en el año 1999 emitieron una cantidad del orden de 1.000.000 de toneladas. Si se compara esta cifra respecto de la emisión en el año 1995 (del orden de 1.700.000 ton/año) se tiene que la emisión se ha reducido aproximadamente en un 60%, producto de la aplicación de Planes de Descontaminación.

Tomando como base los cronogramas de reducción de emisiones establecidos en los Planes de Descontaminación vigentes o en reformulación como es el caso de Chuquicamata, se proyecta para el año 2003 una emisión del orden de 460.000 toneladas al año, que respecto de la situación base 1999 corresponde una reducción del orden del 54 %.

A nivel de la Región Metropolitana, el inventario de emisiones para SO2, base 1997 (Plan de Descontaminación Región Metropolitana), estima una emisión total anual del orden de 22.000 toneladas. Las metas de reducción establecidas en el Plan de Descontaminación establecen una emisión del orden de 16.000 toneladas para el año 2005 y 6.000 toneladas para el año 2011.

Información mas detallada respecto de las emisiones de las fuentes mas importantes en términos de la magnitud de su emisión se presenta en el anexo 4.

5 Metodologías de Medición

A nivel Internacional los métodos de medición para medir los niveles de concentración de calidad de aire para SO2 se encuentran bastante estandarizados.

Estados Unidos (EPA, Code Federal Regulation, part 50) establece como método de referencia el de la Pararosanilina o metodología equivalente. Como método equivalente se utiliza el de la Fluorescencia Ultravioleta.

Por su parte la Unión Europea en su última directiva (Directiva 1999/CE) establece como método de referencia el de la Fluorescencia Ultravioleta o metodología equivalente.

En Chile, a la fecha, se utilizan ambos métodos, el de la Pararosanilina como método de referencia y el de Fluorescencia Ultravioleta como método equivalente.

La norma ISO 6467 establece el método de la Pararosanilina y la norma ISO 10498 establece el método de la Fluorescencia Ultravioleta.

5. Valores que Definen Situaciones de Emergencia Ambiental

<u>Chile:</u>

El reglamento mediante el cual se establece el procedimiento para la dictación de normas de calidad ambiental, señala que una norma primaria de calidad de aire debe contener los valores críticos que definen situaciones de emergencia ambiental (D.S Nº 93/95 del Ministerio Secretaría General de la Presidencia).

La normativa vigente (Res. 1215/78 del Ministerio de Salud) que establece los valores de norma para SO2, no incorpora la definición de valores críticos de contaminación. Estos se encuentran definidos en el D.S Nº 185/91 del Ministerio de Minería.

Los niveles establecidos y su clasificación son las siguientes:

- Nivel de alerta, 1.965 ug/Nm3 en 1 hora.
- Nivel de advertencia, 2.620 ug/Nm3 en 1 hora, y
- Nivel de Emergencia, 3.930 ug/Nm3 en 1 hora.

En base a la legislación vigente, la aplicación de medidas en cada uno de estos niveles, esta asociada a planes operacionales para el control de los episodios críticos de contaminación insertos dentro de Planes de Descontaminación.

Las localidades en la cuales se encuentran los valores horarios más altos (anexo 1, tabla 4) y en donde se sobrepasan los niveles señalados anteriormente, son en general, aquellas circundantes a las Fundiciones de Cu. En algunas localidades se han alcanzado niveles por sobre 13.000 ug/Nm3 para un periodo de una hora (base 1999).

En el anexo 3 se presentan los niveles máximos horarios para SO2 en distintas localidades del país.

Si se analizan los niveles horarios de SO2 para la información de monitoreo disponible, se encuentra por ejemplo, que valores sobre 1000 ug/Nm3, se superan principalmente en localidades circundantes a Fundiciones de Cu y Talcahuano (anexo 1, tabla 4). A este nivel de concentración y considerando que para un periodo de 10 minutos la concentración es superior, podrían observarse efectos agudos en los grupos de población mas sensible (asmáticos) si se compara con el valor guía recomendado por la OMS (500 ug/Nm3 en 10 minutos).

<u>Otros Países</u>:

En general se definen valores críticos a nivel horario y como promedio de 24 horas (anexo 1, tablas 5 y 6). Sin embargo cabe destacar, que independientemente que un país establezca valores críticos para periodos de una hora o de 24 horas, el país cuenta con una norma de calidad para el mismo periodo.

En Estados Unidos (EPA, Code Federal Regulation, part 51, appendix L) la ocurrencia de episodios críticos de contaminación para SO2 y otros contaminantes se regula a través de Planes de Contingencia Estatales que tienen como objetivo evitar que se llegue a un nivel de concentración determinado definido como nivel significativo de daño, que en el caso del SO2 es de 2.620 ug/Nm3 como promedio de 24 horas.

En este sentido, en las regiones en las cuales se alcance un nivel superior a 455 ug/Nm3 para un periodo de 24 horas y 100ug/Nm3 para un periodo de un año (clasificadas como de prioridad 1) se debe elaborar un Plan de Contingencia que evite alcanzar el nivel de 2.620 ug/Nm3. A nivel Federal se recomiendan valores críticos definidos para periodos de 24 horas y que corresponden a 800, 1600 y 2100 ug/Nm3 (anexo 1 tabla 5). Un aspecto importante a considerar es que como criterio para declarar la existencia de un episodio no solo se toma en consideración que el valor se haya superado, sino que además debe existir un pronóstico de condiciones meteorológicas adversas para el día siguiente.

La Unión Europea en su última Directiva (Directiva 1999/CE) establece un umbral de alerta para SO2 de 500 ug/Nm3 para un periodo de una hora y declara un episodio crítico cuando este valor se ha superado consecutivamente durante tres horas.

Países como Japón y Francia establecen valores críticios para periodos de una hora, pero inferiores a los definidos en Chile (anexo 1 tabla 6).

ANEXO 1

Tabla 1: Niveles de efectos agudos SO2.
Tabla 2: Normas internacionales y excedencia de norma.
Tabla 3: Monitoreo Calidad de Aire.
Tabla 4: Máximos niveles horarios.
Tablas 5 y 6: Niveles que definen situaciones de emergencia ambiental.

Tabla 1
Efectos a Exposiciones Agudas de SO_2 por Tipo de Población, Efectos y Nivel de Exposición

Valor Ug/Nm3	Población Afectada	Efectos Asociados	Tipo de Estudio
572	Asmáticos (ejercicio pesado)	Algunos síntomas No se evidencia cambio en la función pulmonar	Cámara
572	Sujeto Normal (ejercicio pesado)	No se evidencia cambió ni respuesta	
1148	Asmáticos (ejercicio pesado)	Pequeños cambios en la función pulmonar	
1148	Sujeto Normal (ejercicio pesado)	No se evidencia cambio ni respuesta	
1430	Asmáticos Reposo	No se evidencia cambio ni respuesta	
2860	Sujeto Normal	Pequeño incremento de RAW	

Tabla 2
Normativa Internacional para SO2

Pais	SO2 (ug/Nm3)						
	10 min	15 min	30 min	1hr	3 hr	24 hr	1 año
WHO (1987)				350		125	50
WHO (1999)	500					125	50
Unión Europea				350		125	
Unión Europea (1989)						250 -350	80 - 120
Alemania							
Inglaterra		266		350		125	20
Austria			200			120	
Francia							120
Italia						125	250
Portugal							250
Suecia				200		100	50
Europa							
Croacia				350		250	
Estonia				500		125	20
Finlandia				250		80	
Lituania				500		50	
Macedonia				500		150	
Slovakia				500		150	60
Suiza				100		100	30
América del Norte							
EPA (USA) 1997						365	80
Georgia					1310	365	80
Florida						260	53
Washington				1050		260	53
California				655		105	
Canada				450 (deseable) 900 (aceptable)		150 (deseable) 300 (aceptable)	30 (deseable) 60 (aceptable)
América Latina							
Chile						365	80
México						341	79
Argentina				2620			
Bolivia						365	80
Brasil						365	80
Colombia					1500	400	100
Costa Rica					1500	365	80
Ecuador						400	80
Venezuela						365	80
Asia							
China							60
India						80	60
Israel			500			280	60
Japón				260		205	
Libano				75			
Tailandia				788			
Oceanía							
Australia							
Victoria				525			
New S.Wales				525		210	53
New Zeland	500			350		125	60
Egipto				350		150	60
N°	2	1	2	21	3	33	28
Máx	500	266	500	2620	1500	400	250
Mín	500	266	200	75	1310	50	20
Promedio	500	266	350	531	1437	216	78

Fuente: Javier Garcia

Tabla 2A
Normas y Excedencias Permitidas para SO2

País	Valor límite ($\mu g/m^3$)[1]	Tiempo promedio de muestreo	Frecuencia de excedencia permitida
Argentina	2620[2]	1 hora	El valor límite no podrá superarse en ninguna ocasión
	780[2]	8 horas	
	70[3]	1 mes	
Belice[4,5]	30 (I), 80 (II), 120 (III)		El valor límite no podrá superarse en ninguna ocasión
Bolivia	365	24 horas	El valor límite no podrá superarse en ninguna ocasión
	80[6]	1 año	
Brasil	365	24 horas	El valor límite no podrá superarse en más de una ocasión por año
	80[6]	1 año	El valor límite no podrá superarse en ninguna ocasión
Chile	365	24 horas	El valor límite no podrá superarse en más de una ocasión por año
	80[6]	1 año	El valor límite no podrá superarse en ninguna ocasión
Colombia	1500	3 horas	El valor límite no podrá superarse en más de una ocasión por año
	400	24 horas	
	100[6]	1 año	El valor límite no podrá superarse en ninguna ocasión
Costa Rica	1500	3 horas	El valor límite no podrá superarse en más de una ocasión por año
	365	24 horas	
	80[6]	1 año	El valor límite no podrá superarse en ninguna ocasión
Cuba			
Ecuador	400	24 horas	El valor límite no podrá superarse en ninguna ocasión
	80[6]	1 año	
Guatemala			
Jamaica			
México	341	24 horas	El valor límite no podrá superarse en más de una ocasión por año
	79[6]	1 año	El valor límite no podrá superarse en ninguna ocasión
Venezuela	80 – 365	24 horas	El valor 80 $\mu g/m^3$ no podrá superarse en más de 50% de las mediciones, el valor 200 $\mu g/m^3$ no podrá superarse en más de 5% de las mediciones, el valor 250 $\mu g/m^3$ no podrá superarse en más de 2% de las mediciones y el valor 365 $\mu g/m^3$ no podrá superarse en más de 0.5% de las mediciones por año.
Perú			
Canadá[7]	450 (deseable) 900 (aceptable)	1 hora	

	150 (deseable) 300 (aceptable) 800 (tolerable)	24 horas	
	30[6] (deseable) 60[6] (aceptable)	1 año	
China[4]	150 (I), 500 (II), 700 (III)	1 hora	El valor límite no podrá superarse en ninguna ocasión
	50 (I), 150 (II), 250 (III)	24 horas	
	20 (I), 60 (II), 100 (III)[6]	1 año	
Estados Unidos	365	24 horas	El valor límite no podrá superarse en más de una ocasión por año
	80[6]	1 año	El valor límite no podrá superarse en ninguna ocasión
Japón	260	1 hora	El valor límite no podrá superarse en ninguna ocasión
	110	24 horas	
Unión Europea	350	1 hora	El valor límite no podrá superarse en más de 24 ocasiones por año
	125	24 horas	El valor límite no podrá superarse en más de 3 ocasiones por año

1 Las concentraciones de los contaminantes se calculan para condiciones de 1 atmósfera y 298 K.
2 Valores de la norma son aproximados: 1ppm (1 hora) y 0,3 ppm (8 horas)
3 Promedio aritmético mensual
4 (I) áreas sensibles de protección especial; (II) áreas urbanas y rurales típicas y (III) áreas industriales especiales.
5 El tiempo promedio de muestreo no esta estipulado en la norma
6 Promedio aritmético anual
7 El nivel máximo deseable define una meta a largo plazo y provee una base para las políticas de prevención del deterioro de la calidad del aire en áreas no contaminadas. El nivel máximo aceptable intenta proveer una adecuada protección contra los efectos adversos en humanos, animales, vegetación, suelos, agua, materiales y visibilidad. El nivel máximo tolerable indica concentraciones de contaminantes por encima de las cuales se deben tomar medidas inmediatas para proteger la salud de la población en general.

Fuente:Doc. En elaboración, Marcelo Cox

000795

Tabla 3
Monitoreo Calidad de Aire para SO2
Año 1999

Región	Localidad	Estación	Promedio Anual ug/Nm3 Norma: 80 ug/Nm3	Número de veces sobre norma diaria 365 ug/Nm3	Escenario Número veces sobre 300 ug/Nm3	Escenario Número veces sobre 250 ug/Nm3	Concentración Máxima Diaria
I	Iquique(*)	15 puntos.	Pom. Máx : 12				
II	Chuquicamata	A. Huasi	**145**	**33**	**46**	**60**	**1003**
		J. Bradford	**153**	**37**	**49**	**71**	**1093**
		S. José	**146**	**27**	**51**	**63**	**960**
	Calama	V. Ayquina	4	0	0	0	73
		V. Caspana	2	0	0	0	31
	Tocopilla	Escuela E.10	–	0	0	0	95
		Comisería	25	0	0	0	122
	Antofagasta	P. Coviefi	2	0	0	0	46
		La Negra	22	0	0	0	152
III	Copiapó	Copiapó	12	0	0	0	100
	S. Fernando	S. Fernando	19	0	0	0	146
	Paipote	Paipote	52	**2**	**3**	**2**	**560**
	T. Amarilla	T. Amarilla	26	0	0	0	162
	Salvador	E. Cine Salva	11	0	0	0	126
	Huasco	E. Bomberos	49	0	0	0	208
	Vallenar	E. Ramirez	6	0	0	0	23

Tabla 3
Monitoreo Calidad de Aire para SO2
Año 1999

Región	Localidad	Estación	Promedio Anual ug/Nm3 Norma: 80 ug/Nm3	Número de veces sobre norma diaria 365 ug/Nm3	Escenario Número veces sobre 300 ug/Nm3	250 ug/Nm3	Concentración Máxima Diaria
V	Viña (*)	15 puntos	Prom. Máx: 45				
	Valparaiso (*)	15 puntos	Prom. Máx: 40				
	Ventanas	La Greda	25	0	0	**1**	**283**
		Puchuncavi	35	0	0	0	152
		L. Maitenes	52	**1**	**1**	**2**	**424**
		V. Alegre	20	0	0	0	139
	Chagres	Sta. Margarita	63	0	0	0	180
		Lo Campo	32	0	0	0	106
		Catemu	15	0	0	0	55
		Romeral	21	0	0	0	66
	Quillota	Bombero	11	0	0	0	58
		S.Pedro	43	0	0	0	83
		INP		0	0	0	46
		Limache		0	0	0	38
		Cajón S.Pedro		0	0	0	17
VI	Coya	Coya Pob.	42	**1**	**2**	**4**	**369**
	Coya Club	Club de Camp	**203**	**74**	**89**	**101**	**1997**
	Machali	Machali					
	Rancagua (*)	15 puntos	Prom. Máx: 40				
	El Guindal (*)		**100**				
VIII	Talcahuano	S. Vicente	**81**	**2**	**8**	**9**	**518**
		Hualpencillo	67	0	1	21	**314**
		S. Vicente (T.	Prom. Máx: 170				
IX							
	Temuco (*)	16 puntos	Pom. Máx: 21				
RM	Santiago	Seminario					
		La Paz					
		La Florida					
		Las Condes					
		P O'Higgins					
		Pudahuel					
		Cerrillos					
		El Bosque					

Tabla 4
Valores Máximos Horarios SO2
Año 1999

Localidad	Año		
	1997	1998	1999
Chuquicamata			13454
Calama			911
Tocopilla			550
Antofagasta			682
Paipote			7520
Copiapó			855
Huasco			780
Chagres		946	711
Quillota		232	344
Ventanas	10199	6977	4883
Caletones	6166	7201	4673
Talcahuano		1148	1315
R. Metropolitana		629	695

Tabla 5
Valores Críticos para SO2
USA - UE

País	Clasificación	Concentración ug/Nm3			
		1 hora	2 horas	3 horas	24 horas
Estados (1) Unidos	Alerta				800
	Advertencia				1600
	Emergencia				2100
UE	Alerta			500 durante 3 hrs.	

(1) Recomendación Federal a los Estados que deben implementar Plan de Contingencia

Tabla 6
Valores Críticos SO2
Otros Países

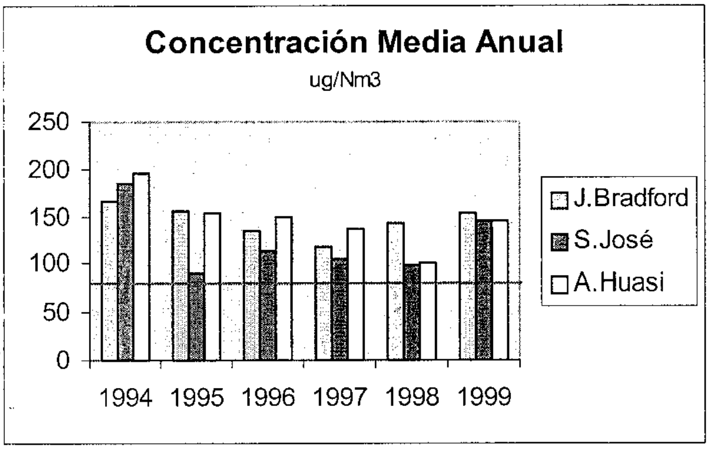
País	Clasificación	Concentración ug/Nm3			
		1 hora	2 horas	3 horas	24 horas
México	Fase 1 Prog. Contingencia Faes 2 Prog. Contingencia				1050 1700
Japón	Aviso Alerta Emergencia	1300	 1300 durante 2 hrs. 1820 durante 2 hrs.	 1300 durante 3 hrs.	
Francia	Aviso Alerta	300 600			
Chile	Alerta Advertencia Emergencia	1965 2620 3930			

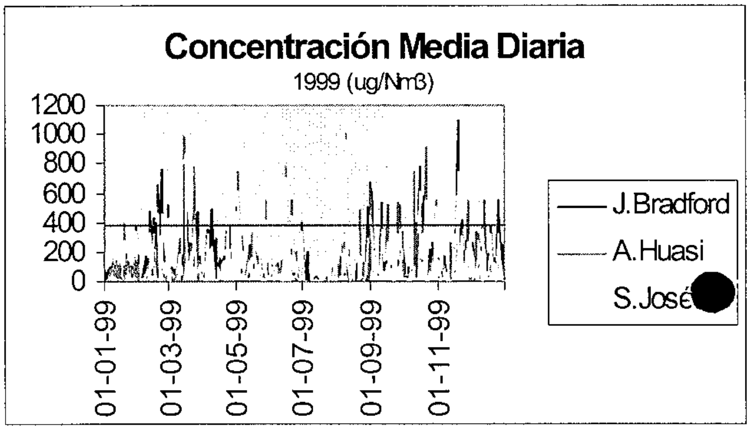
ANEXO 2

CONCENTRACIONES ANUALES Y DIARIAS EN LOCALIDADES CIRCUNDANTES A FUNDICIONES DE COBRE Y TALCAHUANO

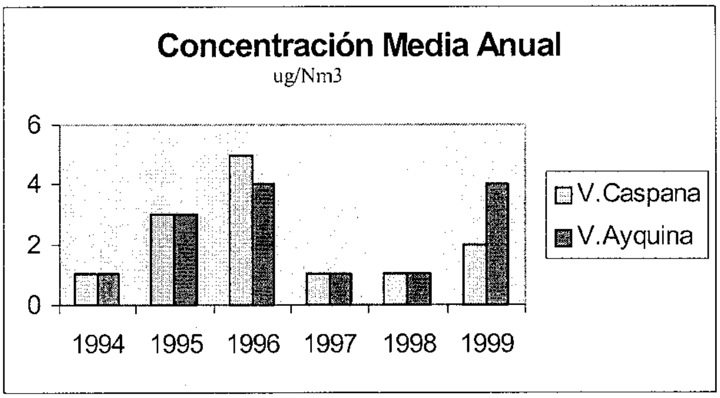
FIGURA 1: CONCENTRACIONES ANUALES Y DIARIAS PARA SO2 AÑO 1999

CHUQUICAMATA





CALAMA



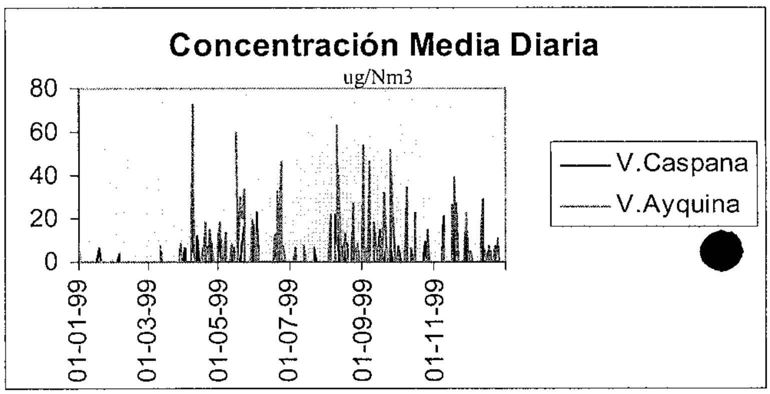
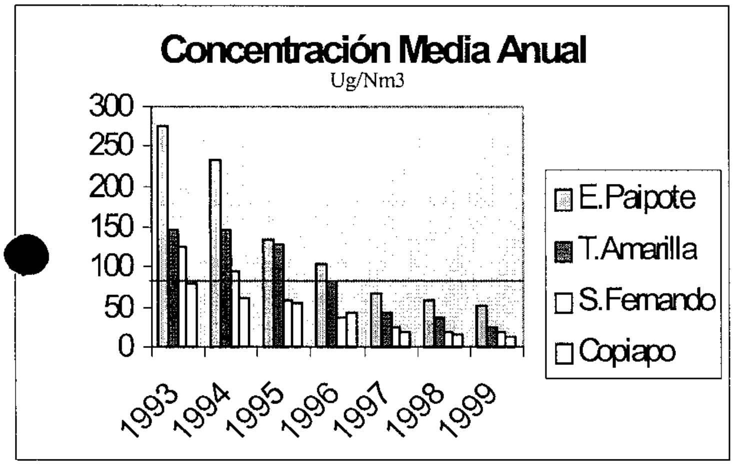
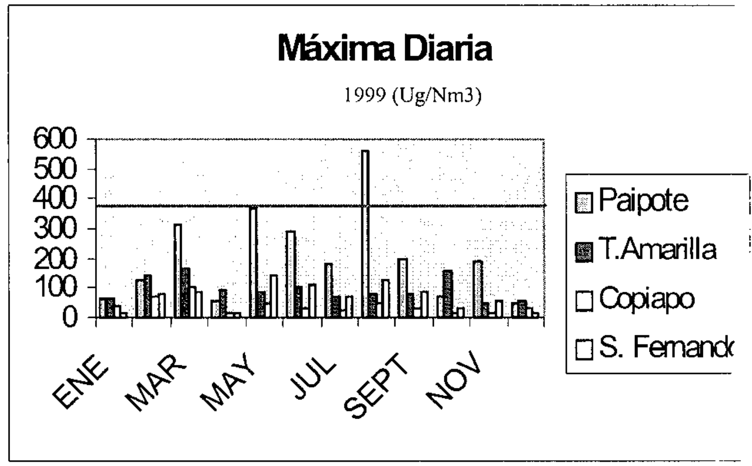


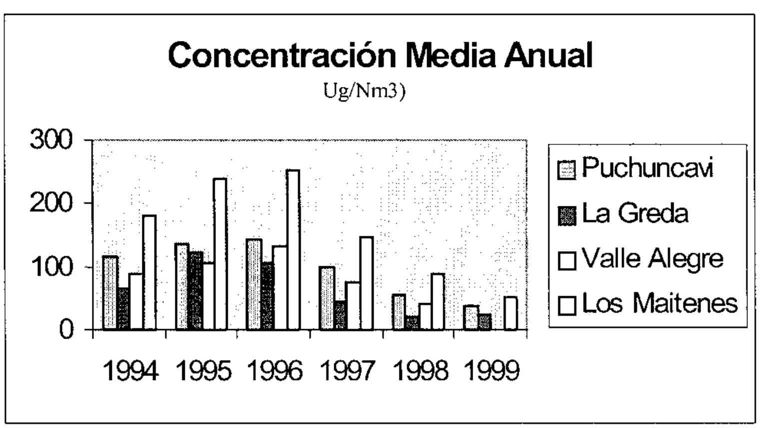
FIGURA 2: CONCENTRACIONES ANUALES Y DIARIAS PARA SO2 AÑO 1999 (PAIPOTE, VENTANAS)

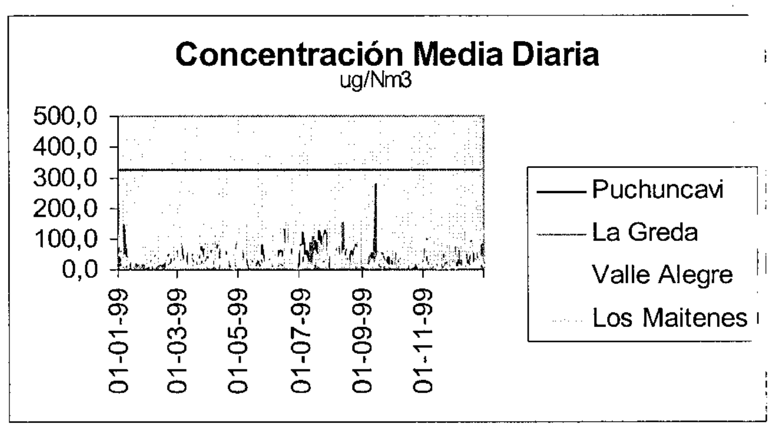
PAIPOTE





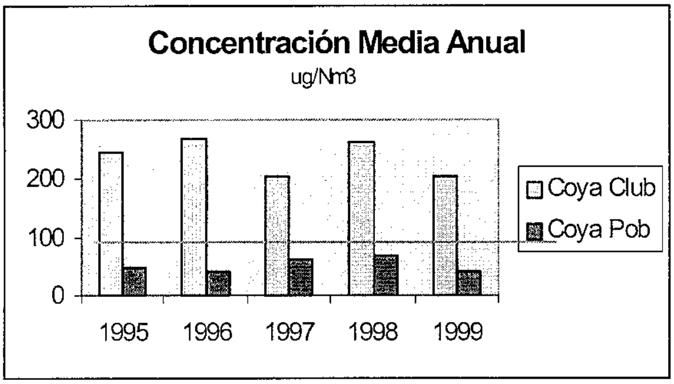
VENTANAS

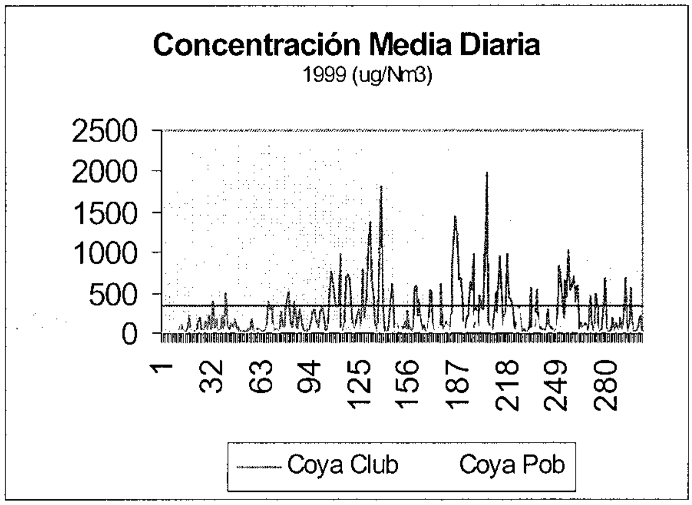




FIOGURA 3: CONCENTRACIONES ANUALES Y DIARIAS PARA SO2, AÑO 1999 (CALETONES)

CALETONES





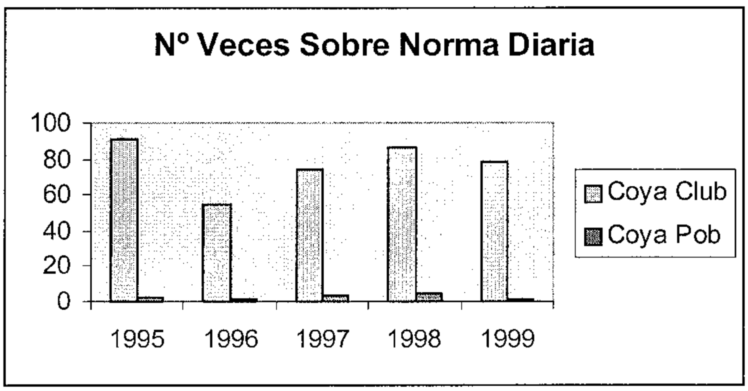
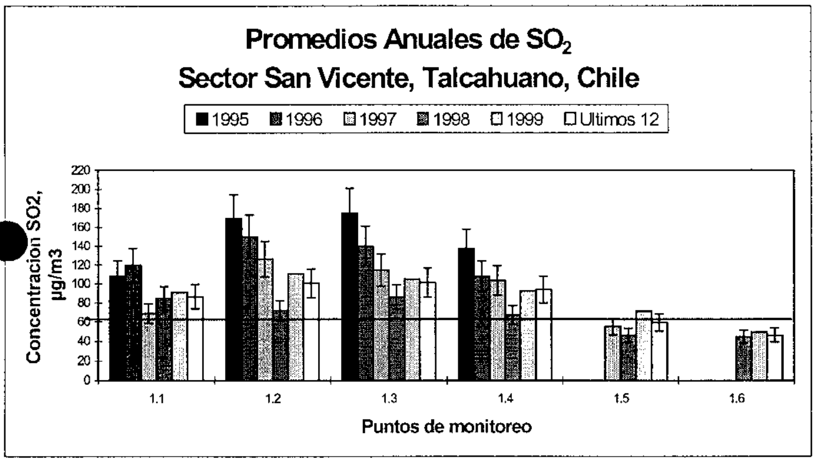
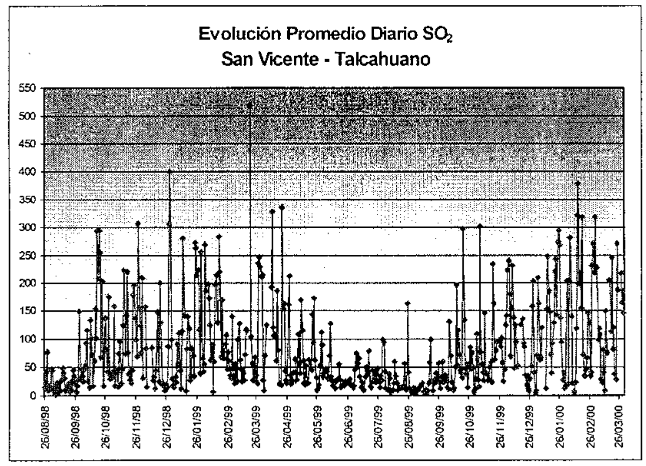
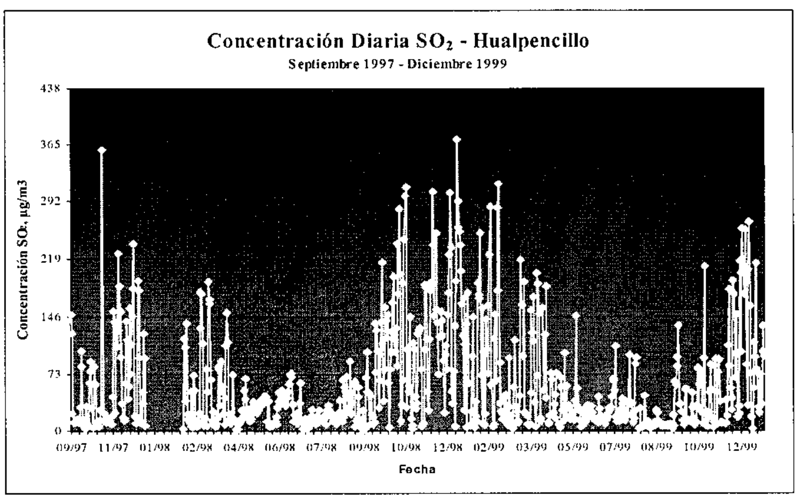


FIGURA 4: CONCENTRACIONES ANUALES Y DIARIAS SO2 AÑO 1999 (TALCAHUANO)

TALCAHUANO





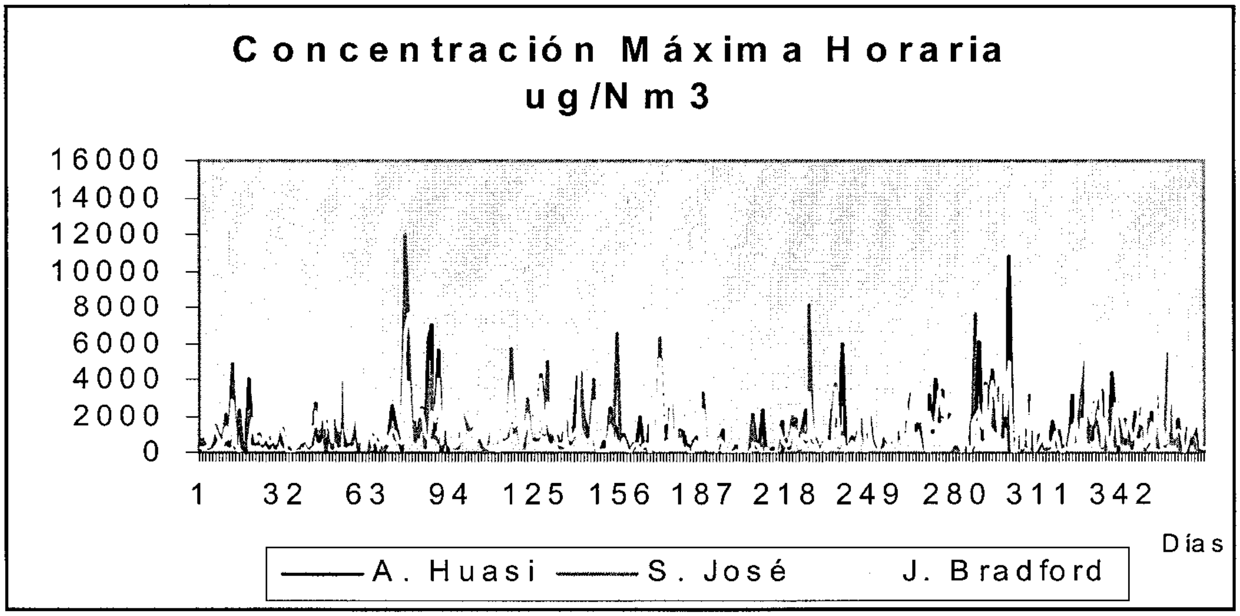


ANEXO 3

CONCENTRACIONES MAXIMAS HORARIAS EN DISTINTAL LOCALODADES
DEL PAIS

FIGURA1: CONCENTRACIONES MAXIMAS HORARIAS, SO2, AÑO 1999 (CHUQUICAMATA-CALAMA)

CHUQUICAMATA



CALAMA

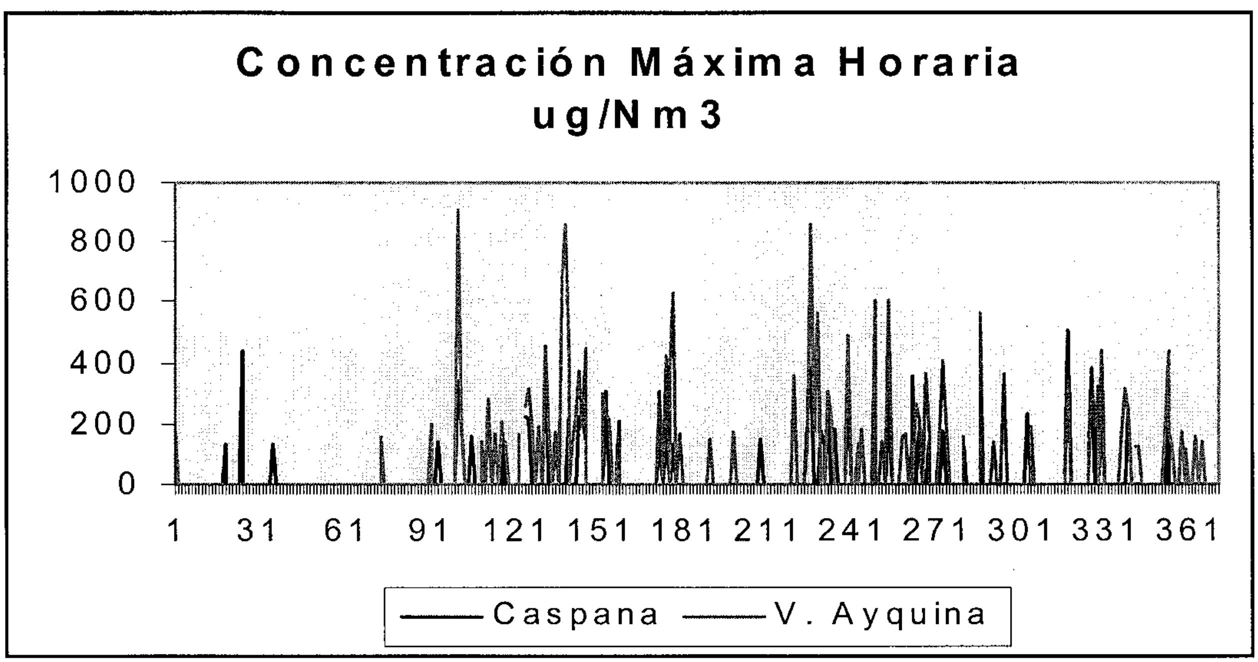
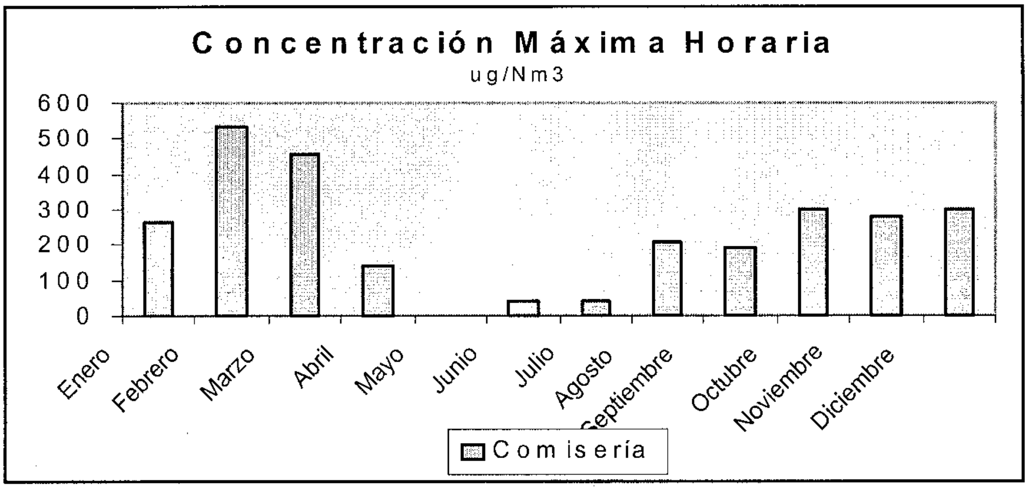
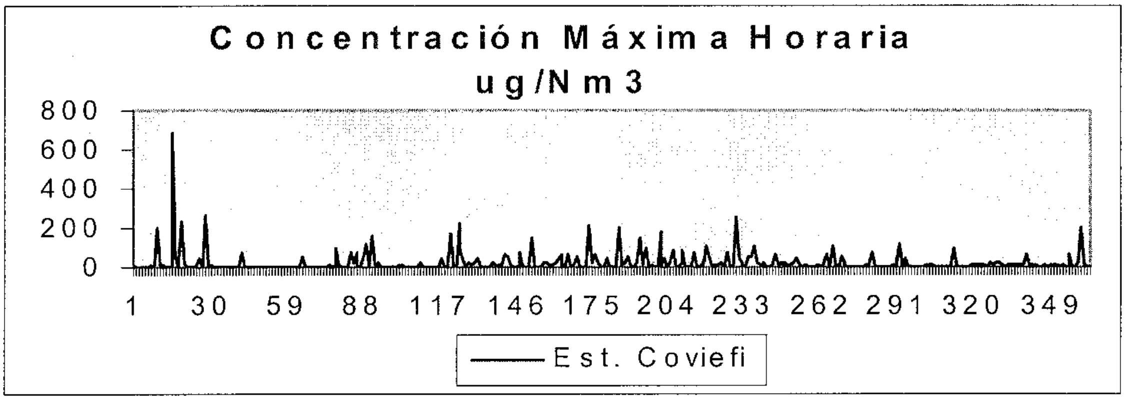


FIGURA 2: CONCANTRACIONES MAXIMA HORARIAS SO2, AÑO 1999 (TOCOPILLA-ANTOFAGASTA)

TOCOPILLA



ANTOFAGASTA



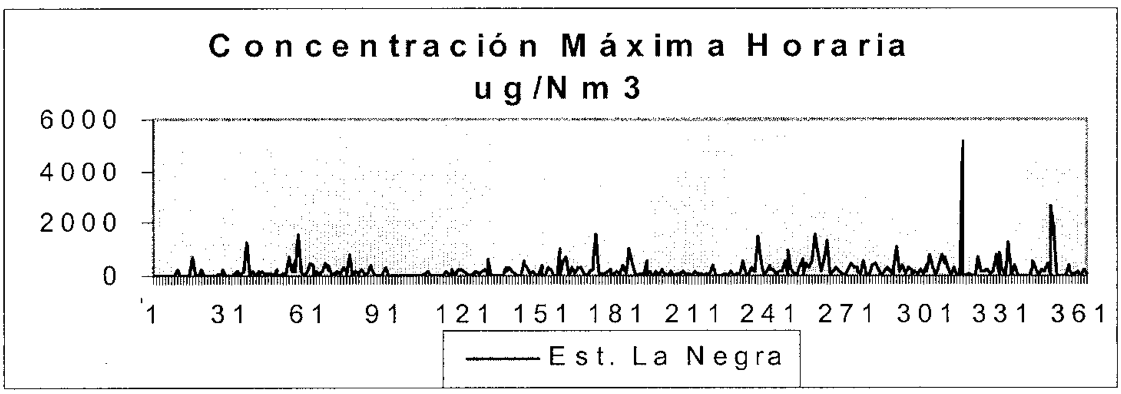
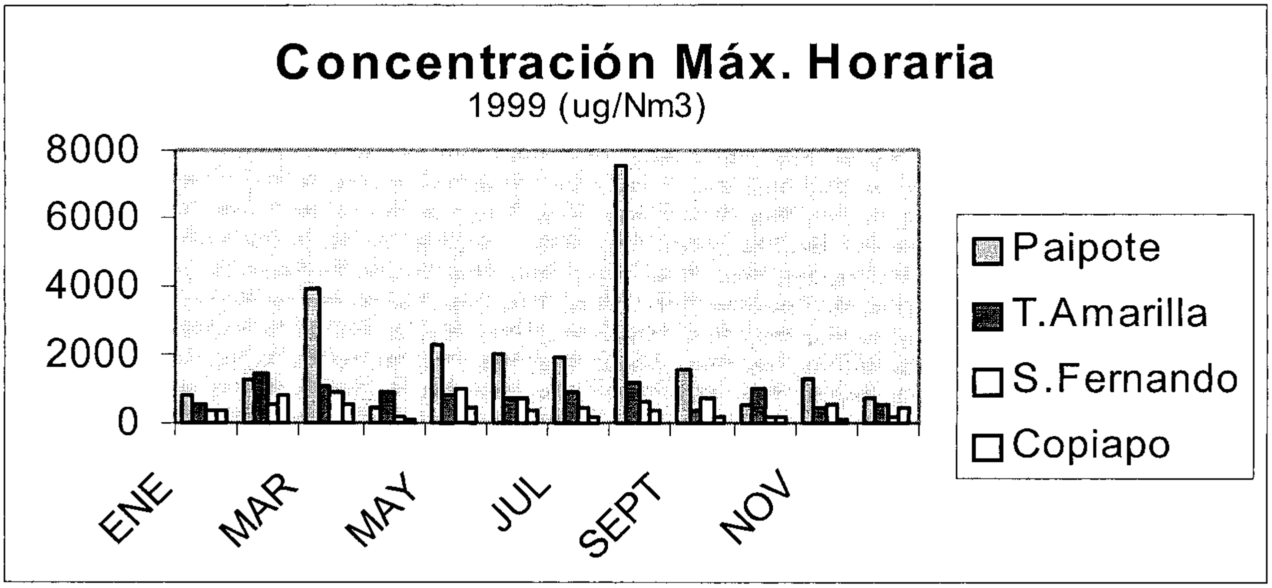


FIGURA 3: CONCENTRACIONES MAXIMAS HORARIAS, SO2, AÑO 1999 (PAIPOTE- HUASCO)

PAIPOTE



HUASCO

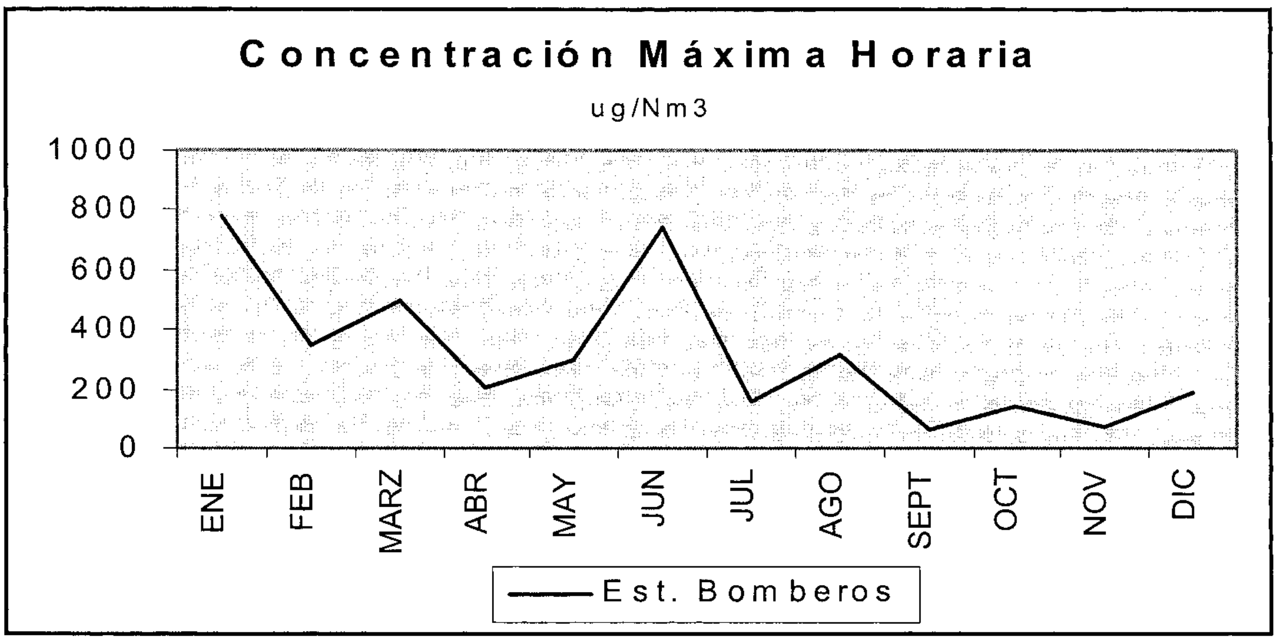
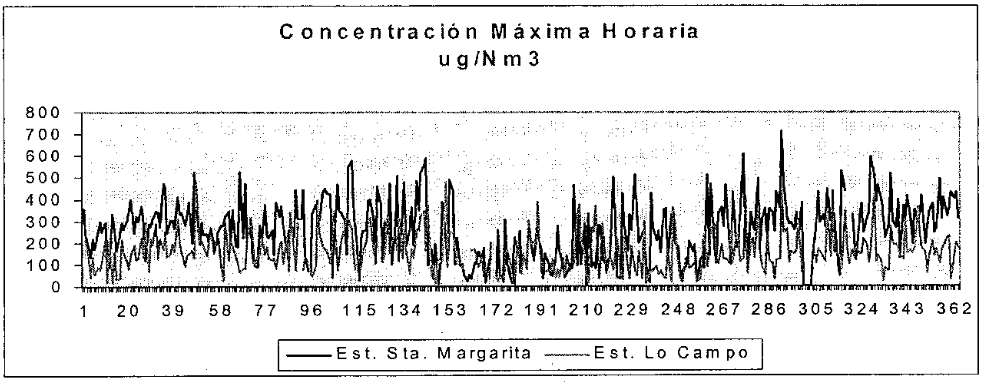
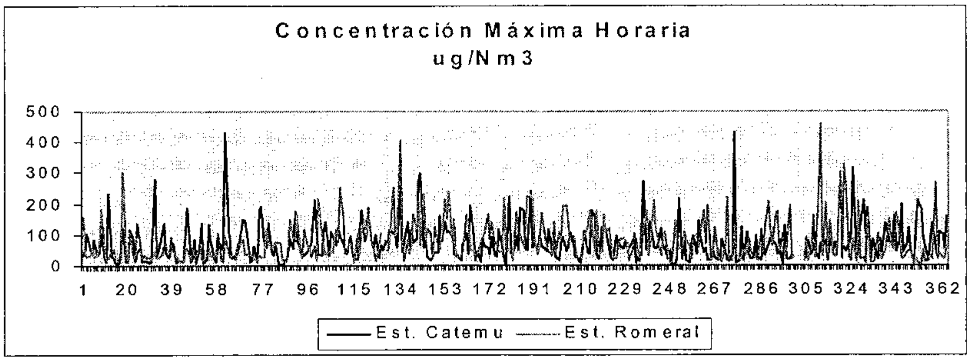


FIGURA 4: CONCENTRACIONES MAXIMAS HORARIAS, SO2, AÑO 1999 000808
(CHAGRES-QUILLOTA)

CHAGRES





QUILLOTA

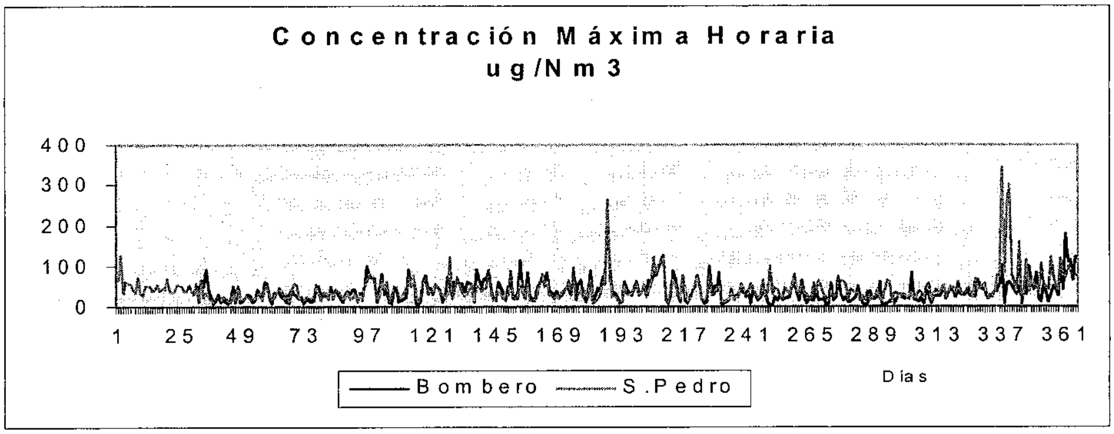
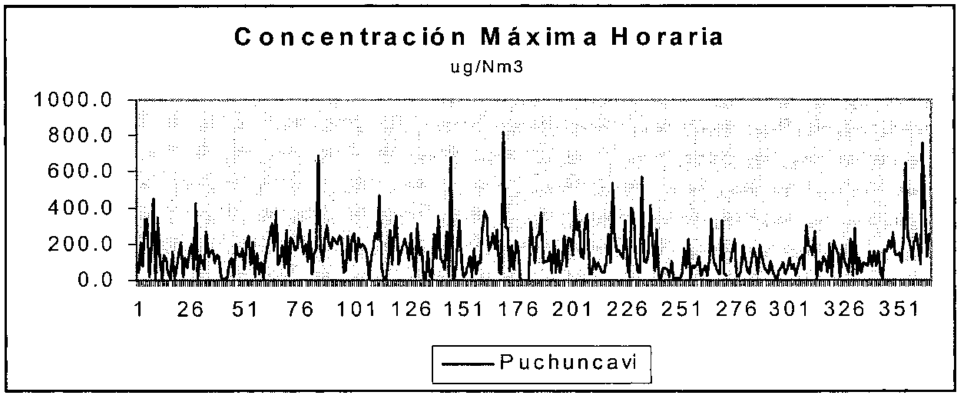
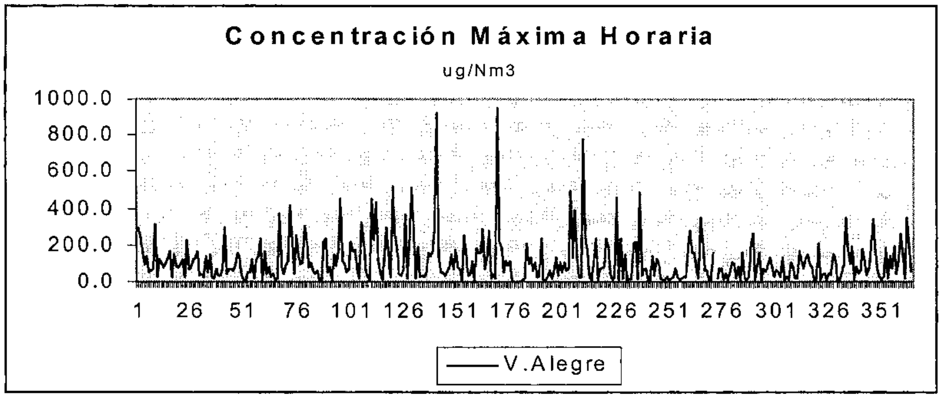
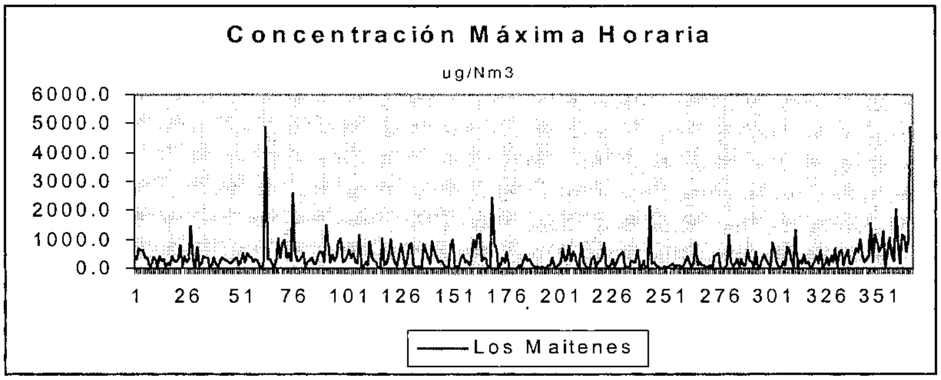


FIGURA 5: CONCENTRACIONES MAXIMAS HORARIAS, SO2,AÑO 1999, (VENTANAS)







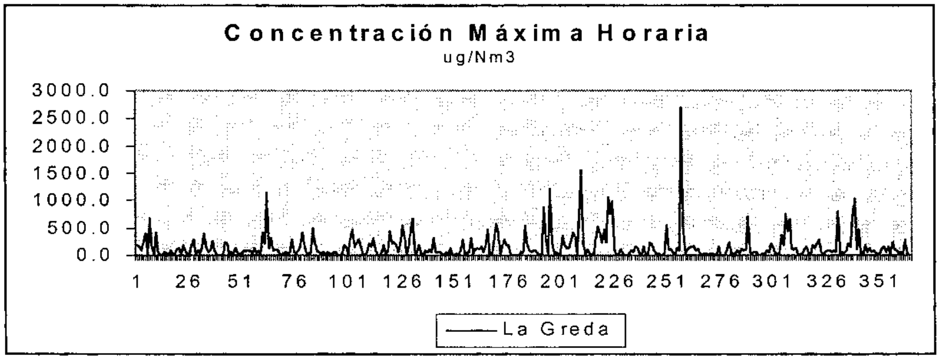
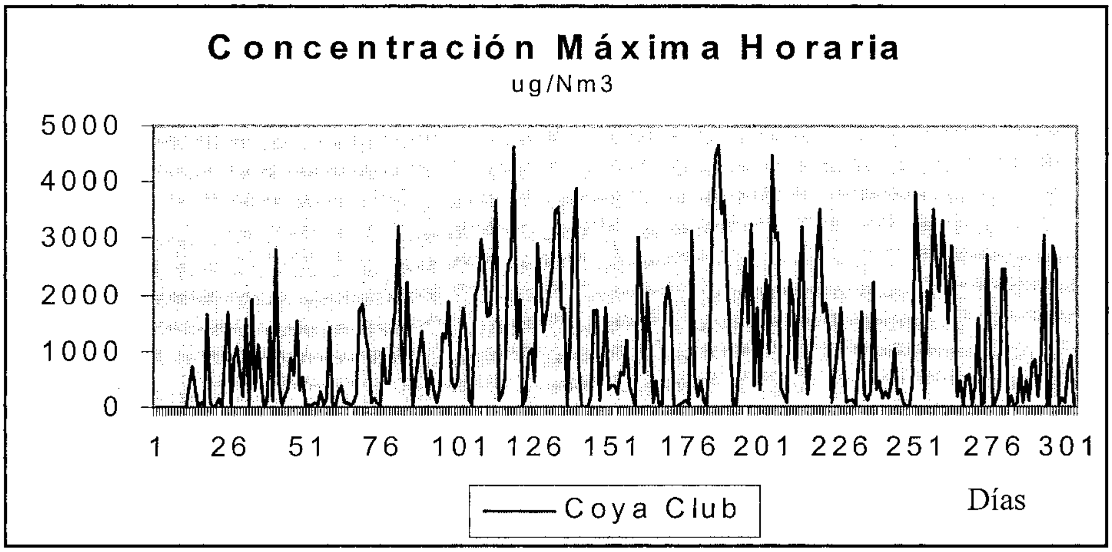


FIGURA 6: CONCENTRACIONES MAXIMAS HORARIAS, SO2, AÑO 1999, (CALETONES) 000810



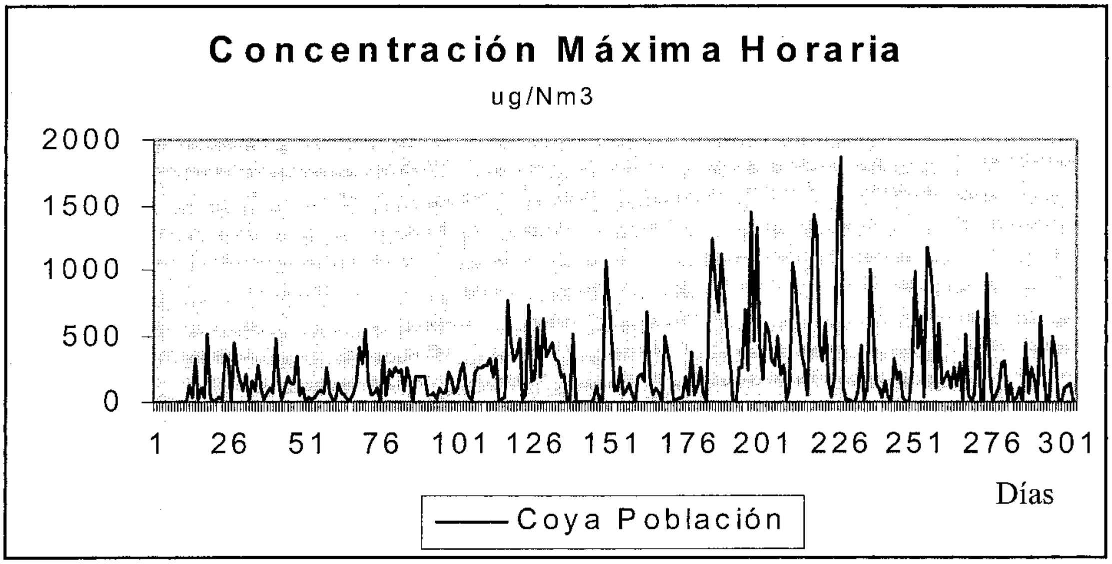
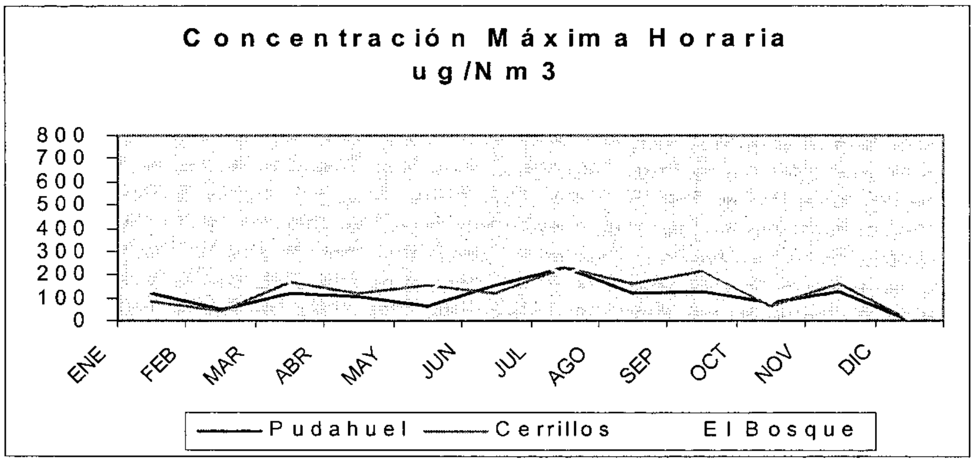
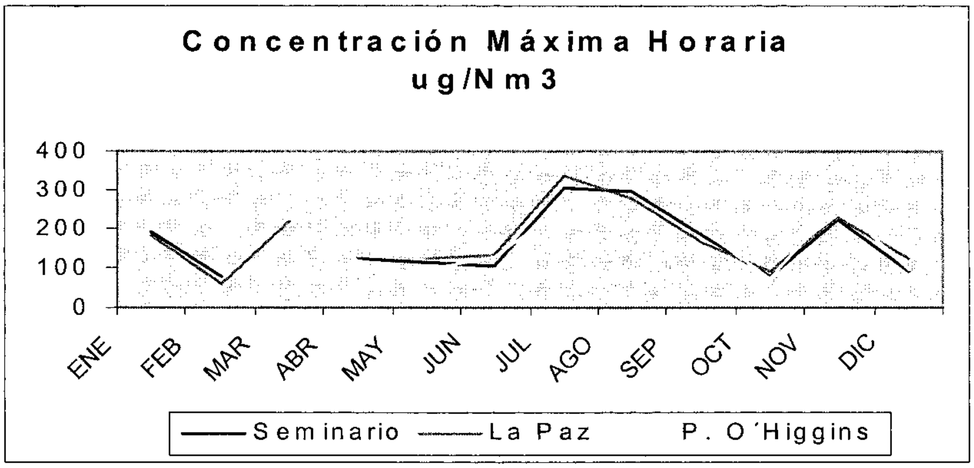
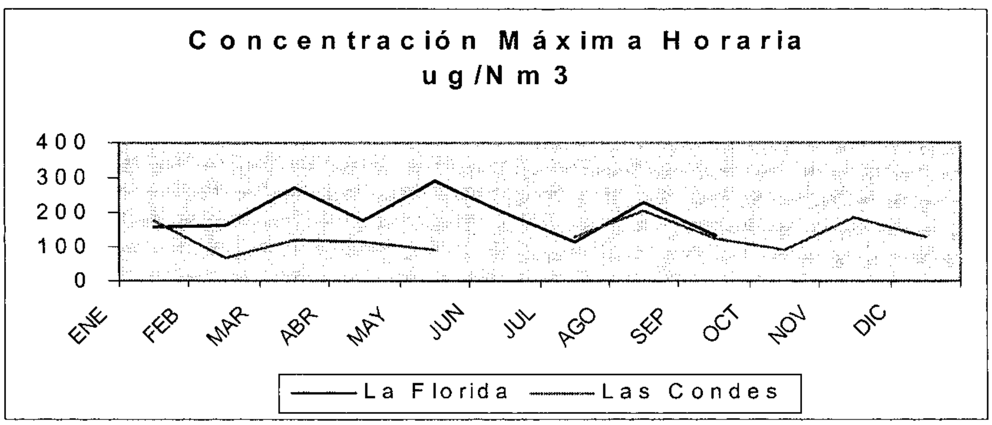


FIGURA 7: CONCENTRACIONES MAXIMAS HORARIAS, SO2, AÑO 1999, (REGION METROPOLITANA)







ANEXO 3

000812

EMISIONES DE SO2 EN FUNDICIONES DE COBRE

CHUQUICAMATA

Año	Fusión Conc. t/año	Emisión Permitida SO2 (t/año)	Emisión S02 t/año	Captación S %
1993		504000		
1994		468000	302000	
1995	1588200	396000	274000	72,4
1996	1591200	396000	296000	71,4
1997	1677500	396000	228000	79,7
1998	1690000	324000	186000	83,6
1999	1741000	-	256000	78,6
2000	-	174600	-	85,1
2001	-	174600	-	85,2
2002	-	158000	-	86,6
2003	-	56600	-	95,5

PAIPOTE

Año	Emisión Permitida SO2 t/año	Emisión SO2 t/año	Capatción S %
1995	79800	57324	48.5
1996	79800	49344	49.8
1997	79800	30900	70.5
1998	60000	35506	79.1
1999	39984	21312	88

VENTANAS

Año	Fusion Conc. t/año	Emisión Permitida SO2 t/año	Emisión SO2 t/año	Captación S %
1993	464575	124000	117258	52,5
1994	450826	124000	123052	53,6
1995	391291	124000	118436	50
1996	446418	124000	117322	51,4
1997	380159	124000	85218	58,3
1998	390789	90000	44800	80,2
1999	389313	-	30732	87

CHAGRES

Año	Fusión Conc. t/año	Emisión S t/año	Emisión S02 t/año	Captación S %
1993	133547	8724	17448	75,9
1994	123299	6748	13496	80,5
1995	254819	5054	10108	93,5
1996	ND	ND	ND	ND
1997	384499	8488	16976	92,86
1998	408633	5963	11926	94,91
1999	487027	5572	11144	96

PROPUESTA REVISION NORMA DE CALIDAD PARA PTS

1. La Resolución 1215 de 1978 regula los efectos en salud que se generan por el material particulado en suspensión (PTS) mediante una norma promedio 24 horas (260 ug/m3)y una norma anual (75 ug/m3), estableciendo para su medición el método gravimétrico de muestreador de alto volumen o equivalente, que permite medir material particulado suspendido en el aire de diámetro aerodinámico equivalente y menor a 25-45 um.

2. Con el D.S. 185 de 1991 y posteriormente con el D.S. 59 de 1998 se regulan los efectos en salud generados por la fracción respirable del material particulado inferior a 10 micrones, a través de una norma para promedio de 24 horas (150 ug/m3). Actualmente, este Decreto está en proceso de revisión e incluye una propuesta para incorporar un valor de norma anual.

3. Históricamente se creía que todas las partículas suspendidas en el aire (PTS) afectaban a la salud de la misma forma. Sin embargo, recientemente se ha demostrado que las partículas que más afectan la salud son aquellas con diámetro aerodinámico menor a 10 um (MP10) y más aún, aquellas con diámetro aerodinámico menor a 2.5 um (MP2.5). De hecho, la fracción del PTS mayor a 10 micrones se deposita en la traquea y son limpiadas por los cilios a través de la formación de mucus y expulsadas a través de la tos o tragar, por lo que no causa los riesgos a la salud comprobados en el MP10.

4. El documento de guías globales de calidad del aire de la OMS sostiene que no se puede establecer un nivel umbral para los efectos del MP en la salud, por lo que las guías para MP son representadas por asociaciones estadísticamente significativas entre el incremento en los efectos observados y el incremento de las concentraciones, específicamente de MP10 y MP2.5. No establece ningún tipo de guías para aquella fracción mayor a 10 um.

5. Además del tamaño de la partícula, otro componente considerado en la revisión de la norma de PTS, es aquel asociado a la toxicidad del PTS en su fracción superior a 10 micrones y que por una determinada exposición a éste pudiese tener efectos nocivos en la salud de las personas.

6. Al respecto, la revisión de antecedentes disponibles permiten suponer que en nuestro país las emisiones de material particulado provenientes de las fundiciones de cobre y oro contienen una mayor concentración de compuestos tóxicos (As, Pb) en comparación con las emisiones provenientes de otras actividades mineras o industriales. Sin embargo, no se cuenta con antecedentes que indiquen la proporción en que estos compuestos están presentes en la fracción emitida del PTS mayor a 10 micrones.

7. En relación a lo anterior, de igual forma es importante señalar que no se cuenta con una evaluación de riesgo que evidencie alguna relación entre la exposición a PTS y en particular a los compuestos tóxicos contenidos en éste y la ocurrencia de alguna enfermedad.

8. En cuanto a su comportamiento atmosférico, se supone una sedimentación del material particulado mayor a 10 micrones en la cercanía a la fuente emisora. Esto podría explicar mayores concentraciones de compuestos tales como As, Cd, Pb en los suelos en zonas aledañas a fundiciones de cobre en comparación con áreas más alejadas de éstas, según estudios de INIA realizados entre 1981 y 1990.

9. En Chile están vigentes las normas de emisión de As para fundiciones de cobre y oro, y en proceso de dictación la norma de calidad primaria para plomo en aire, que incluye su medición en PTS si así se estima necesario Estas normativas son una herramienta preventiva importante de posibles efectos del material particulado (sin distinción de tamaño) derivados de su toxicidad respecto de estos elementos.

Por todo lo anteriormente señalado se propone derogar la actual norma de PTS.

CALETONES

Año	Emisión Permitida S02 (t/año)	Emisión SO2 t/año
Desde 1998	-	710000
Desde1999	494000	478000
Desde 2000	494000	
Desde 2001	230000	
Desde 2002	230000	
Desde 2003	*	

(*) Cumplimiento calidad

NORANDA (REFIMET)

Año	Fusión Conc t/año	Emisión S t/año	Emisión SO2 t/año	Captación S %
1998	352261	21810	43620	75
1999	386682	20022	40044	80

Fuente: NORANDA

ANTECEDENTES RECOPILADOS PARA LA REVISION DE LA NORMA PTS

La Resolución Nº1215 regula la presencia de partículas en suspensión indicando la forma de medición del contaminante, estableciendo el uso del método gravimétrico de muestreador de alto volumen o equivalente (método propuesto por la EPA para medir PTS), el cual permite medir material particulado en suspensión en el aire de diámetro aerodinámico equivalente menor a 25-45 micrones.

- Efectos en salud

Los efectos biológicos de las partículas en suspensión dependen de las características físicas químicas, de la forma de distribución y deposición en el árbol respiratorio y de los efectos biológicos en respuesta. La composición química y física del material particulado en distintos ambientes aún no ha sido totalmente caracterizado y debido a la heterogeneidad de la composición del material particulado es muy difícil hacer estudios experimentales de dosis respuesta en animales o humanos. Muchos de los efectos de las partículas reflejan la combinación con otros contaminantes que pueden formar parte de las distintas fracciones del material particulado, por ejemplo sulfuro-sulfatos, aerosoles ácidos o algunos metales.

Hay varios mecanismos posibles por los cuales se producirían los efectos en salud, dependiendo entre otros del tamaño de la partícula y de la concentración de ésta en el aire. El tamaño determina el mayor o menor grado de depósito en la vía respiratoria.

Las partículas más grandes se depositan en la traquea y son limpiadas por los cilios a través de la formación de mucus y son expulsadas a través de la tos o tragar. Las partículas más pequeñas, a su vez, son limpiadas por los macrófagos que las transportan a los cilios o al sistema linfático.

Cuando se inhalan partículas muy pequeñas (0,2 um) estas pueden traspasar el espacio insterticial del alvéolo y provocan un síndrome de inflamación crónica. La capacidad inflamatoria depende del contenido de metales y tipo de ellos, así como el contenido de derivados orgánicos de combustión.

En el aparato respiratorio las partículas producen inflamación en los alvéolos del pulmón. Al producirse inflamación aumentan algunas células y otras que tienen como función limpiar elementos extraños y actuar contra los virus y bacterias, empiezan a funcionar mal, no limpian las partículas que se acumulan, no actúan bien contra virus y bacterias y por lo tanto hay mayor riesgo de infección respiratoria (resfrios, bronquitis, neumonías) y por otro se van degenerando y pueden transformarse en células malignas en el largo plazo. En el corto plazo, se altera el intercambio de gases con absorción de oxígeno deficiente y en personas propensas puede haber cuadros de dificultad respiratoria, enfermedad y eventualmente muerte.

A su vez, los efectos cardiovasculares de la contaminación por material particulado se producen a través de un aumento de la viscosidad y por lo tanto coagubilidad de la sangre que hace que se produzcan trombos (tapones) que impiden el flujo de sangre y producen isquemia (que en su grado mayor es un infarto al corazón o una trombosis al cerebro.

Una serie de estudios recientes epidemiológicos muestran una asociación entre muertes diarias y concentración de MP10 (porcentaje de aumento de mortalidad por cada 50 ug/m3 de incremento en las concentraciones de MP10 en 24 horas). En Chile se han realizado varios estudios que han mostrado el efecto de los niveles de contaminación del aire, especialmente por partículas sobre mortalidad diaria, consultas y síntomas respiratorios.[1]

Desde el punto de vista de los efectos sobre la salud se debe entonces diferenciar, entre material particulado respirable (MP10) y aquel presente en la fracción mayor a 10 micrones que sólo ingresa a la traquea desde donde es removido y puede ser tragado. De hecho, la recopilación realizada por SGA indica que ninguno de los estudios nacionales más relevantes en lo cuantitativo con respecto a contaminación por material particulado ha vinculado efectos en salud con PTS, sino que todos han usado MP10 como indicador del factor de riesgo a la salud.

- Mecanismos de formación y emisión de partículas

Las partículas finas (<2.5um) y gruesas (>2.5um) generalmente tienen distintas fuentes y mecanismos de formación, a pesar de que pueden superponerse. Las partículas finas primarias se forman por condensación de vapores a muy alta temperatura durante la combustión. Las partículas finas secundarias se forman usualmente desde gases por tres vías: nucleación (moleculas de gases se unen a formar una partícula nueva), condensación de gases sobre partículas existentes o por reacción de gases absorbidos en gotitas líquidas. Las partículas formadas por nucleación pueden también coagular para formar partículas relativamente grandes o gotas de diámetro entre 0.1 y 1 um, y estas partículas normalmente no crecen al modo grueso. Aunque algunas partículas directamente emitidas se encuentran en la fracción fina, partículas secundarias formadas desde gases dominan la masa de la fracción fina.

En contraste, la mayoría de las partículas gruesas son formadas directamente como partículas y resultan del rompimiento mecánico tal como el aplastamiento, molienda, o de la evaporación de sprays o suspensión de polvo desde la construcción, operación agrícola, actividad minera, etc. Consideraciones energéticas normalmente limitan a 1 um a la partícula gruesa. Algunas partículas minerales generadas en procesos de combustión, como la ceniza volante, también se encuentra en la fracción gruesa. También materia biológica como bacterias, polen y esporas se pueden encontrar en esta fracción.

<u>Resuspensión de polvo</u>
La emisión de las partículas más gruesas puede generarse por el tránsito de vehículos en calles y caminos no pavimentados (de tierra) como consecuencia de pulverización del material rodado (por fricción y abrasión) causado por neumáticos y la turbulencia aerodinámica producida por el paso de vehículos a cierta velocidad. El tránsito de vehículos en calles y caminos pavimentados también genera emisiones de polvo, aunque en cantidades significativamente inferiores a un camino de tierra.

[1] Ver Expediente Público, "Efectos de la contaminación atmosférica en la salud humana. Evidencias de estudios recientes", Dra. Jeanette Vega M., Abril 2000

Erosión eólica

En una superficie de suelo natural, pila de mineral, o cualquier material granular, existe en un determinado momento una cierta fracción o porcentaje de partículas (< 75 um) susceptibles de ser emitidas por erosión eólica. Si ocurre un viento suficientemente intenso, estas partículas son emitidas a la atmósfera, ya sea en un único evento de viento fuerte o en varios eventos sucesivos, hasta que la superficie pierda la condición de "erosionable" (la erosión eólica es finita; después de ocurrida la erosión en la superficie sólo quedan expuestas las partículas más gruesas, que no pueden ser arrastradas por los vientos, pasando a constituir una cubierta protectora de las partículas finas presentes en capas más profundas. Sin embargo, diversas actividades o acciones desarrolladas sobre la superficie, en general ocasionan la destrucción de la cubierta o la generación de partículas finas por fricción o abrasión (activación de la superficie) otorgando una nueva condición de "erosionable".

Emisiones de polvo fugitivo también pueden generarse en procesos de transferencias discretas y continuas de materiales granulares, operaciones de chancado de minerales y tronaduras.

Transferencias de materiales granulares

Las transferencias de materiales granulares, como mineral o estéril, corresponden a operaciones donde una cantidad fija de material es transferido desde un recipiente hacia otro recipiente o superficie receptora. Este tipo de acción involucra la caída libre del material entre un punto y el otro, y cierta fricción interna de las partículas, generando estos efectos emisiones de partículas más finas: la fricción genera partículas más finas y la caída libre ocasiona la puesta en suspensión de éstas en el aire (turbulencias aerodinámicas también pueden contribuir al aumento de las emisiones.

Las transferencias continuas de materiales granulares, como mineral o estéril, corresponden a operaciones ininterrumpidas (intervalo prolongado) donde un material es transferido desde una correa transportadora o elemento similar hacia un elemento u superficie receptora. Este tipo de operación involucra la caída libre del material y cierta fricción interna de las partículas, generándose la emisión de partículas más finas.

Chancado

Las operaciones de chancado pueden constituir fuentes significativas de emisión de material particulado, siendo las partículas pesadas (de gran diámetro) una parte importante de la emisión, las cuales sedimentan cerca de la fuente. Los factores que más inciden en la emisión son la dureza y humedad de la roca, el contenido de finos, el tipo de equipos involucrados, las prácticas de operación y las condiciones climáticas (viento y precipitación). Las emisiones son mayores en zonas áridas, y mayores durante los períodos de verano debido a la mayor tasa de evaporación, que reduce la humedad del material.

Tronadura

La tronadura está asociada a la operación de remoción de roca/mineral estéril desde un yacimiento. Se efectúa utilizando explosivos dispuestos en una malla de perforaciones. La tronadura propiamente tal general el desprendimiento del material, y también la pulverización y trituración de parte de él. Genera en un momento muy breve (un par de segundos), cantidades relativamente significativas de polvo, aunque con baja frecuencia (1 o 2 veces al día).

En el caso de las actividades mineras es necesario hacer una clara distinción entre polvos o residuos mineros y polvos o residuos metalúrgicos.

Los primeros se generan en todos los procesos de extracción de mineral y en el procesamiento de mineral. Se entiende por procesamiento de minerales el conjunto de operaciones de molienda y concentración de mineral. Son procesos físicos que no involucran transformaciones químicas del material. Sólo se ven afectadas las características físicas (tamaño y forma de las partículas). Tienen la misma composición química y mineralógica que el mineral extraído. Sólo en la fracción más fina debería encontrarse mayores concentraciones de metales volátiles generados por condensación. Por lo tanto, en este caso resulta difícil distinguir entre partículas "naturales" y partículas "antropogénicas". Sin embargo, hay que mencionar que estos cuerpos minerales una vez expuestos a la atmósfera se ven alterados. Es así como en la parte superior de los yacimientos porfíricos de cobre se encuentran minerales oxidados. Tambien es ineteresante mencionar, que por ejemplo en el caso de los tranques de relave, en climas áridos, por oxidación de metales hay una migración de elementos metálicos solubles por capilaridad hacia la superficie formando una costra de sulfatos metálicos con concentraciones más altas.

Las partículas metalúrgicas, generadas esencialmente en las fundiciones tienen características totalmente distintas a los polvos mineros antes mencionados. Generalmente, son productos oxidados enriquecidos en compuestos volátiles (cinc, arsénico, y otros). Sin embargo, no está claro si el As que condensa en su entorno también se encuentra en partículas más gruesas.

- Mecanismos de remoción

Los mecanismos de remoción de aerosoles son la coagulación, la precipitación y la sedimentación. El primer proceso afecta preferentemente a las partículas pequeñas en el rango de 0.001-0.1 m, llamadas de Aitken o núcleos de Aitken. El segundo es dominante para las partículas en el rango 0.1-1 m, llamadas en el "modo de acumulación"[2] pero también es eficiente para partículas de hasta 10 m. Para aquellas partículas de radios superiores a 10 m es la sedimentación el proceso de remoción dominante.
Lo anterior se traduce en tiempos de recambio típicos en la troposfera de unas pocas horas para los aerosoles de Aitken, un par de días para las partículas en el modo de acumulación y de minutos u horas para partículas mayores de 10 m. Por lo tanto, el material particulado, dependiendo del tamaño, puede dispersarse a escalas local o regional. Incluso hay evidencia bien documentada de transporte intercontinental[3].

Es así como las partículas más grandes (> 10 um) tienden a caer desde el aire rápidamente y tienen tiempos de vida atmosféricos de sólo minutos a horas dependiendo de su tamaño,

[2] Estas son las partículas que sirven como núcleos de condensación de nubes. Además, son aquellas que afectan la visibilidad pues dispersan la luz.
[3] L.Gallardo " "

velocidad del viento y otros factores. Su impacto espacial está típicamente limitado por una tendencia a caer en áreas cercanas a favor del viento.

Partículas finas típicamente tiempo un tiempo de vida más largo (días a semanas) que las gruesas, y tienden a dispersarse más uniformemente a través del área urbana o grandes regiones geográficas. Transformaciones atmosféricas pueden suceder durante el estancamiento atmosférico o durante el transporte por largas distancias.

Partículas más grandes generalmente depositan más rápido que las más finas; como resultado, la masa total de partículas gruesas es menos uniforme en su concentración a través de la región que aquella de partículas finas.
El comportamiento atmosférico de las partículas pequeñas dentro de la fracción gruesa (MP10-MP2.5) es intermedio entre aquel de las gruesas y de las finas.

El tamaño y la dimensión de las partículas definen la velocidad con que éstas sedimentan (la viscosidad del aire también interviene, aunque con una incidencia relativa menor. Al comparar la cantidad de partículas de gran tamaño con la cantidad de partículas de menor tamaño (MP10) se puede deducir un indicador de la distancia desde la fuente: a mayor distancia de la fuente se observan menos partículas gruesas.

- Elementos tóxicos (As, Pb, Cd) en suelos

El país posee cuantiosos yacimientos metálicos que es lo básico para desarrollar una actividad minera de importancia. Parte importante del territorio nacional posee en forma natural un alto fondo metálico, quizás largamente por encima de las regiones del planeta con menor riqueza geoquímica, por lo que los aportes antrópicos deben considerarse adicionales a líneas de base naturalmente elevadas.

En relación al arsénico, en nuestro país existen escasos antecedentes de arsénico en los suelos, el cual se espera encontrar por origen natural de los suelos y antropogénico depositado sobre éstos.

El Estudio Determinación de Línea Base Nacional de As en PM10 (actualmente en ejecución) midió concentraciones de As en muestras de suelo (capa superior) en 7 lugares del país. Se escogieron en lo posible lugares fuera del ambiente urbano y los más lejos posible de fuentes locales de arsénico. Los lugares están suficientemente distantes de las fundiciones de cobre para evitar niveles altos de As directamente emitido. Esto significa distancias superiores a 50-100 km. Resultados preliminares (1 sólo punto), registran un índice alto de 291 mg/kg (Quillagua), comparado con 79 mg/kg en el segundo punto más alto (Pica). En Quillagua se espera encontrar arsénico transportado por el Río Loa, que atraviesa la zona mineras de Chuquicamata.

Comparativamente, una publicación reciente, Matschullat (2000), donde se resume un gran número de estudios del balance de masa de arsénico, entrega para la concentración de As en suelos un promedio global en el rango de 5 – 7 mg/kg. Sin embargo, la variación local es muy grande, y se menciona resultados de estudios en Austria donde el nivel de As natural puede llegar hasta 100-115 mg/kg.

En relación a otros elementos, entre 1981 y 1990 el INIA estudió el contenido en suelos de algunos elementos metálicos. En estos estudios se detectó en la V y VI región y RM una asociación del cadmio con cobre a niveles de emisiones de centros mineros. En la V Región, en general, el contenido total de cadmio cayó bajo el límite de detección de la técnica analítica empleada (alrededor de 1 mg/kg, con espectrofotometría de absorción atómica) y sólo se exceptuaron de ello un sector del valle Catemu y otro de Puchuncaví, vecinos a fundiciones de cobre.

También se concluyó, que la alta cuprocidad de los suelos de Catemu en ese entonces, producto de las emisiones de la fundición (Chagres), parecía estar asociada también a plomo y cadmio, que mostraron notorios enriquecimientos en ese sector. En el área de Puchuncaví también se detectó una importante acumulación metálica en suelos vecinos a la zona industrial de Ventanas, que disminuyó al alejarse de ésta.

- Fiscalización y cumplimiento de la normativa vigente en Chile

Los Servicios de Salud han abandonado las PTS como los mejores indicadores del efecto en la salud de las partículas. Esto se traduce en que los Servicios de Salud han reemplazado paulatinamente la fiscalización del PTS por la del PM10.

En Santiago se mantiene una Red de Vigilancia que mide PTS, pero esta red no es considerada para los efectos de la fiscalización de la calidad del aire en la RM.

BIBLIOGRAFÍA UTILIZADA EN LA RECOPILACIÓN DE ANTECEDENTES

- Guías para calidad del aire OMS, 1999
- Estudio SGA
- Estudio Determinación Línea Base As
- Estudio Evaluación contaminación atmosférica en zonas con aportes de fuentes naturales y antropgénicas: caso Andacollo (Geotecnica)
- Expediente Público Norma Plomo
- Tesis, Javier García
- Environmental Toxicology 1998
- Estudio calidad del aire en 5 ciudades
- Inventario de emisiones CONAMA RM

ANEXOS

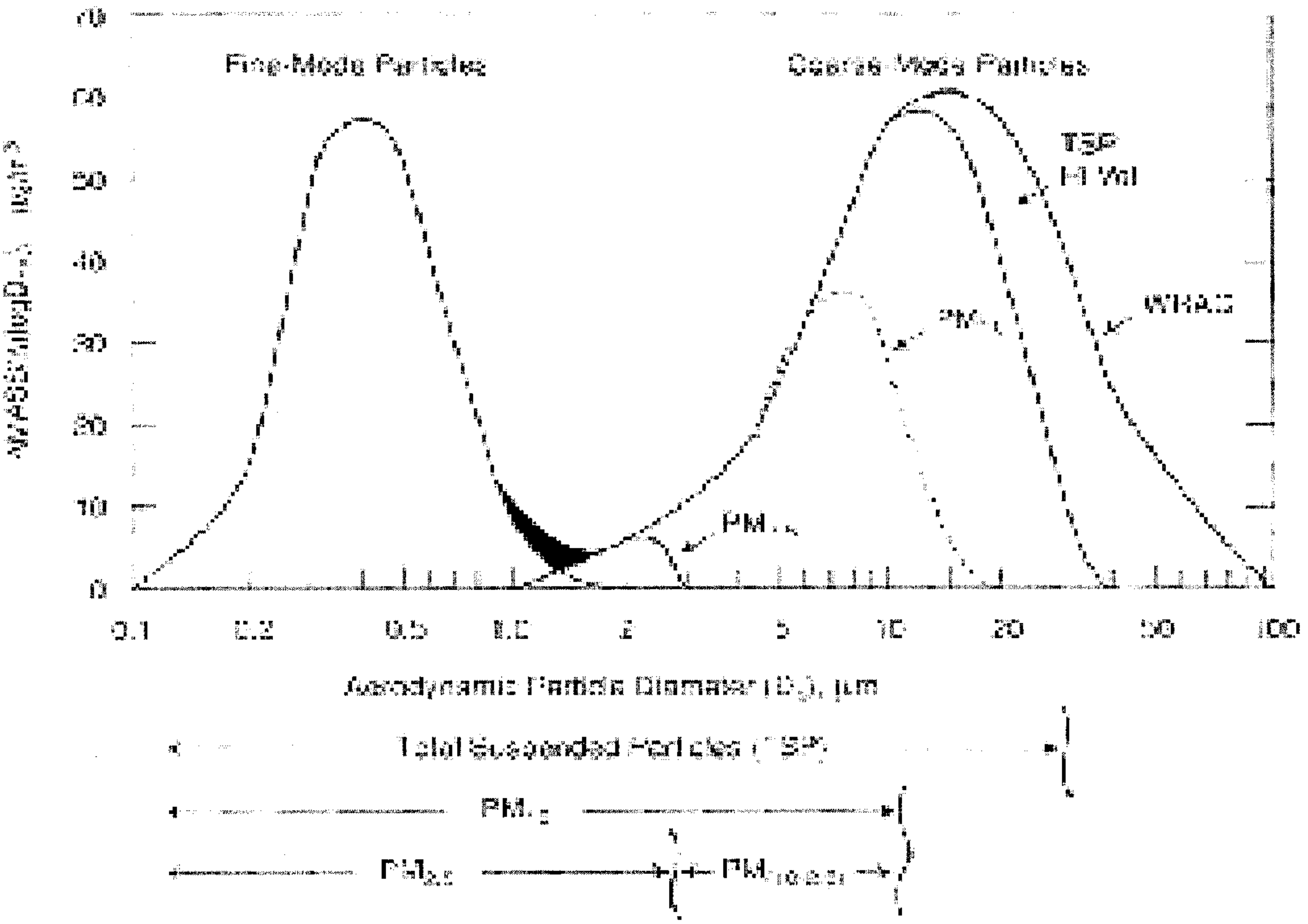
NORMATIVA INTERNACIONAL

		TSP		
	Pays	1 h	24 h	1 y
	WHO 1987		120	
	WHO 1999			
Europe UE	Union européenne			
	Allemagne			
	Anglaterre			
	Autriche			
	Belgique B			
	Belgique F			
	Belgique W			
	Denmark			
	España			
	France			
	Grece			
	Irlande			
	Italia		150	150
	Louxembourg			
	Pays Bas			
	Portugal			150
	Suède			
Europe	Albanie			
	Bosnia-H			
	Bulgaria			
	Croacie			300
	Czech R.		150	60
	Estonia	500	150	
	Finlandia		20	50
	Hungary			
	Latvia			
	Liechtenstein			
	Lituania			
	Macedonia			
	Noruega			
	Poland			
	Romania			
	Slovak		150	60
	Slovenia			
	Suisse		*150*	*70*

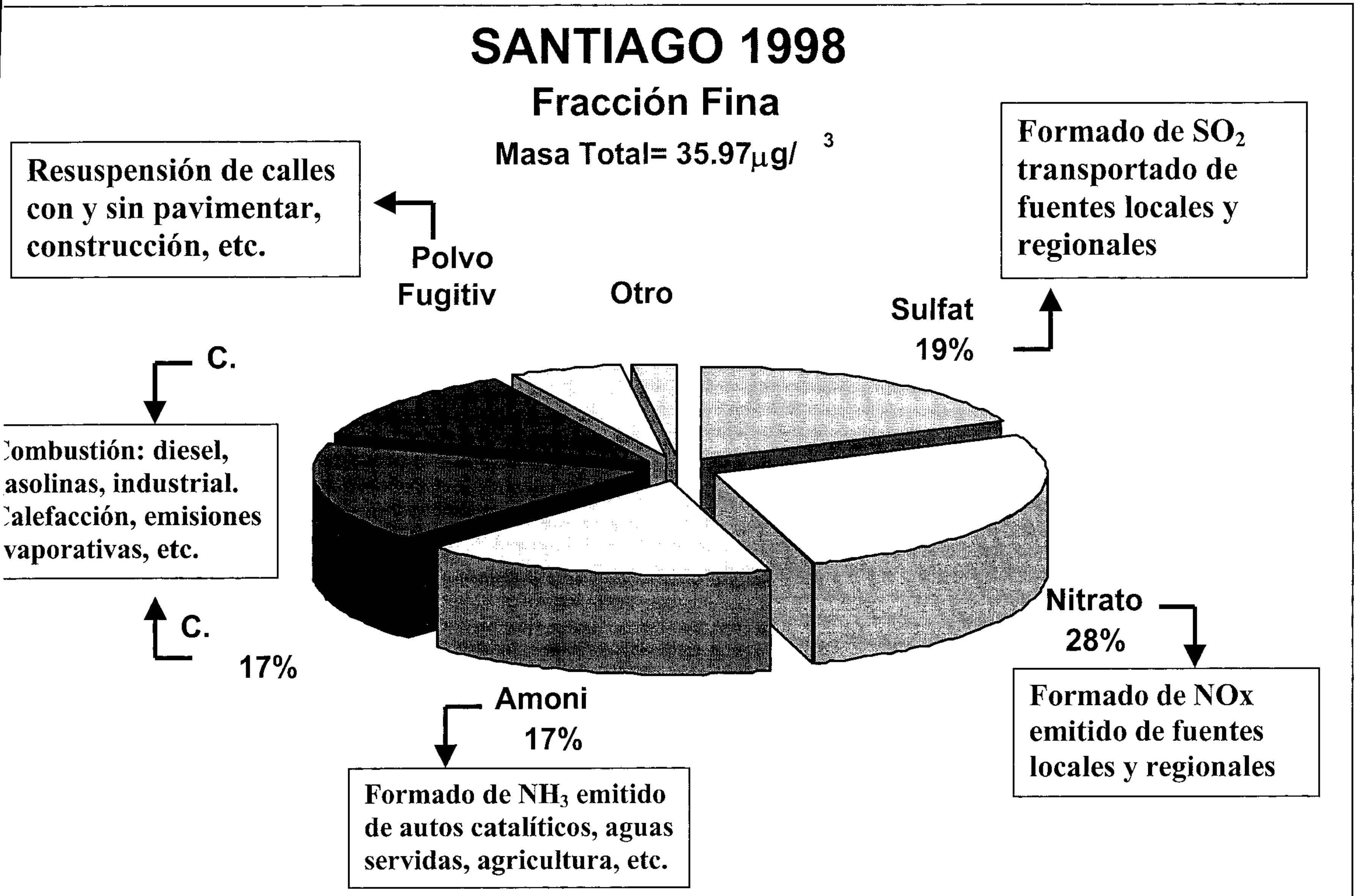
	Pays	TSP 1 h	TSP 24 h	TSP 1 y
Amerique du Nord				
	EPA (USA) 1997			
	Georgia			
	Florida			
	Washington		150	60
	California			
	Canada		120	60
Amérique Latine				
	Chili		260	75
	Mexico		260	75
	Brasil		240	80
	Venezuela			
Asie				
	Chine		*300*	*120*
	Inde		200	140
	Hong-Kong			
	Israel		200	75
	Japon			
	Liban		120	

Nivel de cumplimiento de Normas Diarias de
Partículas en Suspensión

CIUDAD	PTS (% de cumplimiento)
Santiago (1990) Santiago (1991) Santiago (1992) Santiago (1993) Santiago (1994) Santiago (1995)	45.00 39.39 45.83 53.52 63.73 49.43
Antofagasta (enero – febrero 1990) Antofagasta (octubre 1991) Antofagasta (agosto – diciembre 1994) Antofagasta (marzo – junio 1995)	100.00 66.66 80.00 75.86
Rancagua (agosto – septiembre 1996)	73.33



Source: USEPA, 1996


SANTIAGO 1998
Fracción Fina
Masa Total= 35.97µg/ 3
Resuspensión de calles con y sin pavimentar, construcción, etc.
Polvo Fugitiv
Otro
Formado de SO_2 transportado de fuentes locales y regionales
Sulfat 19%
C.
ombustión: diesel, asolinas, industrial. alefacción, emisiones vaporativas, etc.
C.
17%
Nitrato 28%
Formado de NOx emitido de fuentes locales y regionales
Amoni 17%
Formado de NH_3 emitido de autos catalíticos, aguas servidas, agricultura, etc.

Porcentaje de contribución de las diferentes fuentes a las concentraciones de partículas gruesas

TEMUCO		
FUENTES	**%PM - 2,5**	**%PM - 10**
Combustión de Leña	41	29
Sulfuros	29	20
Tráfico Vehicular	26	26
Suelo	2	22
Mar	2	3

VALPARAISO		
	PM - 2,5	**PM - 10**
Suelo	1	36
Fundición	6	6
Petróleo	2	2
Tráfico Vehicular	21	11
Fuente de Azufre	40	27
Quema de leña	30	14

RANCAGUA		
FUENTES	**%PM - 2,5**	**%PM - 10**
Quema de Leña	37	23
Tráfico Vehicular	30	9
Fundición	27	22
Industria Metalmecánica	4	5
Suelo	2	41

COMISIÓN NACIONAL DEL MEDIO AMBIENTE
DEPARTAMENTO DE DESCONTAMINACIÓN, PLANES Y NORMAS

Revisión Norma de Calidad Primaria contenidas en la Resolución Nº 1215/78

ACTA DE REUNION DE COMITÉ OPERATIVO Y AMPLIADO

FECHA REUNION : 07 de agosto de 2000
LUGAR : CONAMA. Obispo Donoso 6. Santiago
ASISTENCIA : Se adjunta hoja de asistencia

Tabla :

1. Discusión de la propuesta de CONAMA u otras propuestas

Discusión :

SO2
R.Pedrero (*CODELCO*) presenta brevemente la situación de la fundición de Chuquicamata considerando la propuesta de CONAMA e indica que una nivel diario de 300 ug/m3 con un 20% de incertidumbre, parece mas posible de cumplir, por lo que propone mantener el nivel de norma diario vigente. En relación a la propuesta de norma horaria sostiene que ésta no es procedente. **A.Diez** (*ENAMI*) indica que actualmente está cumpliendo con las normas de calidad primaria vigentes y que las nuevas exigencias no pueden ser cumplidas por esta empresa, aún considerando un control de la variable meteorológica. Sostiene que al no cumplir la normativa no podrá obtener certificación 14000. Advierte que la situación económico-financiera de la empresa no da pie para invertir en nuevos Planes de Descontaminación e indica que con el último Plan la empresa tiene una deuda importante. Señala además que nadie daría crédito para un proyecto sin rentabilidad. Sostiene que la empresa requeriría unos 7 años para sanear los problemas económicos actuales. **G.Muñoz** (*CODELCO*) indica que en Coya Club de Campo habría problemas para cumplir con la norma horaria, no así en Coya Poblacional. Afirma que si bien las simulaciones podrían producir cumplimiento de norma, éstas son inexactas **C.Salvo** (*SONAMI*) reflexiona que Chile es un país en vías de desarrollo. Que es necesario realizar una evaluación que considere la población afectada y evaluar el costo beneficio sobre esta población. Sostiene que el principio de gradualidad contenido en la Ley de Bases no está siendo aplicado en la propuesta. **D.VanBeer** (*U. Concepción*) sostiene que según los antecedentes que el dispone en diversas regiones se estarían superando los niveles de norma propuestos: Coronel, San Vicente. Es de la opinión que el esfuerzo debería estar orientado a cumplir con la normativa vigente, cumplir con acciones más concretas, por lo que propone mantener la normativa vigente. **A.Tchernitchin** *(Colegio Médico)* señala que las normas de calidad primaria deben garantizar la salud de las personas y no evitar costos adicionales de empresas. Indica estar de acuerdo con la propuesta de CONAMA. **E.Cohen** (*Consejo Minero)* solicita realizar la evaluación económica de la propuesta antes de que se publique el anteproyecto y se someta a consulta pública. **S.Pimentel** *(COCHILCO)* indica que es preocupante que se haga una evaluación costo-beneficio si no existen estudios en Chile. No está de acuerdo con una norma horaria.

Rodrigo Lucero Ch.
Depto. Descontaminación, Planes y Normas
CONAMA

COMISION NACIONAL DEL MEDIO AMBIENTE
DEPTO. DESCONTAMINACION, PLANES Y NORMAS

Reunión "Revisión Normas Primarias de Calidad de Aire para SO2, PTS, CO, NO2 Y O3"
Santiago, 07 de Agosto 2000

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Propuesta Modificación Resolución Nº 1215

Norma [ug/Nm3]	Actual	Propuesta	Estado de Cumplimiento Actual 1999 Pu	1999 VA	1999 LG	1999 Sur	1999 Mait	1999 Total	2000 Pu	2000 VA	2000 LG	2000 Sur	2000 Mait	2000 Total
Anual	80	80	36	20	25	42	52		38	21	22	57	52	
Diario	365	250 Percentil 99			1	1	2	4				2		2
Horario	1000 N. Secundaria	1050 Percentil diario 99 Promedio Horario más alto Norma Primaria	0	0	5	6	14	25	1	0	3	6	17	27

Red de Monitoreo Ambiental Fundición H. Videla L.

Frecuencia mensual superación Norma Secundaria de SO2 (> 1.000 µg/Nm3)

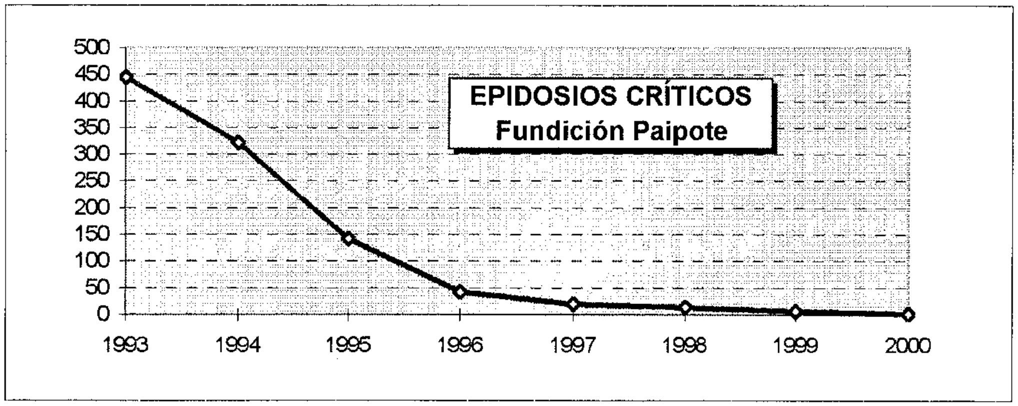
2000

MES	T. Amarilla	S. Fernando	Pabellón	E. Paipote	Copiapó	Los Volcanes	TOTAL
ENE	0	0	0	0	0	0	0
FEB	1	0	0	2	0	0	3
MAR	0	0	0	1	0	0	1
ABR	0	0	0	1	0	0	1
MAY	0	0	0	1	0	1	2
JUN	1	0	0	6	0	0	7
JUL	3	0	0	12	0	0	15
AGO							
SEP							
OCT							
NOV							
DIC							
TOTAL	5	0	0	23	0	1	29

: Localidades donde oficialmente se aplica Norma Secundaria de SO_2

EPISODIOS CRÍTICOS SO_2 (> 1963 µg / Nm3)

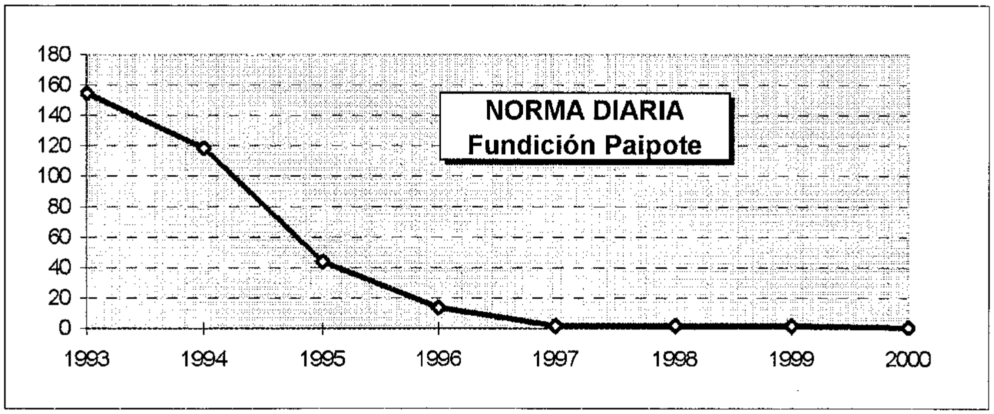
MES	1993	1994	1995	1996	1997	1998	1999	2000
ENE	7	18	10	3	3	1	0	0
FEB	13	16	13	2	4	1	0	0
MAR	32	16	27	1	1	1	2	0
ABR	19	38	33	1	0	4	0	1
MAY	25	42	21	7	1	0	1	0
JUN	68	60	10	4	3	0	2	0
JUL	88	34	11	3	1	1	0	2
AGO	94	34	11	0	2	2	2	
SEP	52	24	2	5	2	2	0	
OCT	20	12	3	4	2	2	0	
NOV	14	23	2	6	1	0	0	
DIC	13	6	0	7	0	0	0	
TOTAL	**445**	**323**	**143**	**43**	**20**	**14**	**7**	**3**



000837

VECES SOBRE LA NORMA DIARIA SO_2 (> 365 µg / Nm^3)

MES	1993	1994	1995	1996	1997	1998	1999	2000
ENE	0	4	1	0	0	0	0	0
FEB	2	3	3	1	0	0	0	0
MAR	6	2	5	0	0	0	0	0
ABR	7	14	10	0	0	1	0	0
MAY	11	16	7	2	1	0	1	0
JUN	34	25	4	4	0	0	0	0
JUL	36	18	10	3	1	0	0	1
AGO	33	16	3	1	0	0	1	
SEP	17	9	0	2	0	0	0	
OCT	3	3	1	1	0	1	0	
NOV	4	8	0	0	0	0	0	
DIC	2	1	0	0	0	0	0	
TOTAL	**155**	**119**	**44**	**14**	**2**	**2**	**2**	**1**



CONCENTRACIÓN DE SO_2 ($\mu g/Nm^3$)

AÑO	COPIAPO	S. FERNANDO	PAIPOTE	T. AMARILLA	Los VOLCANES
1993	79.1	125.5	275.5	148.2	-
1994	62.2	95.8	234.5	148.3	-
1995	56.4	56.6	134.1	128.8	52.4
1996	43.2	38.5	104.6	84.4	42.4
1997	18.6	23.4	67.1	44.3	19.9
1998	14.0	17.4	57.0	36.2	18.0
1999	9.0	15.3	45.0	24.8	5.1
2000 (*)	3.7	7.1	44.7	25.0	11.0

(*): Promedio al mes de Julio

Episodios Críticos por SO_2 en los entornos de la F.H.V.L. durante año 2000

Fecha	Día	Estación	Tipo	Concentración	Hora	Peak	Promedio Día
28/04/00	Viernes	E. Paipote	Alerta	2.045 $\mu g/Nm^3$	09 - 10	4.836 $\mu g/Nm^3$	166 $\mu g/Nm^3$
12/07/00	Miércoles	E. Paipote	Alerta	1.984 $\mu g/Nm^3$	10 - 11	3.805 $\mu g/Nm^3$	341 $\mu g/Nm^3$
23/07/00	Domingo	E. Paipote	Alerta	1.979 $\mu g/Nm^3$	09 - 10	3.936 $\mu g/Nm^3$	259 $\mu g/Nm^3$

Alertas: 3
Advt.: 0
Emerg.: 0
Total: 3

E. Paipote: 3
T. Amarilla: 0
S. Fndo : 0
Copiapó: 0
L. Volcanes: 0
Pabellón: 0
Total: 3

L : 0
M: 0
M: 1
J: 0
V: 1
S: 0
D: 1
Total: 3

9 - 10 Hrs.: 2
10 - 11 Hrs.: 1
Total: 3

Superación Norma Diaria de SO_2 en los entornos de la F.H.V.L. durante año 2000

Fecha	Día	Estación	Promedio Día	Máx. Promedio Hora
16/07/00	Domingo	E. Paipote	493 $\mu g/Nm^3$	1.824 $\mu g/Nm^3$

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Red de Monitoreo Ambiental Fundición H. Videla L.

Promedios horarios > 1000 µg/m^3

Fecha	Estación	Concentración	Hora
27/02/00	E. Paipote	1112 µg/Nm^3	9 - 10
27/02/00	E. Paipote	1156 µg/Nm^3	10 - 11
28/02/00	**T. Amarilla**	**1224 µg/Nm^3**	**10 - 11**
21/03/00	E. Paipote	1129 µg/Nm^3	9 - 10
28/04/00	**E. Paipote**	**2045 µg/Nm^3**	**9 - 10**
5/05/00	E. Paipote	1580 µg/Nm^3	10 - 11
7/05/00	Volcanes	1115 µg/Nm^3	12 - 13
11/06/00	E. Paipote	1611 µg/Nm^3	10 - 11
12/06/00	**T. Amarilla**	**1421 µg/Nm^3**	**12 - 13**
16/06/00	E. Paipote	1632 µg/Nm^3	10 - 11
19/06/00	E. Paipote	1195 µg/Nm^3	10 - 11
21/06/00	E. Paipote	1047 µg/Nm^3	10 - 11
25/06/00	E. Paipote	1070 µg/Nm^3	11 - 12
26/06/00	E. Paipote	1508 µg/Nm^3	10 - 11
1/07/00	**T. Amarilla**	**1351 µg/Nm^3**	**10 - 11**
3/07/00	E. Paipote	1092 µg/Nm^3	8 - 9
11/07/00	E. Paipote	1697 µg/Nm^3	10 - 11
12/07/00	E. Paipote	1868 µg/Nm^3	9 - 10
12/07/00	**E. Paipote**	**1984 µg/Nm^3**	**10 - 11**
16/07/00	E. Paipote	1269 µg/Nm^3	2 - 3
16/07/00	E. Paipote	1824 µg/Nm^3	3 - 4
16/07/00	E. Paipote	1047 µg/Nm^3	5 - 6
16/07/00	E. Paipote	1027 µg/Nm^3	6 - 7
16/07/00	E. Paipote	1180 µg/Nm^3	9 - 10
16/07/00	E. Paipote	1727 µg/Nm^3	10 - 11
23/07/00	**E. Paipote**	**1979 µg/Nm^3**	**9 - 10**
25/07/00	**T. Amarilla**	**1291 µg/Nm^3**	**10 - 11**
25/07/00	**T. Amarilla**	**1208 µg/Nm^3**	**11 - 12**
26/07/00	E. Paipote	1236 µg/Nm^3	13 - 14

Red de Monitoreo Ambiental Fundición H. Videla L.

Frecuencia mensual superación Potencial Norma Horaria Primaria de SO_2 (> 1.050 µg/Nm3)

2000

MES	T. Amarilla	S. Fernando	Pabellón	E. Paipote	Copiapó	Los Volcanes	TOTAL
ENE	0	0	0	0	0	0	0
FEB	1	0	0	2	0	0	3
MAR	0	0	0	1	0	0	1
ABR	0	0	0	1	0	0	1
MAY	0	0	0	1	0	1	2
JUN	1	0	0	5	0	0	6
JUL	3	0	0	10	0	0	13
AGO							
SEP							
OCT							
NOV							
DIC							
TOTAL	**5**	**0**	**0**	20	0	1	**26**

Fundición H. Videla Lira

Análisis Estadístico Cumplimiento Potencial Norma Diaria de SO_2

Niveles de SO_2 en µg/Nm^3

	Enero 2000						
Estaciones	veces > 250	veces > 280	veces > 300	veces > 320	veces > 340	veces > 365	peak
Copiapó	0	0	0	0	0	0	36
S. Fernando	0	0	0	0	0	0	22
Paipote	0	0	0	0	0	0	0
T. Amarilla	0	0	0	0	0	0	53

	Febrero 2000						
Estaciones	veces > 250	veces > 280	veces > 300	veces > 320	veces > 340	veces > 365	peak
Copiapó	0	0	0	0	0	0	17
S. Fernando	0	0	0	0	0	0	8
Paipote	0	0	0	0	0	0	114
T. Amarilla	0	0	0	0	0	0	90

	Marzo 2000						
Estaciones	veces > 250	veces > 280	veces > 300	veces > 320	veces > 340	veces > 365	peak
Copiapó	0	0	0	0	0	0	19
S. Fernando	0	0	0	0	0	0	12
Paipote	0	0	0	0	0	0	98
T. Amarilla	0	0	0	0	0	0	56

	Abril 2000						
Estaciones	veces > 250	veces > 280	veces > 300	veces > 320	veces > 340	veces > 365	peak
Copiapó	0	0	0	0	0	0	19
S. Fernando	0	0	0	0	0	0	20
Paipote	0	0	0	0	0	0	166
T. Amarilla	0	0	0	0	0	0	116

	Mayo 2000						
Estaciones	veces > 250	veces > 280	veces > 300	veces > 320	veces > 340	veces > 365	peak
Copiapó	0	0	0	0	0	0	47
S. Fernando	0	0	0	0	0	0	67
Paipote	0	0	0	0	0	0	162
T. Amarilla	0	0	0	0	0	0	88

	Junio 2000						
Estaciones	veces > 250	veces > 280	veces > 300	veces > 320	veces > 340	veces > 365	peak
Copiapó	0	0	0	0	0	0	22
S. Fernando	0	0	0	0	0	0	72
Paipote	1	1	1	0	0	0	316
T. Amarilla	0	0	0	0	0	0	103

	Julio 2000						
	veces > 250	veces > 280	veces > 300	veces > 320	veces > 340	veces > 365	peak
Copiapó	0	0	0	0	0	0	27
S. Fernando	0	0	0	0	0	0	76
Paipote	5	3	3	2	2	1	493
T. Amarilla	0	0	0	0	0	0	144

Detalle Plan Operacional Preventivo

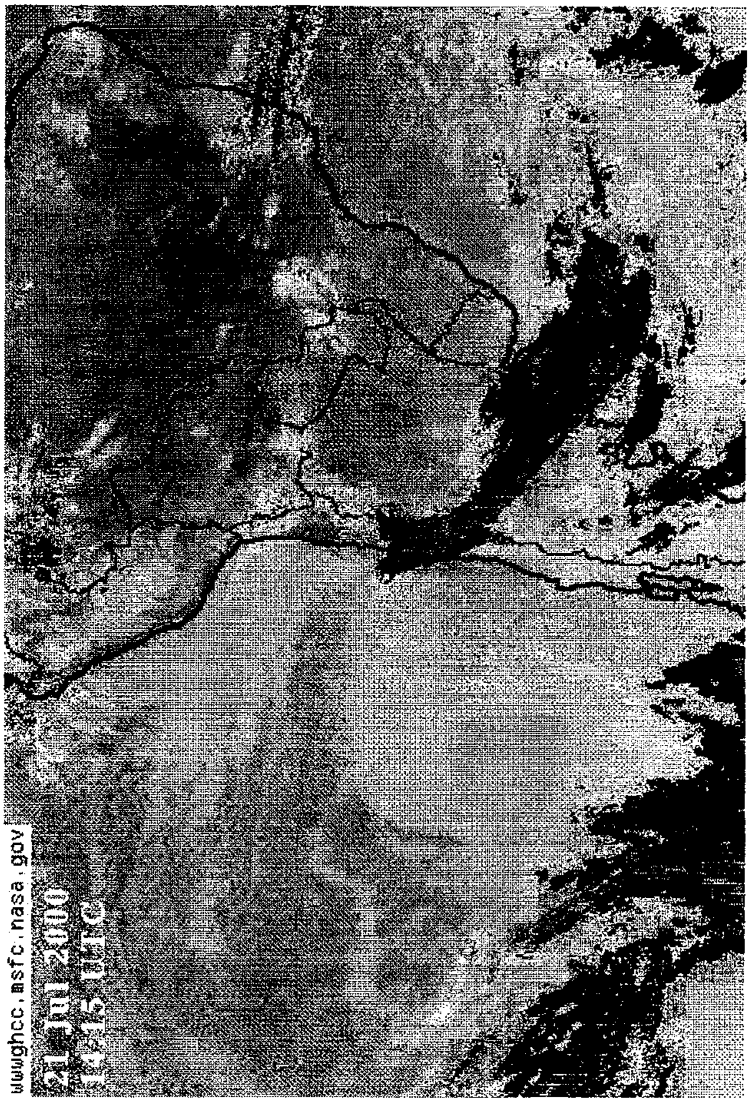
Enero 2000

Día	Operación preventiva según recomendación de Meteorología			Peak horario		Peak diario	
	Horas en Condición Regular	Horas en Condición Mala	Total horas Prevención	(µg/Nm3)	Estación	(µg/Nm3)	Estación
1	2.00	0.00	2.00	62	T.Amarilla	12	T.Amarilla
2	0.00	0.00	0.00	101	T.Amarilla	10	T.Amarilla
3	0.00	0.00	0.00	154	T.Amarilla	17	T.Amarilla
4	0.00	0.00	0.00	22	T.Amarilla	3	T.Amarilla
5	0.00	0.00	0.00	6	T.Amarilla	3	T.Amarilla
6	0.00	0.00	0.00	46	T.Amarilla	5	T.Amarilla
7	2.25	0.00	2.25	439	L.Volcanes	27	L.Volcanes
8	4.25	0.00	4.25	474	L.Volcanes	39	L.Volcanes
9	4.00	0.00	4.00	11	T.Amarilla	4	T.Amarilla
10	0.00	0.00	0.00	12	T.Amarilla	5	T.Amarilla
11	0.00	0.00	0.00	13	T.Amarilla	4	T.Amarilla
12	0.00	0.00	0.00	8	T.Amarilla	4	T.Amarilla
13	0.00	0.00	0.00	9	T.Amarilla	4	T.Amarilla
14	2.25	2.00	4.25	24	T.Amarilla	6	T.Amarilla
15	3.50	0.00	3.50	4	T.Amarilla	3	T.Amarilla
16	0.00	0.00	0.00	11	T.Amarilla	4	T.Amarilla
17	0.00	0.00	0.00	44	L.Volcanes	3	T.Amarilla
18	0.00	0.00	0.00	7	S. Fernando	3	T.Amarilla
19	0.00	0.00	0.00	11	T.Amarilla	4	T.Amarilla
20	0.00	0.00	0.00	16	L.Volcanes	4	T.Amarilla
21	0.00	0.00	0.00	6	T.Amarilla	3	T.Amarilla
22	0.00	0.00	0.00	20	T.Amarilla	5	T.Amarilla
23	0.00	0.00	0.00	182	L.Volcanes	15	L.Volcanes
24	0.00	0.00	0.00	24	T.Amarilla	7	T.Amarilla
25	1.75	0.00	1.75	31	T.Amarilla	8	T.Amarilla
26	0.00	0.00	0.00	30	T.Amarilla	11	T.Amarilla
27	0.00	0.00	0.00	69	T.Amarilla	15	T.Amarilla
28	0.00	0.00	0.00	94	T.Amarilla	11	T.Amarilla
29	1.00	3.50	4.50	67	L.Volcanes	6	T.Amarilla
30	2.50	2.50	5.00	177	T.Amarilla	52	T.Amarilla
31	2.50	3.50	6.00	712	T.Amarilla	53	T.Amarilla
Total	**26.00**	**11.50**	**37.50**	**2886.00**		**350.00**	
Promedio	**0.84**	**0.37**	**1.21**	**93.10**		**11.29**	
Porcentaje	**69.33%**	**30.67%**	**100%**				

Detalle Plan Operacional Preventivo

Julio 2000

Día	Operación preventiva según recomendación de Meteorología			Peak horario		Peak diario	
	Horas en Condición Regular	Horas en Condición Mala	Total horas Prevención	(µg/Nm3)	Estación	(µg/Nm3)	Estación
1	2.00	9.00	11.00	**1,351**	**T.Amarilla**	133	E. Paipote
2	2.25	8.00	10.25	319	E. Paipote	69	E. Paipote
3	2.50	9.25	11.75	1,092	E. Paipote	301	E. Paipote
4	10.50	0.00	10.50	282	E. Paipote	42	E. Paipote
5	0.00	0.00	0.00	315	T.Amarilla	63	E. Paipote
6	8.50	0.00	8.50	56	T.Amarilla	10	E. Paipote
7	6.50	0.00	6.50	436	T.Amarilla	54	T.Amarilla
8	8.75	0.00	8.75	200	T.Amarilla	52	E. Paipote
9	0.00	0.00	0.00	350	E. Paipote	39	E. Paipote
10	4.00	6.00	10.00	98	Volcanes	12	E. Paipote
11	2.00	9.00	11.00	1,697	E. Paipote	145	E. Paipote
12	1.00	11.00	12.00	**1,984**	**E. Paipote**	341	E. Paipote
13	1.25	11.50	12.75	829	E. Paipote	257	E. Paipote
14	5.50	3.00	8.50	302	E. Paipote	55	E. Paipote
15	5.00	3.00	8.00	916	E. Paipote	148	E. Paipote
16	2.75	8.50	11.25	1,824	E. Paipote	**493**	**E. Paipote**
17	5.00	0.00	5.00	419	E. Paipote	78	E. Paipote
18	10.00	0.00	10.00	591	T.Amarilla	51	E. Paipote
19	3.75	8.00	11.75	995	E. Paipote	214	E. Paipote
20	2,50	9,25	11,75	867	E. Paipote	183	E. Paipote
21	0.00	0.00	0.00	40	T.Amarilla	4	T.Amarilla
22	0.00	0.00	0.00	855	E. Paipote	84	E. Paipote
23	2.75	9.25	12.00	**1,979**	**E. Paipote**	259	E. Paipote
24	2.00	10.50	12.50	858	E. Paipote	144	E. Paipote
25	2.00	10.00	12.00	**1291 / 1208**	**T.Amarilla**	161	E. Paipote
26	3.50	4.50	8.00	1,236	E. Paipote	186	E. Paipote
27	4.50	4.50	9.00	115	E. Paipote	19	E. Paipote
28	11.00	0.00	11.00	411	T.Amarilla	54	E. Paipote
29	2.00	9.00	11.00	789	E. Paipote	239	E. Paipote
30	4.00	9.50	13.50	800	E. Paipote	204	E. Paipote
31	3.50	4.00	7.50	965	E. Paipote	140	E. Paipote
Total	**116.50**	**147.50**	**264.00**	**22971.00**		**4234.00**	
Promedio	**3.88**	**4.92**	**8.80**	**765.70**		**136.58**	
Porcentaje	**44.13%**	**55.87%**	**100%**				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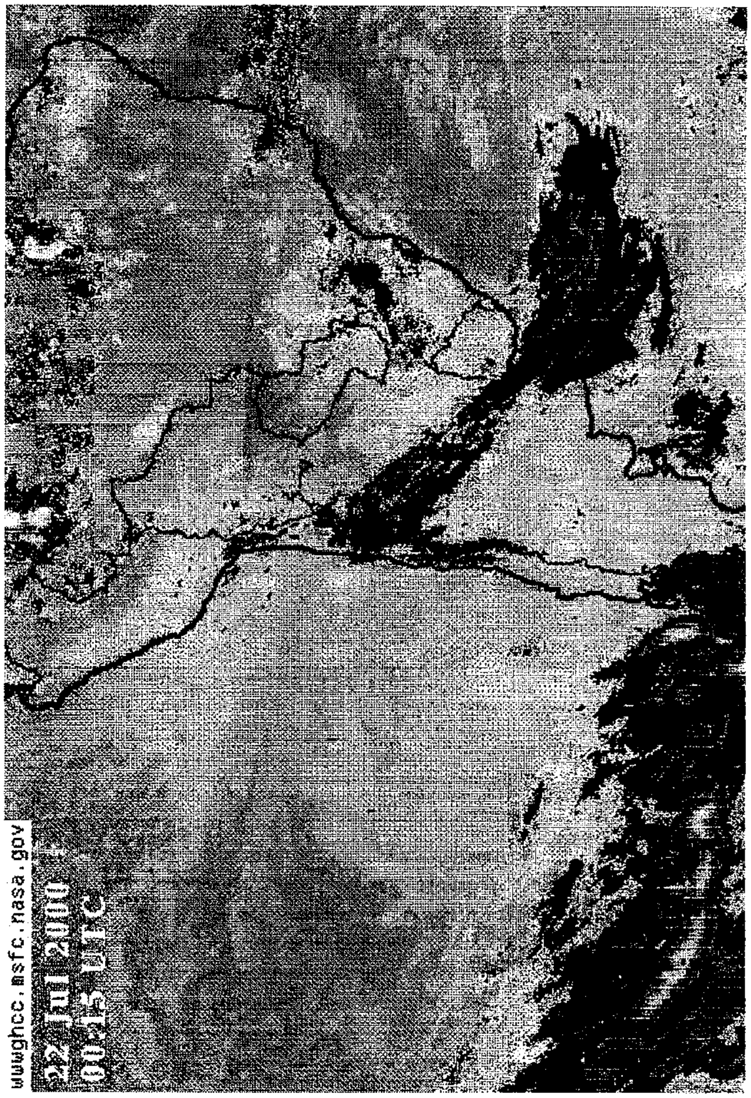

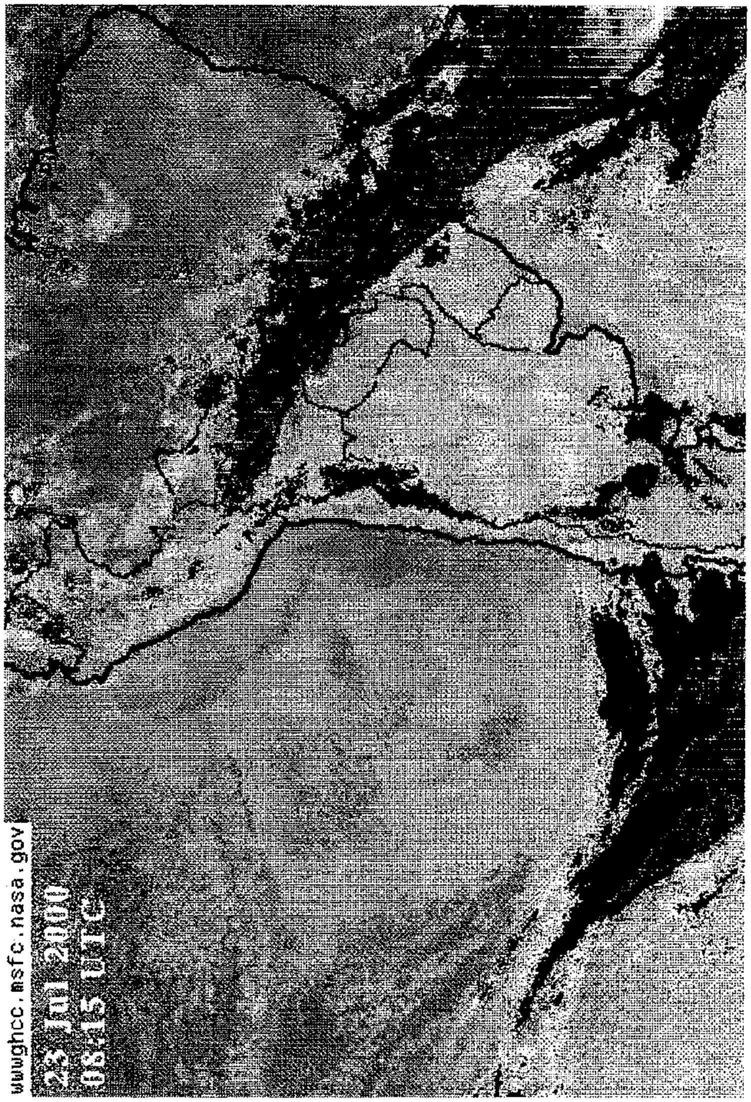
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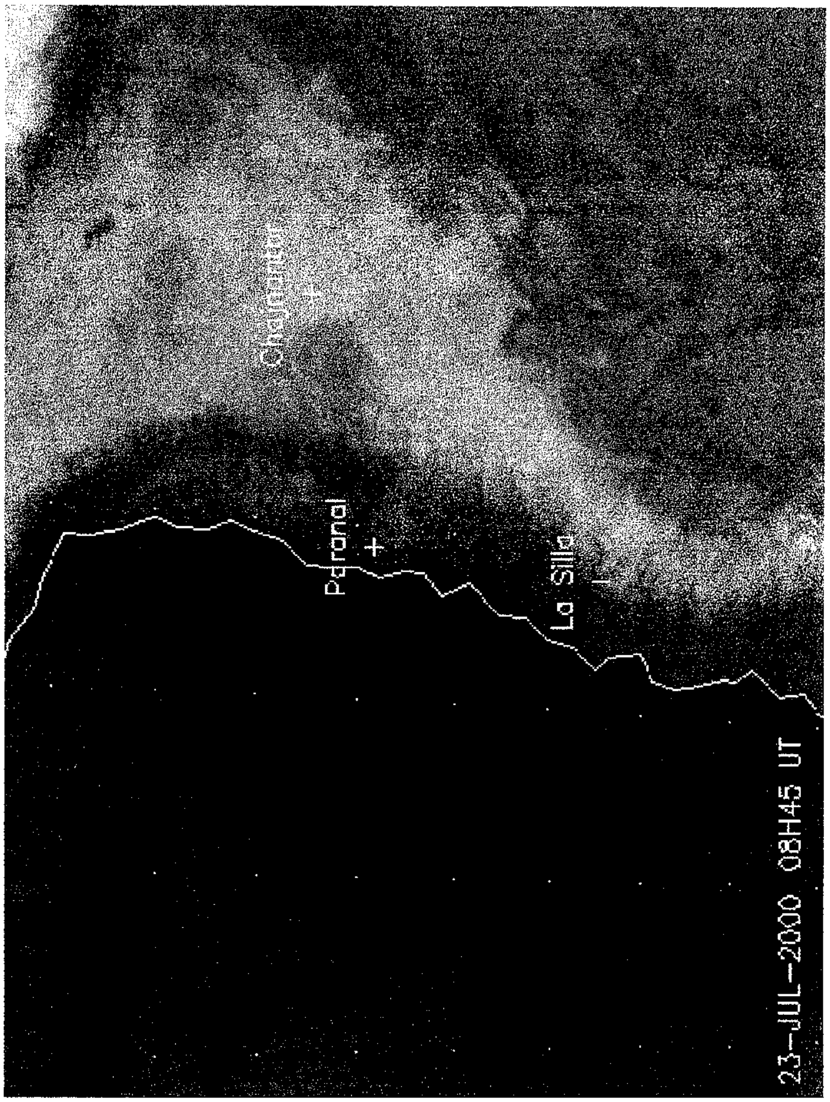
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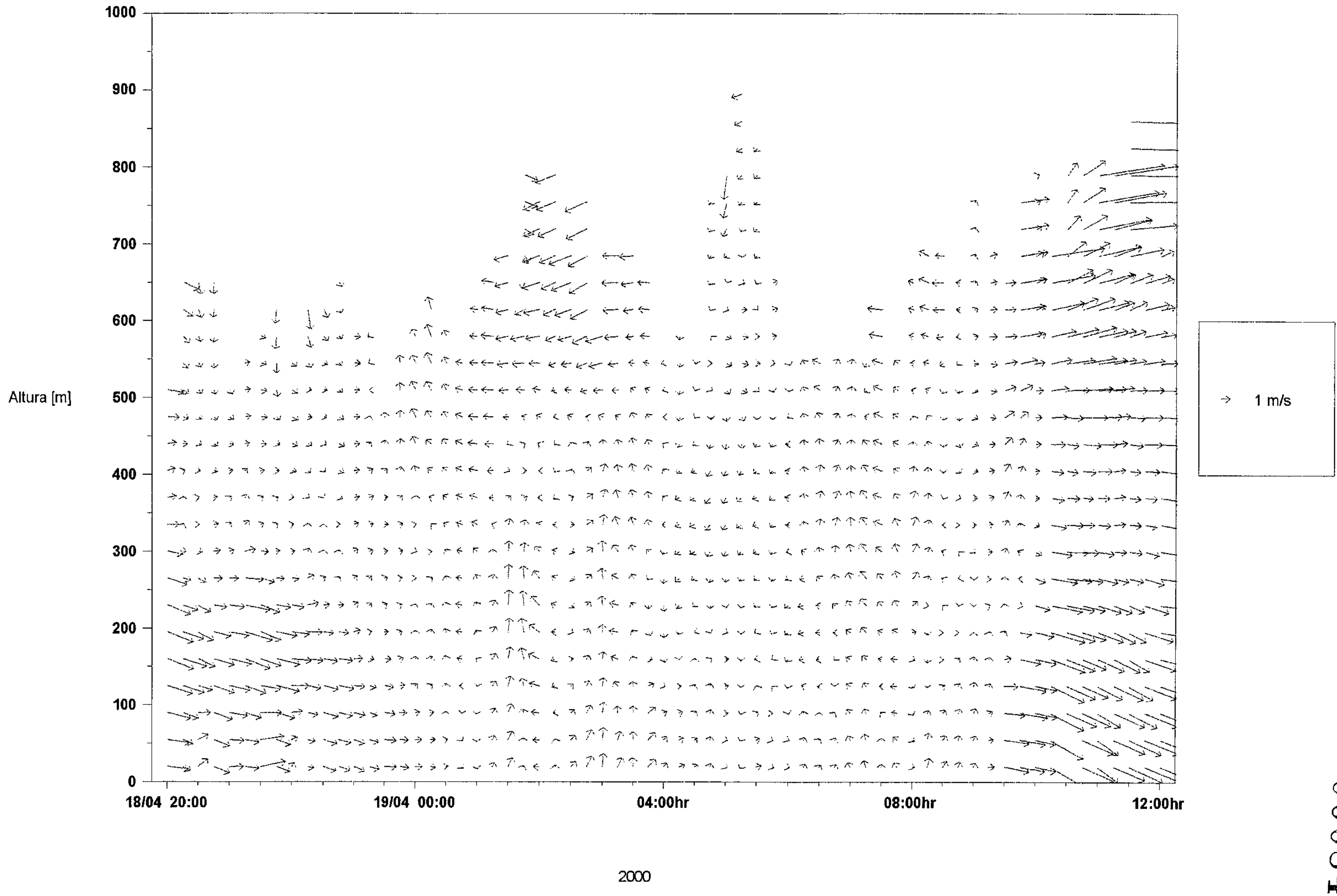
Vectores de Viento - Datos Ecosonda



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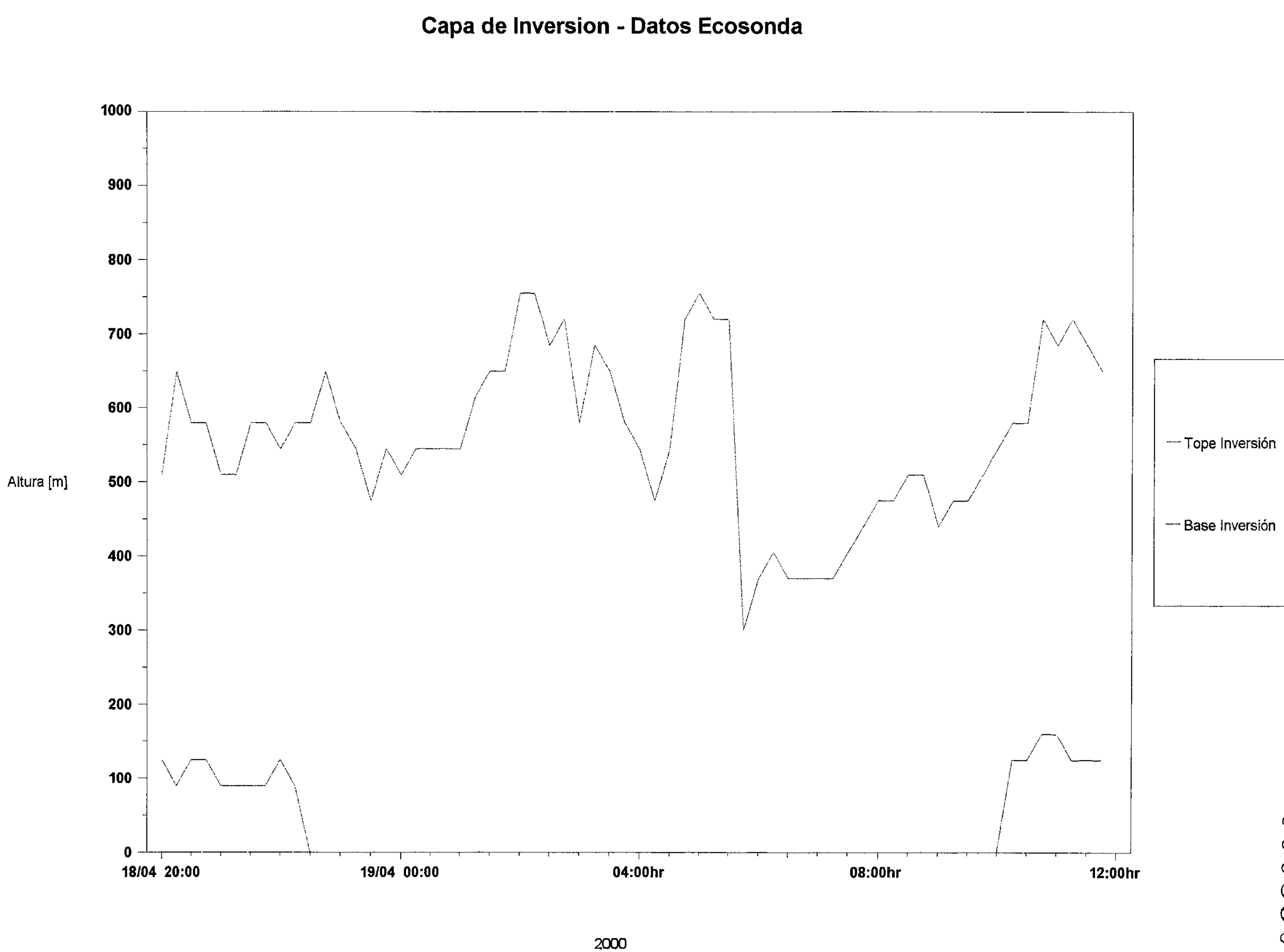
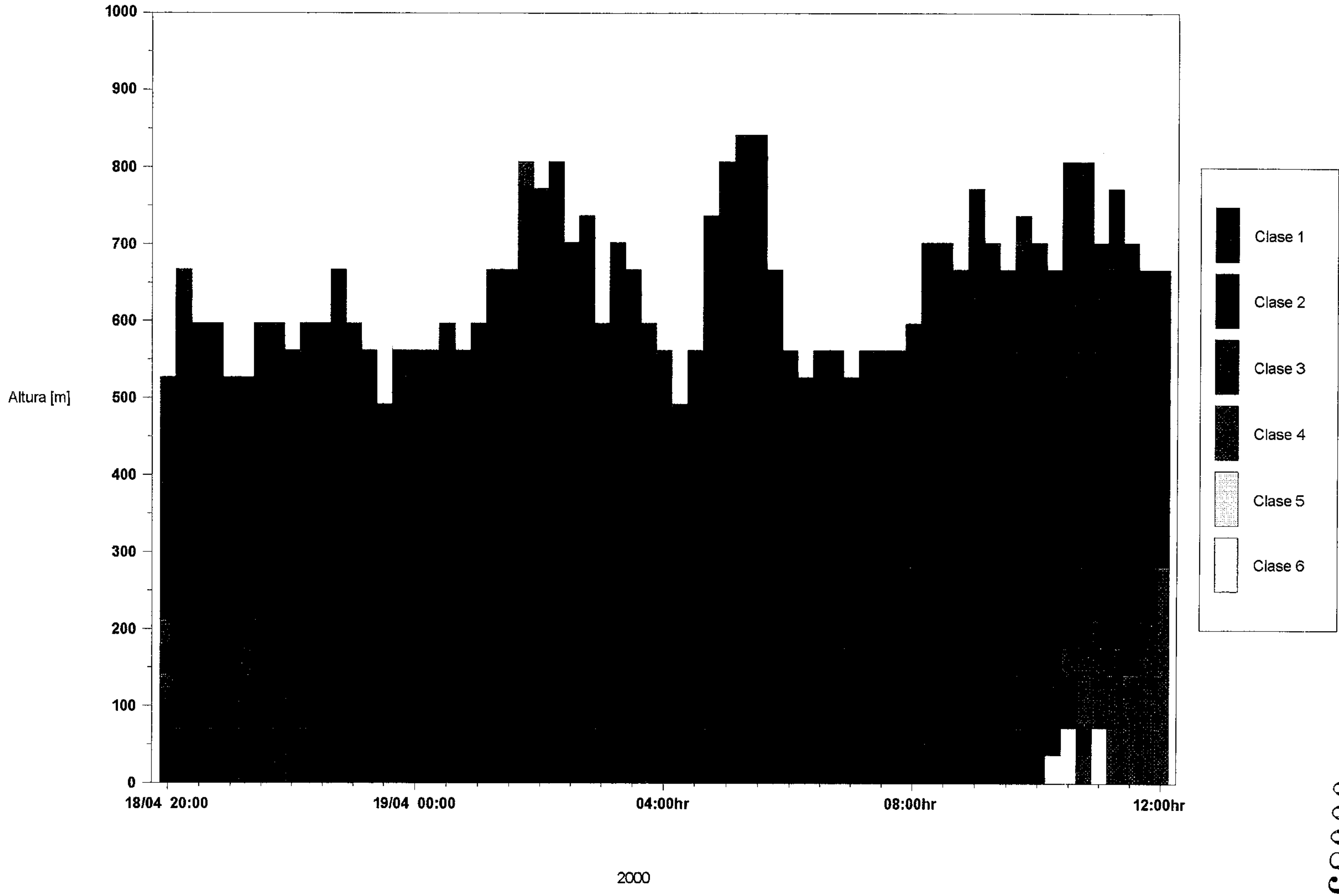
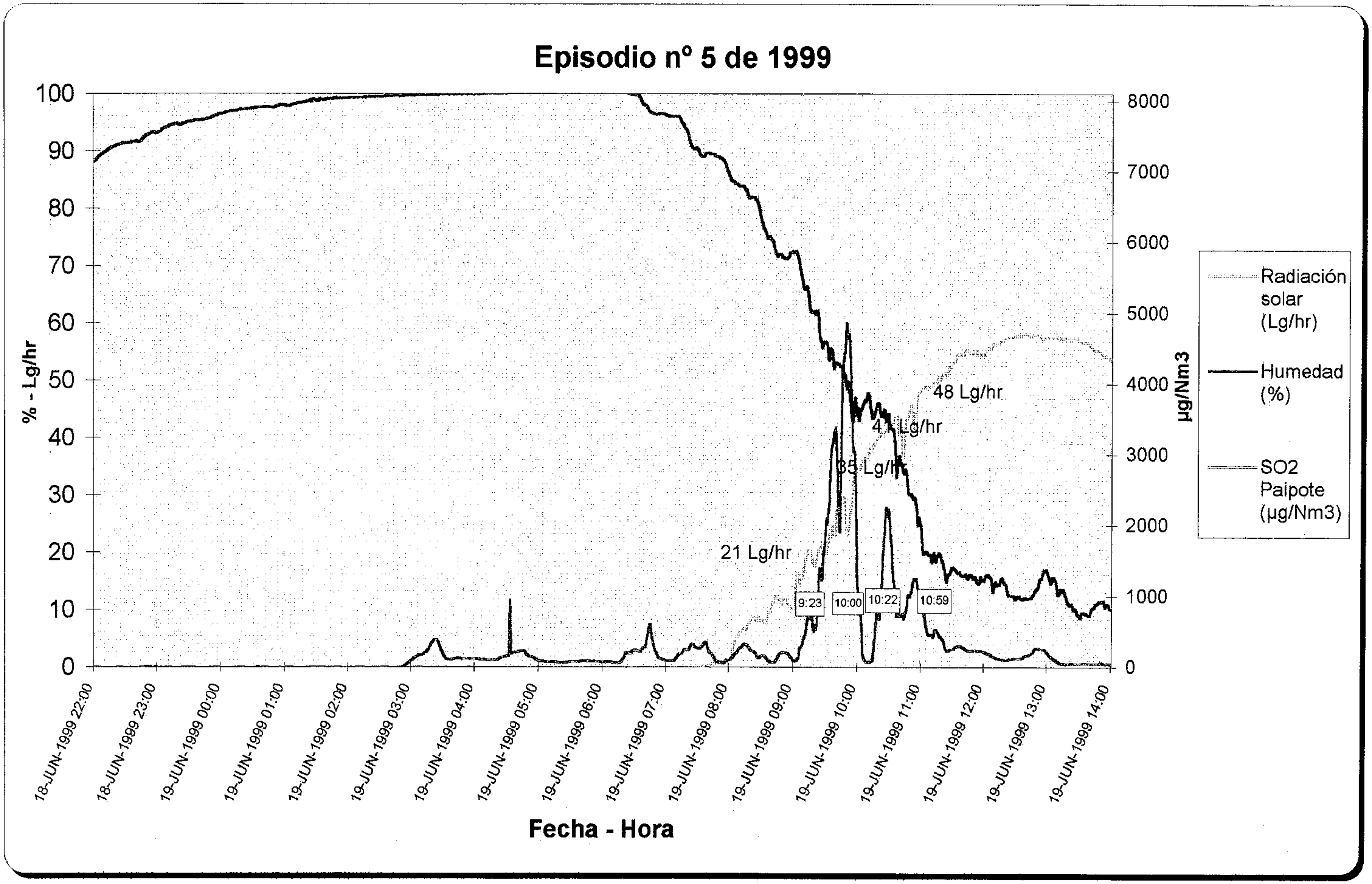


Capa de Inversion - Datos Ecosonda
Altura [m]
1000
900
800
700
600
500
400
300
200
100
0
18/04 20:00
19/04 00:00
04:00hr
08:00hr
12:00hr
2000
Tope Inversión
Base Inversión

000851

Estabilidad Atmosférica - Datos Ecosonda




Episodio nº 5 de 1999
% - Lg/hr
µg/Nm3
Fecha - Hora
Radiación solar (Lg/hr)
Humedad (%)
SO2 Paipote (µg/Nm3)
21 Lg/hr
35 Lg/hr
41 Lg/hr
48 Lg/hr
9:23
10:00
10:22
10:59
0
10
20
30
40
50
60
70
80
90
100
1000
2000
3000
4000
5000
6000
7000
8000
18-JUN-1999 22:00
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19-JUN-1999 13:00
19-JUN-1999 14:00

COMISIÓN NACIONAL DEL MEDIO AMBIENTE
DEPARTAMENTO DE DESCONTAMINACIÓN, PLANES Y NORMAS

Revisión Norma de Calidad Primaria contenidas en la Resolución Nº 1215/78

ACTA DE REUNION DE COMITÉ OPERATIVO Y AMPLIADO

FECHA REUNION : 14 de agosto de 2000
LUGAR : CONAMA. Obispo Donoso 6. Santiago
ASISTENCIA : Se adjunta hoja de asistencia

Tabla :

1. Discusión de la propuesta de CONAMA u otras propuestas

Discusión :

Ozono:

- **M.Alday** (IAConsult) señala que según la auditoría al plan de descontaminación de la RM el ozono es producto de hidrocarburos no metánicos más que de NO2/NOx. Señala además que la modificación de la norma a 8 horas estaría afectando el nivel normativo sin tomar control sobre contaminantes primarios. Hay que pensar también en las compensaciones de 150%. Manifiesta su preocupación por la complejidad que pueden tener los proyectos nuevos en cuanto a la modelación requerida para proyectar cumplimiento de una norma de 8 horas. **F.Farías** *(CONAMA)* indica que las normas que se están revisando son de calidad primaria por lo que buscan proteger los efectos en la salud de la población. Los Planes de descontaminación deberán tomar en cuenta los precursores. Con la meta establecida en el nivel de norma se deben establecer las medidas que conduzcan a su cumplimiento. En cuanto al tema de las compensaciones éstas son más complejas en relación con el ozono. En relación a los modelos aplicables **L.Gallardo** *(CONAMA)* sostiene que no hay problema siempre y cuando las herramientas se apliquen correctamente. **R.Sanguinetti** *(CONAMARM)* manifiesta la necesidad de que las consultoras avancen a la par con los conocimientos cientifíco-técnicos.

- **C.Salvo** (*SONAMI*) indica que a su entender se están proponiendo dos normas para ozono, una de 8 horas y otra de 1 hora, presentada la última como niveles de emergencia. Desde el punto de vista del usuario se deben cumplir con ambos niveles. **F.Farías** *(CONAMA)* responde que conceptualmente son distintas, siendo los niveles de emergencia para proteger de exposiciones a niveles extremadamente altos, ante los cuales deben tomarse medidas inmediatas o prevenirlos. Sostiene que de acuerdo a al OMS a niveles sobre 500 ug/m3 se encuentran efectos constatables. Con el valor de 8 horas propuesto se estaría protegiendo contra efectos horarios, sin embargo, si los niveles suben drásticamente es necesario tomar medidas. **A.Tchernitchin** *(Colegio Médico)* sostiene que para proteger de efectos agudos de una hora debería mantenerse la norma horaria. **F.Farías** *(CONAMA)* afirma que el valor propuesto para 8 horas protege también de aquellos efectos horarios.

- **C.Santana** (*CONAMA*) señala que la norma es una meta de calidad del aire y que el gradualismo para su cumplimiento se da a través de los planes de descontaminación, estableciendo los plazos de acuerdo a la realidad del país. Hace hincapié en la necesidad de definir una norma de calidad con una meta clara, dado que un mal diseño de ésta significará una inadecuada planificación a futuro y que a la larga aumentará los costos asociados al cumplimiento de las metas.

- **E.Cohen** *(Consejo Minero)* consulta si la propuesta fue generada por el Comité Operativo o sólo por CONAMA. **F.Farías** *(CONAMA)* responde que la propuesta es de CONAMA.

Fernando Farías E.
Depto. Descontaminación, Planes y Normas
CONAMA

Celestino : fax 3696695

COMISION NACIONAL DEL MEDIO AMBIENTE
DEPTO. DESCONTAMINACION, PLANES Y NORMAS

Reunión "Revisión Normas Primarias de Calidad de Aire para SO2, PTS, CO, NO2 Y O3"
Santiago, 14 de Agosto 2000

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5.	Macarena Aldag	Illanes y Asoc.	2641328	2649915	m-aldag@jaimeillanes.cl.
6.	Alejandra Arancibia	UTMA. Ministerio OOPP.	3612835	3612749	utma@mop.cl.
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12.	Andrei N. Tchernitchin	Colegio Médico de Chile	6786222		atcherni@machi.med.uchile.cl.
13.	Laura Gallardo	CONAMA (P y N)	2405668	2443430	lgallardo@conama.cl
14.	Andrea Varas C.	C.N.E.	3656800	3656888	avaras@cne.cl
15.	Mauro Lopez C.	S. Salud O'Higgins	072-238686		dpa@entelchile.net
16.	Ian Nelson	Colegio Ingenieros	3342701	3392717	inelson@metrogas.cl
17.					

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CODELCO-CHILE

CORPORACION NACIONAL DEL COBRE DE CHILE

CHUQUICAMATA - R. TOMIC - EL SALVADOR - ANDINA - EL TENIENTE - TALLERES

Huérfanos 1270 - Casilla 150-D - Santiago, Chile - Fax: (56-2) 690 3059 - 672 1473

GMA-372/00

Santiago, 21 de Agosto de 2000

COMISION NACIONAL DEL MEDIO AMBIENTE
OFICINA DE PARTES Y ARCHIVO
Nº INGRESO: 9335/7868
FECHA: 22 AGO 2000
DESPACHADO:
OBS.: P. Matus 24

Sra.
Patricia Matus C.
Jefe Depto. Descontaminación,
Planes y Normas
Comisión Nacional del Medio Ambiente
PRESENTE

Ref: **Revisión de Normas Primarias de Calidad del Aire**

Estimada Sra. Matus:

Hemos tomado conocimiento de la propuesta de Anteproyecto para la Revisión de la Norma en referencia, que incluye algunos cambios en ella que son de nuestra preocupación.

La Corporación ha realizado un importante esfuerzo en la realización de proyectos diseñados para dar cumplimiento a los Planes de Descontaminación de sus Fundiciones, los que han sido concebidos sobre la base de la normativa actualmente vigente. Estos Planes, por sí solos, no están en condiciones de dar respuesta apropiada a los nuevos límites de concentración que impondría la nueva Norma y, aún con la ejecución de proyectos complementarios, sus operaciones quedarían en una situación bastante vulnerable para la seguridad de su cumplimiento.

A continuación nos referimos a los principales cambios considerados en la revisión:

1. **Partículas Totales en Suspensión:** la propuesta elimina este parámetro, idea con la cual concordamos plenamente, al existir otras normas que controlan en mejor forma el material particulado.

2. **Norma Anual SO2:** la propuesta mantiene el valor de este parámetro, posición con la que concordamos, pues no existen antecedentes que ameriten modificarlo.

3. **Norma SO2 24 horas:** se ha propuesto disminuirla de 365 a 250 ugr/Nm3, con un percentil de cumplimiento de 99%. El valor límite propuesto no es posible de ser cumplido bajo ninguna circunstancia en el campamento de Chuquicamata, ni ser cumplida a cabalidad en el Centro de Alojamiento de Potrerillos (División Salvador) o en Coya Club de Campo y en lugares residenciales de Coya cercanos a él (División El Teniente). Ante un eventual traslado del campamento de Chuquicamata, estaríamos corporativamente en condiciones de cumplir una Norma no inferior a 300 ugr/Nm3, con un percentil de cumplimiento de 98%.

4. **Norma Primaria Horaria de SO2:** aquí se ha propuesto, contra la opinión del consultor de CONAMA sobre esta materia, establecer una Norma Horaria, fijándola en un valor de 1050 ugr/Nm3, con un percentil de cumplimiento de 99%. Al margen de las consideraciones de beneficio-costo realizadas por el consultor, se debe tener en cuenta lo poco práctico de una norma de este tipo, pues las acciones de control operacional a adoptar de tipo reactivas no tendrían efectos dentro de este corto período. Para evitar su ocurrencia, las medidas necesariamente deberían ser de tipo preventivas, lo que obligaría a operar las fundiciones en base a complejos modelos meteorológicos predictivos (que han revelado ser de escasa exactitud), que las llevaría a significativas pérdidas productivas, muchas veces innecesarias. Nos parece que las situaciones de impactos agudos de corto tiempo pueden ser mucho mejor manejados a través de las medidas establecidas para el manejo de episodios críticos, los que se pueden establecer aún cuando no existan Planes de Descontaminación en vigencia (Ejemplo: restricciones de circulación de vehículos y paralización de fábricas en Santiago desde mucho tiempo antes que se estableciera un Plan de Descontaminación al respecto).

   Si se mantuviera la idea de manejar estas situaciones a través de una Norma de Calidad, nos parece más lógico establecer una que regule el promedio móvil de tres horas, período en el cual sí se puede reaccionar con medidas de control operacional efectivas. El valor podría ser el mismo propuesto, pero con un percentil de cumplimiento de 98%.

No entendemos la razón de aplicar para este contaminante percentiles de cumplimiento de 99%, en circunstancias que para PM10 este percentil es de 98%. A nuestro juicio, este nivel de percentil debería igualarse para todas las normas y no definir este valor en forma arbitraria para cada una de ellas.

Finalmente, queremos hacer llegar a Ud. una preocupación respecto del proceso normativo ambiental, en general. La globalización del comercio internacional ha llevado a establecer modelos de comportamiento ambiental aceptables internacionalmente, para evitar discriminaciones arbitrarias al respecto. Las empresas chilenas que basan su gestión en el comercio internacional de sus productos, están siendo presionadas progresivamente por el mercado a establecer estos modelos de gestión ambiental consensuados. Codelco, así como otras empresas exportadoras, están implementando sistemas de gestión ambiental para ser certificados por la Norma ISO-14001. Esta Norma tiene como su principal exigencia, el cumplimiento del marco regulatorio aplicable. Un no cumplimiento de este marco es razón suficiente para no certificar o, peor aún, para perder una certificación alcanzada. Ello lleva a la necesidad de ser muy cuidadosos al definir la normativa a aplicar, teniendo en consideración sus posibilidades reales de cumplimiento, a fin de no dejar fuera del mercado internacional a volúmenes importantes de la producción nacional.

Esperando que nuestras observaciones puedan ser acogidas en el Anteproyecto de Revisión de las Normas Primarias de Calidad de Aire, la saluda muy atentamente,

Santiago Torres E.
Gerente de Medio Ambiente

COMISIÓN NACIONAL DEL MEDIO AMBIENTE
DEPARTAMENTO DE DESCONTAMINACIÓN, PLANES Y NORMAS

Revisión Norma de Calidad Primaria contenidas en la Resolución Nº 1215/78

ACTA DE REUNION DE COMITÉ OPERATIVO

FECHA REUNION : 23 de agosto de 2000
LUGAR : CONAMA. Obispo Donoso 6. Santiago
ASISTENCIA : Se adjunta hoja de asistencia

Tabla :

1. Discusión de la propuesta de CONAMA u otras propuestas

Discusión :

- **C.Saavedra** (*MOP*) señalan su conformidad con la propuesta de CONAMA.
- **S.Pimentel/M.Vasquez** (*COCHILCO/M.MINERIA*) señala que proponer niveles de norma sin una evaluación previa de costo beneficio no es razonable. La propuesta del Comité Operativo a las instancias superiores debería ya considerar esa variable. Señala que las situaciones críticas se prsentarían en las fundiciones de ENAMI y también se debe considerar que el acuerdo de Chile-Canadá exige cumplimiento de normativa en un plazo de 2 años. Además indica que con el D.S. Nº185 el país optó por una tecnología determinada con su inversión asociada. Las normas propuestas significarían una reconversión de la tecnología. Señalan que el punto más crítico es la norma horaria, por lo que proponen no normar para ese período.
- **W.Folch** (*M.Salud*) indica que CONAMA recibirá un oficio formal con la opinión de este ministerio respecto a la propuesta de CONAMA.
- **I.Olaeta** (*SESMA*) sostiene que se tiene información internacional respecto a los efectos en salud que causan los distintos contaminantes así como también se cuenta con información respecto a normativas internacionales. Estos antecedentes respaldan los niveles propuestos. Sostiene que si estos niveles se cambian por considerar el factor económico, entonces eso debe hacerse con la debida transparencia.

Rodrigo Lucero Ch.
Depto. Descontaminación, Planes y Normas
CONAMA

COMISION NACIONAL DEL MEDIO AMBIENTE
DEPTO. DESCONTAMINACION, PLANES Y NORMAS

Reunión "Revisión Normas Primarias de Calidad de Aire para SO2, PTS, CO, NO2 Y O3"
Santiago, 23 de Agosto 2000

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17.						

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DISPUTADA

Chagres, 23 de Agosto de 2000

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COMISION NACIONAL DEL MEDIO AMBIENTE
OFICINA DE PARTES Y ARCHIVO
Nº INGRESO: 9614 / 2033
FECHA:
DESPACHADO: 28 AGO 2000
OBS.: Rodrigo Lucero.

Señores
Comisión Nacional de Medio Ambiente
CONAMA
Departamento Planes y Normas
Presente

At. : Sr. **Rodrigo Lucero Ch.**

Estimados Señores:

Adjuntamos la siguiente información para su consideración con relación a la revisión de la Resolución 1215:

Inversiones de Capital:

En los últimos años la Fundición Chagres modificó sus instalaciones con una inversión superior a US $ 210.- Millones Esta inversión consideró el cambio de tecnología de Reverbero a Fusión Flash, aumentando considerablemente la recuperación de azufre, elevándola a estándares internacionales.

Otros proyectos ambientales adicionales se han desarrollado con posterioridad, con una inversión de US $ 20.- Millones. Estas inversiones tienen como base ambiental la legislación vigente, la cual Chagres cumple con rigurosidad.

De lo anterior se puede ver que los niveles de inversión para modernizar las fundiciones son muy altos y con horizontes de largo plazo para su justificación. Estas altas inversiones podrían restringir la viabilidad del negocio en la medida que algunas reglas puedan ser cambiadas mediante la vía de estándares ambientales o de otra índole.

Cumplimiento de Normas Ambientales:

Fundición Chagres ha invertido en tecnología computacional y de sistemas de información para contar con una Red de Vigilancia Ambiental acorde a los tiempos y exigencias.
En otro ámbito, las Políticas de Disputada manifiestan el firme propósito de cumplir estrictamente las disposiciones legales vigentes, debido a lo cual, además de las inversiones ha sido necesario desarrollar estrictos procedimientos preventivos para minimizar las posibilidades de exceder la normativa ambiental aplicable.

COMPAÑIA MINERA DISPUTADA
DE LAS CONDES LTDA.
Av. Pedro de Valdivia 291
Casilla 16178
Santiago, Chile
Teléfono: 2306000
Fax: 2306700
Télex: 341621 CMDLC

Para el caso del SO_2, el procedimiento preventivo considera desde tempranas acciones de “observación de las condiciones meteorológicas” hasta la detención total de la fundición.
Para la operación de Chagres, las detecciones en las estaciones de monitoreo se consideran como variables del proceso productivo.
No obstante todo lo anterior dada la variable meteorológica (explicada más adelante), y con el propósito de asegurar el cumplimiento de las normas, estimamos actualmente una pérdida directa de producción anual del orden de 650 ton de Cobre Fino.

Efecto de la Meteorología:

La meteorología juega un papel importante en Chagres para el cumplimiento de la Norma Horaria (norma secundaria), debido a que ésta es sumamente sensible al comportamiento meteorológico sobre el cual no existen posibilidades de control.

Existen dos escenarios claves para el cumplimiento de la norma horaria:
1.- Condiciones de Calma; En esta condición meteorológica, es relativamente alta la probabilidad de excedencia debido a que los gases se acumulan en el entorno de la fundición por la inexistencia de ventilación.
2.- Atmósferas estables; Es una condición diferente a la de calma donde el viento “se fija” en una dirección dada en forma persistente con velocidades tales que la dispersión es muy ineficiente produciéndose una baja turbulencia. En estas condiciones se produce un impacto directo debido a lo cual se hace necesario tomar acciones preventivas para no transgredir la norma.

De las dos condiciones descritas, evidentemente la de calma es la de mayor dificultad de controlar y en consecuencia la que produce mayores perdidas.

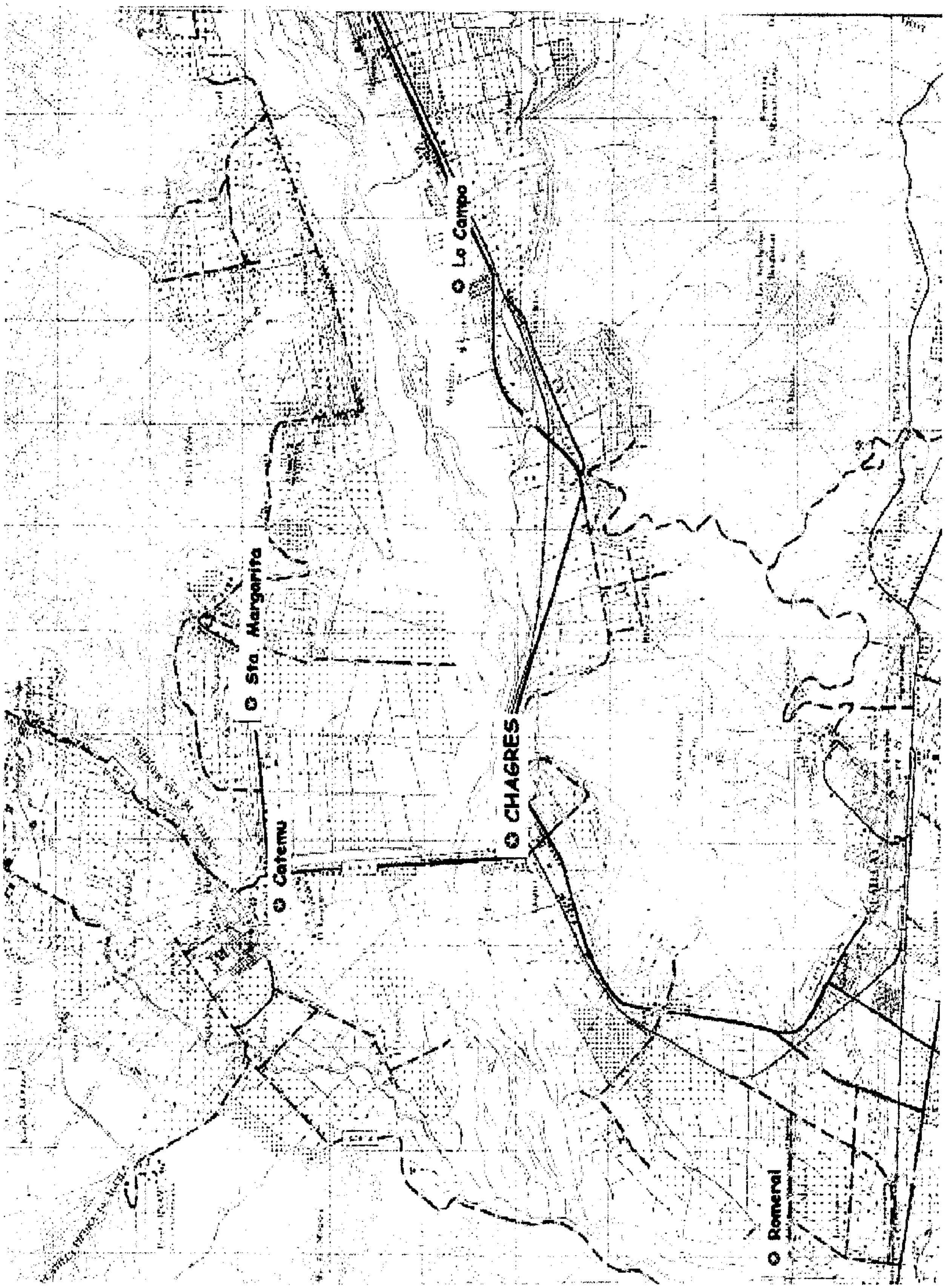
Por último, estimamos que antes de poner en vigencia los estándares propuestos para la Resolución 1215, es necesario evaluar el impacto de ellos sobre la viabilidad de las fundiciones en el país y el beneficio que estos nuevos estándares traerían para la población.

Sin otro particular, saluda atentamente a Ud.

MA.

Miguel Angel Duran V.
Gerente General Fundición Chagres

CSP/ CG80061.00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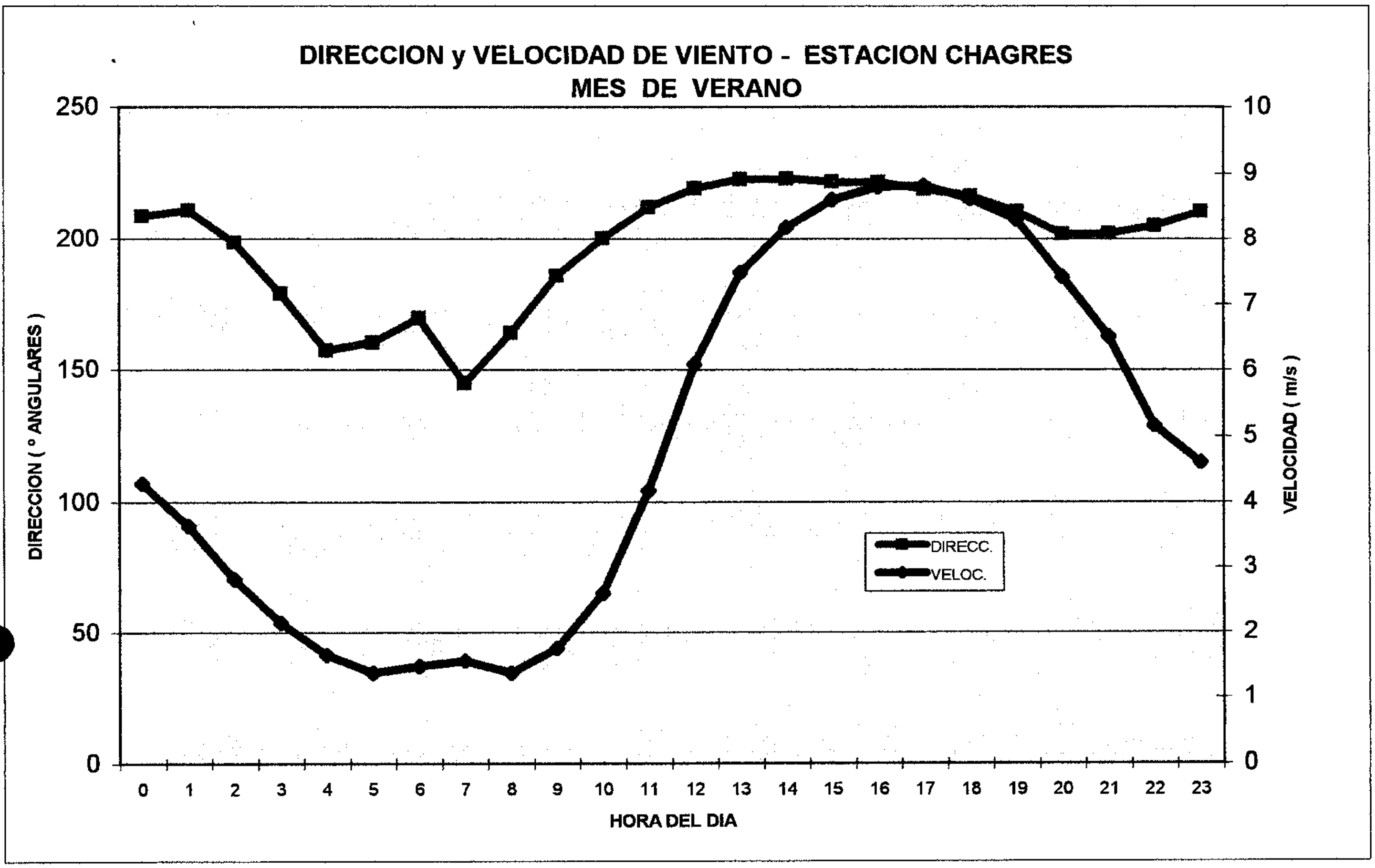
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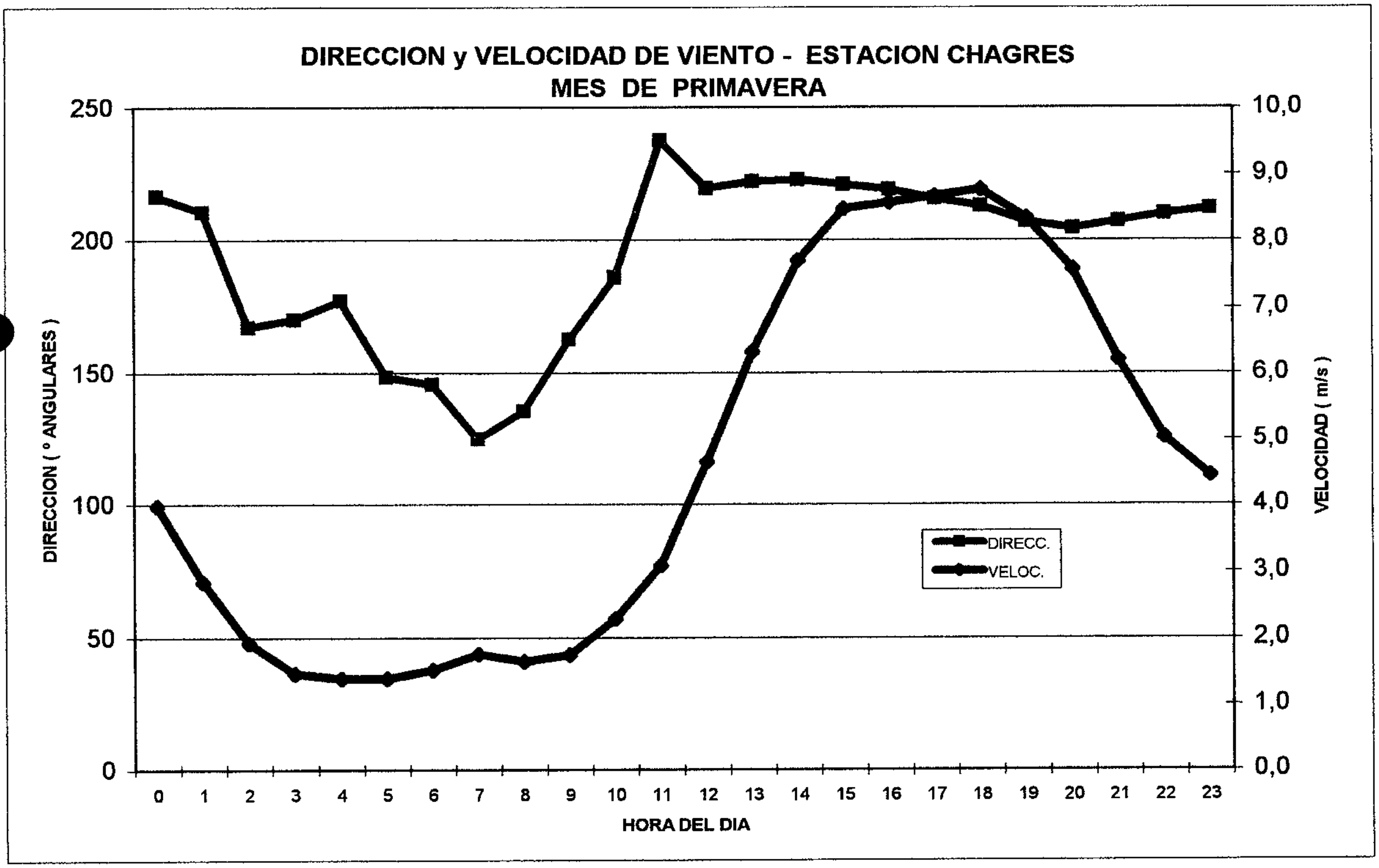
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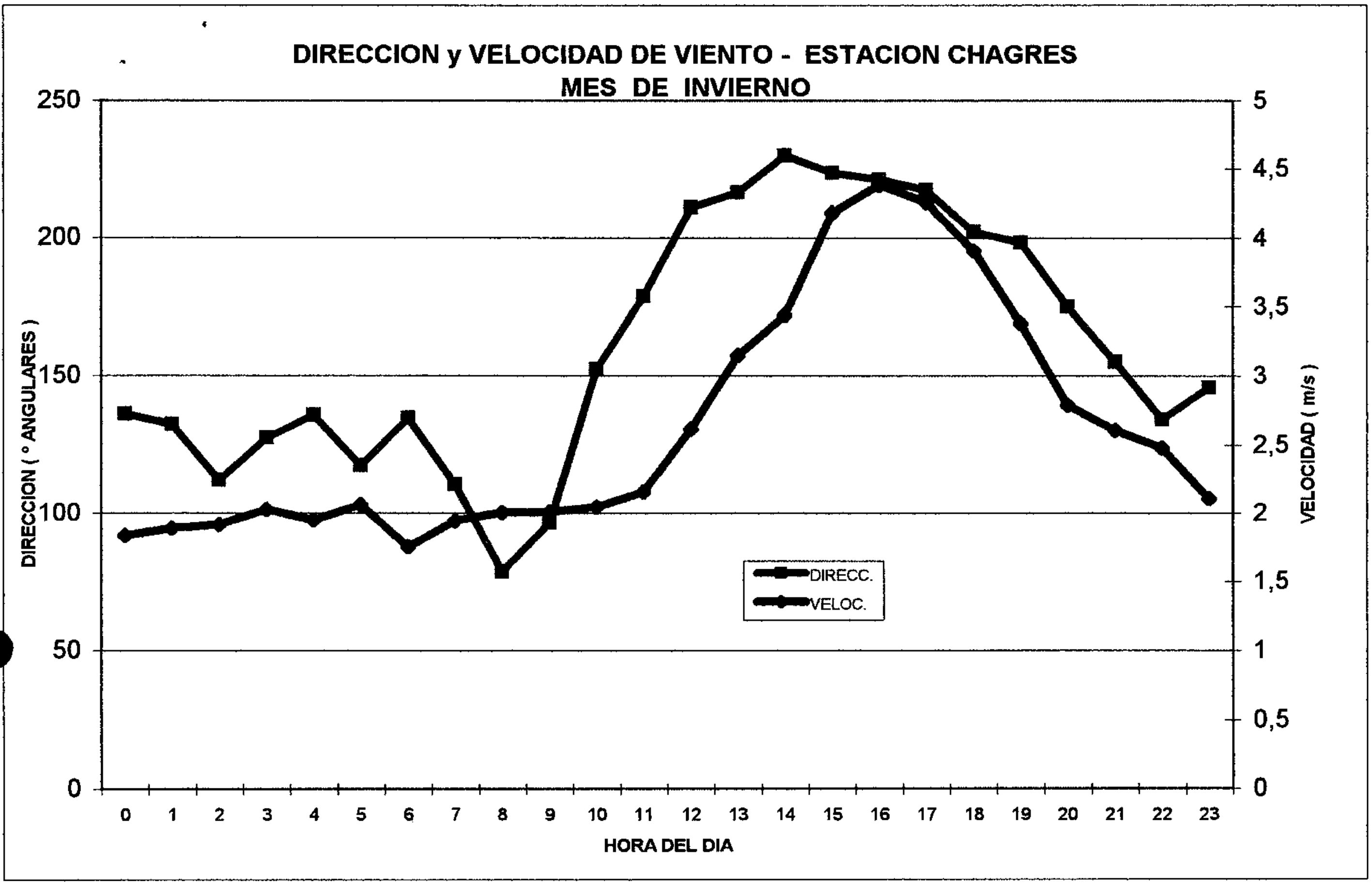
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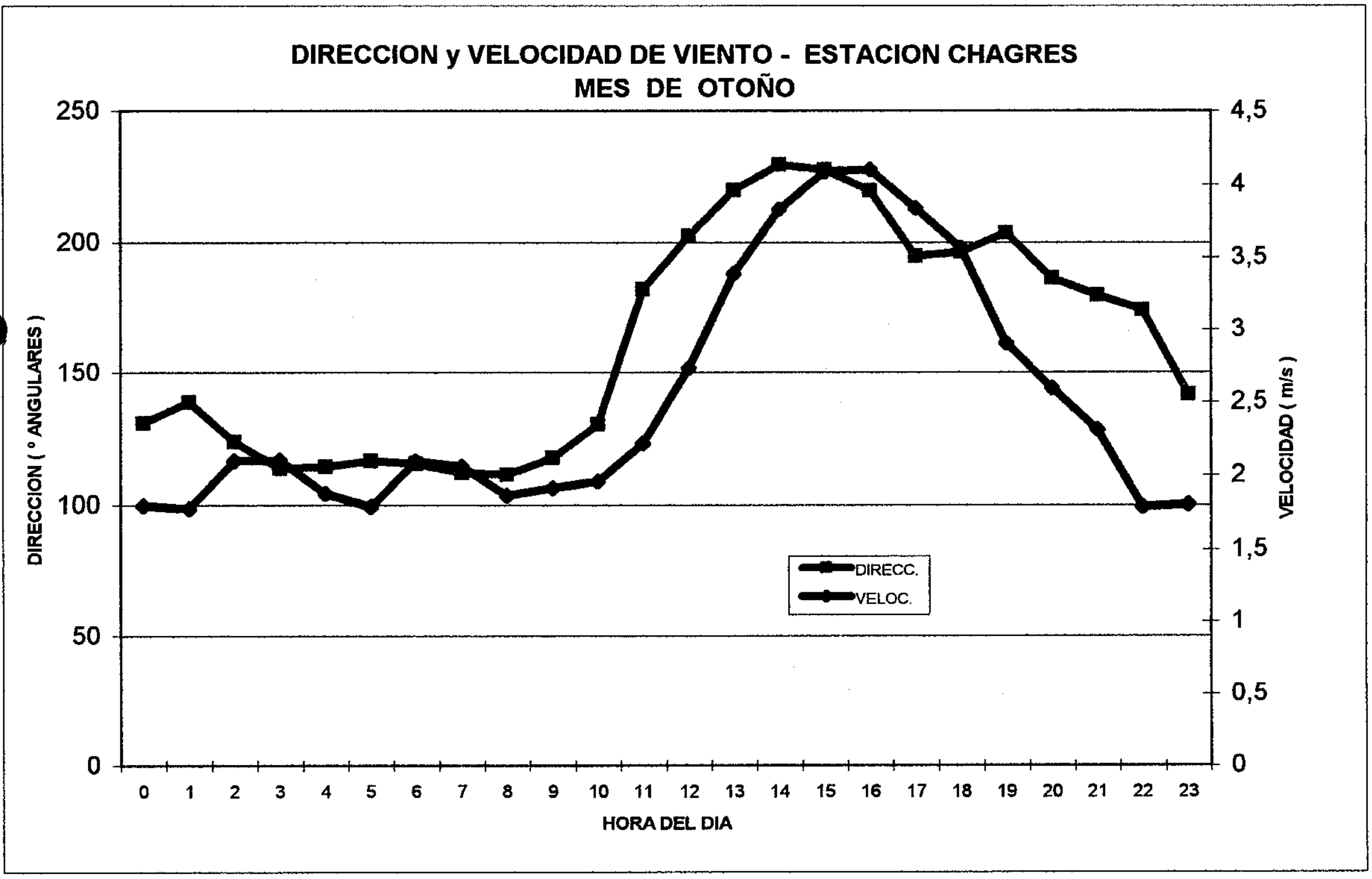
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Comisión Nacional del Medio Ambiente
Departamento de Descontaminación Planes y Normas

Revisión Normas Primarias de Calidad de Aire para SO2, CO, O3, NO2 y PTS

ACTA DE REUNIÓN DE COMITÉS OPERATIVO Y AMPLIADO

FECHA REUNION: 05 de septiembre de 2000
LUGAR: CONAMA, Obispo Donoso 6. Santiago
ASISTENCIA: Se adjunta hoja de asistencia

Tabla:
1. Discusión Observaciones del Comité Operativo y Ampliado a Borrador de Anteproyectos de Normas Primarias de Calidad de Aire para CO,O3,NO2,SO2 y PTS.

Discusión:

- Principalmente se formularon observaciones en relación al borrador de Anteproyecto para Anhídrido Sulfuroso.
- Con respecto a las definiciones establecidas en los Anteproyectos, Marcela Alday (Illanes y Asoc.) y en general, los miembros del Comité Ampliado, señalan su preocupación respecto de establecer para efecto de mediciones un año calendario. Lo anterior dado que si las campañas de medición se inician con posterioridad al comienzo del año calendario, estas no se considerarían válidas y se perderían. Solicitan que reevalue el tema, ante lo cual CONAMA señala que se estudiará.
- En relación a la definición de Estación Monitora con Representatividad Poblacional para Gases (EMRPG). El Comité señalo que se requiere especificar mas el concepto de área habitada, en cuanto a población. CONAMA señala al respecto que área habitada se refiere a que exista población residiendo en el lugar, pero que no existe una especificación clara a que número de personas constituye una población representativa.
- Gerardo Muñoz (CODELCO-Chile), solicita para el caso de SO2, que en los objetivos de la norma se especifique que la protección de la población es "solo" de efectos agudos y crónicos por exposición al SO2.
- En lo que respecta a la validación de la información, Carlos Salvo (CHAGRES) señala que el porcentaje propuesto es muy estricto y que podría ser muy difícil poder cumplir con este requerimiento. CONAMA señala al respecto, que los valores propuestos corresponden a los establecidos en la normativa de la Comunidad Europea y que la red de monitoreo de calidad de aire en la Región Metropolitana se cumpliría con estos requerimientos. Sin embargo, manifiesta que evaluará el tema.
- En relación a los valores de norma propuestos en los borradores de Anteproyectos, los representantes de las empresas reiteran su desacuerdo con la propuesta para norma diaria y horaria para SO2, aduciendo principalmente problemas de cumplimiento,

económicos y de imagen. CONAMA señala que la norma propuesta se encuentra fundada en lo que respecta a la protección de la salud de la población. Señala además, que un eventual incumplimiento de normas de calidad no es vinculante en responsabilidad a una actividad industrial determinada, dado que de acuerdo a la legislación vigente, la gestión ambiental implica la declaración de zona saturada y elaboración de un plan de descontaminación. Señala, que es dentro del plan donde se tiene que establecer las responsabilidades en reducción de emisiones a fuentes específicas y los plazos necesarios para ello. Los miembros del Comité señalan que a su entender la interpretación es diferente por lo que solicitan, se pueda realizar una consulta jurídica al respecto. CONAMA acoge la solicitud. En relación a la evaluación económica de la norma, CONAMA indica que esto es una obligación establecida en la reglamentación vigente y que constituye un nuevo antecedente a ser considerado en el proceso, junto con las observaciones que se reciban durante el periodo de consulta pública de la norma.

Rodrigo Lucero Ch.

COMISION NACIONAL DEL MEDIO AMBIENTE
DEPTO. DESCONTAMINACION, PLANES Y NORMAS

Reunión "Revisión Normas Primarias de Calidad de Aire para SO2, PTS, CO, NO2 Y O3"
Santiago, 05 de septiembre 2000

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17.	Juan Ladrón de Guevara	CONAMA			
18.	Nicolás Chacón Sánchez	Econot			
19.	Andrea Muñoz	~~[illegible]~~ CONAMA			
20	Christian Santana O.	CONAMA			
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GOBIERNO DE CHILE
COMISION NACIONAL
DEL MEDIO AMBIENTE
Dirección Regional – Sexta Región
Del Libertador General Bernardo O'Higgins

COMISION NACIONAL DEL MEDIO AMBIENTE
OFICINA DE PARTES Y ARCHIVO
Nº INGRESO: 10057 - 1306
FECHA: 06 SEP 2000
DESPACHADO:
ORD.: Patricia Matus
25021

MEMORANDUM Nº 127 /

RANCAGUA 05 SEP 2000

A: DRA. PATRICIA MATUS, JEFE DEPTO. DESCONTAMINACIÓN PLANES Y NORMAS CONAMA
DE: SR. MARIO MENESES TERÁN DIRECTOR REGIONAL CONAMA VI REGION
MATERIA: ENVÍA INFORMACIÓN SOLICITADA.

Adjunto envío a usted, minuta con información relativa a la gente (visitantes, turistas, deportistas) que visita el Club de Campo Coya (comuna de Machalí), y población residente. Esta información fue solicitada a esta Dirección Regional por el Sr. Rodrigo Lucero en el contexto de la revisión de las normas primarias de calidad ambiental (revisión de la Resolución N °1215, MinSal.). Esta información también fue despachada por correo electrónico a rlucero@conama.cl

Sin otro particular. Saluda cordialmente,

COMISION NACIONAL DEL MEDIO AMBIENTE
DIRECTOR REGIONAL
* VI REGION *

Mario Meneses Terán
Director
Comisión Nacional de Medio Ambiente
Sexta Región

Cc.: Archivo

Hermano Claudio Nº 364 – Rancagua — Fono: (72) 22 45 49 – Fax: (72) 23 91 06 – E-mail: xubilla.6@conama.cl

COMISIÓN NACIONAL DEL MEDIO AMBIENTE (CONAMA)
DIRECCIÓN REGIONAL - SEXTA REGIÓN
Del Libertador General Bernardo O'Higgins

MINUTA
POBLACIÓN RESIDENTE EN COYA CLUB DE CAMPO COYA

Con fecha 18 de agosto de 2000, esta Dirección Regional realizó una visita al Club de Campo en la localidad de Coya, Comuna Machalí, VI Región. La visita se realizó a partir de la petición del Departamento de Descontaminación, Planes y Normas de CONAMA, que solicitaba información respecto de la población residente el las dependencias del Club. La consulta fue realizada en el contexto de la revisión de las normas primarias de calidad de aire para los contaminantes SO2, PTS, CO, O3 y NO2 (Resolución Exenta Nº1514 de la Dirección Ejecutiva de CONAMA).

En la visita nos recibió y atendió las consultas el Gerente del Club de Campo Coya, Sr. Faudy Mosre. Las preguntas estuvieron orientadas a conocer lo siguiente:

- Número y tipo de personas que viven en el club (población residente)
- Personal que trabaja
- Número y tipo de visitantes.
- Tipo de Deportes que se practica (estacionalidad, número de horas, y cantidad de deportistas)
- Medidas adoptadas durante la ocurrencia de episodios críticos.
- Otros tipos de visitantes o turistas.

Respecto de población residente en el club, es decir número de personas que viven en el lugar, solamente el Gerente, su esposa y dos hijas pequeñas (5 y 2 años), viven allí (el club dispone de una casa para esta familia). El primero está todo el día, la esposa e hijas se trasladan a Rancagua de lunes a viernes, por alrededor de 8 horas (jornada laboral y jardines infantiles).

El personal que trabaja es alrededor de 40 personas, tanto en tareas administrativas, mantención y operación (1 turno), el personal de cocina y comedor labora en dos turnos. También hay personal de guardia que trabaja en la noche.

En forma regular se desarrollan en este centro, actividades de capacitación para empresas e instituciones. Estas actividades pueden tener la duración de un o varios días, hasta una semana de duración.

Durante los fines de semanas existe una afluencia de público que visita el lugar por el día, o turistas que alojan por el fin de semana.

Durante la época de verano, la afluencia de público diario es mayoritariamente por las actividades recreativas de la piscina.

Entre las actividades deportivas que se efectúan en forma regular, y en orden de importancia está el golf, y luego el tenis. La única restricción para estos deportes es en días de lluvias, (tampoco se practica golf en la noche).

Los golfistas en mayoría visitan el club durante los fines de semanas, aún cuando también se practica durante días hábiles. Cada juego dura aproximadamente cuatro horas, y en promedio mensual se estima unos 550 jugadores.

El tenis en promedio lo practican unas veinte personas por mes. Las prácticas de entrenamiento de la Selección Chilena de Fútbol en este club de campo preferentemente han sido en el verano.

Respecto de las medidas adoptadas durante la ocurrencia de episodios críticos en el club, el Gerente informa que el sistema de envío de fax con el aviso del episodio crítico por parte de la División El Teniente, ha funcionada en forma regular, existe un cuaderno para el registro de ellos, están habilitadas y ha funcionado el sistema de banderas en la entrada al jardín del club, cuando ha sido pertinente, y que en la gran mayoría de los casos, estos episodios ocurren durante el invierno y en la noche.

COMISION NACIONAL DEL MEDIO AMBIENTE
OFICINA DE PARTES Y ARCHIVO
Nº INGRESO: 10106 – 8339
FECHA: 07 SEP 2000
DESPACHADO:
OBS.: Patricia Matus
25059

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GOBIERNO DE CHILE
Comisión Nacional del Medio Ambiente
Región de Atacama

00625

ORD.: N°________/

ANT.: No hay.

MAT.: Observaciones Propuesta de Modificación de Resolución N° 1215.

COPIAPO, 05 SEP 2000

DE : DIRECTOR REGIONAL COMISION NACIONAL DEL MEDIO AMBIENTE REGION DE ATACAMA

A : DRA. PATRICIA MATUS CORREA
JEFE DEPARTAMENTO DESCONTAMINACION, PLANES Y NORMAS
COMISION NACIONAL DEL MEDIO AMBIENTE

Por el presente, vengo en enviar a Ud., comentarios y observaciones a Propuesta de Modificación de Resolución N° 1215.

Esperando que dichas observaciones sean un aporte al Proceso Normativo en cuestión.

Saluda atentamente a Ud.,

Comisión Nacional del Medio Ambiente
DIRECTOR

DANIEL ALVAREZ PARDO
DIRECTOR REGIONAL
COMISIÓN NACIONAL DEL MEDIO AMBIENTE

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COMENTARIOS A LOS ANTECEDENTES TÉCNICOS PARA LA PROPUESTA DE NORMATIVA DE CALIDAD PRIMARIA, NORMA 1215.

A continuación se presentan algunas observaciones a los Antecedentes Técnicos presentados para la Modificación de Norma N°1215, con el fin de dar cumplimiento a los objetivos planteados al comienzo del proceso de elaboración de dicha normativa y aportar al desarrollo de éste.

El documento elaborado por el Comité Operativo y Ampliado del proceso normativo antes referido es un importante aporte y puede ser un instrumento de trabajo muy útil en la generación de una buena normativa, que apunte a dar solución a los problemas existentes, pero sobre todo en lo a que a la prevención se refiere.

No obstante lo anterior, cabe señalar algunas observaciones al documento que se estiman necesarias de considerar en una nueva revisión de éste y que permiten darle mayor consistencia y una mejor comprensión al texto.

Las observaciones se realizarán de acuerdo al siguiente orden de documentos entregados:

1.- Antecedentes Técnicos para Propuesta Norma Primaria de Calidad de Aire para SO_2.
2.- Propuesta de Normativa de Calidad Primaria: Dióxido de Nitrógeno.
3.- Propuesta de Normativa de Calidad Primaria: Ozono.
4.- Propuesta de Norma de Calidad Primaria para el Monóxido de Carbono
5.- Propuesta de Norma de Calidad Primaria para Partículas Totales en Suspensión
6.- Anexo 1
7.- Anexo 2

1.- Antecedentes Técnicos para Propuesta Norma Primaria de Calidad de Aire para SO_2.

A) Se solicita enumerar las páginas de este y los demás documentos, a fin de poder realizar las observaciones con mayor facilidad y dar un orden al documento.

B) En la segunda página se expresa: "Por el contrario, **<u>se espera</u>** que un porcentaje considerable (>20 a 25%) de individuos asmáticos leves o moderados expuestos entre 1.572 ug/Nm3 y 2.620 ug/Nm3 durante actividad física, sufra cambios en la función respiratoria y agravamientos ....". Se solicita esclarecer si dichos estudios han sido realizados o sólo es una proyección y bajo que estudios se realizó dicha proyección y su correspondiente incertidumbre.

C) En el segundo párrafo de la tercera hoja se expresa: "La UE en su última revisión ha acogido el valor recomendado por la OMS, no así Estados Unidos (Estudio SGA, Final Decisión; Vol 61; number 100, 1996), quien ha mantenido un valor de 350 ug/Nm3 por considerar que este resguarda adecuadamente la salud de la población".

En tanto en la siguiente página expresa "Estados Unidos posee estándares a nivel Federal para un periodo de un año (80 ug/Nm3) y para un periodo de 24 horas (365 ug/Nm3) (Code Federal Regulation, part. 50)".
Se solicita clarificar los valores y si realmente existe una normativa para periodos de 24 horas, pues tampoco aparece en la tabla 1 del anexo 1.

D) Revisar la redacción del documento en su conjunto, a fin de abordar en cada tema lo correspondiente a éste, con el objeto de poder entender lo expresado en estos antecedentes técnicos.

E) El tema de las excedencias de los estándares ambientales, presentado someramente en la quinta página, debiera tocarse como un tema aparte, pues tiene directa relación con el tema de gradualidad con que deben ser diseñadas las normas ambientales y que está inmerso en el Reglamento de Dictación de Normas de Calidad Ambiental.

F) En el punto 3 sobre Monitoreo de Calidad de Aire para SO2, debe incluirse en el primer párrafo, a los estudios regionales financiados con fondos del FNDR y estudios de otros Ministerios, como es el caso del Ministerio de Minería.

G) En la sexta página se expone "Teniendo en consideración los antecedentes en salud señalados en el punto 1 anterior, un nivel de 250 ug/Nm3 para un periodo de 24 horas....", a cual punto se refiere, pues lo único señalado a este respecto es lo expresado por la OMS en la segunda página: "Los resultados de estos **estudios con grupos sensibles** indican que a partir de un nivel de concentración de 250 ug/Nm3 **y en presencia de material particulado en suspensión**, existe un aumento en los síntomas de la población expuesta".
Los antecedentes esgrimidos fueron hechos éstos en grupos sensibles, sin detallarse la metodología utilizada, su incertidumbre y representatividad de los resultados obtenidos, además cabe hacer mención que es en presencia de material particulado en suspensión, contaminante que está siendo abordado por otras normativas, se debe considerar la cantidad si es correlacionable con los estudios realizados. También se deben detallar los "síntomas", a los cuales se hace mención y si éstos son realmente por efectos del contaminante a ser regulado.

H) Por qué se considera un escenario de 300 ug/Nm3 y no otros escenarios posibles, que relevancia toxicológica y sus efectos crónicos y agudos en la población, tiene dicho valor?

I) En la séptima página se menciona un anexo 4, este no fue ubicado en la documentación entregada, se solicita enviar dicho anexo.

J) Se requieren más antecedentes de por qué la Normativa de Estados Unidos definió el valor de 2620 ug/Nm3 como nivel de significativo daño para un lapso de 24 horas y cual es el método de operar si se supera dicho límite, pues con los planes de contingencia estatales se trata de evitar alcanzar dicho valor, pero no se especifica como se opera superado dicho valor. Y por qué en la propuesta de Situaciones de Emergencia Ambiental se toma el mismo valor como nivel dos.

K) Anexar antecedentes que respalden los valores asignados para definir las situaciones de emergencia ambiental, pues en los documentos enviados no se encuentran dichos antecedentes.

L) Se solicita anexar estudios epidemiológicos nacionales e internacionales, en lo posible con países con igual PGB y actividades productivas acordes a lo realizado en las regiones críticas en relación al cumplimiento de los estándares ambientales actuales y proyectados, que respalden todos los valores propuestos como Normativa Ambiental.

M) Se solicita explicar el origen del valor de 1050 ug/Nm3 para el periodo de una hora y si este valor tiene alguna relación con la normativa existente en el Estado de Washington que establece el mismo valor, si es así explicar cuales son las similitudes que hacen exigir en Chile un valor de norma igual al establecido en sólo un Estado de USA y que por lo demás según consta en este mismo documento es la más exigente a nivel internacional.

N) Adjuntar los antecedentes que justifiquen los valores utilizados por la empresa consultora, como valores de norma propuestos y los criterios para utilizar dichos valores como norma nacional.

2.- Propuesta de Normativa de Calidad Primaria: Dióxido de Nitrógeno.

A) En atención del estudio aún no publicado de Cifuentes, Lave, Vega y Kopfer, del año 2000, se solicita profundizar en la información expuesta, pues se contrapone a la inexistencia de dicha información y es de suma importancia para determinar los valores de norma, que se están proponiendo.

B) Se reitera la observación vertida en relación a la redacción de este documento, la que debiera ser corregida, para su comprensión.

C) En el tema de los valores que definen las situaciones de emergencia, se solicita profundizar en los argumentos esgrimidos para fijar esos valores, pues en la Normativa estadounidense, consideran las condiciones climáticas futuras antes de calificar una situación como episodio crítico, a la vez en el análisis se deja afuera lo sucedido en México y la Comunidad Europea, en este punto sería recomendable que la empresa consultora que realizó el estudio de levantamiento de información para el proceso normativo, revise lo sucedido en otros países como es el caso de Japón, que tienen más antecedentes al respecto.

3.- Propuesta de Normativa de Calidad Primaria: Ozono.

A) Con el propósito de clarificar los términos empleados en el documento presentado, se solicita modificar el texto del primer párrafo de la segunda página, por el siguiente texto: Los efectos dañinos del ozono provienen de su gran capacidad oxidante, lo cual le hace reaccionar con toda clase de sustancias biológicas. El ozono puede penetrar a todos los tejidos del sistema respiratorio, pero la concentración máxima de contaminante es absorbida en la fracción inferior del sistema respiratorio, específicamente en las regiones de los bronquiolos y la región alveolar. La rapidez de la penetración depende de la concentración de ozono en la traquea y de la frecuencia respiratoria. Parte del ozono inhalado se absorbe en la sangre. Los efectos típicos del ozono en la salud es el detrimento de la función pulmonar, que van precedidos de angina de pecho e irritación aguda de ojos, sobretodo en poblaciones sensibles1. Estudios en animales han mostrado efectos sobre el metabolismo de las células epiteliales del pulmón.

B) En la página N°3 se expone: "El estudio de Belmar (`88) encontró un resultado inesperado, ya que el ozono resultó ser un agente protector respecto a la tasa de consultas de Atención Primaria en Salud. (Estudio SGA pp 7/2)". Se solicita profundizar en los antecedentes entregados, pues se contraponen a la idea de normar dicho contaminante, crucial a nuestro entender antes de realizar el proceso normativo.

C) Se solicita profundizar en los antecedentes entregados del estudio expuesto en la página N°3 de los señores Cifuentes, Lave, Vega y Kopfer, sobretodo en relación a los grupos etarios estudiados, ingresos económicos de los pacientes a fin de apreciar nivel de impacto que tienen dichos pacientes a emisiones de Ozono y ubicación de domicilios, otras patologías presentadas por las personas estudiadas, etc.

D) Se solicita recolectar información relativa a este contaminante y los estudios realizados al respecto en la ciudad de Osaka - Japón, por ejemplo con la institución gubernamental Government Environmental Centre (GEC) de la ciudad de Osaka.

E) Se solicita esclarecer la aplicabilidad de utilizar los mismos criterios de Estados Unidos y la Comunidad Europea en el país, a la luz de estudios epidemiológicos, extender los argumentos en el texto de la propuesta.

4.- Propuesta de Norma de Calidad Primaria para el Monóxido de Carbono

A) Se solicita mencionar estudios nacionales en el tema tratado, sobretodo estudios epidemiológicos y toxicológicos realizados por Instituciones Nacionales

B) Exponer argumentos relativos a salud pública y protección de comunidades sensibles, en el texto de la propuesta.

5.- Propuesta de Norma de Calidad Primaria para Partículas Totales en Suspensión

A) Se solicita presentar los argumentos de la propuesta in extenso en el texto entregado.

6.- Anexo 1

A) Explicar cuales son los criterios para las apreciaciones vertidas en la tabla 1, sobretodo "pequeños cambios en la función pulmonar", extender los argumentos y clarificar la terminología utilizada.

B) Se solicita completar la cuarta columna de la tabla 1.

C) Se solicita explicar por qué son incluidos los países como Cuba, Guatemala, Jamaica y Perú, en la tabla 2ª, en circunstancias que no se exponen datos al respecto de esos países.

D) Se debe modificar la tabla N°3, respecto del escenario de veces sobre el valor de la norma. En el encabezamiento de la columna debieran considerarse la utilización de rangos y no valores puntuales, ejemplo de esta incongruencia es el caso de Paipote, donde aparece excedido el nivel 300 en tres oportunidades y el valor 250 sólo en dos.

7.- Anexo 2

A) Se solicita corregir la Figura 4, específicamente la gráfica de Promedios Anuales de SO2 para sectores San Vicente, Talcahuano, Chile.

GOBIERNO DE CHILE
COMISION NACIONAL
DEL MEDIO AMBIENTE

Con fecha 5 de septiembre de 2000 se archivaron antecedentes remitidos por NORANDA-Chile S.A., Fundición Alto Norte, para el proceso de Revisión de las Normas Primarias de Calidad de Aire para CO, O3, NO2, SO2 y PTS

RODRIGO LUCERO CH.
Depto. Descontaminación, Planes y Normas
Comisión Nacional del Medio Ambiente

noranda

Noranda Chile S. A.
Fundición Altonorte

Avda. Rendic 5032, Casilla 740
Antofagasta, Chile
Fono (56) 55 - 630100

Antofagasta, Agosto 30 del 2000
G.G.Nº091/2000

Señora:
Patricia Matus
Jefe Depto. Descontaminación Planes y Normas
CONAMA
Presente

De nuestra consideración:

Tengo a bien adjuntar a Ud. copia de lo expuesto por Noranda Chile S.A. durante la reunión efectuada en sus oficinas el día 23 del presente al Grupo Técnico y Asesor de Conama, con relación a las dificultades de cumplimiento de la Norma Horaria para SO2 propuesta con ocasión de la revisión de la Norma 1215 y nuestra opinión fundada de la impracticabilidad operacional de tomar acciones efectivas en el control de las medias horarias.

Es prioritario para nuestra Empresa cumplir absolutamente las regulaciones ambientales vigentes. Con ese propósito, como se describe en el documento, asumimos como política interna el cumplimiento de la Norma Secundaria de 1000 microgramos por metro cúbico, a pesar de no ser aplicable en esta localización geográfica de carácter desierto.

A pesar de estas acciones que significaron 340 horas de producción restringida parcial o total en el primer semestre de este año en 20 ocasiones se excedió de 1000 ug. El nivel de exigencia requerido para cumplir la normativa tal como se está proponiendo requiere una eficacia de 99.96 %, situación que no resulta viable en el corto ni mediano plazo.

Saluda a Ud. atentamente,

MW Petersmeyer

Mark Petersmeyer
Gerente General

MP/ECJ
c.c.: Archivo G.G.

noranda

Fundición Altonorte

Presentación para CONAMA Santiago 23 de Agosto 2000

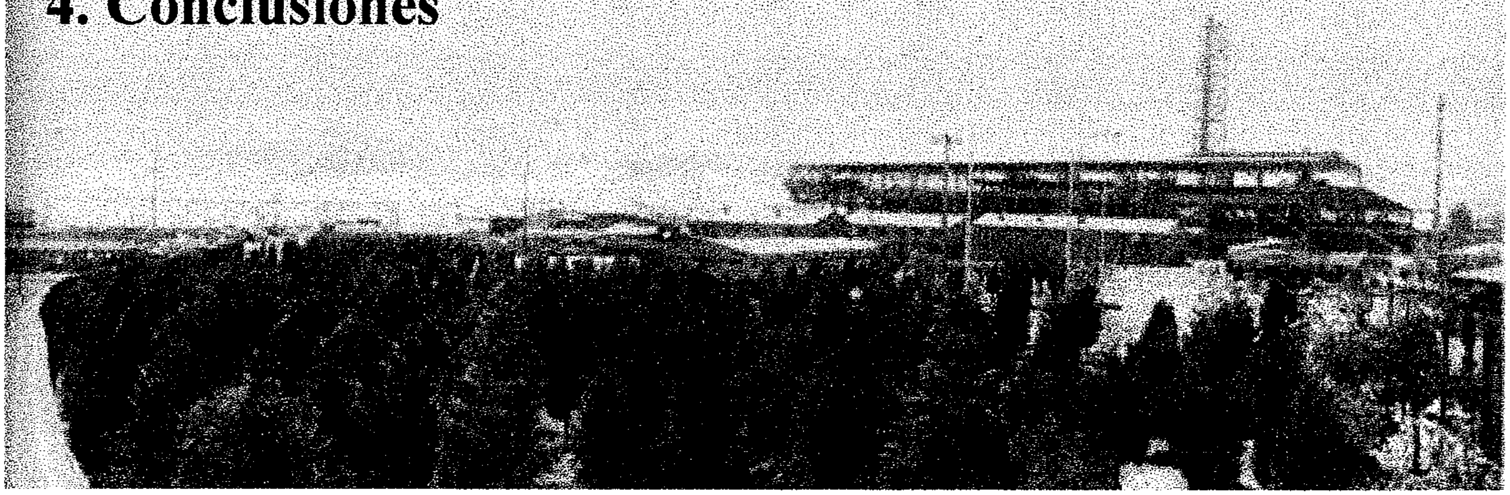
ANALISIS CALIDAD DE AIRE POR SO_2 EN EL ENTORNO DE LA FUNDICION ALTONORTE Y CUMPLIMIENTO DE LAS NORMAS VIGENTES

Elliot Cohen
Gerente Calidad y Medio Ambiente...

7

CONTENIDO

1. Calidad de Aire por SO2 en Fundición ALTONORTE
2. Plan de Contingencia de la Fundición
3. Factibilidad de Operar con Nueva Norma Horaria
4. Conclusiones



1. Calidad de Aire por SO2 en Fundición Altonorte

Normativa aplicable **D.S. 185.**

Norma anual **Lograda años 1996, 1998, 1999**

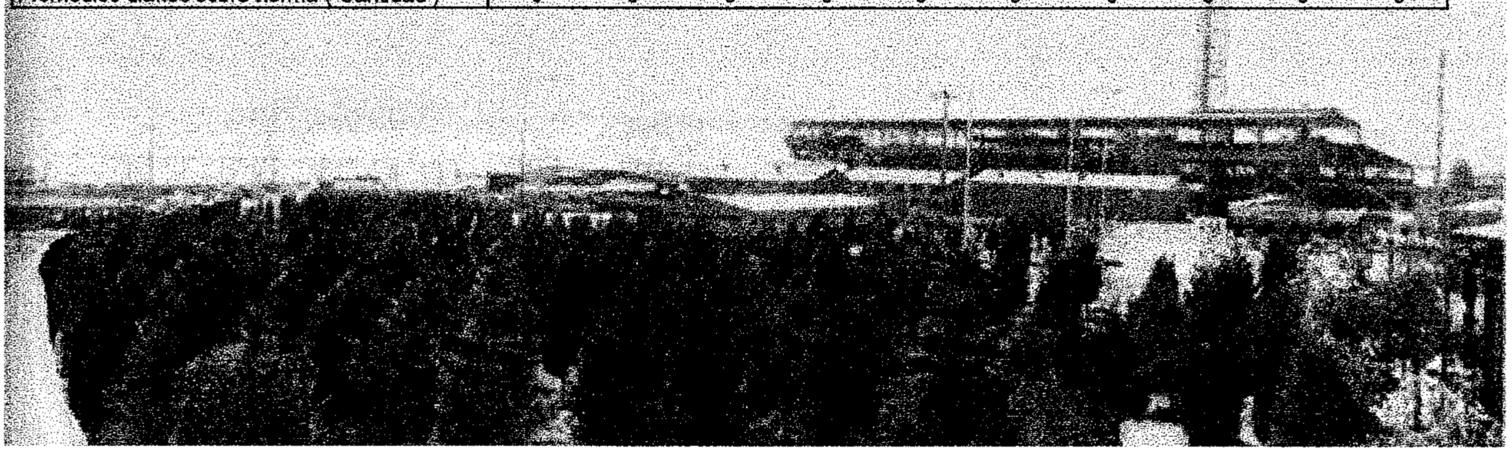
Norma diaria **Ultima excedencia 13 Septiembre 1998**

Norma horaria: La Resolución de COREMA II Región que aprobó el EIA de Fase II (actual operación) consideró un cronograma de cumplimiento <u>incluida la Norma Horaria, a pesar de su carácter secundario</u> y no aplicable para esta zona.
La política operacional definió como objetivo interno el cumplimiento de esta norma.

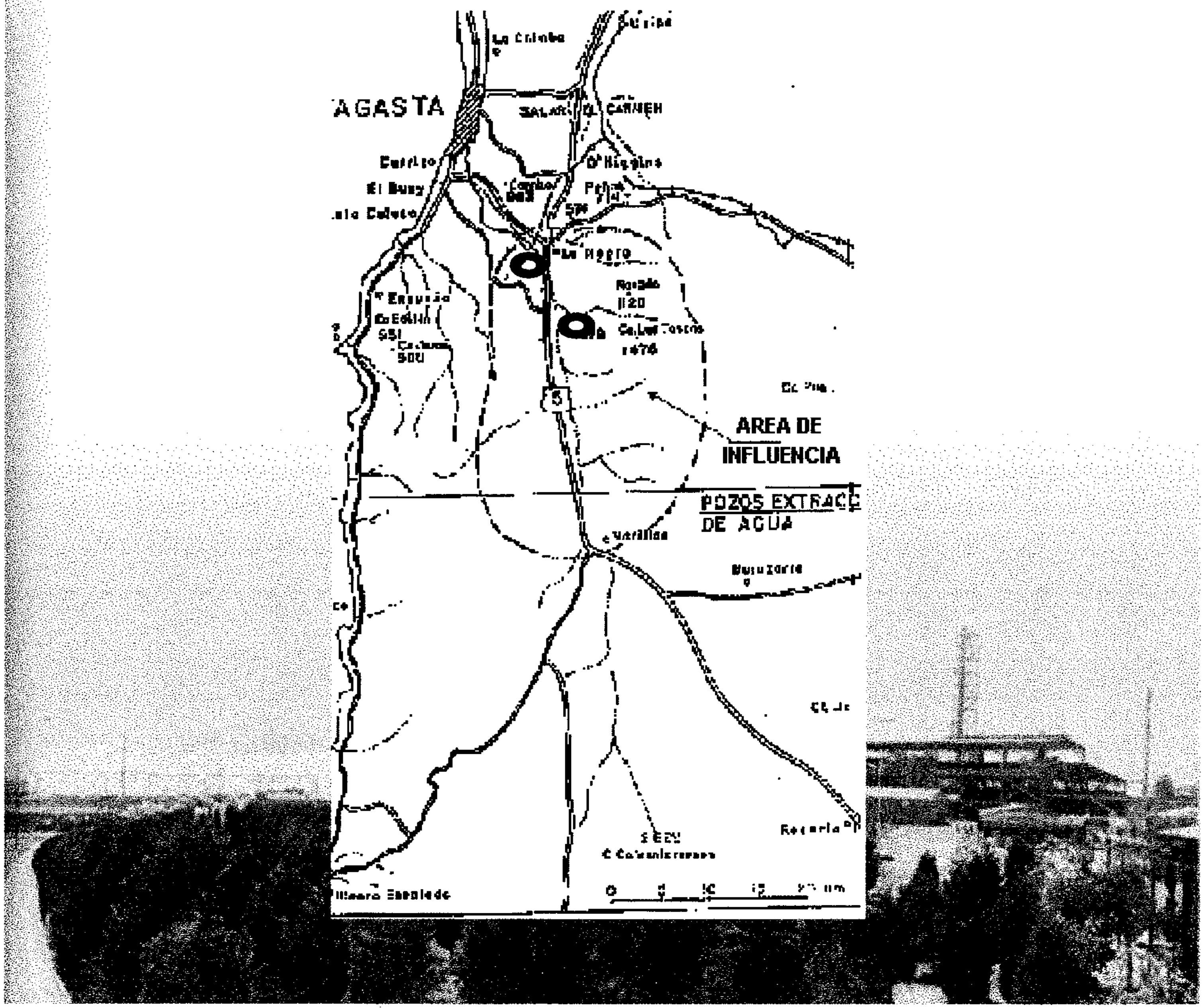
Cronograma de Cumplimiento de Calidad de Aire
Resolución 388 del 13 de Septiembre de 1995

CRONOGRAMA CALIDAD DE AIRE SEGUN D.S. 185

ANHIDRIDO SULFUROSO										
ESTACION LA NEGRA										
Año / Semestre	1994/1	1994/2	1995/1	1995/2	1996/1	1996/2	1997/1	1997/2	1998/1	1998/2
Promedios horarios sobre norma (Cantidad)	135	95	48	38	36	36	36	24	12	0
Promedios diarios sobre norma (Cantidad)	26	6	1	1	0	0	0	0	0	0
Concentración media del periodo (ug/m3)	158	136	89	82	<80	<80	<80	<80	<80	<60
ESTACION ANTOFAGASTA										
Año/ Semestre	1994/1	1994/2	1995/1	1995/2	1996/1	1996/2	1997/1	1997/2	1998/1	1998/2
Promedios horarios sobre norma (Cantidad)	0	0	0	0	0	0	0	0	0	0
Promedios diarios sobre norma (Cantidad)	0	0	0	0	0	0	0	0	0	0
Concentración media del periodo (ug/m3)	8	8	8	8	8	8	8	8	8	8
MATERIAL PARTICULADO PM 10										
ESTACION LA NEGRA										
Año / Semestre	1994/1	1994/2	1995/1	1995/2	1996/1	1996/2	1997/1	1997/2	1998/1	1998/2
Promedios diarios sobre norma (Cantidad)	1	0	0	1	0	0	0	0	0	0
ESTACION ANTOFAGASTA										
Año / Semestre	1994/1	1994/2	1995/1	1995/2	1996/1	1996/2	1997/1	1997/2	1998/1	1998/2
Promedios diarios sobre norma (Cantidad)	0	0	0	0	0	0	0	0	0	0



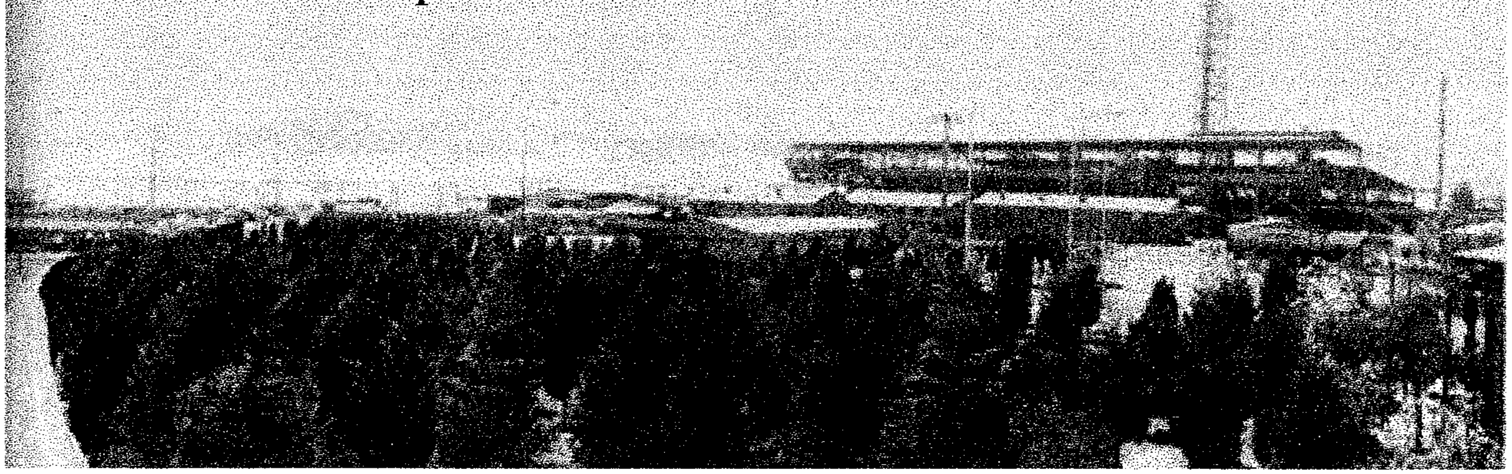
Ubicación de las estaciones monitoreo



2. Plan de Contingencia por SO2

Características

- Objetivo no exceder 1000 ug/m3 en Estación La Negra
- Aplicable en cualquier situación operacional que implique reducción de capacidad de tratamiento de gases en la Fundición.
- Procedimiento de reducción gradual de capacidad en función de la información disponible (en tiempo real)
- Nivel de activación 500 ug/m3, en La Negra
- La responsabilidad de la decisión es del Jefe General de Turno presente 24 horas diarias.
- Auditoría a la operación en caso de ocurrir una excedencia.



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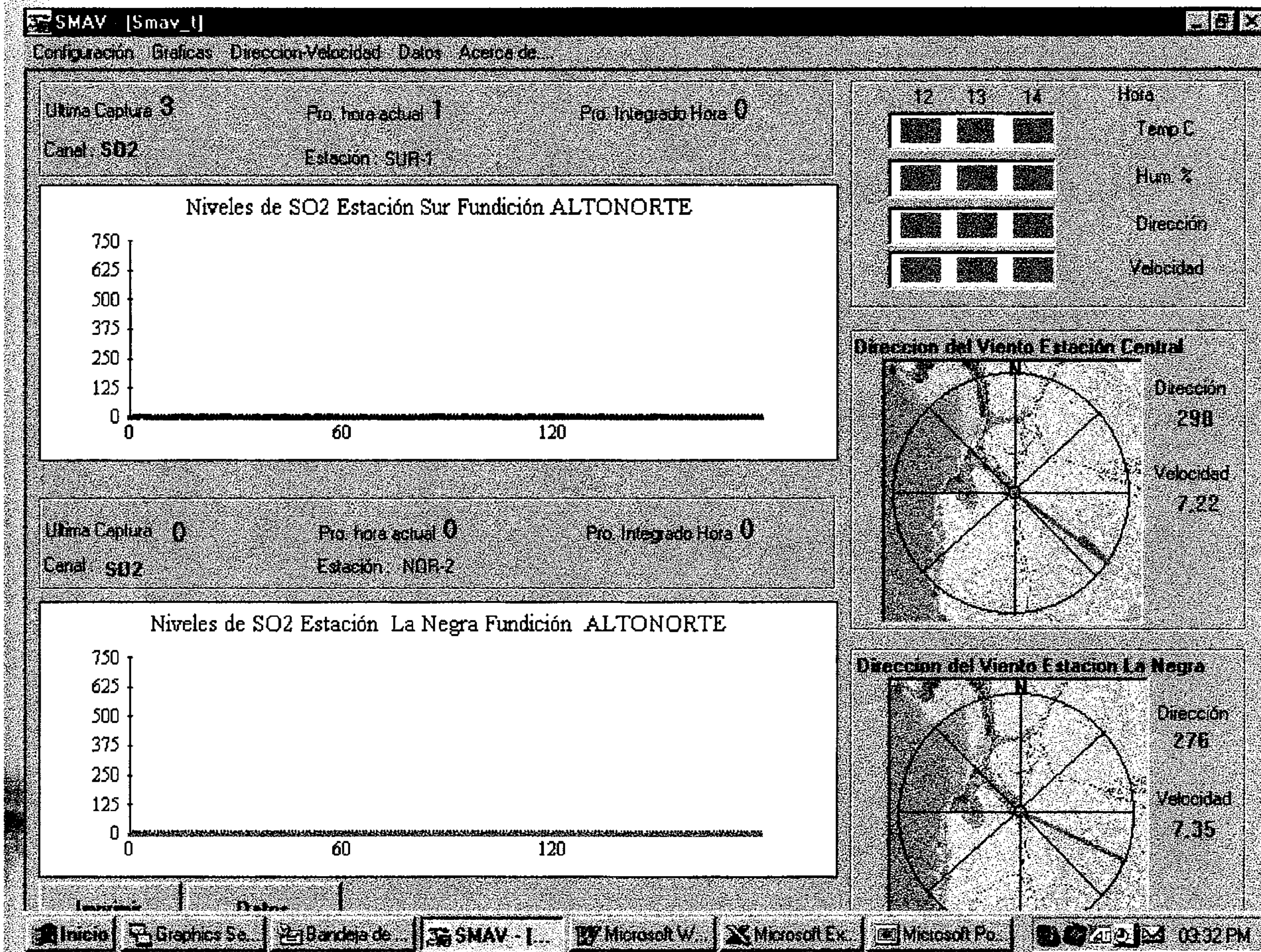
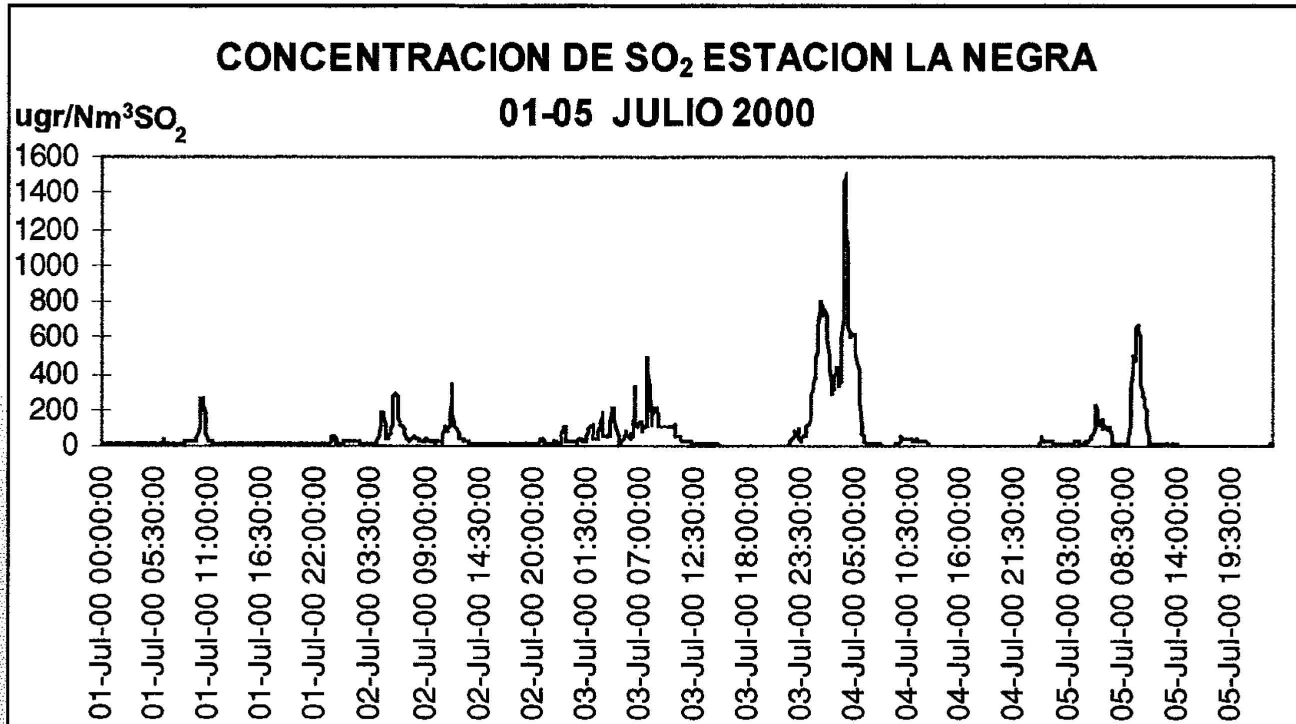
Plan de Contingencia por SO2

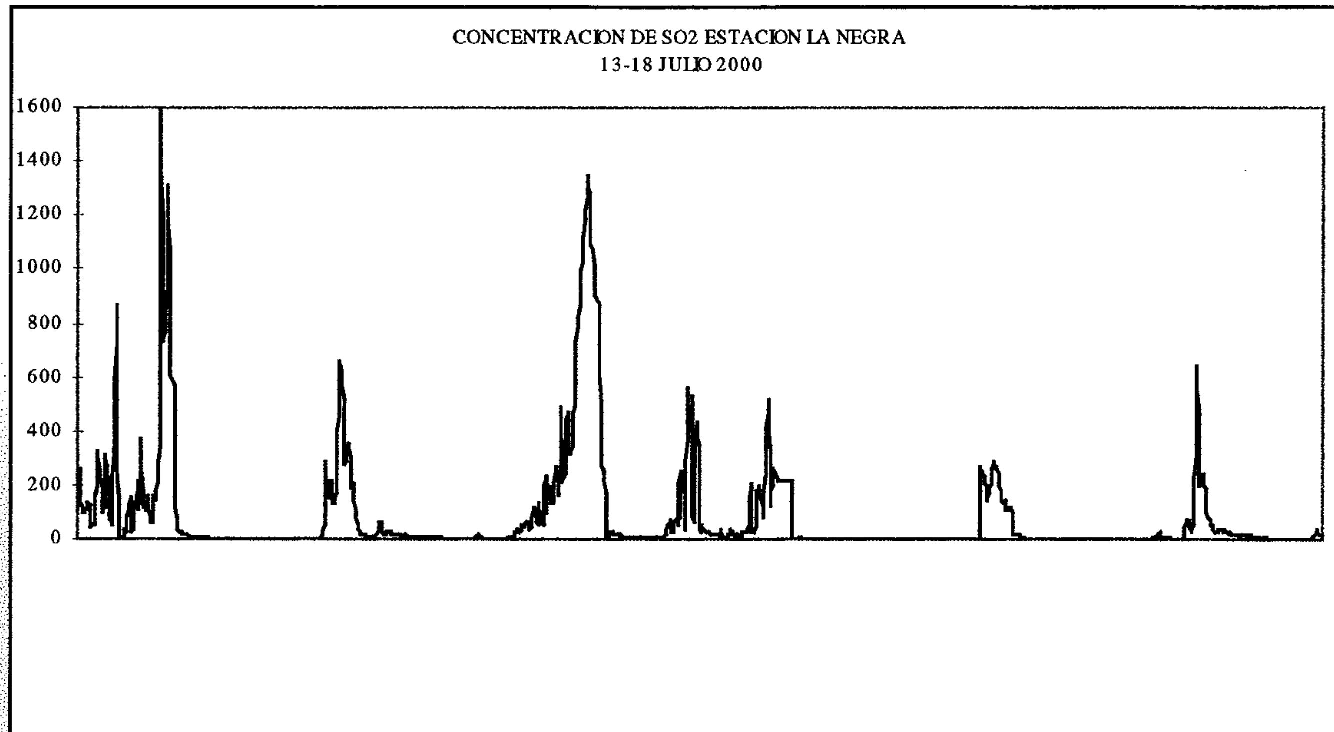
Pantalla en tiempo real en Consola Sala de control



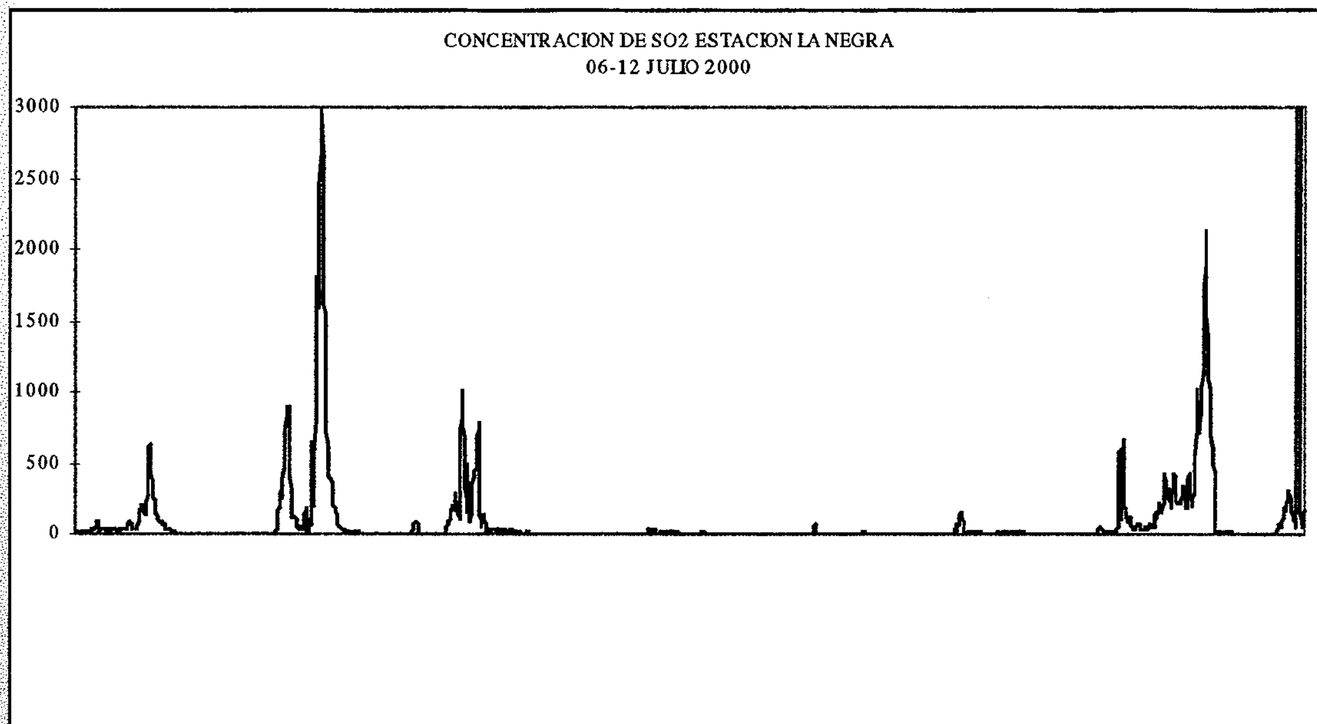
Perfil de promedios de 10 minutos



Perfil de promedios de 10 minutos (2)



Perfil de promedios de 10 minutos (3)



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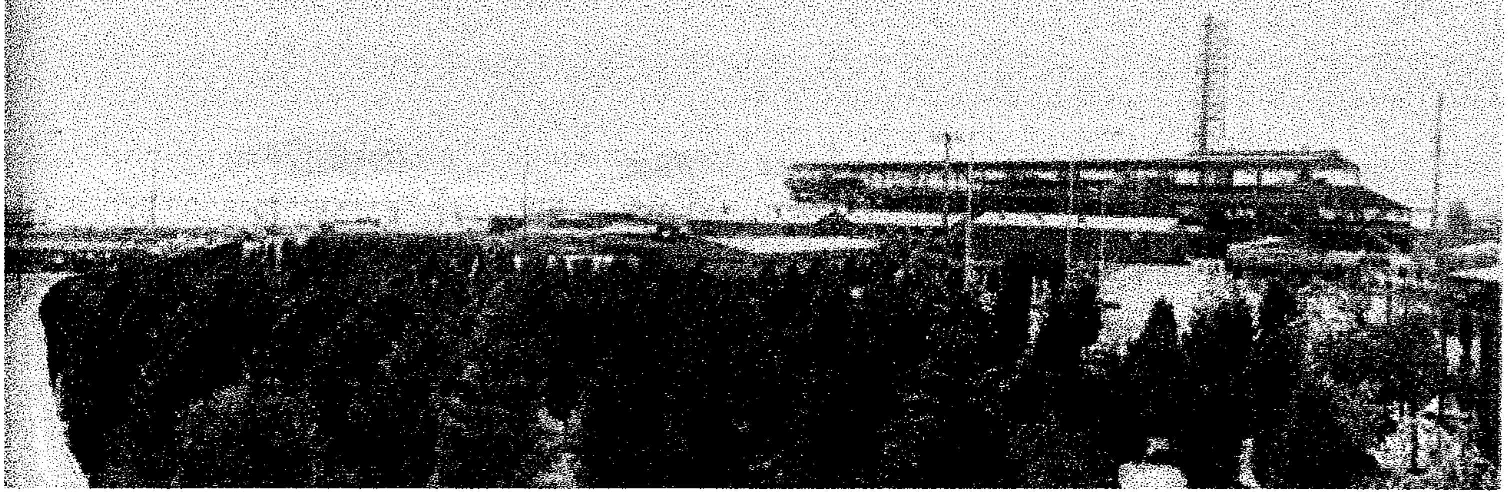
Plan de Contingencia por SO2

Análisis de resultados del Plan en el año 2000

- Horas de aplicación : 344
- Horas excedidas : 20
- Eficacia del plan : 94.2%
- Estado actual con una norma horaria (teórica) de 1050 : Percentil 99 Excedido en Mayo



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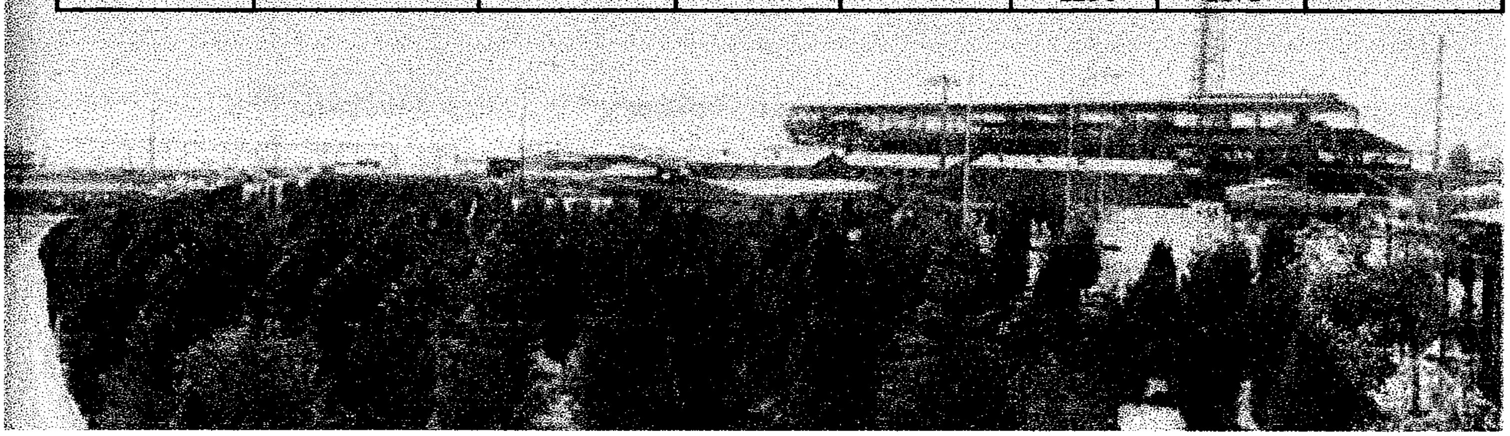
Distribución de las excedencias a la norma horaria secundaria de 1000 ug/Nm3. Periodo Enero - Agosto del 2000

Promedios horarios >1000 $\mu g/Nm^3$

ENERO	FEBRERO	MARZO	ABRIL	MAYO	JUNIO	JULIO	AGOSTO
1	2	0	1	2	7	7	1
1136	1170		1018	1078	1049	2319	1369
	1308			1175	1249	1327	
					1207	1451	
					1228	1165	
					1089	1005	
					1018	1086	
					1254	1175	



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Plan de Contingencia por SO2 (costos)

APLICACIÓN PLAN DE CONTINGENCIA AMBIENTAL COSTO - EFICIENCIA AÑO 2000					
FECHA	N° HRS. CON RESTRICCION	N° HRS CON ESCEDENCIAS	% (*) ÉXITO	PERDIDAS TOTALES (TMS C. Nueva)	COSTO US$
ENERO	40	1	97,5	833	33320
FEBRERO	70	2	97,1	457	18280
MARZO **	65	0	100	630	25200
ABRIL	43	1	97,6	351	14040
MAYO	29	2	93,1	187	7480
JUNIO	71	7	90,1	589	23560
JULIO	26	7	73,1	175	7000
	344	**20**	**94,2**	**3.222**	**128880**

CARGA NUEVA - PROMEDIO NORMAL 1138 TMS/día
CARGO FUSION US$ 80/ton
** MANTENCION MAYOR ANUAL

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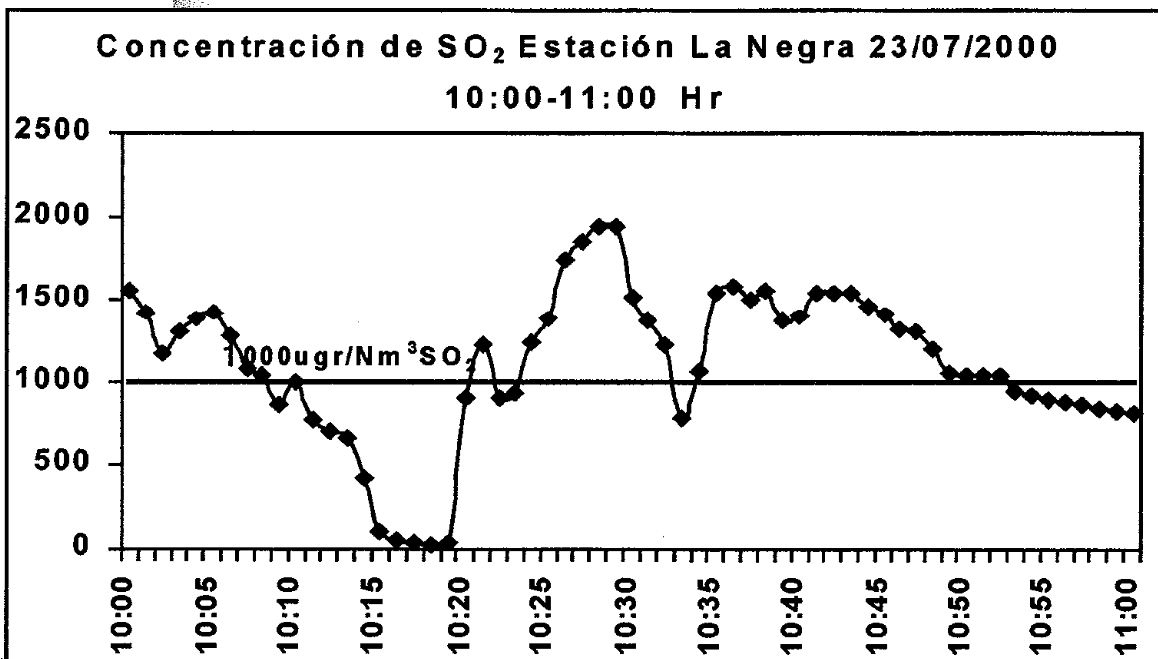
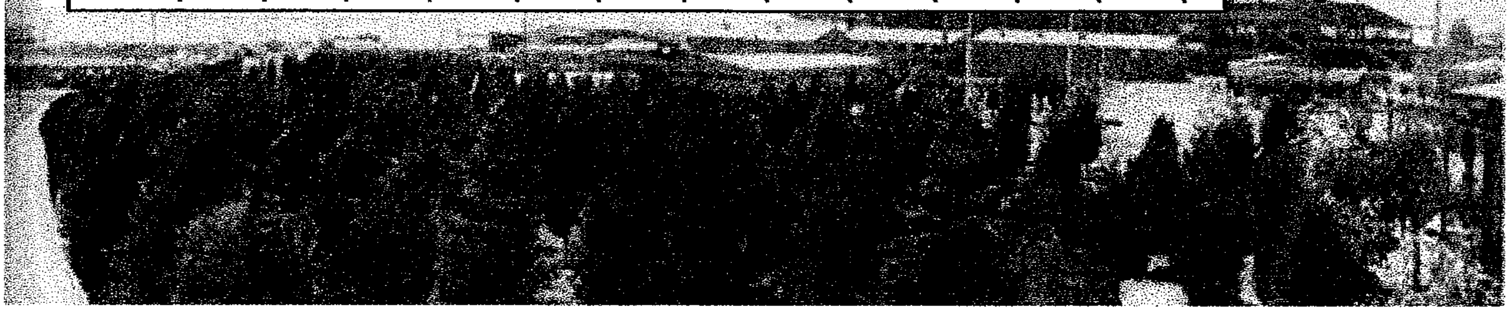
3. Factibilidad de operar con Norma Horaria

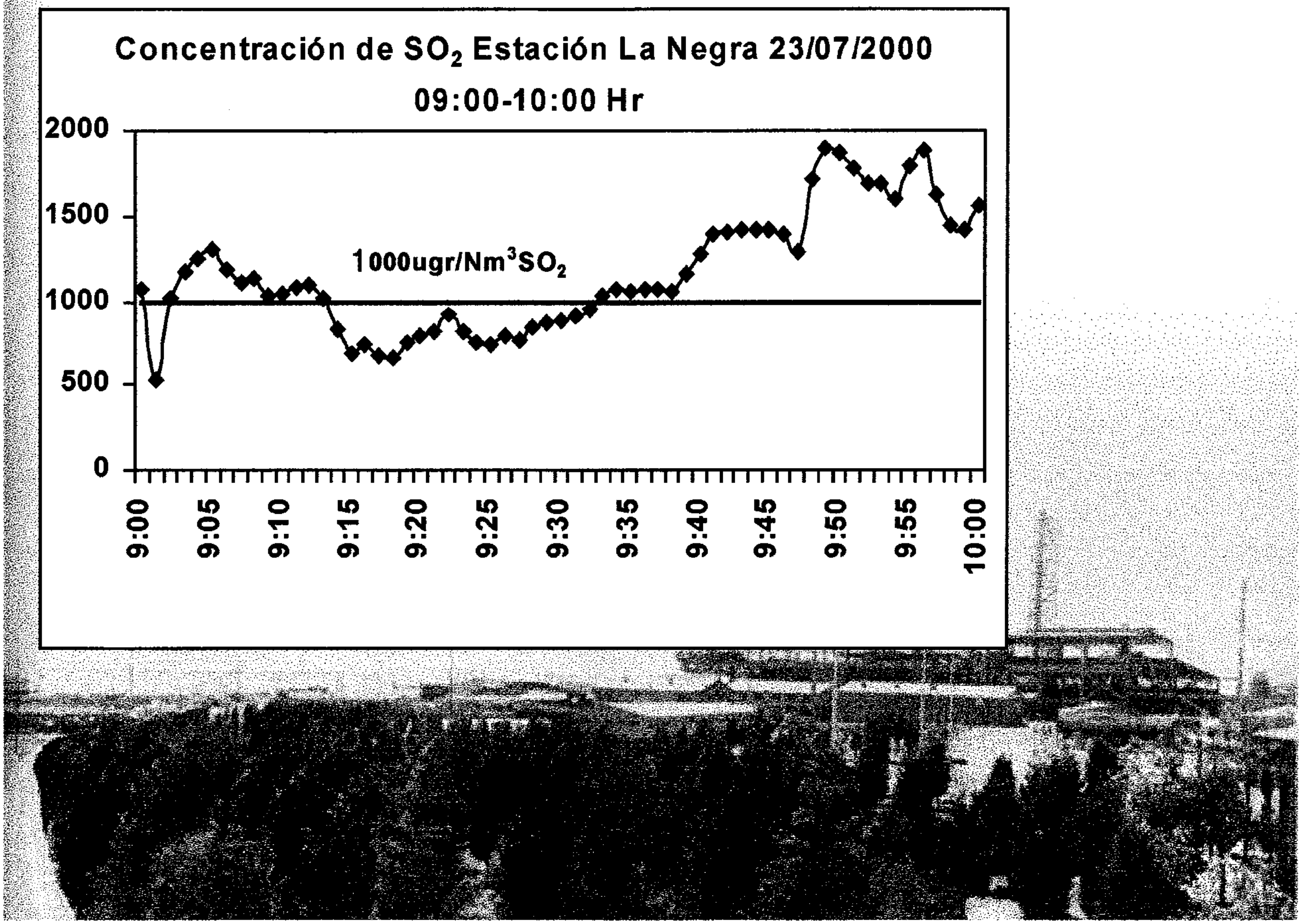
Perfiles de concentración durante las excedencias (1)





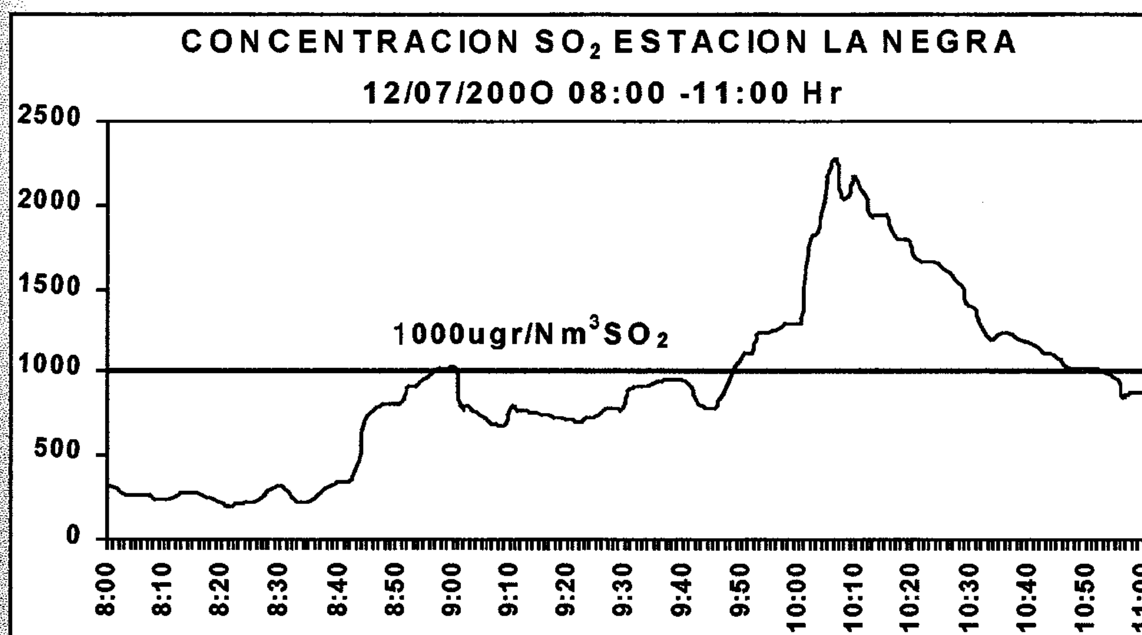
Factibilidad de operar con Norma Horaria

Perfiles de concentración durante las excedencias (2)



Factibilidad de operar con Norma Horaria

Perfiles de concentración durante las excedencias (3)



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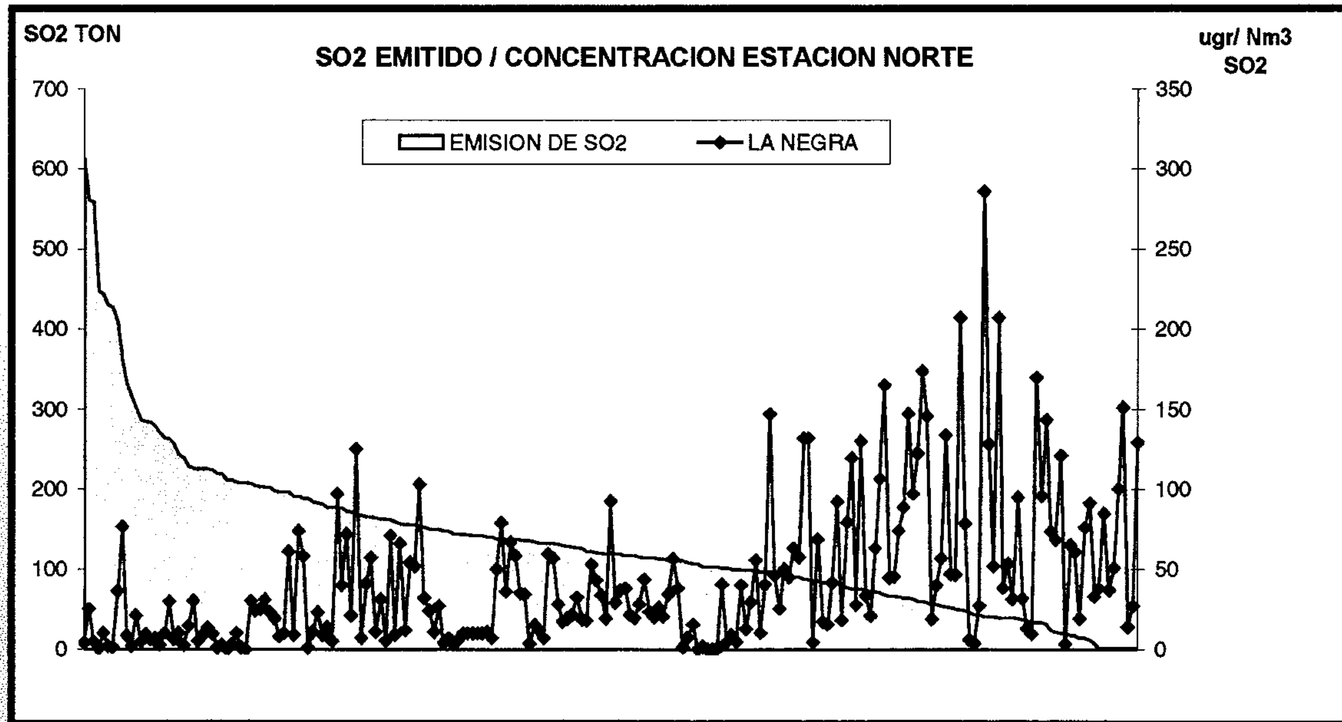
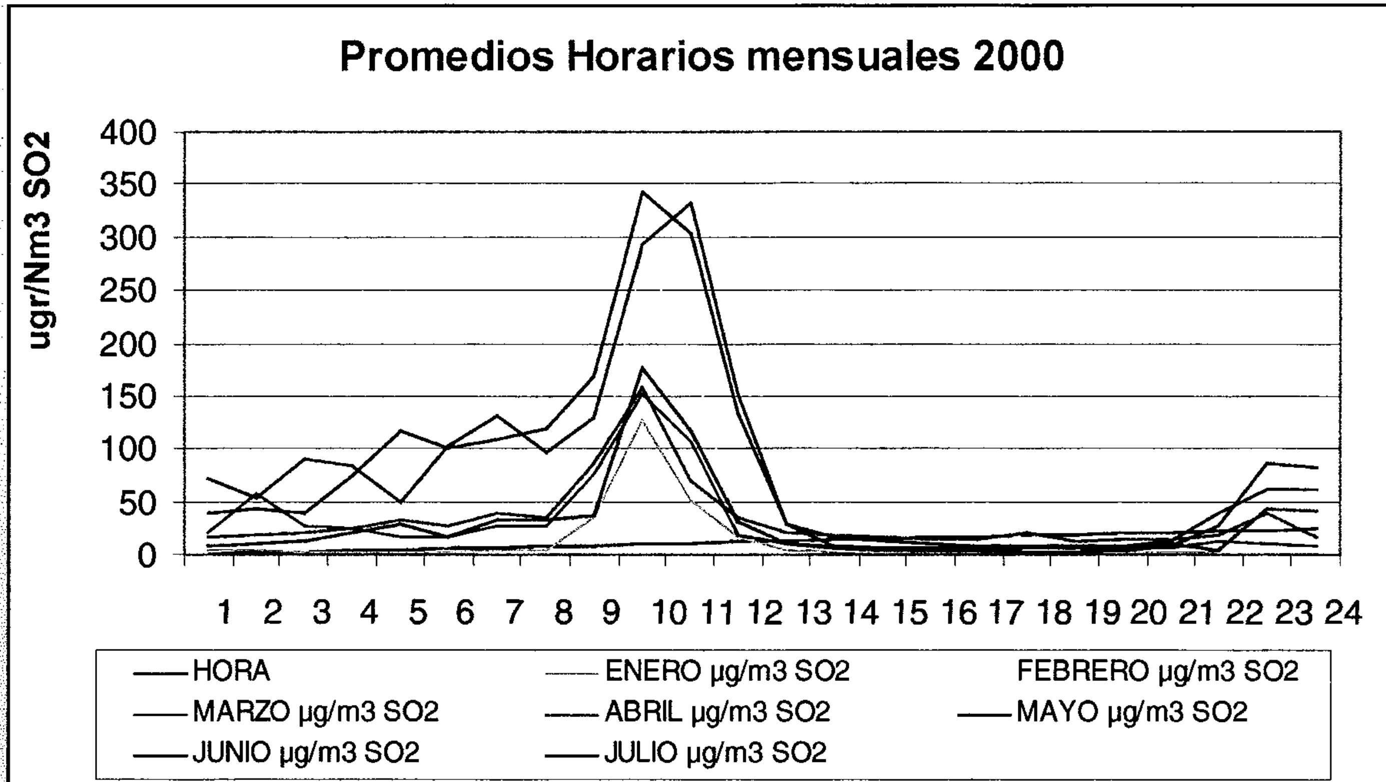
Factibilidad de operar con Norma Horaria

Correlación entre emisión y calidad de aire



Factibilidad de operar con Norma Horaria

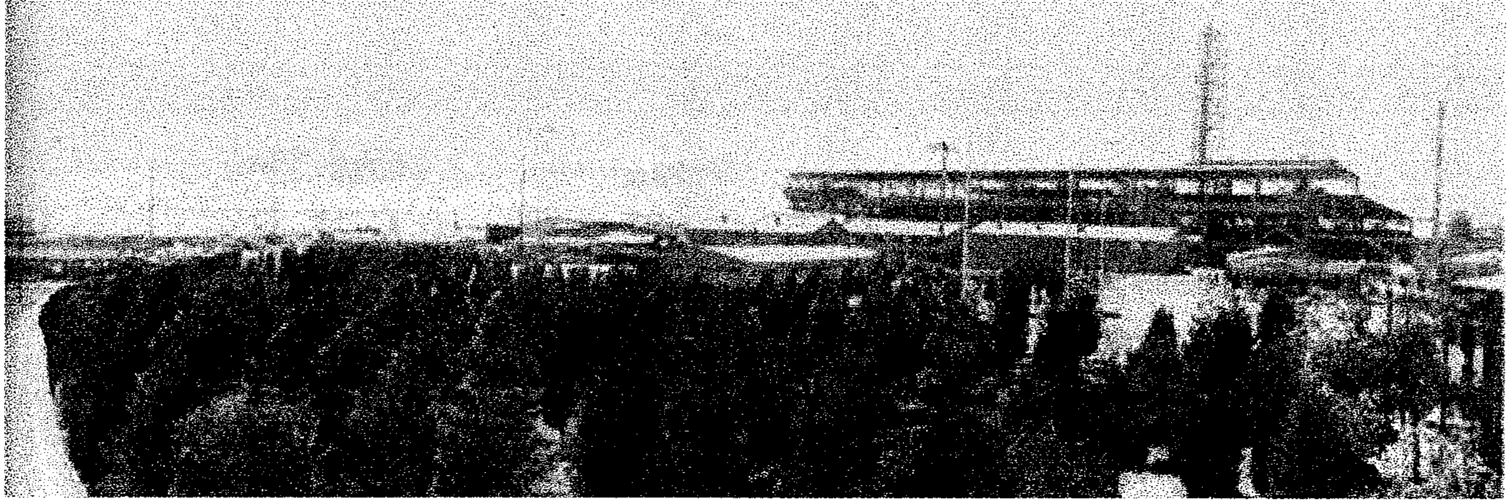
Comportamiento de las medias Horarias por mes



Factibilidad de operar con Norma Horaria

Explicaciones del fenómeno

- Régimen de calma durante la noche especialmente en el período invernal .
- Descenso del nivel de capa de inversión por debajo de la altura de la chimenea con presencia de camanchaca
- Ruptura de la capa de inversión y transporte vertical durante las primeras horas de la mañana.
- Desplazamiento en dirección imprevisible o estacionamiento sobre la estación de monitoreo.
- Ocurrencia Inversión de Subsidencia en la zona



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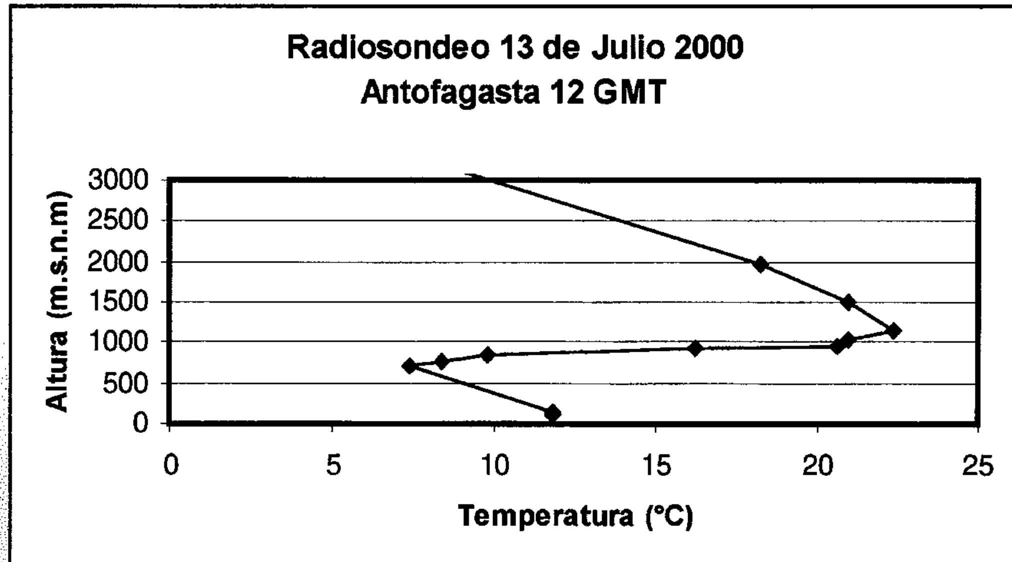
Inversión de subsidencia en la zona
Fenómeno que limita la dispersión del SO2

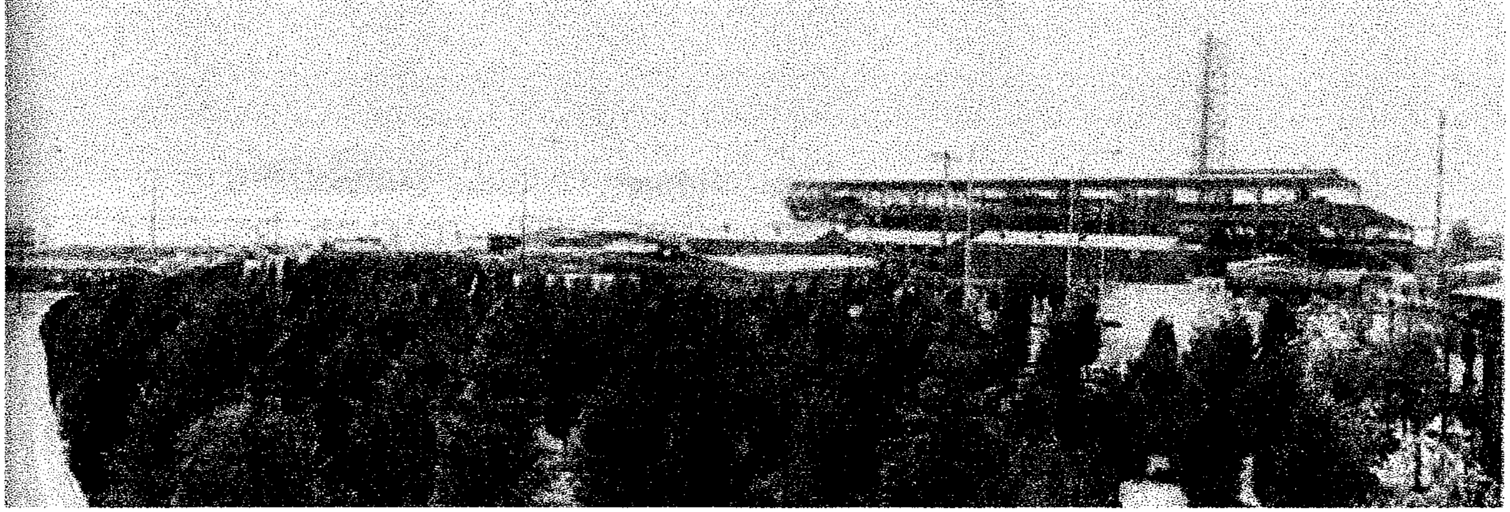


Inversion se situa a los 700 m.s.n.m. Solo a 100 sobre superficie en zona Altonorte

Factibilidad de operar con Norma Horaria

Velocidad de respuesta posible frente a las contingencias

- Distancia a la estación 2600 mts
- Régimen de calma o velocidad de viento menor a 1 m/seg
- Tiempo de detección de una situación que provoque un "impacto directo" en la estación la Negra es de 43 minutos.
- Si la modificación operacional es corregida "instantáneamente" , el cambio sería detectado en otros 43 minutos.
- Ambos tiempos sumados se acercan a 1 hora y media.

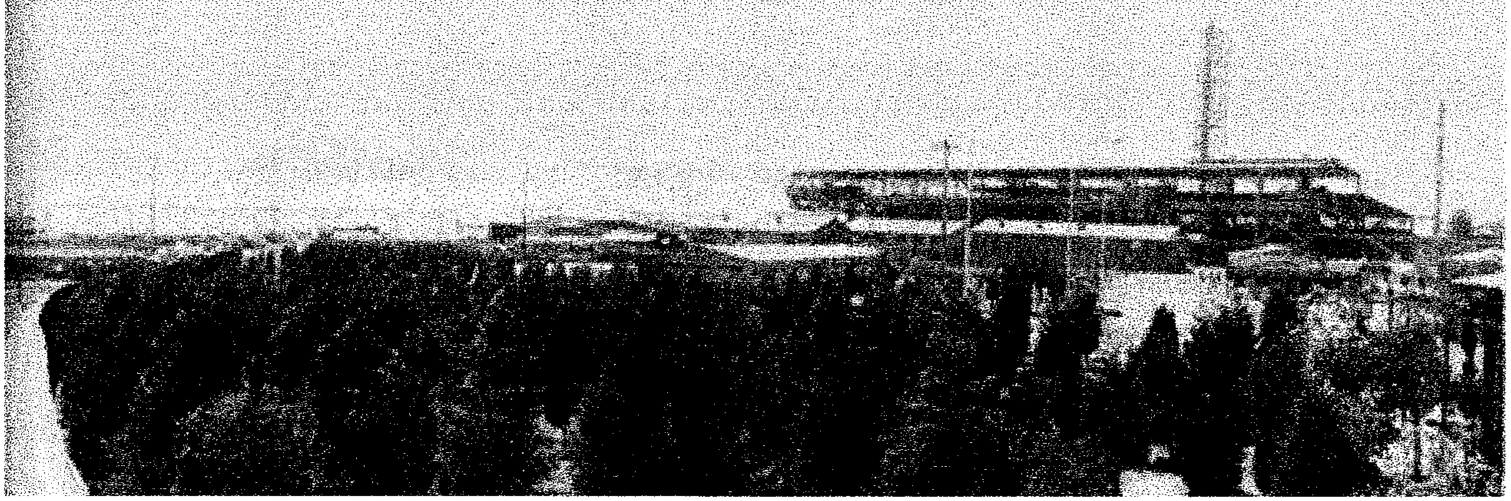


4. Conclusiones

- La aplicación del Plan de Contingencia por Altonorte tuvo por objetivo primario evitar excedencias sobre la actual Norma Diaria de 365 ug/m3.
- El carácter de primaria aplicado a la norma Horaria transforma una situación de cumplimiento de Norma a una de situación incumplimiento.
- La aplicación “voluntaria” ha costado 128.000 dólares en lo que va del presente año.
- Subir la eficacia del Plan de Contingencia por sobre el percentil 99, implica pérdidas de capacidad de fusión del orden de 20 a 25 %.
- El tiempo de respuesta ante medidas operacionales supera el plazo de una hora a lo menos en 50%.

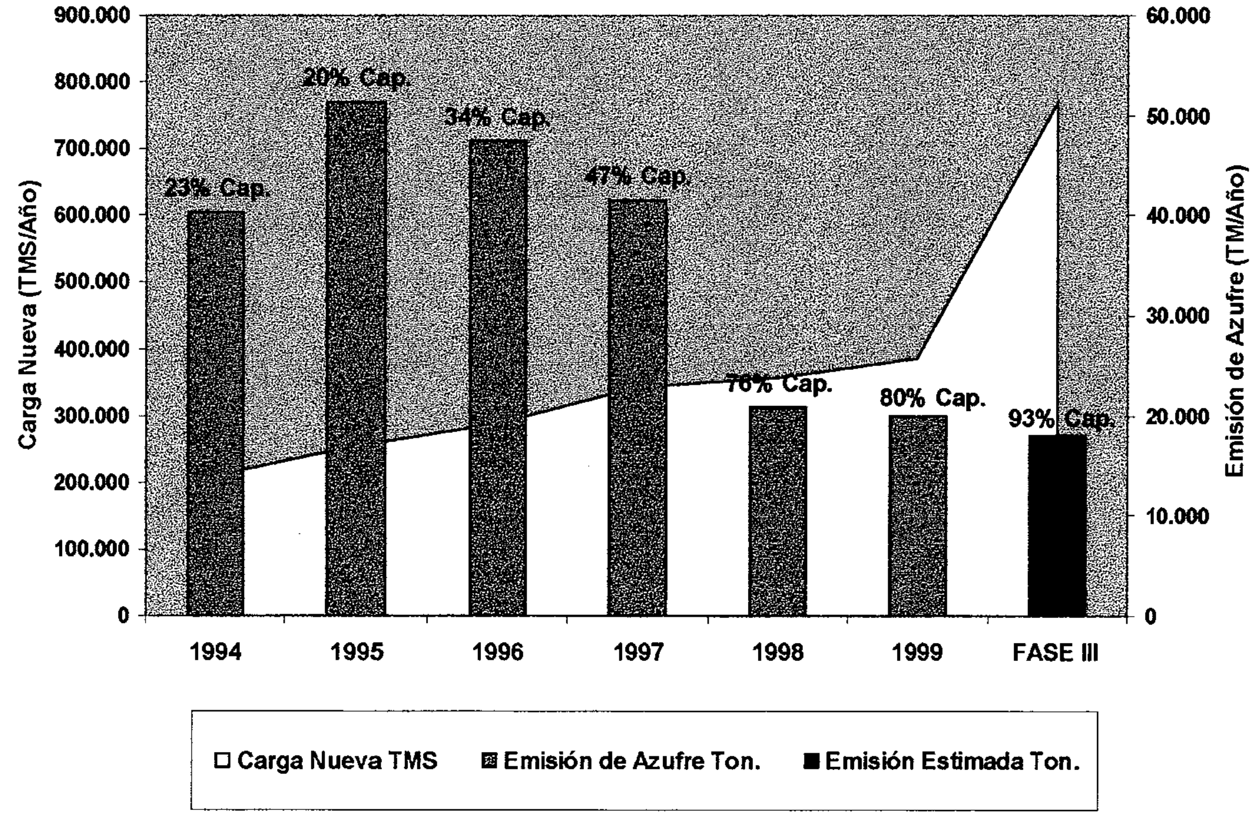
4. Conclusiones (cont.)

- La ejecución del Proyecto de Expansión Fase III, con una inversión de 170 millones de dólares, debería ser revisada a la luz de la nueva regulación.
- En el EIA del proyecto Expansión Fase III, se informó una emisión de SO_2 similar a la actual y una capacidad de fusión equivalente a mas del doble de la actual y fue aprobado en Enero de este año.
- Las mejoras tecnológicas descritas en el EIA mejoran la eficiencia de captura de S a fin de no alterar el nivel de emisión, de SO_2. Los equipos principales de este proyecto se encuentran comprometidos en su etapa de adquisición.

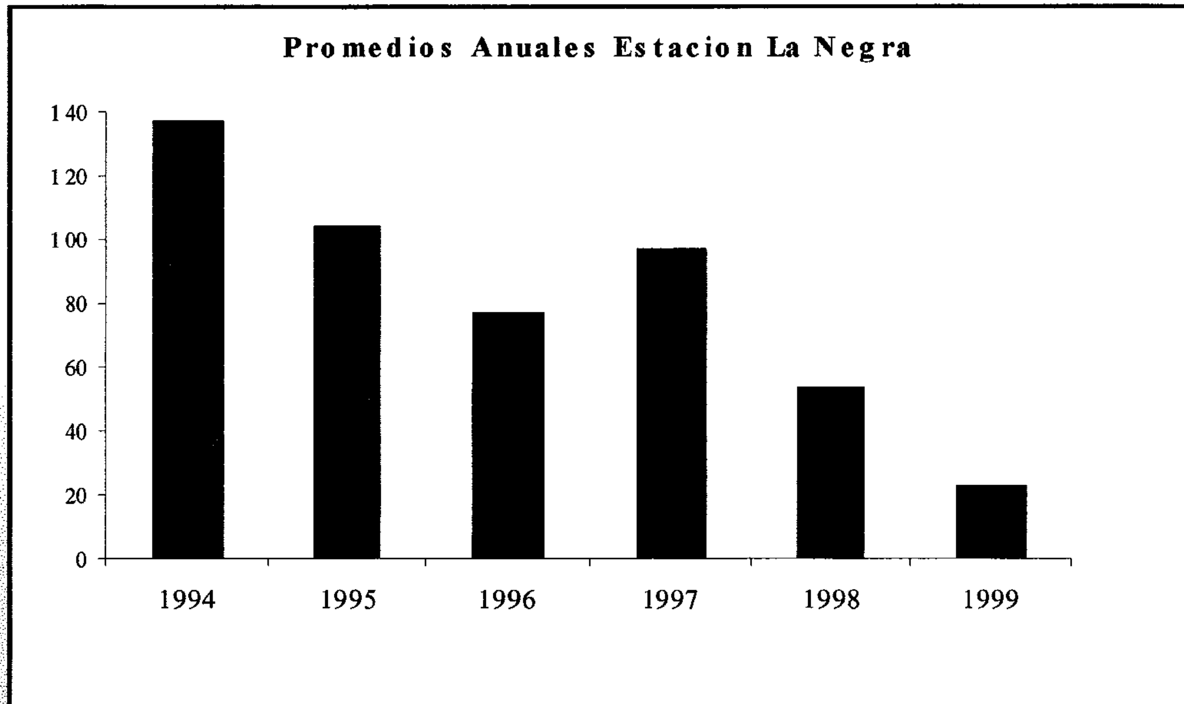


Factibilidad de operar con Norma Anual

EMISION DE AZUFRE / CARGA NUEVA



Factibilidad de operar con Norma Anual



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REPUBLICA DE CHILE
COMISION NACIONAL DEL MEDIO AMBIENTE
ASR/PMC

APRUEBA ANTEPROYECTO DE REVISION DE NORMA PRIMARIA DE CALIDAD DE AIRE PARA MONÓXIDO DE CARBONO (CO)

SANTIAGO, 8 de septiembre de 2000

EXENTA N° 912

VISTOS:

El acuerdo N°67 de fecha 27 de marzo de 1998, del Consejo Directivo de CONAMA que aprobó el Tercer Programa Priorizado de Normas; La Resolución N°1215 de 1978, del Delegado de Gobierno en el Servicio Nacional de Salud, la Resolución Exenta N° 1514 de 1999, de la Dirección Ejecutiva de la Comisión Nacional del Medio Ambiente; lo dispuesto en el Decreto Supremo N°93 de 1995, del Ministerio Secretaría General de la Presidencia que fija el procedimiento para la dictación de normas de calidad y emisión; y los demás antecedentes que obran en el expediente público.

RESUELVO

1.- Apruébase el siguiente Anteproyecto de Revisión de Norma Primaria de Calidad de Aire para Monóxido de Carbono (CO).

I. FUNDAMENTOS:

De acuerdo con lo preceptuado en la ley 19.300, es deber del Estado dictar normas para regular la presencia de contaminantes en el medio ambiente, de manera de prevenir que estos puedan significar o representar, por sus niveles, concentraciones y periodos, un riesgo para la salud de las personas, la preservación de la naturaleza y la conservación del patrimonio ambiental.

La exposición al CO se puede evaluar a través de los niveles de carboxyhemoglobina (COHb) que se expresa como porcentaje de la hemoglobina (Hb) total que está unida al CO.

El pulmón es la principal ruta de excreción y absorción de CO. La tasa de HbCO depende de la concentración de CO en el aire inspirado, la tasa de difusión aire-sangre, el contenido de Hb en la sangre, la tensión capilar de O2 y el nivel de COHb en los capilares pulmonares.

Durante una exposición a una concentración fija de CO, la concentración de COHb aumenta rápidamente hasta situarse en los niveles de la exposición, después de 3 horas comienza a decaer y alcanza su condición estable después de 6-8 horas de exposición.

Los resultados de diversos estudios recientes han mostrado que el CO aparece asociado a efectos respiratorios y efectos cardiovasculares.

Según la OMS (1999), no debiera ser excedido el nivel de 2.5% de COHb en la sangre de las personas expuestas a CO. Con lo anterior, se protege a la población no fumadora, de mediana y mayor edad con enfermedad de la arteria coronaria latente o reportada, de ataques de isquemia miocárdica aguda, y al feto en madres no fumadoras, de efectos hipóxicos adversos.

Sobre esa base, la Organización Mundial de la Salud recomienda los siguientes valores guía para monóxido de carbono:

Efectos sobre la salud de las personas	**Valor guía (ppm)**	**Valor guía ($\mu g/m^3$)**	**Tiempo promedio de exposición**
Nivel crítico de COHb <2.5%	90	100.000	15 minutos
	50	60.000	30 minutos
	25	30.000	1 hora
	9	10.000	8 horas

Los automóviles con motores de combustión interna son una de las principales fuentes de emisión de monóxido de carbono. Las chimeneas, las calderas, los calentadores de agua o calefones y los aparatos domésticos que queman combustible, como las estufas u hornillas de la cocina o los calentadores a Kerosene, también pueden emitir monóxido de carbono. El humo de cigarrillo puede ser una fuente significativa de monóxido de carbono en interiores.

El monóxido de carbono en áreas urbanas es el resultado, en casi un 90%, de las emisiones del tráfico de vehículos a combustión, estando las concentraciones más altas cerca de las calles, decreciendo a medida que nos alejamos de éstas.

A la fecha no existen métodos pasivos consolidados que permitan obtener valores representativos de la concentración ambiental de monóxido de carbono para intervalos breves de medición: 1-hora u 8-horas.

El conocimiento de los efectos del monóxido de carbono en la salud de la población, permite realizar proposiciones de niveles objetivo para ser cumplidos a través de normas ambientales, así como niveles que definen las situaciones de emergencia ambiental, por lo que los valores de normas de calidad primaria para monóxido de carbono contenidos en la Resolución 1215 de 1978, del Delegado de Gobierno en el Servicio Nacional de Salud (40000 ug/m3N como concentración media aritmética de una hora y 10000 como concentración media aritmética de ocho horas) deben ser revisados a la luz de tales resultados.

II. Disposiciones Generales y Definiciones

Art.1.- La presente norma tiene por objetivo proteger la salud de la población de aquellos efectos agudos generados por la exposición a niveles de concentración de monóxido de carbono en el aire.

Art.2.- Para efectos de lo dispuesto en la presente norma, se entenderá por:

a. *Efectos Agudos*: Aquellos producidos por la acción de concentraciones variables del contaminante en periodos cortos de exposición.

b. *ppmv:* Unidad de medida de concentración en volumen, correspondiente a una parte por millón.

c. *Concentración de monóxido de carbono*: Valor promedio temporal detectado en el aire expresado en ppmv.

d. *Concentración de 1 hora*: Media aritmética de los valores de concentración de monóxido de carbono medidos en cada estación monitora en 1 hora.

e. *Concentración de 8 Horas*: Media aritmética de los valores de concentración de monóxido de carbono medidos en cada estación monitora en 8 horas consecutivas, promedio móvil.

f. *Año calendario*: Período que se inicia el 1 de enero, y culmina el 31 de diciembre del mismo año.

g. *Estación de monitoreo con representatividad poblacional para gas monóxido de carbono (EMRPG):* Una estación de monitoreo podrá clasificarse como EMRPG si existe a lo menos un área habitada en un radio de 2 kilómetros (km), medido desde la ubicación de la estación.

Una estación EMRPG tendrá un área de representatividad para la población expuesta correspondiente a un radio de 2 km, medido desde la ubicación de la estación.

h. *Percentil:* Corresponde al valor "q" calculado a partir de los valores efectivamente medidos, aproximados al ug/m3N más próximo. Todos los valores se anotarán en una lista establecida por orden creciente para cada estación de monitoreo.

$X1 \leq X2 \leq X3 \ldots\leq Xk \leq X\,n - 1 \leq Xn$

El percentil será el valor del elemento de orden "k", para el que "k" se calculará por medio de la siguiente fórmula:

k = q X n , donde "q" = 0.99 para el Percentil 99, y "n" corresponde al número de valores efectivamente medidos. El valor "k" se aproximará al número entero más próximo

i. *Situaciones de emergencia ambiental declarada por pronóstico de superación de niveles*: Son aquellas que se declaran en base a los resultados de la metodología de pronóstico de calidad del aire.

j. *Situaciones de emergencia ambiental declarada por constatación de superación de niveles*: son aquellas que se declaran en base a las mediciones constatadas en las estaciones de monitoreo de la calidad del aire.

III. Nivel de Norma Primaria de Calidad de Aire para Monóxido de Carbono

Art.3.- La norma primaria de calidad de aire para monóxido de carbono como concentración de 1 hora será de 25 ppmv.

Se considerará sobrepasada la norma primaria de calidad de aire para monóxido de carbono como concentración de 1 hora, cuando el percentil 99 del máximo diario de concentración de 1 hora registrada durante un año calendario, o en su defecto de 12 meses a partir del mes de inicio de las mediciones, en cualquier estación monitora clasificada como EMRPG, sea mayor o igual al valor indicado en el inciso precedente.

Asimismo, se considerará sobrepasada la norma, si antes que concluya el año calendario, o en su defecto de 12 meses a partir del mes de inicio de las mediciones, se registrare en cualquier estación monitora clasificada como EMRPG, más de cuatro días con mediciones de máximo diario de concentración de 1 hora de monóxido de carbono igual o sobre el valor de la norma.

Art.4. La norma primaria de calidad de aire para monóxido de carbono como concentración de 8 horas será de 9 ppmv.

Se considerará sobrepasada la norma primaria de calidad de aire para monóxido de carbono como concentración de 8 horas, cuando el percentil 99 del máximo diario de concentración de 8 horas registradas durante un año calendario, o en su defecto de 12 meses a partir del mes de inicio de las mediciones, en cualquier estación monitora clasificada como EMRPG sea mayor o igual al valor indicado en el inciso precedente.

Asimismo, se considerará sobrepasada la norma, si antes que concluya el año calendario, o en su defecto de 12 meses a partir del mes de inicio de las mediciones se registrare en cualquier estación clasificada como EMRPG, mas de cuatro días con mediciones de máximo diario de concentración de 8 horas de monóxido de carbono igual o sobre el valor de la norma.

Art.5.- Los siguientes niveles originarán situaciones de emergencia ambiental para monóxido de carbono en concentración de ocho horas:

Nivel 1: 15 - 29 ppmv.
Nivel 2: 30 - 34 ppmv
Nivel 3: 35 ppmv o superior

Las situaciones de emergencia ambiental para monóxido de carbono se declararán en función de los niveles anteriores, los cuales podrán ser obtenidos mediante la aplicación de una metodología de pronóstico de calidad de aire aprobada por el Servicio de Salud correspondiente, o por medio de la constatación de las concentraciones del contaminante a partir de alguna de las estaciones monitoras de calidad de aire clasificadas como EMRPG.

La autoridad que realice la declaración de situación de emergencia ambiental podrá omitir tal declaración, dejarla sin efecto o adoptar las medidas correspondientes a los niveles menos estrictos, cumpliendo con las mismas formalidades a que está sujeta la declaración de estas situaciones. Ello sólo podrá realizarse si se detecta un cambio en las condiciones meteorológicas en forma posterior a la hora de comunicación del pronóstico o a la constatación de la superación de los niveles de calidad de aire, y siempre que dicho cambio asegure una mejoría tal en las condiciones de calidad de aire que invalide los resultados entregados por el pronóstico o que asegure la reducción de los niveles de calidad de aire por debajo de aquellos que definen situaciones de emergencia ambiental.

Los planes operacionales para enfrentar las situaciones de emergencia ambiental podrán considerar medidas de control diferentes ya sea se trate de situaciones de emergencia ambiental declaradas por pronóstico o situaciones de emergencia ambiental declaradas por constatación.

IV. Metodología de Medición de la Norma

Art.6.- La medición de la concentración de monóxido de carbono en el aire se realizará mediante el método de medición denominado Fotometría Infrarroja no dispersiva o mediante un método de medición cuya metodología de operación sea aprobada por un organismo internacional calificado para este fin.

El monitoreo deberá realizarse con instrumentos aprobados por un organismo internacional calificado para ese fin y en concordancia con los requerimientos para instalación, calibración y operación de los equipos de muestreo y análisis aprobados por el Servicio de Salud correspondiente.

Art.7.- Para efectos del emplazamiento de un colector de muestras de monóxido de carbono en una estación clasificada como EMRPG se debe considerar los siguientes aspectos:

a) La toma de muestra deberá estar ubicada a una altura no inferior a 3 metros (m) ni superior a 15m, desde el nivel del suelo.

b) Obstrucciones espaciales:

i. La toma de muestra deberá estar ubicada a una distancia igual o mayor a 1m, verticalmente y horizontalmente desde la estructura que la soporta. Cuando la toma de muestras está localizada sobre techos, esta distancia de separación se refiere a paredes, cercos o habitaciones ubicadas sobre azoteas.
ii. La estación de monitoreo deberá localizarse a una distancia superior a 20m de cualquier edificación existente en el lugar y a una distancia no inferior a 10m de árboles que puedan actuar como obstrucción al flujo de aire.
iii. La toma de muestra deberá encontrarse a una distancia igual o superior al doble de la altura de la perturbación más próxima en sentido horizontal, que sobresale por sobre la toma de muestra.
iv. El movimiento del aire no deberá estar restringido en un arco de 270° alrededor de la entrada de la toma de muestra.

V. Validación de la Información de Monitoreo de Calidad del Aire

Art. 8.- La concentración de una hora se considerará válida, si a lo menos el 75% de los datos para calcular el valor horario se encuentran disponibles.

La concentración de 8 horas se considerará válida, si a lo menos el 75% de los datos para calcular el valor de 8 horas se encuentran disponibles.

VI. Criterios de priorización para el establecimiento de Redes de Monitoreo de Calidad del Aire.

Art. 9.- Para efectos de determinar los lugares prioritarios dentro del país en que se deberán instalar redes de monitoreo para evaluar el cumplimiento de la presente norma, debe considerarse lo siguiente:

1. Cantidad de población expuesta;
2. Volumen del parque automotor existente y proyectado;
3. Presencia de desarrollos industriales significativos emisores de monóxido de carbono
4. Valores absolutos de concentraciones de monóxido de carbono en aire medido, y tendencias históricas, positivas o negativas, de dichos valores;

VII. Fiscalización de la Norma

Art.10.- Corresponderá a los Servicios de Salud del país y, en la Región Metropolitana al Servicio de Salud del Ambiente de la Región Metropolitana, fiscalizar el cumplimiento de las disposiciones de la presente norma.

VIII. Entrada en Vigencia

Art. 11.- La presente norma entrará en vigencia el día 1° del mes siguiente a su publicación en el Diario Oficial quedando desde esa fecha sin efecto las normas primarias de calidad de aire para monóxido de carbono vigentes a dicha fecha.

2.- Sométase a consulta el presente anteproyecto de norma.

Para tales efectos:

1. Remítase copia del expediente al Consejo Consultivo de la Comisión Nacional del Medio Ambiente, para que emita su opinión sobre el anteproyecto de revisión de norma de calidad. Dicho Consejo dispondrá de 60 días contados desde la recepción de la copia del expediente, para el despacho de su opinión. La opinión que emita el Consejo Consultivo de la Comisión Nacional del Medio Ambiente será fundada, y en ella se dejará constancia de los votos disidentes.

2. Dentro del plazo de 60 días, contados desde la publicación en el Diario Oficial, del extracto de la presente resolución, cualquier persona, natural o jurídica, podrá formular observaciones al contenido del anteproyecto de revisión de norma de calidad. Dichas observaciones deberán ser presentadas, por escrito, en la Comisión Regional del Medio Ambiente correspondiente al domicilio del interesado, y deberán ser acompañadas de los antecedentes en los que se sustentan, especialmente los de naturaleza técnica, científica, social, económica y jurídica.

Anótese, publíquese en extracto, comuníquese y archívese.

COMISION NACIONAL DEL MEDIO AMBIENTE
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REPUBLICA DE CHILE
COMISION NACIONAL DEL MEDIO AMBIENTE
ASR/PMC

APRUEBA ANTEPROYECTO DE REVISION DE NORMA PRIMARIA DE CALIDAD DE AIRE PARA OZONO (O3)

SANTIAGO, 8 de septiembre de 2000

EXENTA N° 913

VISTOS:

El acuerdo N°67 de fecha 27de marzo de 1998, del Consejo Directivo de CONAMA que aprobó el Tercer Programa Priorizado de Normas.; La Resolución N°1215 de 1978, del Delegado de Gobierno en el Servicio Nacional de Salud, la Resolución Exenta N° 1514 de 1999; de la Dirección Ejecutiva de la Comisión nacional del Medio Ambiente; lo dispuesto en el Decreto Supremo N°93 de 1995, del Ministerio Secretaría General de la Presidencia que fija el procedimiento para la dictación de normas de calidad y emisión; y los demás antecedentes que obran en el expediente público.

RESUELVO

1.- Apruébase el siguiente Anteproyecto de Revisión de Norma Primaria de Calidad de Aire para Ozono (O_3).

I. FUNDAMENTOS:

De acuerdo con lo preceptuado en la ley 19.300, es deber del Estado dictar normas para regular la presencia de contaminantes en el medio ambiente, de manera de prevenir que estos puedan significar o representar, por sus niveles, concentraciones y periodos, un riesgo para la salud de las personas, la preservación de la naturaleza y la conservación del patrimonio ambiental.

El ozono es un fotooxidante que se produce en la tropósfera por efecto de la oxidación de monóxido de carbono e hidrocarburos en presencia de oxidos de nitrógeno y luz solar. de este modo, los hidrocarburos, el monóxido de carbono y los oxidos de nitrógeno constituyen precursores en la formación de ozono.

Las características dañinas del ozono en la salud de la población se originan en su gran capacidad oxidante que lo hace reaccionar con toda clase de sustancias orgánicas. El ozono puede penetrar los tejidos de la región pulmonar pero la dosis máxima de contaminante la recibe las regiones bronquiales y alveolares.

Los efectos típicos del ozono en la salud son cambios en la función pulmonar que van precedidos por irritación de ojos y síntomas del pecho y de las vías respiratorias en poblaciones sensibles. A este respecto la Organización Mundial de la Salud indica que en el caso del ozono, "los problemas de salud de mayor preocupación son: aumento en las admisiones hospitalarias, exacerbación del asma, inflamaciones pulmonares y alteraciones estructurales del pulmón" (Guidelines for Air Quality, WHO, 1999. pp.36).

En términos cuantitativos, la Organización Mundial de la Salud (OMS) reporta efectos en la salud, estadísticamente significativos, a concentraciones de 160 ug/m3 para exposiciones de 6-horas en un grupo de adultos saludables, experimentando los sujetos más sensitivos más de un 10% de decremento en la función pulmonar a las 4-5 horas. También que, a valores de 240 ug/m3 por 2 horas se producen disminuciones en la función pulmonar en niños y adultos realizando ejercicio físico intenso.

Por último, indica que se producen efectos agudos sustanciales cuando se realiza ejercicio físico con exposiciones de 1-hora de 500ug/m3 o superior, particularmente en individuos susceptibles o sub-grupos: "El balance de las evidencias indica que disminuciones de VEF1 (Volumen Expiratorio Forzado en 1 segundo) de más de un 10% ocurren a niveles de 160 ug/m3 y superior. Se acepta generalmente que la duración en la exposición a ozono es importante en el control de la respuesta."

Sobre esta base, un valor guía de 120 ug/m3 por un período máximo de 8 horas se establece como un nivel en el cual los efectos agudos sobre la salud pública son bajos (Guidelines for Air Quality, WHO, Geneva, 1999, pp32 y 33).

En los Estados Unidos (EE.UU.), la Agencia de Protección Ambiental (USEPA) reporta en su Ozone Final Rule: 40CFR, part 50 de julio de 1997, que existe clara evidencia a partir de estudios clínicos (respuestas estadísticamente significativas) que los efectos del ozono se asocian con exposiciones de una duración entre 6 a 8 horas. Por tanto, resulta relevante el control de eventos de varias horas con concentraciones moderadamente altas de este contaminante

Respecto al intervalo de evaluación de la norma, la OMS indica que el valor guía propuesto por tal entidad para 8 horas, protegería también contra exposiciones agudas de 1 hora, concluyéndose por lo tanto que un valor guía de 1 hora no sería necesario (Guidelines for Air Quality, WHO, Geneva, 1999, pp36). Esta aseveración es confirmada por USEPA que indica, que "desde el punto de vista de EPA, el hecho de que al usar un promedio de evaluación de 8 horas, resulta un estándar que protege en forma significativamente más uniforme que el estándar de 1 hora, es una consideración importante en términos de salud pública, que apoya la selección del uso de un promedio de 8 horas" (Ozone Final Rule, pp38862, Julio 1997).

Esta a su vez se basa en una recomendación unánime realizada por el Comité Consejero Científico para el Aire Limpio (CASAC), en el sentido que "el estándar de 1ª hora actual debe ser eliminado y reemplazado por uno de 8 horas" (Wolff, 1995b)

Existe un número reducido de estudios nacionales en el ámbito de efectos en la salud de este contaminante. La mayoría de los estudios realizados en Chile no encuentran efectos entre mortalidad total y exposición a ozono. El estudio de Ilabaca muestra un aumento en las consultas de urgencia infantil de hasta un 23% con niveles de ozono del orden de 106 ug/m3. Un último estudio realizado con información de Santiago para el periodo 1988-1996 encuentra relaciones estadísticamente significativas entre mortalidad diaria y ozono (máximos de 1 hora en la estación con el mayor valor de la red), pero solo en meses cálidos. (Cifuentes, Lave, Vega y Kopfer, en paper del año 2000 aún no publicado).

El ozono presenta efectos adicionales a los reportados a través de indicadores de salud. Por la reducción en el ambiente de este contaminante, también se esperan beneficios –secundarios- a recursos naturales (cultivos y vegetación natural) cercanos a las comunidades a proteger, así como indirectamente a ecosistemas y materiales expuestos a este contaminante.

Algunos de los precursores fotoquímicos del ozono, adicionalmente a aportar en la formación de ozono, tienen características carcinogénicas, por lo que en el futuro también podrían ser materia de regulación.

En el caso del ozono, a la fecha no existen métodos pasivos consolidados que permitan obtener valores representativos de la concentración ambiental de ozono para intervalos breves de medición: 1 hora, 8 horas.

A la fecha, el conocimiento de los efectos del ozono en la salud de la población permite realizar proposiciones de niveles objetivo para ser cumplidos a través de normas ambientales, así como niveles que definen las situaciones de emergencia ambiental por ozono, por lo que los que los valores de normas de calidad primaria para ozono contenidos en la Resolución 1215 de 1978, del Delegado de Gobierno en el Servicio Nacional de Salud (160 ug/m3N como concentración media aritmética de una hora) deben ser revisados a la luz de tales resultados;

II. Disposiciones Generales y Definiciones

Art.1.- La presente norma tiene por objetivo proteger la salud de la población de aquellos efectos agudos generados por la exposición a niveles de concentración de ozono en el aire.

Art.2.-Para efectos de lo dispuesto en la presente norma, se entenderá por:

a. *Efectos Agudos*: Aquellos producidos por la acción de concentraciones variables del contaminante en periodos cortos de exposición.

b. *ppbv:* Unidad de medida de concentración en volumen, correspondiente a una milésima de parte por millón.

c. *Concentración de Ozono*: Valor promedio temporal detectado en el aire expresado en partes por billón (ppbv)

d. *Concentración de 8-Horas*: Media aritmética de los valores de concentración de ozono medidos en cada estación monitora en 8 horas consecutivas, promedio móvil.

e. *Año calendario:* Periodo que se inicia el 1° de enero, y culmina el 31 de diciembre del mismo año.

f. *Estación de monitoreo con representatividad poblacional para gas ozono (EMRPG):* Una estación de monitoreo podrá clasificarse como EMRPG si se cumple que:

   i. Exista a lo menos un área habitada en un radio de 2 kilómetros (km), medido desde la ubicación de la estación,
   ii. Esté colocada a una distancia mínima de la calle o avenida más cercana, o de una fuente fija emisora de óxidos de nitrógeno, que asegure que no existan interferencia sistemática por sumideros de ozono.

Una estación EMRPG tendrá un área de representatividad para la población expuesta correspondiente a un radio de 2km, medido desde la ubicación de la estación.

g. *Percentil:* Corresponde al valor "q" calculado a partir de los valores efectivamente medidos, aproximados al ug/m3N más próximo. Todos los valores se anotarán en una lista establecida por orden creciente para cada estación de monitoreo.

$X1 \leq X2 \leq X3 \ldots\leq Xk \leq X\, n - 1 \leq Xn$

El percentil será el valor del elemento de orden "k", para el que "k" se calculará por medio de la siguiente fórmula:

k = q X n , donde "q" = 0.99 para el Percentil 99, y "n" corresponde al número de valores efectivamente medidos. El valor "k" se aproximará al número entero más próximo

h. *Situaciones de emergencia ambiental declarada por pronóstico de superación de niveles*: Son aquellas que se declaran en base a los resultados de la metodología de pronóstico de calidad del aire.

i. *Situaciones de emergencia ambiental declarada por constatación de superación de niveles*: Son aquellas que se declaran en base a las mediciones constatadas en las estaciones de monitoreo de la calidad del aire.

III. Nivel de Norma Primaria de Calidad de Aire para Ozono

Art.3.- La norma primaria de calidad de aire para ozono como concentración de 8-horas será de 60 ppbv.

Se considerará sobrepasada la norma primaria de calidad de aire para ozono como concentración de 8 horas, cuando el percentil 99 del máximo diario de las concentraciones de 8 horas registradas durante un año calendario, o en su defecto de 12 meses a partir del mes de inicio de las mediciones, en cualquier estación monitora clasificada como EMRPG sea mayor o igual al valor indicado en el inciso precedente.

Asimismo, se considerará sobrepasada la norma, si antes que concluya el año calendario, o en su defecto de 12 meses a partir del mes de inicio de las mediciones, se registrare en cualquier estación monitora clasificada como EMRPG, mas de cuatro días con mediciones de máximo diario de concentración de ozono igual o sobre el valor de la norma.

Art.4.- Los siguientes niveles originarán situaciones de emergencia ambiental para ozono, en concentración de una hora.

Nivel 1: 200-399 ppbv
Nivel 2: 400- 499 ppbv
Nivel 3: 500 ppbv o superior

Las situaciones de emergencia ambiental para ozono se declararán en función de los niveles anteriores, los cuales podrán ser obtenidos mediante la aplicación de una metodología de pronóstico de calidad de aire aprobada por el Servicio de Salud correspondiente, o por medio de la constatación de las concentraciones del contaminante a partir de alguna de las estaciones monitoras de calidad de aire clasificadas como EMRPG.

La autoridad que realice la declaración de situación de emergencia ambiental podrá omitir tal declaración, dejarla sin efecto o adoptar las medidas correspondientes a los niveles menos estrictos, cumpliendo con las mismas formalidades a que está sujeta la declaración de estas situaciones. Ello sólo podrá realizarse si se detecta un cambio en las condiciones meteorológicas en forma posterior a la hora de comunicación del pronóstico o a la constatación de la superación de los niveles de calidad de aire, y siempre que dicho cambio asegure una mejoría tal en las condiciones de calidad de aire que invalide los resultados entregados por el pronóstico o que asegure la reducción de los niveles de calidad de aire por debajo de aquellos que definen situaciones de emergencia ambiental.

Los planes operacionales para enfrentar las situaciones de emergencia ambiental podrán considerar medidas de control diferentes ya sea se trate de situaciones de emergencia ambiental declaradas por pronóstico o situaciones de emergencia ambiental declaradas por constatación.

IV. Metodología de Medición de la Norma

Art.5.- La medición de la concentración de ozono en el aire se realizará mediante los métodos de medición:

- Quimiluminiscencia con etileno
- Fotometría de absorción ultravioleta
- Cromatografía líquida gas/sólido
- Espectrometría de absorción óptica diferencial, con calibración in-situ.
- Un método de medición cuya metodología de operación sea aprobada por un organismo internacional calificado para ese fin.

El monitoreo deberá realizarse con instrumentos aprobados por un organismo internacional calificado para ese fin y en concordancia con los requerimientos para instalación, calibración y operación de los equipos de muestreo y análisis aprobados por el Servicio de Salud correspondiente.

Art.6.- Para efectos del emplazamiento de un colector de muestras en una estación monitora clasificada como EMRPG, se debe considerar los siguientes aspectos:

a) La toma de muestra deberá estar ubicada a una altura no inferior a 3 metros (m) ni superior a 15 m, desde el nivel del suelo.

b) Obstrucciones espaciales:

i. La toma de muestra deberá estar ubicada a una distancia igual o mayor a 1m, verticalmente y horizontalmente desde la estructura que la soporta. Cuando la toma de muestras está localizada sobre techos, esta distancia de separación se refiere a paredes, cercos o habitaciones ubicadas sobre azoteas.
ii. La estación de monitoreo deberá localizarse a una distancia superior a 20m de cualquier edificación existente en el lugar y a una distancia no inferior a 10m de árboles que puedan actuar como obstrucción al flujo de aire.
iii. La toma de muestra deberá encontrarse a una distancia igual o superior al doble de la altura de la perturbación mas próxima en sentido horizontal, que sobresale por sobre la toma de muestra.
iv. El movimiento del aire no deberá estar restringido en un arco de 270° alrededor de la entrada de la toma de muestra.

V. Validación de la Información de Monitoreo de Calidad de Aire

Art.7.- La concentración de 8 horas se considerará válida, si a lo menos, el 75% de los datos para calcular el valor de 8 horas se encuentran disponibles.

VI. Criterios de priorización para el establecimiento de Redes de Monitoreo de Calidad del Aire.

Art.8.- Para efectos de determinar los lugares prioritarios dentro del país en que se deberá instalar redes de monitoreo a fin de evaluar el cumplimiento de la presente norma, deberá considerarse lo siguiente:

1. Cantidad de población expuesta;
2. Volumen del parque automotor existente y proyectado;
3. Presencia de desarrollos industriales significativos emisores de precursores de ozono
4. Valores absolutos de concentraciones de ozono en aire medido, y tendencias históricas, positivas o negativas, de dichos valores.

VII. Fiscalización de la Norma

Art.9.- Corresponderá a los Servicios de Salud del país y, en la Región Metropolitana al Servicio de Salud del Ambiente de la Región Metropolitana, fiscalizar el cumplimiento de las disposiciones de la presente norma.

VIII. Entrada en Vigencia

Art.10.- La presente norma entrará en vigencia el día 1° del mes siguiente a su publicación en el Diario Oficial quedando desde esa fecha sin efecto las normas primarias de calidad de aire para ozono vigentes a dicha fecha.

2.- Sométase a consulta el presente anteproyecto de norma.

Para tales efectos:

1. Remítase copia del expediente al Consejo Consultivo de la Comisión Nacional del Medio Ambiente, para que emita su opinión sobre el anteproyecto de revisión de norma de calidad. Dicho Consejo dispondrá de 60 días contados desde la recepción de la copia del expediente, para el despacho de su opinión. La opinión que emita el Consejo Consultivo de la Comisión Nacional del Medio Ambiente será fundada, y en ella se dejará constancia de los votos disidentes.

2. Dentro del plazo de 60 días, contados desde la publicación en el Diario Oficial, del extracto de la presente resolución, cualquier persona, natural o jurídica, podrá formular observaciones al contenido del anteproyecto de revisión de norma de calidad. Dichas observaciones deberán ser presentadas, por escrito, en la Comisión Regional del Medio Ambiente correspondiente al domicilio del interesado, y deberán ser acompañadas de los antecedentes en los que se sustentan, especialmente los de naturaleza técnica, científica, social, económica y jurídica.

Anótese, publíquese en extracto, comuníquese y archívese.

Adriana Hoffmann Jacoby
Directora Ejecutiva

CRF/RLCH
Distribución:
Comité Operativo;
Dirección Ejecutiva;
Directores Regionales;
Consejo Consultivo de CONAMA;
Depto. Jurídico;
Depto. Descontaminación, Planes y Normas;
Unidad Economía Ambiental;
Oficina de Partes;
Archivo.

REPUBLICA DE CHILE
COMISION NACIONAL DEL MEDIO AMBIENTE
ASR/PMC

APRUEBA ANTEPROYECTO DE REVISION DE NORMA PRIMARIA DE CALIDAD DE AIRE PARA DIOXIDO DE NITROGENO (NO2)

SANTIAGO, 8 de septiembre de 2000

EXENTA N° 914

VISTOS:

El acuerdo N°67 de fecha 27 de marzo de 1998, del Consejo Directivo de CONAMA que aprobó el Tercer Programa Priorizado de Normas.; La Resolución N°1215 de 1978, del Delegado de Gobierno en el Servicio Nacional de Salud, la Resolución Exenta N° 1514 de 1999; de la Dirección Ejecutiva de la Comisión Nacional del Medio Ambiente; lo dispuesto en el Decreto Supremo N°93 de 1995, del Ministerio Secretaría General de la Presidencia que fija el procedimiento para la dictación de normas de calidad y emisión; y los demás antecedentes que obran en el expediente público.

RESUELVO

1.- Apruébase el siguiente Anteproyecto de Revisión de Norma Primaria de Calidad de Aire para Dióxido de Nitrógeno (NO2).

I. FUNDAMENTOS:

De acuerdo con lo preceptuado en la ley 19.300, es deber del Estado dictar normas para regular la presencia de contaminantes en el medio ambiente, de manera de prevenir que estos puedan significar o representar, por sus niveles, concentraciones y periodos, un riesgo para la salud de las personas, la preservación de la naturaleza y la conservación del patrimonio ambiental.

El dióxido de nitrógeno (NO2) es producido directa e indirectamente por la quema de combustibles a altas temperaturas. En el proceso de combustión, nitrógeno se oxida para formar principalmente monóxido de nitrógeno (NO) y en menor proporción dióxido de nitrógeno. El NO se transforma en NO2 mediante reacciones fotoquímicas.

La Organización Mundial de la Salud (OMS) reporta efectos directos en la salud de la población por la presencia de dióxido de nitrógeno. Para tal efecto distingue:

a. Efectos a exposiciones de corto plazo: "Seres humanos saludables expuestos, en descanso o con ejercicio liviano por menos de 2 horas a concentraciones sobre los 4700 ug/m3 (2,5 ppm) experimentan reducciones pronunciadas en la función pulmonar; generalmente, sujetos normales no son afectados por concentraciones menores que 1880 ug/m3 (1ppm).

Se ha reportado un amplio rango de efectos en asmáticos. Ellos son probablemente los más sensitivos, aunque existen algunas incertezas en las bases de datos de salud.

La concentración más baja que causaría efectos en la función pulmonar se reportó en dos estudios de laboratorio que expusieron a asmáticos leves por 30-110 minutos a 565 ug/m3 (0,3ppm) de NO2 durante ejercicio intermitente. Sin embargo, ninguno de estos estudios lograron replicar tales respuestas con un grupo más grande de sujetos asmáticos."

b. Efectos de exposiciones en el largo plazo: "Estudios con animales han mostrado claramente que exposiciones de varias semanas a meses con concentraciones menores a 1880 ug/m3 (1ppm) de NO2 ya causan una variedad de efectos, primeramente en el pulmón, pero también en otros órganos tal como el bazo e hígado, y en la sangre. Se han observado efectos reversibles e irreversibles en pulmones.

   No hay estudios epidemiológicos que puedan ser usados en forma confiable para cuantificar una exposición de largo plazo de NO2 o una concentración capaz de ser asociada con la inducción de riesgos inaceptables a la salud de niños o adultos.

   Los resultados de estudios en extramuros indican en forma consistente que niños expuestos por largo plazo a concentraciones ambientales de NO2 exhiben síntomas respiratorios de larga duración y muestran un descenso en la función pulmonar. Sin embargo, estudios epidemiológicos intra y extramuros proveen poca evidencia que exposiciones de largo plazo de NO2 están asociadas con efectos en la salud de adultos" (Guidelines for Air Quality, WHO, 1999. pp.30).

En los Estados Unidos de Norteamérica (EE.UU.) la Agencia de Protección Ambiental (US EPA) reporta en su NO2 Final Rule Review, que la exposición a dióxido de nitrógeno puede irritar los pulmones y disminuir la resistencia ante infecciones respiratorias (ej. influenza), particularmente en individuos con enfermedades respiratorias pre-existentes, tales como asma. Los efectos de exposiciones de corto plazo a dióxido de nitrógeno aún no están claros, pero exposición continuada o frecuente al dióxido de nitrógeno más altas que aquellas encontradas normalmente en el aire ambiente pueden incrementar la incidencia de enfermedades respiratorias agudas en niños" (US EPA NO2/Fact Sheet 16 de septiembre de 1996).

La OMS indica que en el caso del corto plazo, basado en pequeños cambios en las funciones pulmonares -menor que 5% de disminución en VEF1- y cambios en respuestas respiratorias en estudios con asmáticos y pacientes con enfermedades pulmonares crónicas, un rango de 365-565 ug/m3 (0,20 a 0,30ppm) es un claro LOEL (lowest-observed-effect-level).

Sobre este último valor, la OMS propone el uso de un margen de seguridad de 50% porque se han reportado aumentos estadísticamente significativos en respuestas a un broncoconstrictor con exposiciones a 188ug/m3, y porque un meta-análisis sugiere respuestas bajo los 365 ug/m3. Sin embargo, la significancia en la respuesta a 188ug/m3 se ha cuestionado. Con un valor doble respecto a la guía recomendada (400ug/m3) hay evidencia que sugiere posibles efectos leves en la función pulmonar de asmáticos. Si un asmático fuera expuesto simultáneamente o secuencialmente a NO2 y a un aero-alergeno, el riesgo de una respuesta exagerada al alergeno se incrementaría.

Para el caso de valores anuales, la OMS reporta que basado en los estudios revisados, no es posible en la actualidad seleccionar un valor específico de guía como promedio anual. Sin embargo, una revisión previa de NO2 recomendó un valor anual de 40 ug/m3 (WHO 1997, la que a su vez se basó en una recomendación realizada por la OMS en 1987). En la ausencia de un valor alternativo, se reconoce este valor como valor guía ("Guidelines for Air Quality", WHO, 1999. pp.31).

Existe un número reducido de estudios locales para este contaminante. Los estudios realizados en Chile no encuentran relación entre mortalidad total y exposición a NO2. El estudio de Ilabaca muestra un exceso de riesgo de 11% para consultas de urgencia infantil, esto equivaldría a un exceso de 4617 consultas anuales atribuibles a NO2. Un último estudio realizado con información de Santiago para el periodo 1988-1996 encuentra relaciones estadísticamente significativas entre mortalidad diaria y dióxido de nitrógeno en modelos de contaminantes únicos así como en modelos que evalúan contaminantes en parejas (Cifuentes, Lave, Vega y Kopfer, en paper del año 2000 aún no publicado).

El dióxido de nitrógeno puede combinarse con compuestos orgánicos volátiles en presencia de luz solar para formar ozono, así como con agua para formar ácido nítrico y nitratos. Esto contribuye a la producción de lluvia ácida y al aumento de los niveles de MP_{10} y $MP_{2,5}$.

A la fecha, el conocimiento de los efectos del dióxido de nitrógeno en la salud de las personas permite realizar proposiciones de niveles objetivo para ser cumplidos a través de normas ambientales, así como niveles que definen las situaciones de emergencia ambiental, por lo que los que los valores de normas de calidad primaria para dióxido de nitrógeno contenidos en la Resolución 1215 de 1978, del Delegado de Gobierno en el Servicio Nacional de Salud (100 ug/m3N como concentración media aritmética anual) deben ser revisados a la luz de tales resultados;

II. Disposiciones Generales

Art.1.- La presente norma tiene por objetivo proteger la salud de la población de aquellos efectos agudos y crónicos generados por la exposición a niveles de concentración de dióxido de nitrógeno en el aire.

Art.2.- Para efectos de lo dispuesto en la presente norma, se entenderá por:

a. *Efectos Agudos*: Aquellos producidos por la acción de concentraciones variables del contaminante en periodos cortos de exposición.

b. *Efectos Crónicos*: Aquellos producidos por la acción de concentraciones variables del contaminante en periodos prolongados de exposición.

c. *ppbv:* Unidad de medida de concentración en volumen, correspondiente a una milésima de parte por millón.

d. *Concentración de Dióxido de Nitrógeno*: Valor promedio temporal detectado en el aire expresado en partes por billón (ppbv).

e. *Concentración de 1 hora*: Media aritmética de los valores de concentración de dióxido de nitrógeno medidos en cada estación monitora en 1 hora.

f. *Concentración anual*: Media aritmética de los valores de concentración de dióxido de nitrógeno medidos en cada estación monitora en un año calendario, o en su defecto de 12 meses a partir del mes de inicio de las mediciones.

g. *Año calendario*: Período que se inicia el 1 de enero, y culmina el 31 de diciembre del mismo año.

h. *Estación de monitoreo con representatividad poblacional para gas dióxido de nitrógeno (EMRPG):* Una estación de monitoreo podrá clasificarse como EMRPG si existe a lo menos un área habitada en un radio de 2 kilómetros (km), medido desde la ubicación de la estación.

Una estación EMRPG tendrá un área de representatividad para la población expuesta correspondiente a un radio de 2 km, medido desde la ubicación de la estación.

i. *Percentil:* Corresponde al valor "q" calculado a partir de los valores efectivamente medidos, aproximados al ug/m3N más próximo. Todos los valores se anotarán en una lista establecida por orden creciente para cada estación de monitoreo.

$$X1 \leq X2 \leq X3 \ldots\leq Xk \leq X\, n - 1 \leq Xn$$

El percentil será el valor del elemento de orden "k", para el que "k" se calculará por medio de la siguiente fórmula:

k = q X n , donde "q" = 0.99 para el Percentil 99, y "n" corresponde al número de valores efectivamente medidos. El valor "k" se aproximará al número entero más próximo

j. *Situaciones de emergencia ambiental declarada por pronóstico de superación de niveles*: Son aquellas que se declaran en base a los resultados de la metodología de pronóstico de calidad del aire.

k. *Situaciones de emergencia ambiental declarada por constatación de superación de niveles*: Son aquellas que se declaran en base a las mediciones constatadas en las estaciones de monitoreo de la calidad del aire.

III. Nivel de Norma Primaria de Calidad de Aire para Dióxido de Nitrógeno

Art.3.- La norma primaria de calidad de aire para dióxido de nitrógeno como concentración anual será de 53 ppbv.

Se considerará sobrepasada la norma primaria de calidad de aire para dióxido de nitrógeno como concentración anual, cuando la concentración anual en un año calendario, o en su defecto de 12 meses a partir del mes de inicio de las mediciones en cualquier estación monitora clasificada como EMRPG sea mayor o igual al valor indicado en el inciso precedente.

Art.4.-La norma primaria de calidad de aire para dióxido de nitrógeno como concentración de 1 hora será de 212 ppbv.

Se considerará sobrepasada la norma primaria de calidad de aire para dióxido de nitrógeno como concentración de 1 hora, cuando el percentil 99 del máximo diario de las concentraciones de 1 hora registradas durante un año calendario, o en su defecto de 12 meses a partir del mes de inicio de las mediciones, en cualquier estación monitora clasificada como EMRPG, sea mayor o igual al valor indicado en el inciso precedente.

Asimismo, se considerará sobrepasada la norma, si antes que concluya el año calendario, o en su defecto de 12 meses a partir del mes de inicio de las mediciones, se registrare en cualquier estación monitora clasificada como EMRPG, mas de cuatro días con mediciones de máximo diario de concentración de 1 hora de dióxido de nitrógeno igual o sobre el valor de la norma.

Art.5.- Los siguientes niveles originarán situaciones de emergencia ambiental para dióxido de nitrógeno en concentración de una hora:

Nivel 1: 600-1199 ppbv
Nivel 2: 1200- 1599 ppbv
Nivel 3: 1600 ppbv o superior

Las situaciones de emergencia ambiental para dióxido de nitrógeno se declararán en función de los niveles anteriores, los cuales podrán ser obtenidos mediante la aplicación de una metodología de pronóstico de calidad de aire aprobada por el Servicio de Salud correspondiente, o por medio de la constatación de las concentraciones del contaminante a partir de alguna de las estaciones monitoras de calidad de aire clasificadas como EMRPG.

La autoridad que realice la declaración de situación de emergencia ambiental podrá omitir tal declaración, dejarla sin efecto o adoptar las medidas correspondientes a los niveles menos estrictos, cumpliendo con las mismas formalidades a que está sujeta la declaración de estas situaciones. Ello sólo podrá realizarse si se detecta un cambio en las condiciones meteorológicas en forma posterior a la hora de comunicación del pronóstico o a la constatación de la superación de los niveles de calidad de aire, y siempre que dicho cambio asegure una mejoría tal en las condiciones de calidad de aire que invalide los resultados entregados por el pronóstico o que asegure la reducción de los niveles de calidad de aire por debajo de aquellos que definen situaciones de emergencia ambiental.

Los planes operacionales para enfrentar las situaciones de emergencia ambiental podrán considerar medidas de control diferentes ya sea se trate de situaciones de emergencia ambiental declaradas por pronóstico o situaciones de emergencia ambiental declaradas por constatación.

Art.6.- En el caso que el dióxido de nitrógeno fuese precursor de otro contaminante normado, los planes de descontaminación o prevención que se establezcan para el control de este último, podrán incluir medidas de reducción de emisiones del contaminante dióxido de nitrógeno, independientemente del cumplimiento de las normas de calidad de aire aquí establecidas.

IV. Metodología de Medición de la Norma

Art.7.- La medición de la concentración de dióxido de nitrógeno en el aire se realizará mediante los métodos de medición:

a) Quimiluminiscencia,
b) Los que se basen en el método modificado de Griess-Saltzmann,
c) Espectrometría de absorción óptica diferencial, con calibración in-situ,
d) Un método de medición cuya metodología de operación sea aprobada por un organismo internacional calificado para este fin.

El monitoreo deberá realizarse con instrumentos aprobados por un organismo internacioal calificado para este fin y en concordancia con los requerimientos para instalación, calibración y operación de los equipos de muestreo y análisis aprobados por el Servicio de Salud correspondiente.

Art.8.- Para efectos del emplazamiento de un colector de muestras en una estación monitora clasificada como EMRPG, se debe considerar los siguientes aspectos:

a) La toma de muestra deberá estar ubicada a una altura no inferior a 3 metros (m) ni superior a 15m, desde el nivel del suelo.

b) Obstrucciones espaciales:

   i. La toma de muestra deberá estar ubicada a una distancia igual o mayor a 1m, verticalmente y horizontalmente desde la estructura que la soporta. Cuando la toma de muestras está localizada sobre techos, esta distancia de separación se refiere a paredes, cercos o habitaciones ubicadas sobre azoteas.

ii. La estación de monitoreo deberá localizarse a una distancia superior a 20m de cualquier edificación existente en el lugar y a una distancia no inferior a 10m de árboles que puedan actuar como obstrucción al flujo de aire.
iii. La toma de muestra deberá encontrarse a una distancia igual o superior al doble de la altura de la perturbación mas próxima en sentido horizontal, que sobresale por sobre la toma de muestra.
iv. El movimiento del aire no deberá estar restringido en un arco de 270° alrededor de la entrada de la toma de muestra.

V. Validación de la Información de Monitoreo de Calidad de Aire

Art.9.- La concentración anual se considerará válida, si para cada uno de los cuatro trimestres de un año calendario, o en su defecto de12 meses a partir del mes de inicio de las mediciones, se dispone de a lo menos un 75% de los datos horarios esperados para ese periodo.

La concentración de una hora se considerará válida, si a lo menos, el 75% de los datos para calcular el valor horario se encuentran disponibles.

Art.10- Podrán utilizarse técnicas exploratorias de medición pasivas o activas para establecer, de modo indicativo, la calidad de aire para dióxido de nitrógeno en un área determinada. Si los resultados de concentración de calidad de aire medida mediante estas técnicas son superiores al nivel de norma correspondiente, el Servicio de Salud deberá establecer en un plazo máximo de 3 años en dicha área, un monitoreo formal de acuerdo a la metodología de medición señalada en el artículo cuarto del presente decreto.

El monitoreo mediante técnicas exploratorias de medición activas o pasivas, deberá realizarse en concordancia con los requerimientos para instalación, calibración, operación y análisis aprobados por el Servicio de Salud correspondiente.

VI. Criterios de Priorización para el Establecimiento de Redes de Monitoreo de Calidad del Aire.

Art.11.- Para efectos de determinar los lugares prioritarios dentro del país en que se deberán instalar redes de monitoreo para de evaluar el cumplimiento de la presente norma, deberá considerarse lo siguientes:

1. Cantidad de población expuesta;
2. Volumen del parque automotor existente y proyectado;
3. Presencia de desarrollos industriales significativos emisores de dióxido de nitrógeno;
4. Valores absolutos, medidos, de concentraciones de dióxido de nitrógeno en aire, y tendencias históricas, positivas o negativas, de dichos valores;
5. Resultados del monitoreo realizado mediante técnicas exploratorias de medición activas o pasivas.

VII. Fiscalización de la Norma

Art.12.- Corresponderá a los Servicios de Salud del país y, en la Región Metropolitana al Servicio de Salud del Ambiente de la Región Metropolitana, fiscalizar el cumplimiento de las disposiciones de la presente norma.

VIII. Entrada en Vigencia

Art.13.- La presente norma entrará en vigencia el día 1° del mes siguiente a su publicación en el Diario Oficial quedando desde esa fecha sin efecto las normas primarias de calidad de aire para dióxido de nitrógeno vigentes a dicha fecha.

2.- Sométase a consulta el presente anteproyecto de norma.

Para tales efectos:

1. Remítase copia del expediente al Consejo Consultivo de la Comisión Nacional del Medio Ambiente, para que emita su opinión sobre el anteproyecto de revisión de norma de calidad. Dicho Consejo dispondrá de 60 días contados desde la recepción de la copia del expediente, para el despacho de su opinión. La opinión que emita el Consejo Consultivo de la Comisión Nacional del Medio Ambiente será fundada, y en ella se dejará constancia de los votos disidentes.

2. Dentro del plazo de 60 días, contados desde la publicación en el Diario Oficial, del extracto de la presente resolución, cualquier persona, natural o jurídica, podrá formular observaciones al contenido del anteproyecto de revisión de norma de calidad. Dichas observaciones deberán ser presentadas, por escrito, en la Comisión Regional del Medio Ambiente correspondiente al domicilio del interesado, y deberán ser acompañadas de los antecedentes en los que se sustentan, especialmente los de naturaleza técnica, científica, social, económica y jurídica.

Anótese, publíquese en extracto, comuníquese y archívese.

COMISIÓN NACIONAL DEL MEDIO AMBIENTE

Adriana Hoffmann Jacoby
Directora Ejecutiva

CRF/RLCH
Distribución:
Comité Operativo;
Dirección Ejecutiva;
Directores Regionales;
Consejo Consultivo de CONAMA;
Depto. Jurídico;
Depto. Descontaminación, Planes y Normas;
Unidad Economía Ambiental;
Oficina de Partes;
Archivo.

REPUBLICA DE CHILE
COMISION NACIONAL DEL MEDIO AMBIENTE
ASR/PMC

APRUEBA ANTEPROYECTO DE REVISION DE NORMA PRIMARIA DE CALIDAD DE AIRE PARA ANHIDRIDO SULFUROSO (SO2)

SANTIAGO, 8 de septiembre de 2000

EXENTA N° 915

VISTOS:

El acuerdo N°67 de fecha 27 de marzo de 1998, del Consejo Directivo de CONAMA que aprobó el Tercer Programa Priorizado de Normas; La Resolución N°1215 de 1978, del Delegado de Gobierno en el Servicio Nacional de Salud, la Resolución Exenta N° 1514 de 1999; de la Dirección Ejecutiva de la Comisión Nacional del Medio Ambiente; lo dispuesto en el Decreto Supremo N°185 de 1991, del Ministerio de Minería; lo dispuesto en el Decreto Supremo N°93 de 1995, del Ministerio Secretaría General de la Presidencia que fija el procedimiento para la dictación de normas de calidad y emisión; y los demás antecedentes que obran en el expediente público.

RESUELVO

1.- Apruébase el siguiente Anteproyecto de Revisión de Norma Primaria de Calidad de Aire para Anhídrido Sulfuroso (SO2.

I. FUNDAMENTOS:

De acuerdo con lo preceptuado en la Ley 19.300, es deber del Estado dictar normas para regular la presencia de contaminantes en el medio ambiente, de manera de prevenir que estos puedan significar o representar, por sus niveles, concentraciones y periodos, un riesgo para la salud de las personas, la preservación de la naturaleza y la conservación del patrimonio ambiental.

El anhídrido sulfuroso es un gas soluble en agua, que al hidratarse da origen a la formación de ácidos sumamente agresivos. El anhídrido sulfuroso al ser inhalado se hidrata con la humedad de las mucosas conjuntival y respiratoria constituyendo un riesgo para la salud de las personas al producir irritación e inflamación de las mismas.

El anhídrido sulfuroso es un importante broncoconstrictor, desde los primeros minutos de exposición y su efecto aumenta con la actividad física, con la hiperventilación, al respirar aire frío y seco y en personas con hiperreactividad bronquial.

La exposición a este contaminante produce efectos agudos y efectos crónicos sobre la salud de las personas.

Los efectos agudos en la población se observan a los pocos minutos de exposición, 5 – 10 minutos y la exposición a un tiempo mayor no incrementa los efectos observados.

La Organización Mundial de la Salud (OMS) con el objetivo de proteger a la población más sensible de los efectos agudos producidos por el anhídrido sulfuroso recomienda que no se supere un nivel de 500 ug/m3N para un periodo de 10 minutos.

Si se analiza la información de calidad de aire para anhídrido sulfuroso disponible en el país para un periodo de una hora, se puede deducir que existen localidades en las cuales el nivel recomendado por la OMS para un periodo de 10 minutos se supera.

La OMS señala, que para un periodo de 24 horas y basado en los resultados de estudios epidemiológicos de morbilidad, mortalidad o cambios en la función pulmonar en grupos de población sensible se observan efectos en las personas a partir de un nivel de concentración de 250 ug/m3N, teniendo en consideración los efectos del material particulado en suspensión y otros contaminantes.

La OMS, aplicando un factor de incertidumbre de 2 y con el objeto de proteger la salud de la población, recomienda un nivel de concentración de 125 ug/m3N para un periodo de 24 horas y un nivel de concentración de 50 ug/m3N para un periodo de un año.

El anhídrido sulfuroso se origina de la combustión del azufre contenido en los combustibles fósiles (petróleos combustibles, gasolina, petróleo diesel, carbón, etc.), de la fundición de minerales que contienen azufre y de otros procesos industriales.

El anhídrido sulfuroso presenta efectos adicionales a los reportados a través de indicadores de salud. De la reducción en el ambiente de este contaminante, también se espera beneficios secundarios sobre los recursos naturales (cultivos y vegetación natural) cercanos a las comunidades a proteger, así como indirectamente a ecosistemas y materiales expuestos a este contaminante.

El anhídrido sulfuroso es un precursor de aerosoles secundarios, típicamente asociados a la fracción fina del material particulado.

Los estudios realizados en nuestro país demuestran que la mortalidad no es estadísticamente significativa, es decir, no relacionan este efecto al contaminante. Los daños a la salud identificados y asociados a exposiciones al anhídrido sulfuroso corresponden a un aumento de tos y un efecto en el flujo respiratorio forzado (FEV). No se encontró evidencia de efectos sinérgicos con otros contaminantes. En general, para ninguno de los modelos de mortatilidad el anhídrido sulfuroso resultó estadísticamente significativo, en particular cuando el modelo incluía el MP10.

A la fecha, el conocimiento de los efectos del anhídrido sulfuroso en la salud de la población permite realizar proposiciones de niveles objetivo para ser cumplidos a través de normas ambientales, así como niveles que definen las situaciones de emergencia ambiental por anhídrido sulfuroso, por lo que, los valores de normas de calidad primaria para anhídrido sulfuroso contenidos en la Resolución 1215 de 1978, del Delegado de Gobierno en el Servicio Nacional de Salud y en el Decreto N°185 de 1991, del Ministerio de Minería (80 ug/m3N como concentración media aritmética anual y 365 ug/m3N como concentración media aritmética de veinticuatro horas) deben ser revisados a la luz de tales resultados,

II. Disposiciones Generales y Definiciones

Art.1.- La presente norma tiene por objetivo proteger la salud de la población de aquellos efectos agudos y crónicos generados por la exposición a niveles de concentración de anhídrido sulfuroso en el aire.

Art.2.- Para efectos de lo dispuesto en la presente norma, se entenderá por:

a. *Efectos Agudos*: Aquellos producidos por la acción de concentraciones variables del contaminante en periodos cortos de exposición.

b. *Efectos Crónicos*: Aquellos producidos por la acción de concentraciones variables del contaminante en periodos prolongados de exposición.

c. *ppbv*: Unidad de medida de concentración en volumen, correspondiente a una milésima de parte por millón.

d. *Concentración de Anhídrido Sulfuroso*: Valor promedio temporal detectado en el aire expresado en partes por billón (ppbv).

e. *Concentración de 1 hora*: Media aritmética de los valores de concentración de anhídrido sulfuroso medidos en cada estación monitora en 1 hora.

f. *Concentración de 24 horas*: Media aritmética de los valores de concentración de anhídrido sulfuroso medidos en cada estación monitora en 24 horas.

g. *Concentración anual*: Media aritmética de los valores de concentración de anhídrido sulfuroso medidos en cada estación monitora en un año calendario, o en su defecto de 12 meses a partir del mes de inicio de las mediciones.

h. *Año calendario:* Período que se inicia el 1 de enero y culmina el 31 de diciembre del mismo año.

i. *Estación de monitoreo con representatividad poblacional para gas anhídrido sulfuroso (EMRPG)*: Una estación de monitoreo podrá clasificarse como EMRPG si existe a lo menos un área habitada en un radio de 2 kilómetros (km), medido desde la ubicación de la estación.

   Una estación EMRPG tendrá un área de representatividad para la población expuesta correspondiente a un radio de 2 km, medido desde la ubicación de la estación.

j. *Percentil*: Corresponde al valor "q" calculado a partir de los valores efectivamente medidos, aproximados al ug/m3N más próximo. Todos los valores se anotarán en una lista establecida por orden creciente para cada estación de monitoreo.

$$X1 \leq X2 \leq X3 \ldots \leq Xk \leq X\,n - 1 \leq Xn$$

   El percentil será el valor del elemento de orden "k", para el que "k" se calculará por medio de la siguiente fórmula:

   k = q X n , donde "q" = 0.99 para el Percentil 99, y "n" corresponde al número de valores efectivamente medidos. El valor "k" se aproximará al número entero más próximo.

i. *Situaciones de emergencia ambiental declarada por pronóstico de superación de niveles*: Son aquellas que se declaran en base a los resultados de la metodología de pronóstico de calidad de aire.

j. *Situaciones de emergencia ambiental declarada por constatación de superación de niveles*: Son aquellas que se declaran en base a las mediciones constatadas en las estaciones de monitoreo de calidad de aire.

III. Nivel de Norma de Calidad Primaria para Anhídrido Sulfuroso en Aire

Art.3.- La norma primaria de calidad de aire para anhídrido sulfuroso como concentración anual será de 30 ppbv.

Se considerará sobrepasada la norma primaria de calidad de aire para anhídrido sulfuroso como concentración anual, cuando la concentración anual en un año calendario, o en su defecto de 12 meses a partir del mes de inicio de las mediciones, en cualquier estación monitora clasificada como EMRPG, sea mayor o igual al valor indicado en el inciso precedente.

Art.4.- La norma primaria de calidad de aire para anhídrido sulfuroso como concentración de 24 horas será de 95 ppbv .

Se considerará sobrepasada la norma primaria de calidad de aire para anhídrido sulfuroso como concentración de 24 horas, cuando el percentil 99 de las concentraciones de 24 horas registradas durante un año calendario, o en su defecto de 12 meses a partir del mes de inicio de las mediciones, en cualquier estación monitora clasificada como EMRPG, sea mayor o igual al valor indicado en el inciso precedente.

Asimismo, se considerará sobrepasada la norma, si antes de concluir el año calendario, o en su defecto de 12 meses a partir del mes de inicio de las mediciones, se registrare en cualquier estación monitora clasificada como EMRPG, mas de cuatro días con mediciones de concentración de 24 horas igual o sobre el valor de la norma.

Art.5.- La norma primaria de calidad de aire para anhídrido sulfuroso como concentración de una hora será de 400 ppbv.

Se considerará sobrepasada la norma primaria de calidad de aire para anhídrido sulfuroso como concentración de 1 hora cuando el percentil 99 máximo diario de las concentraciones de una hora registradas durante un año calendario, o en su defecto de 12 meses a partir del mes de inicio de las mediciones, en cualquier estación monitora clasificada como EMPRG, sea mayor o igual al valor indicado en el inciso precedente.

Asimismo, se considerará sobrepasada la norma, si antes de concluir el año calendario, o en su defecto de 12 meses a partir del mes de inicio de las mediciones, se registrare en cualquier estación monitora clasificada como EMRPG, mas de cuatro días con mediciones de máximo diario de concentración de una hora de anhídrido sulfuroso igual o sobre el valor de la norma.

Art.6.- Los siguientes niveles originarán situaciones de emergencia ambiental para anhídrido sulfuroso, en concentración de una hora:

Nivel 1: 750 - 999 ppbv
Nivel 2: 1.000 – 1.499 ppbv
Nivel 3: 1.500 ppbv o superior

Las situaciones de emergencia ambiental para anhídrido sulfuroso se declararán en función de los niveles anteriores, los cuales podrán ser obtenidos mediante la aplicación de una metodología de pronóstico de calidad de aire aprobada por el Servicio de Salud correspondiente, o por medio de la constatación de las concentraciones del contaminante a partir de alguna de las estaciones monitoras de calidad de aire clasificadas como EMRPG.

La autoridad que realice la declaración de situación de emergencia ambiental podrá omitir tal declaración, dejarla sin efecto o adoptar las medidas correspondientes a los niveles menos estrictos, cumpliendo las mismas formalidades a que está sujeta la declaración de estas situaciones. Ello sólo podrá realizarse si se detecta un cambio en las condiciones meteorológicas en forma posterior a la hora de comunicación del pronóstico o a la constatación de la superación de los niveles de calidad de aire, y siempre que dicho cambio asegure una mejoría tal en las condiciones de calidad de aire que invalide los resultados entregados por el pronóstico o que asegure la reducción de los niveles de calidad de aire por debajo de aquellos que definen situaciones de emergencia ambiental.

Los planes operacionales para enfrentar las situaciones de emergencia ambiental podrán considerar medidas de control diferentes ya sea se trate de situaciones de emergencia ambiental declaradas por pronóstico o situaciones de emergencia ambiental declaradas por constatación.

Art.7.- En el caso que el anhídrido sulfuroso fuese precursor de otro contaminante normado, los planes de descontaminación o prevención que se establezcan para el control de este último, podrán incluir medidas de reducción de emisiones del contaminante anhídrido sulfuroso, independientemente del cumplimiento de las normas de calidad de aire aquí establecidas.

IV. Metodología de Medición de la Norma

Art.8.- La medición de la concentración de anhídrido sulfuroso en el aire se realizará mediante los métodos de medición:

- Fluorescencia ultravioleta
- Espectrometría de absorción diferencial con calibración in – situ
- Un método de medición cuya metodología sea aprobada por un organismo internacional calificado para este fin.

El monitoreo deberá realizarse con instrumentos aprobados por un organismo internacional calificado para este fin y en concordancia con los requerimientos para instalación, calibración y operación de los equipos de muestreo y análisis aprobados por el Servicio de Salud correspondiente.

Art.9.- Para efectos del emplazamiento de un colector de muestras en una estación monitora clasificada como EMRPG, se debe considerar los siguientes aspectos:

a) La toma de muestra deberá estar ubicada a una altura no inferior a 3 metros (m) ni superior a 15 m, desde el nivel del suelo.

b) Obstrucciones Espaciales:

i. La toma de muestra deberá estar ubicada a una distancia igual o mayor a 1 m, verticalmente y horizontalmente desde la estructura que la soporta. Cuando la toma de muestra esta localizada sobre techos, esta distancia de separación se refiere a paredes, cercos o habitaciones ubicadas sobre azoteas.

ii. La estación de monitoreo deberá localizarse a una distancia superior a 20 m de cualquier edificación existente en el lugar y a una distancia no inferior a 10 m de árboles que puedan actuar como obstrucción al flujo de aire.
iii. La toma de muestra deberá encontrarse a una distancia igual o superior al doble de la altura de la perturbación más próxima en sentido horizontal, que sobresale por sobre la toma de muestra.
iv. El movimiento del aire no deberá estar restringido en un arco de 270° alrededor de la entrada de la toma de muestra.

V. Validación de la Información de Monitoreo de Calidad de Aire

Art.10.- La concentración anual se considerará válida, si para cada uno de los cuatro trimestres de un año calendario, o en su defecto de 12 meses a partir del mes de inicio de las mediciones, se dispone de a lo menos un 75% de los datos horarios esperados para ese periodo.

La concentración de 24 horas se considerará válida, si a lo menos, el 75% de los datos promedios horarios para un periodo de 24 horas, se encuentran disponibles.

La concentración de 1 hora se considerará válida, si a lo menos, el 75% de los datos para calcular el valor horario se encuentran disponibles.

Art.11.- Podrán utilizarse técnicas exploratorias de medición pasivas o activas para establecer de modo indicativo la calidad de aire para anhídrido sulfuroso en un área determinada. Si los resultados de concentración de calidad de aire medida con estas técnicas son superiores al nivel de norma correspondiente, el Servicio de Salud deberá establecer en un plazo máximo de 3 años en dicha área, un monitoreo formal de acuerdo a la metodología de medición señalada en el artículo octavo del presente decreto.

El monitoreo mediante técnicas de medición exploratorias pasivas o activas, deberá realizarse en concordancia con los requerimientos para instalación, calibración, operación y análisis aprobados por el Servicio de Salud correspondiente.

VI. Criterios de priorización para el establecimiento de Redes de Monitoreo de Calidad del Aire.

Art.12.- Para efectos de determinar los lugares prioritarios dentro del país en que se deberán instalar redes de monitoreo a fin de evaluar el cumplimiento de la presente norma, deberá considerarse lo siguiente:

1. Cantidad de población expuesta;
2. Presencia de desarrollos industriales significativos emisores de anhídrido sulfuroso
3. Valores absolutos, medidos, de concentraciones de anhídrido sulfuroso en aire, y tendencias históricas positivas o negativas de dichos valores;
4. Resultados del monitoreo realizado mediante técnicas de medición exploratorias pasivas o activas.

VII. Fiscalización de la Norma

Art.13.- Corresponderá a los Servicios de Salud del país y, en la Región Metropolitana al Servicio de Salud del Ambiente de la Región Metropolitana, fiscalizar el cumplimiento de las disposiciones de la presente norma.

VIII. Entrada en Vigencia

Art.14.- La presente norma entrará en vigencia el día 1º del mes siguiente a su publicación en el Diario Oficial quedando desde esa fecha sin efecto las normas primarias de calidad de aire para anhídrido sulfuroso vigentes a dicha fecha.

2.- Sométase a consulta el presente anteproyecto de norma.

Para tales efectos:

1. Remítase copia del expediente al Consejo Consultivo de la Comisión Nacional del Medio Ambiente, para que emita su opinión sobre el anteproyecto de revisión de norma de calidad. Dicho Consejo dispondrá de 60 días contados desde la recepción de la copia del expediente, para el despacho de su opinión. La opinión que emita el Consejo Consultivo de la Comisión Nacional del Medio Ambiente será fundada, y en ella se dejará constancia de los votos disidentes.

2. Dentro del plazo de 60 días, contados desde la publicación en el Diario Oficial, del extracto de la presente resolución, cualquier persona, natural o jurídica, podrá formular observaciones al contenido del anteproyecto de revisión de norma de calidad. Dichas observaciones deberán ser presentadas, por escrito, en la Comisión Regional del Medio Ambiente correspondiente al domicilio del interesado, y deberán ser acompañadas de los antecedentes en los que se sustentan, especialmente los de naturaleza técnica, científica, social, económica y jurídica.

Anótese, publíquese en extracto, comuníquese y archívese.

COMISION NACIONAL DEL MEDIO
DIRECCION EJECUTIVA

Adriana Hoffmann Jacoby
Directora Ejecutiva

CRF/RLCH
Distribución:
Comité Operativo;
Dirección Ejecutiva;
Directores Regionales;
Consejo Consultivo de CONAMA;
Depto. Jurídico;
Depto. Descontaminación, Planes y Normas;
Unidad Economía Ambiental;
Oficina de Partes;
Archivo.

REPUBLICA DE CHILE
COMISION NACIONAL DEL MEDIO AMBIENTE
ASR/PMC

APRUEBA ANTEPROYECTO DE REVISION DE NORMA PRIMARIA DE CALIDAD DE AIRE PARA PARTICULAS TOTALES EN SUSPENSION (PTS)

SANTIAGO, 8 de septiembre de 2000

EXENTA N° 916

VISTOS:

El acuerdo N° 67 de fecha 27 de marzo de 1998, del Consejo Directivo de CONAMA que aprobó el Tercer Programa Priorizado de Normas.; La Resolución N°1215 de 1978, del Delegado de Gobierno en el Servicio Nacional de Salud, la Resolución Exenta N° 1514 de 1999; de la Dirección Ejecutiva de la Comisión Nacional del Medio Ambiente; lo dispuesto en el Decreto Supremo N°93 de 1995, del Ministerio Secretaría General de la Presidencia que fija el procedimiento para la dictación de normas de calidad y emisión; y los demás antecedentes que obran en el expediente público.

RESUELVO

1.- Apruébase el siguiente Anteproyecto de Revisión de Norma Primaria de Calidad de Aire para Partículas Totales en Suspensión.

I. FUNDAMENTOS:

De acuerdo con lo preceptuado en la Ley 19.300, es deber del Estado dictar normas para regular la presencia de contaminantes en el medio ambiente, de manera de prevenir que estos puedan significar o representar, por sus niveles, concentraciones y periodos, un riesgo para la salud de las personas, la preservación de la naturaleza y la conservación del patrimonio ambiental.

Históricamente se consideró que todas las partículas suspendidas en el aire (PTS) afectaban la salud de las personas de la misma forma. Sin embargo, recientemente se ha demostrado que las partículas que más la afectan son aquellas con un diámetro aerodinámico menor a 10 um (MP10) y más aún, aquellas con diámetro aerodinámico menor a 2.5 um (MP2.5).

La fracción del PTS mayor a 10 micrones corresponde a partículas no respirables. Estas se depositan en la traquea y son limpiadas por los cilios a través de la formación de mucus y expulsadas a través de la tos o de la deglución.

El documento de guías globales de calidad del aire de la Organización Mundial de la salud (OMS) sostiene que no puede establecerse un nivel umbral para los efectos del material particulado en la salud, por lo que las guías para material particulado son representadas por asociaciones estadísticamente significativas entre el incremento en los efectos observados y el incremento de las concentraciones, específicamente de MP10 y MP2.5. No estableciéndose ningún tipo de guía para aquella fracción mayor a 10 micrones.

No se cuenta con una evaluación de riesgo que evidencie relación entre la exposición a PTS y en particular a los compuestos tóxicos contenidos en éste y la ocurrencia de alguna enfermedad.

En Chile, se regulan los efectos en salud generados por la fracción respirable del material particulado inferior a 10 micrones, a través de una norma primaria de calidad de aire para material particulado respirable (MP10) como concentración de 24 horas.

Los fundamentos anteriores permiten concluir que no se requiere de una norma primaria de calidad de aire para las partículas totales en suspensión.

II. Dispone no Establecer Niveles de Concentración para las Partículas Totales en Suspensión.

Se dejan sin efecto los valores de concentración para las partículas totales en suspensión que hayan estado vigentes hasta esta fecha.

III. Entrada En Vigencia

Lo dispuesto entrará en vigencia el día 1° del mes siguiente de publicado en el Diario Oficial el decreto supremo que apruebe la presente revisión de norma.

2.- Sométase a consulta el presente anteproyecto de norma.

Para tales efectos:

1. Remítase copia del expediente al Consejo Consultivo de la Comisión Nacional del Medio Ambiente, para que emita su opinión sobre el anteproyecto de revisión de norma de calidad. Dicho Consejo dispondrá de 60 días contados desde la recepción de la copia del expediente, para el despacho de su opinión. La opinión que emita el Consejo Consultivo de la Comisión Nacional del Medio Ambiente será fundada, y en ella se dejará constancia de los votos disidentes.

2. Dentro del plazo de 60 días, contados desde la publicación en el Diario Oficial, del extracto de la presente resolución, cualquier persona, natural o jurídica, podrá formular observaciones al contenido del anteproyecto de revisión de norma de calidad. Dichas observaciones deberán ser presentadas, por escrito, en la Comisión Regional del Medio Ambiente correspondiente al domicilio del interesado, y deberán ser acompañadas de los antecedentes en los que se sustentan, especialmente los de naturaleza técnica, científica, social, económica y jurídica.

Anótese, publíquese en extracto, comuníquese y archívese.

COMISION NACIONAL DEL MEDIO AMBIENTE
DIRECTOR EJECUTIVO

Adriana Hoffmann Jacoby
Directora Ejecutiva

CRF/RLCH
Distribución:
Comité Operativo;
Dirección Ejecutiva;
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Consejo Consultivo de CONAMA;
Depto. Jurídico;
Depto. Descontaminación, Planes y Normas;
Unidad Economía Ambiental;
Oficina de Partes;
Archivo.

REPÚBLICA DE CHILE
COMISIÓN NACIONAL DEL MEDIO AMBIENTE
SEGUNDA REGIÓN DE ANTOFAGASTA

000935

ORD. Nº : 0556 / 2000.-

ANT. : No hay.

MAT. : Lo que se indica.

10.250-7452
11 SEP 2000
Patricia Matus.
25196

Antofagasta, 05 de Septiembre de 2000.

DE : Directora Regional
Comisión Nacional del Medio Ambiente
Segunda Región de Antofagasta

A : Srta. Patricia Matus Correa
Jefa Depto. Descontaminación Planes y Normas
Comisión Nacional del Medio Ambiente

De mi consideración:

Por intermedio del presente, adjunto remito a usted, los siguientes antecedentes del Comité Regional de la Revisión de las Normas de Calidad de Aire:

1. Informe del Sub-grupo SO_2 y PTS, denominado Proposición para Anhídrido Sulfuroso (SO_2) Material Particulado en suspensión (PTS), con sus respectivos anexos:

   - Comentarios a Nivel Regional de la Asociación de Industriales de Antofagasta, conteniendo los comentarios de Chuquicamata y Edelnor.

   - Sugerencias y Consultas de acuerdo a encuesta vecinal.

   - Informe del Sr. Luis Vallejos en representación de la Universidad de Antofagasta.

   - Presentación de Fundición Altonorte.

2. Acta Nº 5 de fecha 28 de Agosto del 2000.

Sin otro particular, saluda atentamente a usted,

COMISIÓN NACIONAL DEL MEDIO AMBIENTE II REGIÓN DIRECTOR REGIONAL

Rosa Escobar Bello
Directora Regional
Comisión Nacional del Medio Ambiente
Segunda Región de Antofagasta

REB /MRT/mem
- Archivo CONAMA II Región.

COMITE REGIONAL II REGION

REVISION NORMAS DE CALIDAD PRIMARIA DEL AIRE

RESOLUCION Nº 1215/78 MINISTERIO DE SALUD

PROPOSICION PARA
ANHIDRIDO SULFUROSO (SO_2) Y
MATERIAL PARTICULADO EN SUSPENSION (PTS)

ANTOFAGASTA , AGOSTO DE 2000

000947

UNIDAD VECINAL N° 2.
"Vientos del Sur". Coviefi.

ANTOFAGASTA, Julio 13 del 2000.

SUGERENCIAS Y CONSULTAS DE ACUERDO A ENCUESTA VECINAL

1.- Felicitaciones por acción conjunta CONAMA, ALTONORTE, COMITÉ VECINAL, A.S.I. ANTOF.

2.- Credibilidad de los informes, ¿son de fiar?. Se entiende que hasta ahora sí, y a futuro, ¿continuarán ¿

3.- ¿ El monoxido de carbono es producido y derivado solamente de las fundiciones o también se considera el emitido por los vehículos ¿

4.- ¿ Es definitivo el traslado de plomo a Portezuelo o puede que nuevamente se tenga cercano a los grupos habitacionales ¿ No olvidar objeciones del Gobierno Boliviano.

5.- ¿ Qué pasará cuando se amplien las industrias que generan contaminantes, tales como los que se mencionan en la encuesta; o que existan otros de acuerdo a nuevas tecnologías ¿

6.- Es bueno que los organismos estatales, tales como CONAMA, pidan opiniones al público en general, vecinos y representantes de industrias,tanto Mineras como de todo orden.

7.- Se debe tener sumo cuidado por la experiencia de Chuquicamata; los vientos cambian y la posible contaminación es la misma (Ex. Funcionarios de CODELCO)

8.- Sugerir a CONAMA y ALTONORTE, la posibilidad de otro monitor, dada la densidad poblacional, más o menos 30.000 habitantes y se sigue construyendo más sectores habitacionales en el sector sur o entrada a la Coviefi.

9.- Incentivar a los vecinos para que cada uno coloque y cuide un árbol enfrente de su casa habitación.

10.- Motivar a los niños y jóvenes en general, a fin de que la Coviefi, sea un sector habitacional señero en cuanto a limpieza y aseo sectorial.

11.- Continuar en forma intensa la motivación de los niños a fin de que se integren al club deportivo,dada la significación del deporte en cuanto a eliminar el alcoholismo y la drogadicción.

12.- Solicitar a las empresas constructoras avisen a la comunidad o vecindario cuando se producirán detonaciones derivadas de trabajos con explosivos para los efectos de cimientos en sus construcciones.-

Atentamente:
Por Comité Medio Ambiente U. Vecinal N° 2. Vientos del Sur. Coviefi.

JULIO VALDIVIA MORGADO
Secretario

JUAN UGARTE GOMEZ
Presidente

C.C: Gobernación Provincial.
CONAMA.

noranda

Fundición Altonorte

Presentación para CONAMA Santiago 23 de Agosto 2000

000953

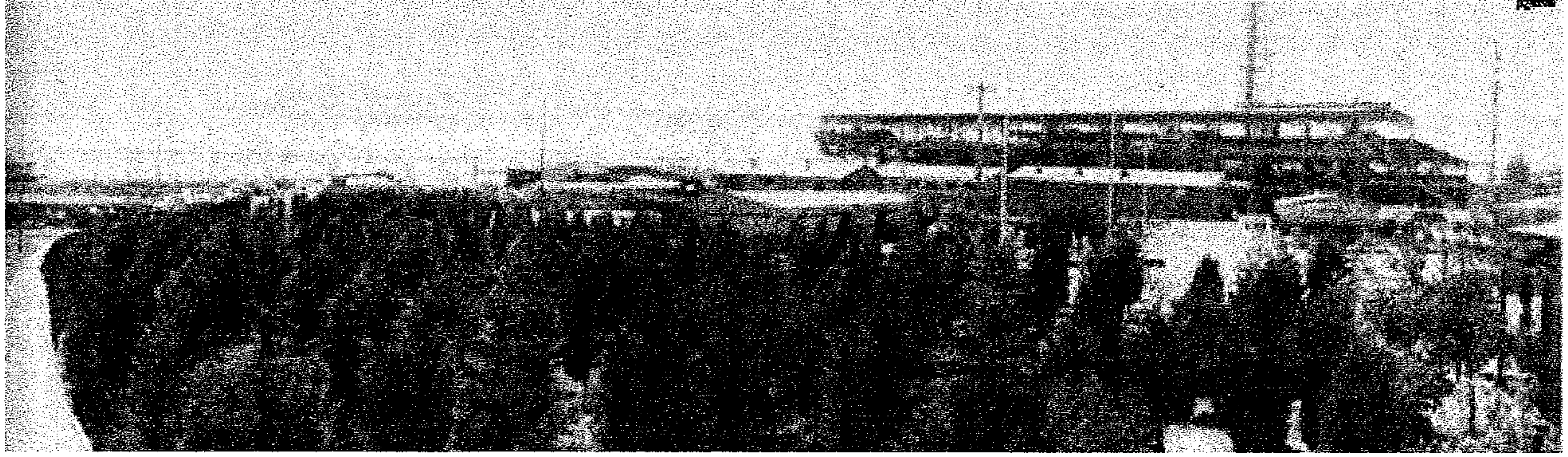
Calidad de Aire por SO2 en Fundición Altonorte

Normativa aplicable **D.S. 185.**

Norma anual **Lograda años 1996, 1998, 1999**

Norma diaria **Ultima excedencia 13 Septiembre 1998**

Norma horaria: La Resolución que aprobó el EIA de Fase II (actual operación) consideró un cronograma de cumplimiento incluida la Norma Horaria, a pesar de su carácter secundario y no aplicable para esta zona.
La política operacional definió como objetivo interno el cumplimiento de esta norma.



Plan de Contingencia por SO2 (costos)

APLICACIÓN PLAN DE CONTINGENCIA AMBIENTAL
COSTO - EFICIENCIA AÑO 2000

FECHA	Nº HRS. CON RESTRICCION	Nº HRS CON ESCEDENCIAS	% EXITO	PERDIDAS TOTALES (TMS C. Nueva)	COSTO US$
ENERO	40	1	97,5	833	33320
FEBRERO	70	2	97,1	457	18280
MARZO	65	0	100	630	25200
** ABRIL	43	1	97,6	351	14040
MAYO	29	2	93,1	187	7480
JUNIO	71	7	90,1	589	23560
JULIO	26	7	73,1	175	7000
	344	**20**	**94,2**	**3.222**	**128880**

CARGA NUEVA - PROMEDIO NORMAL 1138 TMS/día
CARGO FUSION US$ 80/ton
** **MANTENCION MAYOR ANUAL**

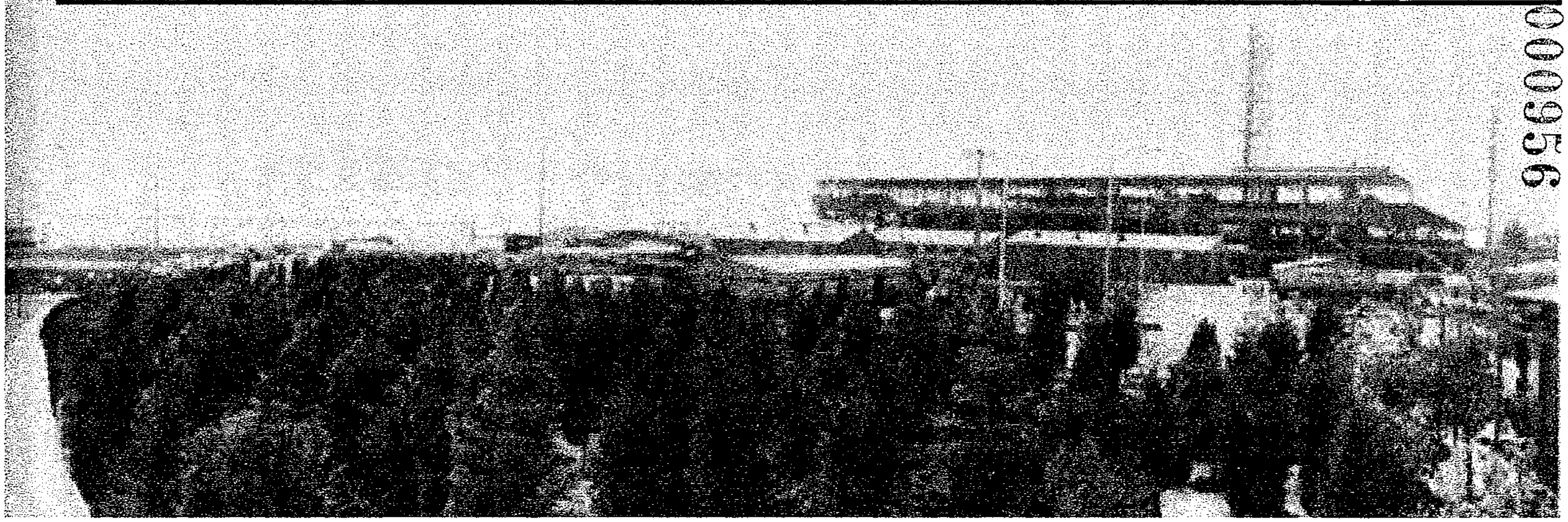
000955

Plan de Contingencia por SO2

Distribución de las excedencias

Promedios horarios >1000 µg/Nm^3

ENERO	FEBRERO	MARZO	ABRIL	MAYO	JUNIO	JULIO	AGOSTO
1	2	0	1	2	7	7	1
1136	1170		1018	1078	1049	2319	1369
	1308			1175	1249	1327	
					1207	1451	
					1228	1165	
					1089	1005	
					1018	1086	
					1254	1175	



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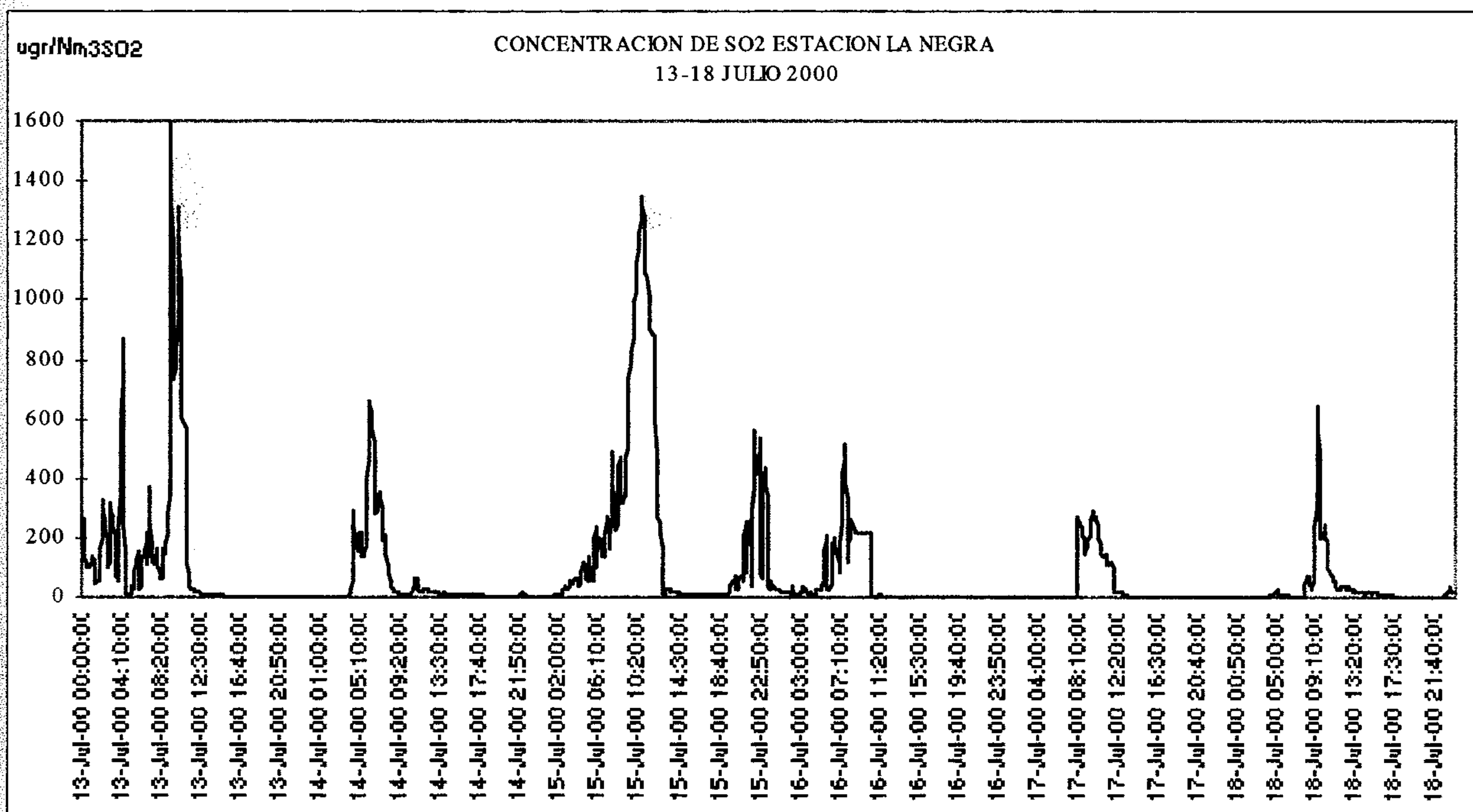
Plan de Contingencia por SO2

Perfil de promedios de 10 minutos



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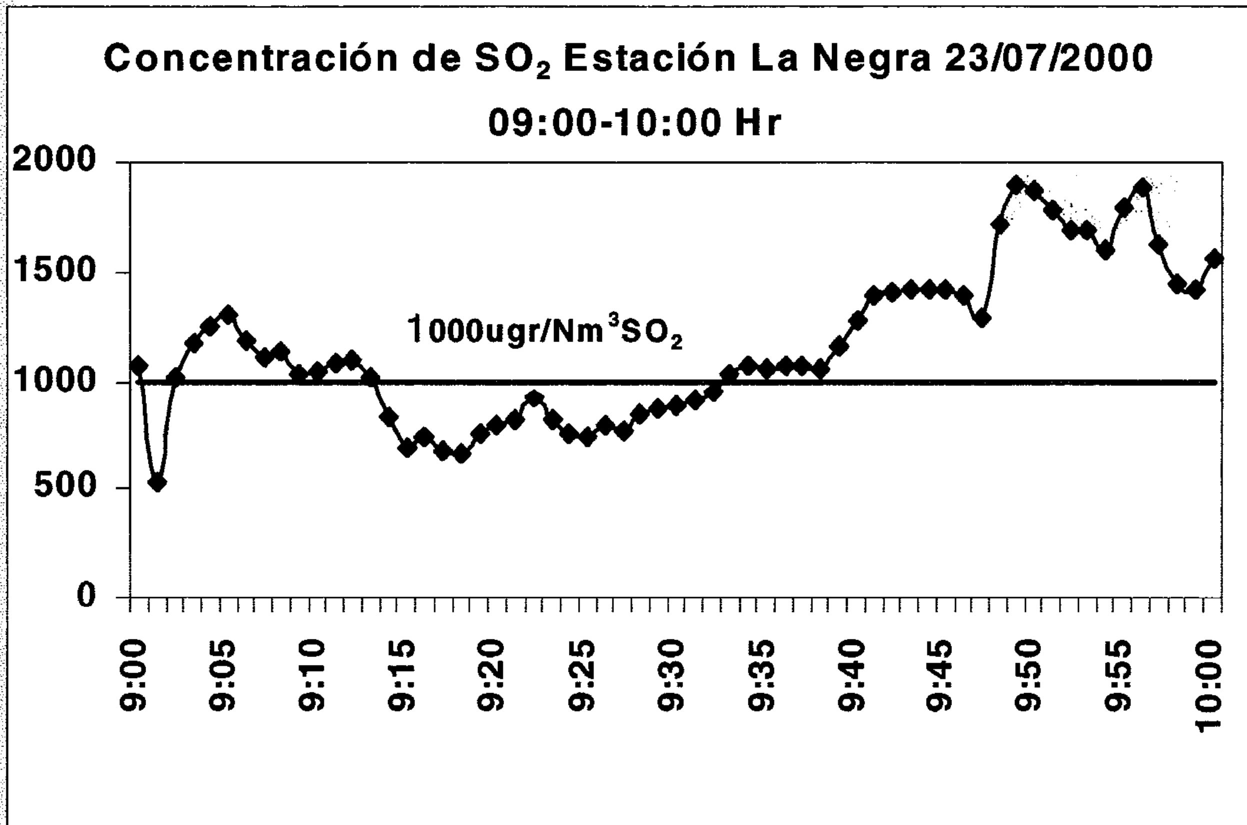
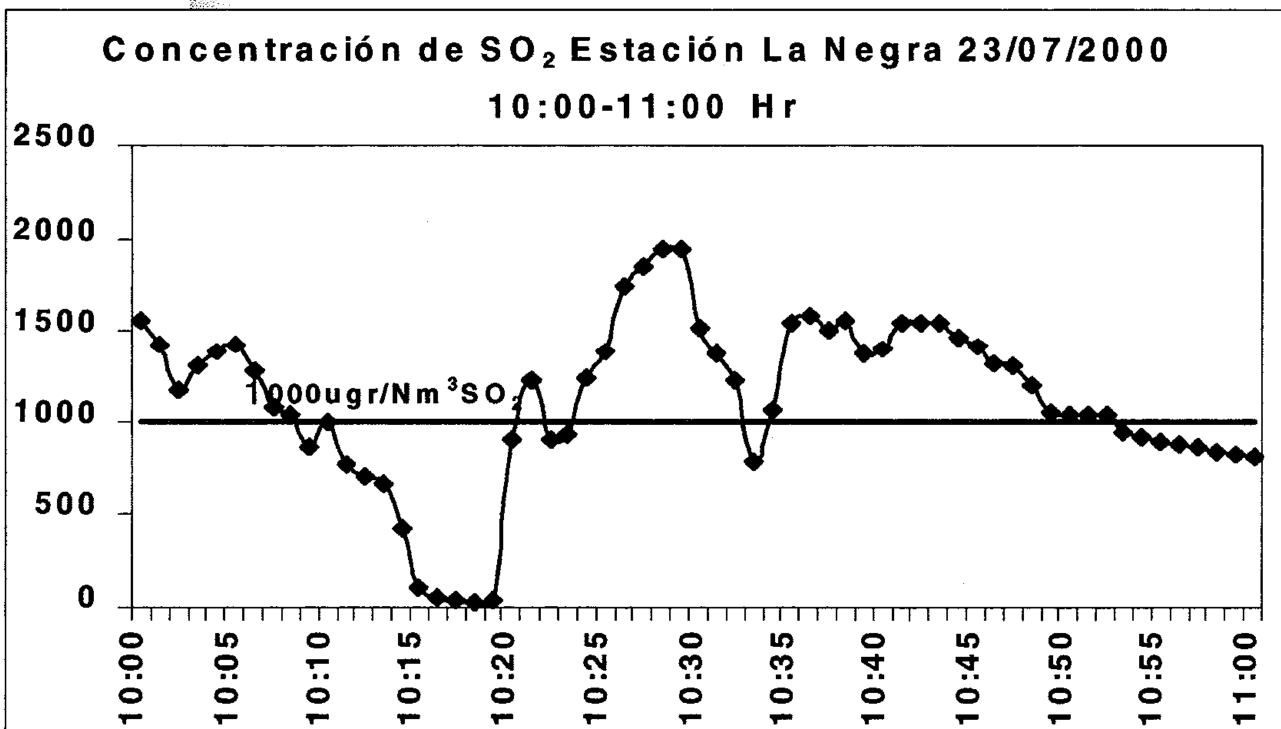
Factibilidad de operar con Norma Horaria

Perfiles de concentración durante las excedencias



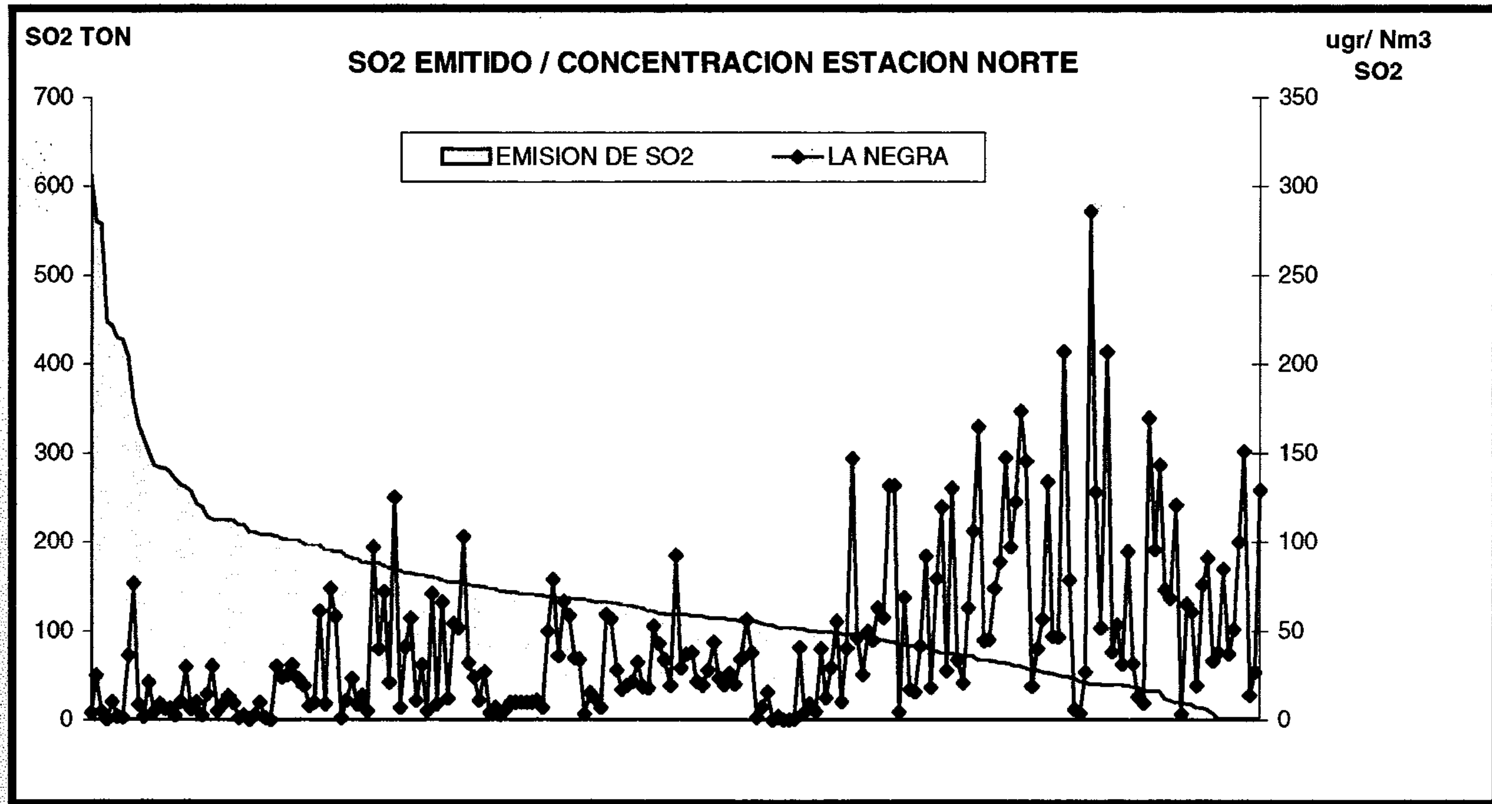
Factibilidad de operar con Norma Horaria

Perfiles de concentración durante las excedencias



Factibilidad de operar con Norma Horaria

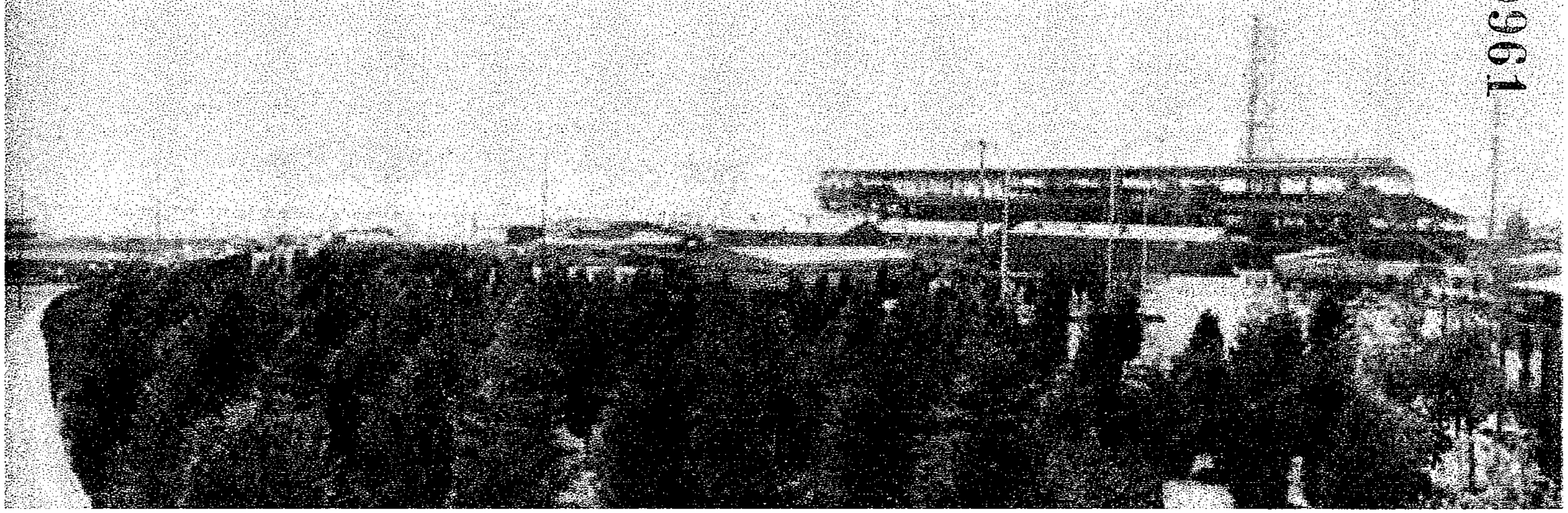
Correlación entre emisión y calidad de aire



Factibilidad de operar con Norma Horaria

Explicaciones del fenómeno

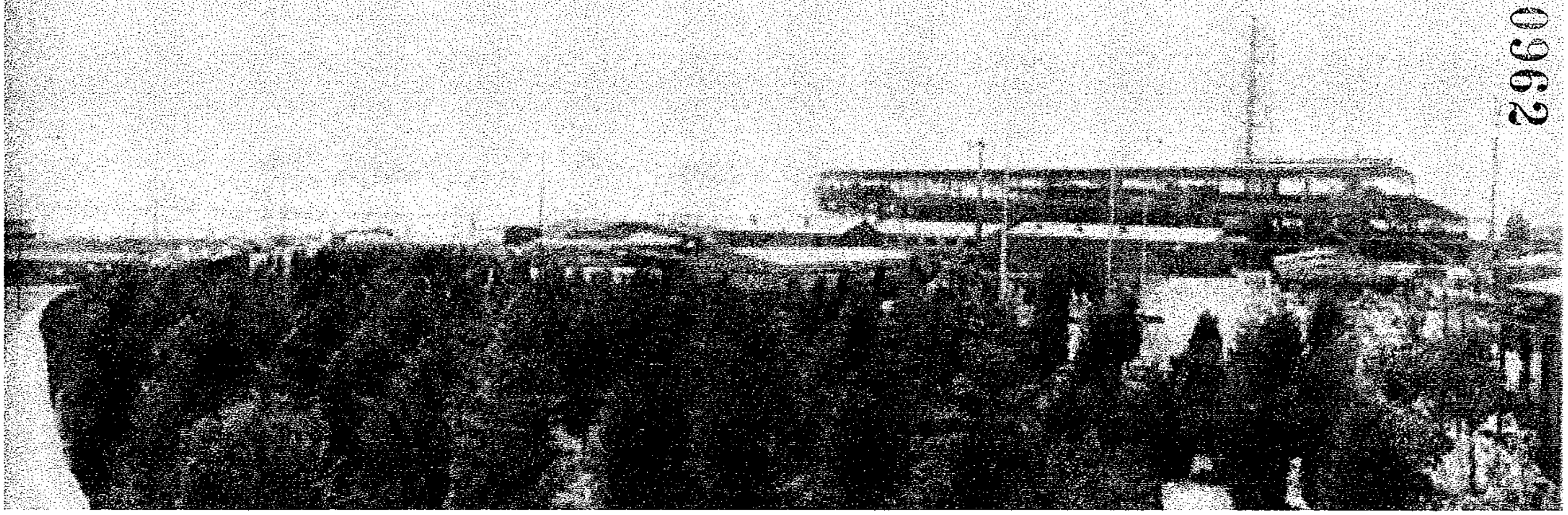
- Régimen de calma durante la noche especialmente en el período invernal .
- Descenso del nivel de capa de inversión por debajo de la altura de la chimenea con presencia de camanchaca
- Ruptura de la capa de inversión y transporte vertical durante las primeras horas de la mañana.
- Desplazamiento en dirección imprevisible o estacionamiento sobre la estación de monitoreo.



Factibilidad de operar con Norma Horaria

Velocidad de respuesta posible frente a las contingencias

- Distancia a la estación 2600 mts
- Régimen de calma o velocidad de viento menor a 1 m/seg
- Tiempo de detección de una situación que provoque un "impacto directo" en la estación la Negra es de 43 minutos.
- Si la modificación operacional es corregida "instantáneamente", el cambio sería detectado en otros 43 minutos.
- Ambos tiempos sumados se acercan a 1 hora y media.



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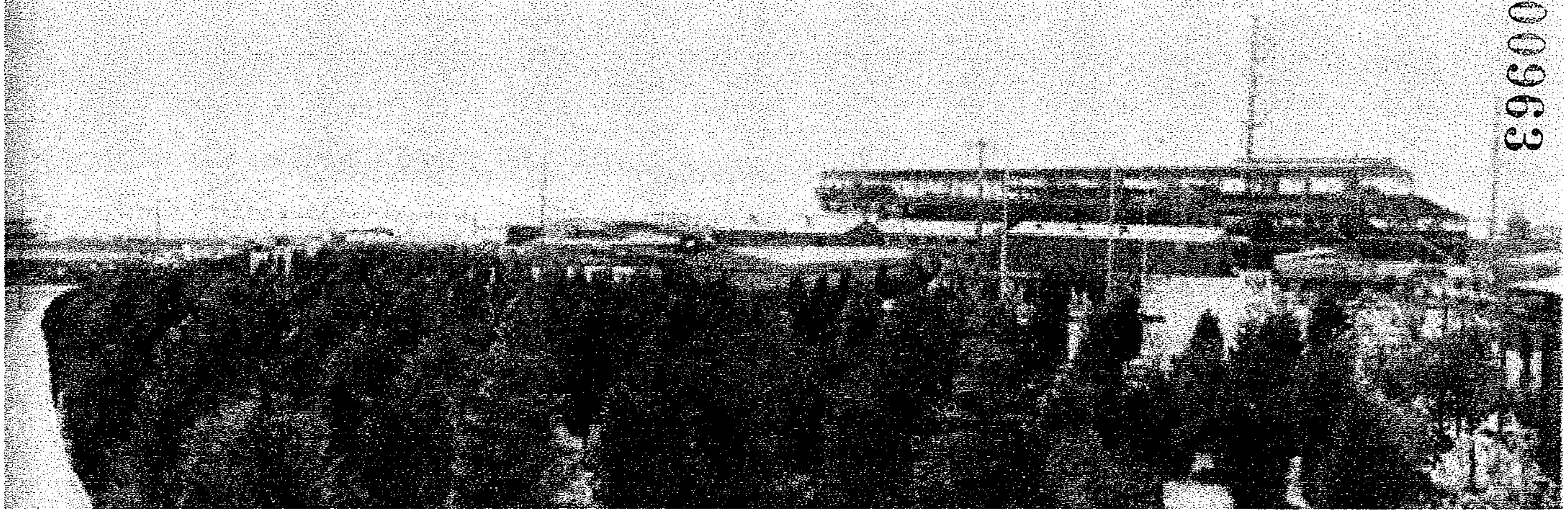
Conclusiones

- La ejecución del Proyecto de Expansión Fase III, con una inversión de 170 millones de dólares, debería ser revisada a la luz de la nueva regulación.
- En el EIA del proyecto Expansión Fase III, se informó una emisión de SO_2 similar a la actual y una capacidad de fusión equivalente a mas del doble de la actual y fue aprobado en Enero de este año.
- Las mejoras tecnológicas descritas en el EIA mejoran la eficiencia de captura de S a fin de no alterar el nivel de emisión, de SO_2. Los equipos principales de este proyecto se encuentran comprometidos en su etapa de adquisición.



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Conclusiones

- La aplicación del Plan de Contingencia por Altonorte tuvo por objetivo primario evitar excedencias sobre la actual Norma Diaria de 365 ug/m3.
- El carácter de primaria aplicado a la norma Horaria transforma una situación de cumplimiento de Norma a una de situación incumplimiento.
- La aplicación "voluntaria" ha costado 128.000 dólares en lo que va del presente año.
- Subir la eficacia del Plan de Contingencia por sobre el percentil 99, obliga a incurrir en un costo por pérdida de fusión no factible de calcular a la fecha.
- Como se ha descrito, la aplicación de medidas operacionales tiene una velocidad de respuesta mayor a lo menos un 50% al tiempo que se pretende normar

7

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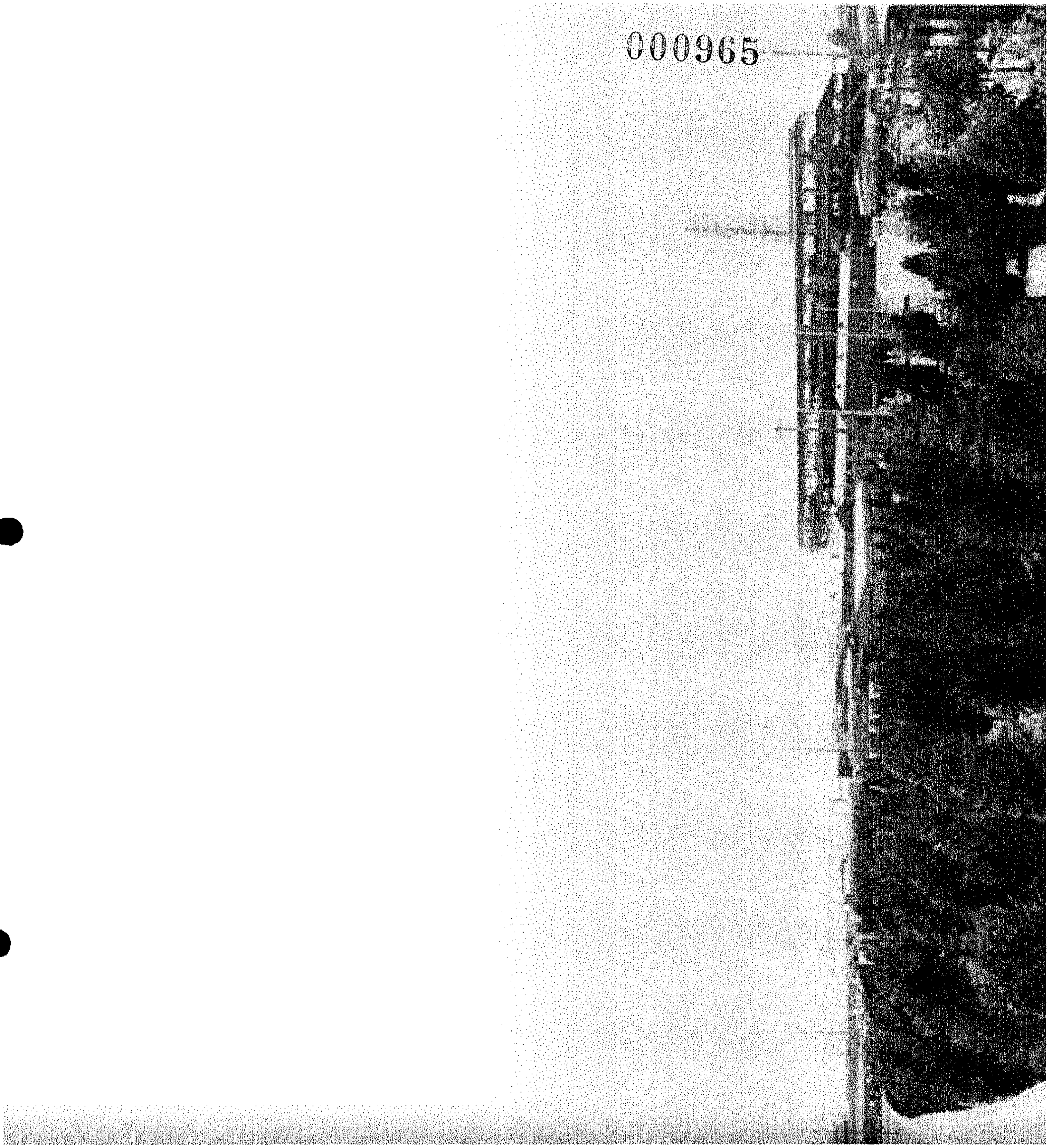

Antofagasta, 30 de agosto de 2000

INFORME DE LUIS VALLEJO D. EN REPRESENTACIÓN DE LA UNIVERSIDAD DE ANTOFAGASTA ANTE EL COMITÉ REGIONAL PARA LA REVISIÓN DE LAS NORMAS DE CALIDAD DEL AIRE

- Se analiza la proposición final de Normativa sobre Partículas en Suspensión y concentración de SO_2 del documento que contiene el Pre-Informe Final del Estudio "Antecedentes para la Revisión de las Normas de Calidad de Aire contenidas en la Resolución N° 1215 del Ministerio de Salud, 1978" que SGA Ltda. desarrolla para CONAMA

- Se observa que el Estudio consideró diversas materias como:

  1. "Estudio comparativo sobre las normas de calidad del aire contenidas en la Res. N° 1215 a nivel internacional"
  2. "Experiencia de la aplicación de la Resolución N°1215"
  3. "Recopilación de datos de la calidad del aire en Chile"
  4. "Fiscalización de las normas de calidad del aire contenidas en la Res. N°1215"
  5. "Revisión de la experiencia nacional sobre los efectos en la salud de la contaminación del aire"
  6. "Revisión de la experiencia internacional sobre los impactos en la salud de la contaminación del aire"
  7. "Proposición preliminar de normativa de modificación de la Resolución N°1215"
  8. "Análisis técnico económico de la normativa propuesta en forma preliminar"
  9. "Proposición final de normativa de modificación de la Resolución N°1215".

  Todo lo cual lo hace un informe muy completo, actualizado, coherente y sobretodo con gran énfasis en materias relacionadas con efectos en la salud humana

- El Pre-Informe Final presenta los resultados de la proposición final de la normativa de modificación de la Resolución N° 1215/78. Resumiéndose los principales antecedentes para cada contaminante, con bastante detalle y con la información de respaldo correspondiente

- La metodología general de trabajo utilizada en el Estudio, constó de diversas etapas y actividades atingentes al tema, con gran respaldo científico y de asesoría de buen nivel académico e institucional, tanto nacional como internacional.

- El cuerpo normativo vigente en la actualidad, para el material particulado y el SO_2, se resume en la tabla N° 1

Tabla N° 1
Cuerpos normativos de calidad de aire (Normas Primarias) para PM-10, PTS y SO_2

Contaminante	Norma	1 hora	8 horas	24 horas	1 año
PM-10	D.S. 185			150 ug/m^3	
PTS	Res. 1215			260 ug/m^3	75 ug/m^3
SO_2	Res. 1215			365 ug/m^3	80 ug/m^3
	D.S. 185			365 ug/m^3	80 ug/m^3
	Res. 369			365 ug/m^3	80 ug/m^3

- La proposición final de Normativa sobre Partículas en Suspensión indica que hay materias que requieren actualizarse y perfeccionarse, como son:

a) Reemplazo de las PTS como indicadores de contaminación del aire por PM-10 y PM-2,5

b) Establecer valores máximos permisibles y períodos de exposición para PM-10 y valores de referencia y períodos de exposición para PM-2,5

Se establecen los siguientes valores máximos permisibles y períodos de exposición para PM-10:

Concentración máxima permisible (μg/m^3)	Período
150	Media de 24 h
50	Media Anual

Se establecen los siguientes valores de referencia y períodos de exposición para PM-2,5:

Concentración máxima permisible (μg/m^3)	Período
60	Media de 24 h
20	Media Anual

Se proponen *valores de referencia* (por 5 años) con el objeto de emitir una señal a las fuentes emisoras y prepararlas para una futura dictación de norma en el año 2005. Esta norma de referencia va acompañada de la exigencia de medir en zonas declaradas saturadas por PM-10.

c) Establecer valores de emergencia para contaminación por PM-10

Se establecen los siguientes valores de emergencia para exposición diaria a PM-10:

Concentración media ($\mu g/m^3$) (24 h)	Nivel
195-239	1°
240-329	2°
> 330	3°

d) Los procedimientos de medición de PM-10 y PM-2,5

-Los procedimientos de medición son los establecidos en el D.S. 59/98 para PM-10.

-En zonas declaradas saturadas, el monitoreo se deberá efectuar a lo menos una vez cada tres días, para PM-10 y PM-2,5, y éste deberá cumplirse a satisfacción de los requerimientos para instalación, calibración y operación de los equipos de muestreo y análisis, aprobados por las Autoridades competentes, así como cumplir otros requerimientos establecidos aprobados por los Servicios de Salud.

-Para efectos del monitoreo de PM-2,5, los métodos de medición serán definidos.

- En general se considera que las materias que se proponen actualizar o perfeccionar en relación con la Normativa sobre Partículas en Suspensión, son atendibles y necesarias, pero deben ser puestas en marcha con un gradualismo que permita paulatinamente en un lapso de tiempo de unos 3 a 5 años llegar a la normativa que se sugiere, con tendencia a considerar el particulado PM-2,5 en la normativa.

- La proposición final de Normativa sobre Dióxido de azufre indica que hay materias que requieren actualizarse y perfeccionarse, como son:

a) Los valores máximos permisibles para exposición diaria a SO_2.

Se establecen los siguientes valores máximos permisibles y períodos de exposición para SO_2:

Concentración máxima permisible ($\mu g/m^3$)	Período
240	Media de 24 h
80	Media Anual

b) Modificar los valores de emergencia para contaminación por SO_2.

Se establecen los siguientes valores de emergencia para exposición diaria a SO_2:

Concentración horaria $\mu g/m^3$ (ppm)	Situación	Nivel
1.300 (0,50)	Aviso de alerta	1
1.965 (0,75)	Aviso de advertencia	2
2.620 (1,00)	Aviso de emergencia	3

Se sabe que existe daño a la salud por elevados niveles de exposición al SO_2. La evaluación económica demuestra que estos niveles están equilibrados con respecto a los costos para mantenerse en la norma.

c) **Los procedimientos de medición**
Para la determinación de la concentración de SO_2 se proponen el método estandarizado del tetracloromercurato/pararosanilina y el método equivalente por fluorescencia ultravioleta, para mediciones continuas, por ser estos métodos los más utilizados a nivel internacional.

d) **Cumplimiento y condiciones de superación de la norma**
La norma diaria de SO_2 se declarará cumplida cuando el percentil 98 de las mediciones diarias sea menor que 240 $\mu g/m^3$.

e) **Indicar el organismo con competencia de fiscalización**
Corresponderá a los Servicios de Salud del país y en la RM al Servicio de Salud del Ambiente de la RM, fiscalizar el cumplimiento de las disposiciones de la norma primaria de calidad del aire para material particulado respirable.

f) **La fecha de entrada en vigencia de la norma**: 1 de Enero del 2000.

- En general se considera que las materias que se proponen actualizar o perfeccionar en relación con la Normativa sobre Dióxido de azufre, son atendibles y necesarias, pero deben ser puestas en marcha con un gradualismo que permita paulatinamente en un lapso de tiempo de unos 3 a 5 años llegar a la normativa que se sugiere

- También, se observa que en la normativa sugerida no se toman en cuenta los sinergismos que se dan con los diversos contaminantes, por lo que un índice de la calidad del aire que considere las concentraciones medias de particulado, SO_2 , CO, O_3 , NO_2 y $C_n H_n$, debe ser tomado en cuenta (Por ejemplo el índice ORAQI: Oak Ridge Air Quality Index)

- Además, se observa que en la normativa sugerida no se toman en cuenta aquellas situaciones en que habiendo cumplimiento de la norma diaria en un año, aquellas situaciones que superan la norma se den en un periodo muy breve de tiempo (el efecto en la salud de las personas no es el mismo si se supera la norma diaria 3 o 4 veces en un año espaciado cada 3 meses a que si se supera durante 4 días seguidos durante el año)

Es todo lo que puedo informar.

UNIVERSIDAD DE ANTOFAGASTA DEPARTAMENTO DE FISICA CHILE

LUIS VALLEJO DELGADO
DEPARTAMENTO DE FÍSICA
UNIVERSIDAD DE ANTOFAGASTA

000970

REPUBLICA DE CHILE
COMISIÓN NACIONAL DEL MEDIO AMBIENTE
REGIÓN DE ANTOFAGASTA

2-5-70-5

COMISION NACIONAL DEL MEDIO AMBIENTE
OFICINA DE PARTES Y ARCHIVO
Nº INGRESO: 10825-8840
FECHA:
DESPACHADO: 25 SEP 2000
OBS.: Rodrigo Lucero

ORD. Nº: 0597 / 2000

ANT. : No Hay

MAT. : Lo que Indica

Antofagasta, 22 de Septiembre de 2000

A: Sr. Rodrigo Lucero Ch.
Jefe (s) Departamento Planes y Normas, CONAMA

DE : Directora Regional
Comisión Nacional del Medio Ambiente
Segunda Región de Antofagasta

De mi consideración:

Por la presente tengo a bien solicitar a Ud., de acuerdo a una petición realizada por COREMA II Región en su sesión ordinaria del día 21 de septiembre, exponer ante esta Comisión el estado de avance del anteproyecto de revisión de la Resolución N° 1215, en sesión programada para el día 28 de septiembre a las 16:00 hrs., en la Intendencia de la II Región.

Su presencia contribuirá significativamente a la aclaración de ciertos aspectos del proceso que preocupan a las autoridades regionales, a la luz de la importancia de la actividad minera para nuestra región.

Sin otro particular y agradeciendo desde ya su participación en esta reunión, le saluda atentamente,

COMISION NACIONAL DEL MEDIO AMBIENTE
II REGION
DIRECTOR REGIONAL

Rosa Escobar Bello
Directora Regional
Comisión Nacional del Medio Ambiente
Segunda Región de Antofagasta

cc. Pedro Hernández. Coordinador Regiones
Archivo Conama II Región.

COPIA FIEL DE ORIGINAL

Planes y Normas.

000906

REPUBLICA DE CHILE
COMISION NACIONAL DEL MEDIO AMBIENTE
ASR/PMC

APRUEBA ANTEPROYECTO DE REVISION DE NORMA PRIMARIA DE CALIDAD DE AIRE PARA MONÓXIDO DE CARBONO (CO)

SANTIAGO, 8 de septiembre de 2000

EXENTA N° 912

VISTOS:

El acuerdo N°67 de fecha 27 de marzo de 1998, del Consejo Directivo de CONAMA que aprobó el Tercer Programa Priorizado de Normas; La Resolución N°1215 de 1978, del Delegado de Gobierno en el Servicio Nacional de Salud, la Resolución Exenta N° 1514 de 1999, de la Dirección Ejecutiva de la Comisión Nacional del Medio Ambiente; lo dispuesto en el Decreto Supremo N°93 de 1995, del Ministerio Secretaría General de la Presidencia que fija el procedimiento para la dictación de normas de calidad y emisión; y los demás antecedentes que obran en el expediente público.

RESUELVO

1.- Apruébase el siguiente Anteproyecto de Revisión de Norma Primaria de Calidad de Aire para Monóxido de Carbono (CO).

I. FUNDAMENTOS:

De acuerdo con lo preceptuado en la ley 19.300, es deber del Estado dictar normas para regular la presencia de contaminantes en el medio ambiente, de manera de prevenir que estos puedan significar o representar, por sus niveles, concentraciones y periodos, un riesgo para la salud de las personas, la preservación de la naturaleza y la conservación del patrimonio ambiental.

La exposición al CO se puede evaluar a través de los niveles de carboxyhemoglobina (COHb) que se expresa como porcentaje de la hemoglobina (Hb) total que está unida al CO.

El pulmón es la principal ruta de excreción y absorción de CO. La tasa de HbCO depende de la concentración de CO en el aire inspirado, la tasa de difusión aire-sangre, el contenido de Hb en la sangre, la tensión capilar de O2 y el nivel de COHb en los capilares pulmonares.

Durante una exposición a una concentración fija de CO, la concentración de COHb aumenta rápidamente hasta situarse en los niveles de la exposición, después de 3 horas comienza a decaer y alcanza su condición estable después de 6-8 horas de exposición.

Los resultados de diversos estudios recientes han mostrado que el CO aparece asociado a efectos respiratorios y efectos cardiovasculares.

Según la OMS (1999), no debiera ser excedido el nivel de 2.5% de COHb en la sangre de las personas expuestas a CO. Con lo anterior, se protege a la población no fumadora, de mediana y mayor edad con enfermedad de la arteria coronaria latente o reportada, de ataques de isquemia miocárdica aguda, y al feto en madres no fumadoras, de efectos hipóxicos adversos.

Sobre esa base, la Organización Mundial de la Salud recomienda los siguientes valores guía para monóxido de carbono:

Efectos sobre la salud de las personas	**Valor guía (ppm)**	**Valor guía ($\mu g/m^3$)**	**Tiempo promedio de exposición**
Nivel crítico de COHb <2.5%	90	100.000	15 minutos
	50	60.000	30 minutos
	25	30.000	1 hora
	9	10.000	8 horas

Los automóviles con motores de combustión interna son una de las principales fuentes de emisión de monóxido de carbono. Las chimeneas, las calderas, los calentadores de agua o calefones y los aparatos domésticos que queman combustible, como las estufas u hornillas de la cocina o los calentadores a Kerosene, también pueden emitir monóxido de carbono. El humo de cigarrillo puede ser una fuente significativa de monóxido de carbono en interiores.

El monóxido de carbono en áreas urbanas es el resultado, en casi un 90%, de las emisiones del tráfico de vehículos a combustión, estando las concentraciones más altas cerca de las calles, decreciendo a medida que nos alejamos de éstas.

A la fecha no existen métodos pasivos consolidados que permitan obtener valores representativos de la concentración ambiental de monóxido de carbono para intervalos breves de medición: 1-hora u 8-horas.

El conocimiento de los efectos del monóxido de carbono en la salud de la población, permite realizar proposiciones de niveles objetivo para ser cumplidos a través de normas ambientales, así como niveles que definen las situaciones de emergencia ambiental, por lo que los valores de normas de calidad primaria para monóxido de carbono contenidos en la Resolución 1215 de 1978, del Delegado de Gobierno en el Servicio Nacional de Salud (40000 ug/m3N como concentración media aritmética de una hora y 10000 como concentración media aritmética de ocho horas) deben ser revisados a la luz de tales resultados.

II. Disposiciones Generales y Definiciones

Art.1.- La presente norma tiene por objetivo proteger la salud de la población de aquellos efectos agudos generados por la exposición a niveles de concentración de monóxido de carbono en el aire.

Art.2.- Para efectos de lo dispuesto en la presente norma, se entenderá por:

a. *Efectos Agudos*: Aquellos producidos por la acción de concentraciones variables del contaminante en periodos cortos de exposición.

b. *ppmv:* Unidad de medida de concentración en volumen, correspondiente a una parte por millón.

c. *Concentración de monóxido de carbono*: Valor promedio temporal detectado en el aire expresado en ppmv.

d. *Concentración de 1 hora*: Media aritmética de los valores de concentración de monóxido de carbono medidos en cada estación monitora en 1 hora.

e. *Concentración de 8 Horas*: Media aritmética de los valores de concentración de monóxido de carbono medidos en cada estación monitora en 8 horas consecutivas, promedio móvil.

f. *Año calendario*: Período que se inicia el 1 de enero, y culmina el 31 de diciembre del mismo año.

g. *Estación de monitoreo con representatividad poblacional para gas monóxido de carbono (EMRPG):* Una estación de monitoreo podrá clasificarse como EMRPG si existe a lo menos un área habitada en un radio de 2 kilómetros (km), medido desde la ubicación de la estación.

Una estación EMRPG tendrá un área de representatividad para la población expuesta correspondiente a un radio de 2 km, medido desde la ubicación de la estación.

h. *Percentil:* Corresponde al valor "q" calculado a partir de los valores efectivamente medidos, aproximados al ug/m3N más próximo. Todos los valores se anotarán en una lista establecida por orden creciente para cada estación de monitoreo.

$X1 \leq X2 \leq X3 \ldots \leq Xk \leq X\,n - 1 \leq Xn$

El percentil será el valor del elemento de orden "k", para el que "k" se calculará por medio de la siguiente fórmula:

k = q X n , donde "q" = 0.99 para el Percentil 99, y "n" corresponde al número de valores efectivamente medidos. El valor "k" se aproximará al número entero más próximo

i. *Situaciones de emergencia ambiental declarada por pronóstico de superación de niveles*: Son aquellas que se declaran en base a los resultados de la metodología de pronóstico de calidad del aire.

j. *Situaciones de emergencia ambiental declarada por constatación de superación de niveles*: son aquellas que se declaran en base a las mediciones constatadas en las estaciones de monitoreo de la calidad del aire.

III. Nivel de Norma Primaria de Calidad de Aire para Monóxido de Carbono

Art.3.- La norma primaria de calidad de aire para monóxido de carbono como concentración de 1 hora será de 25 ppmv.

Se considerará sobrepasada la norma primaria de calidad de aire para monóxido de carbono como concentración de 1 hora, cuando el percentil 99 del máximo diario de concentración de 1 hora registrada durante un año calendario, o en su defecto de 12 meses a partir del mes de inicio de las mediciones, en cualquier estación monitora clasificada como EMRPG, sea mayor o igual al valor indicado en el inciso precedente.

Asimismo, se considerará sobrepasada la norma, si antes que concluya el año calendario, o en su defecto de 12 meses a partir del mes de inicio de las mediciones, se registrare en cualquier estación monitora clasificada como EMRPG, más de cuatro días con mediciones de máximo diario de concentración de 1 hora de monóxido de carbono igual o sobre el valor de la norma.

Art.4. La norma primaria de calidad de aire para monóxido de carbono como concentración de 8 horas será de 9 ppmv.

Se considerará sobrepasada la norma primaria de calidad de aire para monóxido de carbono como concentración de 8 horas, cuando el percentil 99 del máximo diario de concentración de 8 horas registradas durante un año calendario, o en su defecto de 12 meses a partir del mes de inicio de las mediciones, en cualquier estación monitora clasificada como EMRPG sea mayor o igual al valor indicado en el inciso precedente.

Asimismo, se considerará sobrepasada la norma, si antes que concluya el año calendario, o en su defecto de 12 meses a partir del mes de inicio de las mediciones se registrare en cualquier estación clasificada como EMRPG, mas de cuatro días con mediciones de máximo diario de concentración de 8 horas de monóxido de carbono igual o sobre el valor de la norma.

Art.5.- Los siguientes niveles originarán situaciones de emergencia ambiental para monóxido de carbono en concentración de ocho horas:

Nivel 1: 15 - 29 ppmv.
Nivel 2: 30 - 34 ppmv
Nivel 3: 35 ppmv o superior

Las situaciones de emergencia ambiental para monóxido de carbono se declararán en función de los niveles anteriores, los cuales podrán ser obtenidos mediante la aplicación de una metodología de pronóstico de calidad de aire aprobada por el Servicio de Salud correspondiente, o por medio de la constatación de las concentraciones del contaminante a partir de alguna de las estaciones monitoras de calidad de aire clasificadas como EMRPG.

La autoridad que realice la declaración de situación de emergencia ambiental podrá omitir tal declaración, dejarla sin efecto o adoptar las medidas correspondientes a los niveles menos estrictos, cumpliendo con las mismas formalidades a que está sujeta la declaración de estas situaciones. Ello sólo podrá realizarse si se detecta un cambio en las condiciones meteorológicas en forma posterior a la hora de comunicación del pronóstico o a la constatación de la superación de los niveles de calidad de aire, y siempre que dicho cambio asegure una mejoría tal en las condiciones de calidad de aire que invalide los resultados entregados por el pronóstico o que asegure la reducción de los niveles de calidad de aire por debajo de aquellos que definen situaciones de emergencia ambiental.

Los planes operacionales para enfrentar las situaciones de emergencia ambiental podrán considerar medidas de control diferentes ya sea se trate de situaciones de emergencia ambiental declaradas por pronóstico o situaciones de emergencia ambiental declaradas por constatación.

IV. Metodología de Medición de la Norma

Art.6.- La medición de la concentración de monóxido de carbono en el aire se realizará mediante el método de medición denominado Fotometría Infrarroja no dispersiva o mediante un método de medición cuya metodología de operación sea aprobada por un ***organismo internacional calificado para este fin.***

El monitoreo deberá realizarse con instrumentos aprobados por un organismo internacional calificado para ese fin y en concordancia con los requerimientos para instalación, calibración y operación de los equipos de muestreo y análisis aprobados por el Servicio de Salud correspondiente.

Art.7.- Para efectos del emplazamiento de un colector de muestras de monóxido de carbono en una estación clasificada como EMRPG se debe considerar los siguientes aspectos:

a) La toma de muestra deberá estar ubicada a una altura no inferior a 3 metros (m) ni superior a 15m, desde el nivel del suelo.

b) Obstrucciones espaciales:

i. La toma de muestra deberá estar ubicada a una distancia igual o mayor a 1m, verticalmente y horizontalmente desde la estructura que la soporta. Cuando la toma de muestras está localizada sobre techos, esta distancia de separación se refiere a paredes, cercos o habitaciones ubicadas sobre azoteas.
ii. La estación de monitoreo deberá localizarse a una distancia superior a 20m de cualquier edificación existente en el lugar y a una distancia no inferior a 10m de árboles que puedan actuar como obstrucción al flujo de aire.
iii. La toma de muestra deberá encontrarse a una distancia igual o superior al doble de la altura de la perturbación más próxima en sentido horizontal, que sobresale por sobre la toma de muestra.
iv. El movimiento del aire no deberá estar restringido en un arco de 270° alrededor de la entrada de la toma de muestra.

V. Validación de la Información de Monitoreo de Calidad del Aire

Art. 8.- La concentración de una hora se considerará válida, si a lo menos el 75% de los datos para calcular el valor horario se encuentran disponibles.

La concentración de 8 horas se considerará válida, si a lo menos el 75% de los datos para calcular el valor de 8 horas se encuentran disponibles.

VI. Criterios de priorización para el establecimiento de Redes de Monitoreo de Calidad del Aire.

Art. 9.- Para efectos de determinar los lugares prioritarios dentro del país en que se deberán instalar redes de monitoreo para evaluar el cumplimiento de la presente norma, debe considerarse lo siguiente:

1. Cantidad de población expuesta;
2. Volumen del parque automotor existente y proyectado;
3. Presencia de desarrollos industriales significativos emisores de monóxido de carbono
4. Valores absolutos de concentraciones de monóxido de carbono en aire medido, y tendencias históricas, positivas o negativas, de dichos valores;

VII. Fiscalización de la Norma

Art.10.- Corresponderá a los Servicios de Salud del país y, en la Región Metropolitana al Servicio de Salud del Ambiente de la Región Metropolitana, fiscalizar el cumplimiento de las disposiciones de la presente norma.

VIII. Entrada en Vigencia

Art. 11.- La presente norma entrará en vigencia el día 1º del mes siguiente a su publicación en el Diario Oficial quedando desde esa fecha sin efecto las normas primarias de calidad de aire para monóxido de carbono vigentes a dicha fecha.

2.- Sométase a consulta el presente anteproyecto de norma.

Para tales efectos:

1. Remítase copia del expediente al Consejo Consultivo de la Comisión Nacional del Medio Ambiente, para que emita su opinión sobre el anteproyecto de revisión de norma de calidad. Dicho Consejo dispondrá de 60 días contados desde la recepción de la copia del expediente, para el despacho de su opinión. La opinión que emita el Consejo Consultivo de la Comisión Nacional del Medio Ambiente será fundada, y en ella se dejará constancia de los votos disidentes.

2. Dentro del plazo de 60 días, contados desde la publicación en el Diario Oficial, del extracto de la presente resolución, cualquier persona, natural o jurídica, podrá formular observaciones al contenido del anteproyecto de revisión de norma de calidad. Dichas observaciones deberán ser presentadas, por escrito, en la Comisión Regional del Medio Ambiente correspondiente al domicilio del interesado, y deberán ser acompañadas de los antecedentes en los que se sustentan, especialmente los de naturaleza técnica, científica, social, económica y jurídica.

Anótese, publíquese en extracto, comuníquese y archívese.

COMISION NACIONAL DEL MEDIO AMBIENTE

Adriana Hoffmann Jacoby
Directora Ejecutiva

8 SEP 2000

Lo que transcribo a Ud.
para su conocimiento
saluda atentamente a Ud.
CARMEN V. LUNA B.
Oficial de Partes
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Medio Ambiente (CONAMA)

CRF/RLCH
Distribución:
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Dirección Ejecutiva;
Directores Regionales;
Consejo Consultivo de CONAMA;
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Archivo.

REPUBLICA DE CHILE
COMISION NACIONAL DEL MEDIO AMBIENTE
ASR/PMC

APRUEBA ANTEPROYECTO DE REVISION DE NORMA PRIMARIA DE CALIDAD DE AIRE PARA OZONO (O3)

SANTIAGO, 8 de septiembre de 2000

EXENTA N° 913

VISTOS:

El acuerdo N°67 de fecha 27de marzo de 1998, del Consejo Directivo de CONAMA que aprobó el Tercer Programa Priorizado de Normas.; La Resolución N°1215 de 1978, del Delegado de Gobierno en el Servicio Nacional de Salud, la Resolución Exenta N° 1514 de 1999; de la Dirección Ejecutiva de la Comisión nacional del Medio Ambiente; lo dispuesto en el Decreto Supremo N°93 de 1995, del Ministerio Secretaría General de la Presidencia que fija el procedimiento para la dictación de normas de calidad y emisión; y los demás antecedentes que obran en el expediente público.

RESUELVO

1.- Apruébase el siguiente Anteproyecto de Revisión de Norma Primaria de Calidad de Aire para Ozono (O_3).

I. FUNDAMENTOS:

De acuerdo con lo preceptuado en la ley 19.300, es deber del Estado dictar normas para regular la presencia de contaminantes en el medio ambiente, de manera de prevenir que estos puedan significar o representar, por sus niveles, concentraciones y periodos, un riesgo para la salud de las personas, la preservación de la naturaleza y la conservación del patrimonio ambiental.

El ozono es un fotooxidante que se produce en la tropósfera por efecto de la oxidación de monóxido de carbono e hidrocarburos en presencia de oxidos de nitrógeno y luz solar. de este modo, los hidrocarburos, el monóxido de carbono y los oxidos de nitrógeno constituyen precursores en la formación de ozono.

Las características dañinas del ozono en la salud de la población se originan en su gran capacidad oxidante que lo hace reaccionar con toda clase de sustancias orgánicas. El ozono puede penetrar los tejidos de la región pulmonar pero la dosis máxima de contaminante la recibe las regiones bronquiales y alveolares.

Los efectos típicos del ozono en la salud son cambios en la función pulmonar que van precedidos por irritación de ojos y síntomas del pecho y de las vías respiratorias en poblaciones sensibles. A este respecto la Organización Mundial de la Salud indica que en el caso del ozono, "los problemas de salud de mayor preocupación son: aumento en las admisiones hospitalarias, exacerbación del asma, inflamaciones pulmonares y alteraciones estructurales del pulmón" (Guidelines for Air Quality, WHO, 1999. pp.36).

En términos cuantitativos, la Organización Mundial de la Salud (OMS) reporta efectos en la salud, estadísticamente significativos, a concentraciones de 160 ug/m3 para exposiciones de 6-horas en un grupo de adultos saludables, experimentando los sujetos más sensitivos más de un 10% de decremento en la función pulmonar a las 4-5 horas. También que, a valores de 240 ug/m3 por 2 horas se producen disminuciones en la función pulmonar en niños y adultos realizando ejercicio físico intenso.

Por último, indica que se producen efectos agudos sustanciales cuando se realiza ejercicio físico con exposiciones de 1-hora de 500ug/m3 o superior, particularmente en individuos susceptibles o sub-grupos: "El balance de las evidencias indica que disminuciones de VEF1 (Volumen Expiratorio Forzado en 1 segundo) de más de un 10% ocurren a niveles de 160 ug/m3 y superior. Se acepta generalmente que la duración en la exposición a ozono es importante en el control de la respuesta."

Sobre esta base, un valor guía de 120 ug/m3 por un período máximo de 8 horas se establece como un nivel en el cual los efectos agudos sobre la salud pública son bajos (Guidelines for Air Quality, WHO, Geneva, 1999, pp32 y 33).

En los Estados Unidos (EE.UU.), la Agencia de Protección Ambiental (USEPA) reporta en su Ozone Final Rule: 40CFR, part 50 de julio de 1997, que existe clara evidencia a partir de estudios clínicos (respuestas estadísticamente significativas) que los efectos del ozono se asocian con exposiciones de una duración entre 6 a 8 horas. Por tanto, resulta relevante el control de eventos de varias horas con concentraciones moderadamente altas de este contaminante

Respecto al intervalo de evaluación de la norma, la OMS indica que el valor guía propuesto por tal entidad para 8 horas, protegería también contra exposiciones agudas de 1 hora, concluyéndose por lo tanto que un valor guía de 1 hora no sería necesario (Guidelines for Air Quality, WHO, Geneva, 1999, pp36). Esta aseveración es confirmada por USEPA que indica, que "desde el punto de vista de EPA, el hecho de que al usar un promedio de evaluación de 8 horas, resulta un estándar que protege en forma significativamente más uniforme que el estándar de 1 hora, es una consideración importante en términos de salud pública, que apoya la selección del uso de un promedio de 8 horas" (Ozone Final Rule, pp38862, Julio 1997).

Esta a su vez se basa en una recomendación unánime realizada por el Comité Consejero Científico para el Aire Limpio (CASAC), en el sentido que "el estándar de 1ª hora actual debe ser eliminado y reemplazado por uno de 8 horas" (Wolff, 1995b)

Existe un número reducido de estudios nacionales en el ámbito de efectos en la salud de este contaminante. La mayoría de los estudios realizados en Chile no encuentran efectos entre mortalidad total y exposición a ozono. El estudio de Ilabaca muestra un aumento en las consultas de urgencia infantil de hasta un 23% con niveles de ozono del orden de 106 ug/m3. Un último estudio realizado con información de Santiago para el periodo 1988-1996 encuentra relaciones estadísticamente significativas entre mortalidad diaria y ozono (máximos de 1 hora en la estación con el mayor valor de la red), pero solo en meses cálidos. (Cifuentes, Lave, Vega y Kopfer, en paper del año 2000 aún no publicado).

El ozono presenta efectos adicionales a los reportados a través de indicadores de salud. Por la reducción en el ambiente de este contaminante, también se esperan beneficios – secundarios- a recursos naturales (cultivos y vegetación natural) cercanos a las comunidades a proteger, así como indirectamente a ecosistemas y materiales expuestos a este contaminante.

Algunos de los precursores fotoquímicos del ozono, adicionalmente a aportar en la formación de ozono, tienen características carcinogénicas, por lo que en el futuro también podrían ser materia de regulación.

En el caso del ozono, a la fecha no existen métodos pasivos consolidados que permitan obtener valores representativos de la concentración ambiental de ozono para intervalos breves de medición: 1 hora, 8 horas.

A la fecha, el conocimiento de los efectos del ozono en la salud de la población permite realizar proposiciones de niveles objetivo para ser cumplidos a través de normas ambientales, así como niveles que definen las situaciones de emergencia ambiental por ozono, por lo que los que los valores de normas de calidad primaria para ozono contenidos en la Resolución 1215 de 1978, del Delegado de Gobierno en el Servicio Nacional de Salud (160 ug/m3N como concentración media aritmética de una hora) deben ser revisados a la luz de tales resultados;

II. Disposiciones Generales y Definiciones

Art.1.- La presente norma tiene por objetivo proteger la salud de la población de aquellos efectos agudos generados por la exposición a niveles de concentración de ozono en el aire.

Art.2.-Para efectos de lo dispuesto en la presente norma, se entenderá por:

a. *Efectos Agudos*: Aquellos producidos por la acción de concentraciones variables del contaminante en periodos cortos de exposición.

b. *ppbv:* Unidad de medida de concentración en volumen, correspondiente a una milésima de parte por millón.

c. *Concentración de Ozono*: Valor promedio temporal detectado en el aire expresado en partes por billón (ppbv)

d. *Concentración de 8-Horas*: Media aritmética de los valores de concentración de ozono medidos en cada estación monitora en 8 horas consecutivas, promedio móvil.

e. *Año calendario:* Periodo que se inicia el 1° de enero, y culmina el 31 de diciembre del mismo año.

f. *Estación de monitoreo con representatividad poblacional para gas ozono (EMRPG):* Una estación de monitoreo podrá clasificarse como EMRPG si se cumple que:

   i. Exista a lo menos un área habitada en un radio de 2 kilómetros (km), medido desde la ubicación de la estación,
   ii. Esté colocada a una distancia mínima de la calle o avenida más cercana, o de una fuente fija emisora de óxidos de nitrógeno, que asegure que no existan interferencia sistemática por sumideros de ozono.

Una estación EMRPG tendrá un área de representatividad para la población expuesta correspondiente a un radio de 2km, medido desde la ubicación de la estación.

g. *Percentil:* Corresponde al valor "q" calculado a partir de los valores efectivamente medidos, aproximados al ug/m3N más próximo. Todos los valores se anotarán en una lista establecida por orden creciente para cada estación de monitoreo.

$X1 \leq X2 \leq X3 \ldots \leq Xk \leq X\,n - 1 \leq Xn$

El percentil será el valor del elemento de orden "k", para el que "k" se calculará por medio de la siguiente fórmula:

k = q X n , donde "q" = 0.99 para el Percentil 99, y "n" corresponde al número de valores efectivamente medidos. El valor "k" se aproximará al número entero más próximo

h. *Situaciones de emergencia ambiental declarada por pronóstico de superación de niveles*: Son aquellas que se declaran en base a los resultados de la metodología de pronóstico de calidad del aire.

i. *Situaciones de emergencia ambiental declarada por constatación de superación de niveles*: Son aquellas que se declaran en base a las mediciones constatadas en las estaciones de monitoreo de la calidad del aire.

III. Nivel de Norma Primaria de Calidad de Aire para Ozono

Art.3.- La norma primaria de calidad de aire para ozono como concentración de 8-horas será de 60 ppbv.

Se considerará sobrepasada la norma primaria de calidad de aire para ozono como concentración de 8 horas, cuando el percentil 99 del máximo diario de las concentraciones de 8 horas registradas durante un año calendario, o en su defecto de 12 meses a partir del mes de inicio de las mediciones, en cualquier estación monitora clasificada como EMRPG sea mayor o igual al valor indicado en el inciso precedente.

Asimismo, se considerará sobrepasada la norma, si antes que concluya el año calendario, o en su defecto de 12 meses a partir del mes de inicio de las mediciones, se registrare en cualquier estación monitora clasificada como EMRPG, mas de cuatro días con mediciones de máximo diario de concentración de ozono igual o sobre el valor de la norma.

Art.4.- Los siguientes niveles originarán situaciones de emergencia ambiental para ozono, en concentración de una hora.

Nivel 1: 200-399 ppbv
Nivel 2: 400- 499 ppbv
Nivel 3: 500 ppbv o superior

Las situaciones de emergencia ambiental para ozono se declararán en función de los niveles anteriores, los cuales podrán ser obtenidos mediante la aplicación de una metodología de pronóstico de calidad de aire aprobada por el Servicio de Salud correspondiente, o por medio de la constatación de las concentraciones del contaminante a partir de alguna de las estaciones monitoras de calidad de aire clasificadas como EMRPG.

La autoridad que realice la declaración de situación de emergencia ambiental podrá omitir tal declaración, dejarla sin efecto o adoptar las medidas correspondientes a los niveles menos estrictos, cumpliendo con las mismas formalidades a que está sujeta la declaración de estas situaciones. Ello sólo podrá realizarse si se detecta un cambio en las condiciones meteorológicas en forma posterior a la hora de comunicación del pronóstico o a la constatación de la superación de los niveles de calidad de aire, y siempre que dicho cambio asegure una mejoría tal en las condiciones de calidad de aire que invalide los resultados entregados por el pronóstico o que asegure la reducción de los niveles de calidad de aire por debajo de aquellos que definen situaciones de emergencia ambiental.

Los planes operacionales para enfrentar las situaciones de emergencia ambiental podrán considerar medidas de control diferentes ya sea se trate de situaciones de emergencia ambiental declaradas por pronóstico o situaciones de emergencia ambiental declaradas por constatación.

IV. Metodología de Medición de la Norma

Art.5.- La medición de la concentración de ozono en el aire se realizará mediante los métodos de medición:

- Quimiluminiscencia con etileno
- Fotometría de absorción ultravioleta
- Cromatografía líquida gas/sólido
- Espectrometría de absorción óptica diferencial, con calibración in-situ.
- Un método de medición cuya metodología de operación sea aprobada por un organismo internacional calificado para ese fin.

El monitoreo deberá realizarse con instrumentos aprobados por un organismo internacional calificado para ese fin y en concordancia con los requerimientos para instalación, calibración y operación de los equipos de muestreo y análisis aprobados por el Servicio de Salud correspondiente.

Art.6.- Para efectos del emplazamiento de un colector de muestras en una estación monitora clasificada como EMRPG, se debe considerar los siguientes aspectos:

a) La toma de muestra deberá estar ubicada a una altura no inferior a 3 metros (m) ni superior a 15 m, desde el nivel del suelo.

b) Obstrucciones espaciales:

i. La toma de muestra deberá estar ubicada a una distancia igual o mayor a 1m, verticalmente y horizontalmente desde la estructura que la soporta. Cuando la toma de muestras está localizada sobre techos, esta distancia de separación se refiere a paredes, cercos o habitaciones ubicadas sobre azoteas.
ii. La estación de monitoreo deberá localizarse a una distancia superior a 20m de cualquier edificación existente en el lugar y a una distancia no inferior a 10m de árboles que puedan actuar como obstrucción al flujo de aire.
iii. La toma de muestra deberá encontrarse a una distancia igual o superior al doble de la altura de la perturbación mas próxima en sentido horizontal, que sobresale por sobre la toma de muestra.
iv. El movimiento del aire no deberá estar restringido en un arco de 270° alrededor de la entrada de la toma de muestra.

V. Validación de la Información de Monitoreo de Calidad de Aire

Art.7.- La concentración de 8 horas se considerará válida, si a lo menos, el 75% de los datos para calcular el valor de 8 horas se encuentran disponibles.

VI. Criterios de priorización para el establecimiento de Redes de Monitoreo de Calidad del Aire.

Art.8.- Para efectos de determinar los lugares prioritarios dentro del país en que se deberá instalar redes de monitoreo a fin de evaluar el cumplimiento de la presente norma, deberá considerarse lo siguiente:

1. Cantidad de población expuesta;
2. Volumen del parque automotor existente y proyectado;
3. Presencia de desarrollos industriales significativos emisores de precursores de ozono
4. Valores absolutos de concentraciones de ozono en aire medido, y tendencias históricas, positivas o negativas, de dichos valores.

VII. Fiscalización de la Norma

Art.9.- Corresponderá a los Servicios de Salud del país y, en la Región Metropolitana al Servicio de Salud del Ambiente de la Región Metropolitana, fiscalizar el cumplimiento de las disposiciones de la presente norma.

VIII. Entrada en Vigencia

Art.10.- La presente norma entrará en vigencia el día 1º del mes siguiente a su publicación en el Diario Oficial quedando desde esa fecha sin efecto las normas primarias de calidad de aire para ozono vigentes a dicha fecha.

2.- Sométase a consulta el presente anteproyecto de norma.

Para tales efectos:

1. Remítase copia del expediente al Consejo Consultivo de la Comisión Nacional del Medio Ambiente, para que emita su opinión sobre el anteproyecto de revisión de norma de calidad. Dicho Consejo dispondrá de 60 días contados desde la recepción de la copia del expediente, para el despacho de su opinión. La opinión que emita el Consejo Consultivo de la Comisión Nacional del Medio Ambiente será fundada, y en ella se dejará constancia de los votos disidentes.

2. Dentro del plazo de 60 días, contados desde la publicación en el Diario Oficial, del extracto de la presente resolución, cualquier persona, natural o jurídica, podrá formular observaciones al contenido del anteproyecto de revisión de norma de calidad. Dichas observaciones deberán ser presentadas, por escrito, en la Comisión Regional del Medio Ambiente correspondiente al domicilio del interesado, y deberán ser acompañadas de los antecedentes en los que se sustentan, especialmente los de naturaleza técnica, científica, social, económica y jurídica.

Anótese, publíquese en extracto, comuníquese y archívese.

Adriana Hoffmann Jacoby
Directora Ejecutiva

CRF/RLCH
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Dirección Ejecutiva;
Directores Regionales;
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Unidad Economía Ambiental;
Oficina de Partes;
Archivo.

08 SET 2000

**Lo que transcribo a Ud. para su conocimiento saluda atentamente a Ud.
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Oficial de Partes
Comisión Nacional del Medio Ambiente (CONAMA)**

REPUBLICA DE CHILE
COMISION NACIONAL DEL MEDIO AMBIENTE
ASR/PMC

APRUEBA ANTEPROYECTO DE REVISION DE NORMA PRIMARIA DE CALIDAD DE AIRE PARA DIOXIDO DE NITROGENO (NO2)

SANTIAGO, 8 de septiembre de 2000

EXENTA N° 914

VISTOS:

El acuerdo N°67 de fecha 27 de marzo de 1998, del Consejo Directivo de CONAMA que aprobó el Tercer Programa Priorizado de Normas.; La Resolución N°1215 de 1978, del Delegado de Gobierno en el Servicio Nacional de Salud, la Resolución Exenta N° 1514 de 1999; de la Dirección Ejecutiva de la Comisión Nacional del Medio Ambiente; lo dispuesto en el Decreto Supremo N°93 de 1995, del Ministerio Secretaría General de la Presidencia que fija el procedimiento para la dictación de normas de calidad y emisión; y los demás antecedentes que obran en el expediente público.

RESUELVO

1.- Apruébase el siguiente Anteproyecto de Revisión de Norma Primaria de Calidad de Aire para Dióxido de Nitrógeno (NO2).

I. FUNDAMENTOS:

De acuerdo con lo preceptuado en la ley 19.300, es deber del Estado dictar normas para regular la presencia de contaminantes en el medio ambiente, de manera de prevenir que estos puedan significar o representar, por sus niveles, concentraciones y periodos, un riesgo para la salud de las personas, la preservación de la naturaleza y la conservación del patrimonio ambiental.

El dióxido de nitrógeno (NO2) es producido directa e indirectamente por la quema de combustibles a altas temperaturas. En el proceso de combustión, nitrógeno se oxida para formar principalmente monóxido de nitrógeno (NO) y en menor proporción dióxido de nitrógeno. El NO se transforma en NO2 mediante reacciones fotoquímicas.

La Organización Mundial de la Salud (OMS) reporta efectos directos en la salud de la población por la presencia de dióxido de nitrógeno. Para tal efecto distingue:

a. Efectos a exposiciones de corto plazo: "Seres humanos saludables expuestos, en descanso o con ejercicio liviano por menos de 2 horas a concentraciones sobre los 4700 ug/m3 (2,5 ppm) experimentan reducciones pronunciadas en la función pulmonar; generalmente, sujetos normales no son afectados por concentraciones menores que 1880 ug/m3 (1ppm).

Se ha reportado un amplio rango de efectos en asmáticos. Ellos son probablemente los más sensitivos, aunque existen algunas incertezas en las bases de datos de salud.

La concentración más baja que causaría efectos en la función pulmonar se reportó en dos estudios de laboratorio que expusieron a asmáticos leves por 30-110 minutos a 565 ug/m3 (0,3ppm) de NO2 durante ejercicio intermitente. Sin embargo, ninguno de estos estudios lograron replicar tales respuestas con un grupo más grande de sujetos asmáticos."

b. Efectos de exposiciones en el largo plazo: "Estudios con animales han mostrado claramente que exposiciones de varias semanas a meses con concentraciones menores a 1880 ug/m3 (1ppm) de NO2 ya causan una variedad de efectos, primeramente en el pulmón, pero también en otros órganos tal como el bazo e hígado, y en la sangre. Se han observado efectos reversibles e irreversibles en pulmones.

   No hay estudios epidemiológicos que puedan ser usados en forma confiable para cuantificar una exposición de largo plazo de NO2 o una concentración capaz de ser asociada con la inducción de riesgos inaceptables a la salud de niños o adultos.

   Los resultados de estudios en extramuros indican en forma consistente que niños expuestos por largo plazo a concentraciones ambientales de NO2 exhiben síntomas respiratorios de larga duración y muestran un descenso en la función pulmonar. Sin embargo, estudios epidemiológicos intra y extramuros proveen poca evidencia que exposiciones de largo plazo de NO2 están asociadas con efectos en la salud de adultos" (Guidelines for Air Quality, WHO, 1999. pp.30).

En los Estados Unidos de Norteamérica (EE.UU.) la Agencia de Protección Ambiental (US EPA) reporta en su NO2 Final Rule Review, que la exposición a dióxido de nitrógeno puede irritar los pulmones y disminuir la resistencia ante infecciones respiratorias (ej. influenza), particularmente en individuos con enfermedades respiratorias pre-existentes, tales como asma. Los efectos de exposiciones de corto plazo a dióxido de nitrógeno aún no están claros, pero exposición continuada o frecuente al dióxido de nitrógeno más altas que aquellas encontradas normalmente en el aire ambiente pueden incrementar la incidencia de enfermedades respiratorias agudas en niños" (US EPA NO2/Fact Sheet 16 de septiembre de 1996).

La OMS indica que en el caso del corto plazo, basado en pequeños cambios en las funciones pulmonares -menor que 5% de disminución en VEF1- y cambios en respuestas respiratorias en estudios con asmáticos y pacientes con enfermedades pulmonares crónicas, un rango de 365-565 ug/m3 (0,20 a 0,30ppm) es un claro LOEL (lowest-observed-effect-level).

Sobre este último valor, la OMS propone el uso de un margen de seguridad de 50% porque se han reportado aumentos estadísticamente significativos en respuestas a un broncoconstrictor con exposiciones a 188ug/m3, y porque un meta-análisis sugiere respuestas bajo los 365 ug/m3. Sin embargo, la significancia en la respuesta a 188ug/m3 se ha cuestionado. Con un valor doble respecto a la guía recomendada (400ug/m3) hay evidencia que sugiere posibles efectos leves en la función pulmonar de asmáticos. Si un asmático fuera expuesto simultáneamente o secuencialmente a NO2 y a un aero-alergeno, el riesgo de una respuesta exagerada al alergeno se incrementaría.

Para el caso de valores anuales, la OMS reporta que basado en los estudios revisados, **no es posible en la actualidad seleccionar un valor específico de guía como promedio anual. Sin** embargo, una revisión previa de NO2 recomendó un valor anual de 40 ug/m3 (WHO 1997, la que a su vez se basó en una recomendación realizada por la OMS en 1987). En la ausencia de un valor alternativo, se reconoce este valor como valor guía ("Guidelines for Air Quality", WHO, 1999. pp.31).

Existe un número reducido de estudios locales para este contaminante. Los estudios realizados en Chile no encuentran relación entre mortalidad total y exposición a NO2. El estudio de Ilabaca muestra un exceso de riesgo de 11% para consultas de urgencia infantil, esto equivaldría a un exceso de 4617 consultas anuales atribuibles a NO2. Un último estudio realizado con información de Santiago para el periodo 1988-1996 encuentra relaciones estadísticamente significativas entre mortalidad diaria y dióxido de nitrógeno en modelos de contaminantes únicos así como en modelos que evalúan contaminantes en parejas (Cifuentes, Lave, Vega y Kopfer, en paper del año 2000 aún no publicado).

El dióxido de nitrógeno puede combinarse con compuestos orgánicos volátiles en presencia de luz solar para formar ozono, así como con agua para formar ácido nítrico y nitratos. Esto contribuye a la producción de lluvia ácida y al aumento de los niveles de MP_{10} y $MP_{2.5}$.

A la fecha, el conocimiento de los efectos del dióxido de nitrógeno en la salud de las personas permite realizar proposiciones de niveles objetivo para ser cumplidos a través de normas ambientales, así como niveles que definen las situaciones de emergencia ambiental, por lo que los que los valores de normas de calidad primaria para dióxido de nitrógeno contenidos en la Resolución 1215 de 1978, del Delegado de Gobierno en el Servicio Nacional de Salud (100 ug/m3N como concentración media aritmética anual) deben ser revisados a la luz de tales resultados;

II. Disposiciones Generales

Art.1.- La presente norma tiene por objetivo proteger la salud de la población de aquellos efectos agudos y crónicos generados por la exposición a niveles de concentración de dióxido de nitrógeno en el aire.

Art.2.- Para efectos de lo dispuesto en la presente norma, se entenderá por:

a. *Efectos Agudos*: Aquellos producidos por la acción de concentraciones variables del contaminante en periodos cortos de exposición.

b. *Efectos Crónicos*: Aquellos producidos por la acción de concentraciones variables del contaminante en periodos prolongados de exposición.

c. *ppbv:* Unidad de medida de concentración en volumen, correspondiente a una milésima de parte por millón.

d. *Concentración de Dióxido de Nitrógeno*: Valor promedio temporal detectado en el aire expresado en partes por billón (ppbv).

e. *Concentración de 1 hora*: Media aritmética de los valores de concentración de dióxido de nitrógeno medidos en cada estación monitora en 1 hora.

f. *Concentración anual*: Media aritmética de los valores de concentración de dióxido de nitrógeno medidos en cada estación monitora en un año calendario, o en su defecto de 12 meses a partir del mes de inicio de las mediciones.

g. *Año calendario*: Período que se inicia el 1 de enero, y culmina el 31 de diciembre del mismo año.

h. *Estación de monitoreo con representatividad poblacional para gas dióxido de nitrógeno (EMRPG):* Una estación de monitoreo podrá clasificarse como EMRPG si existe a lo menos un área habitada en un radio de 2 kilómetros (km), medido desde la ubicación de la estación.

Una estación EMRPG tendrá un área de representatividad para la población expuesta correspondiente a un radio de 2 km, medido desde la ubicación de la estación.

i. *Percentil:* Corresponde al valor "q" calculado a partir de los valores efectivamente medidos, aproximados al ug/m3N más próximo. Todos los valores se anotarán en una lista establecida por orden creciente para cada estación de monitoreo.

$$X1 \leq X2 \leq X3 \ldots \leq Xk \leq X\,n - 1 \leq Xn$$

El percentil será el valor del elemento de orden "k", para el que "k" se calculará por medio de la siguiente fórmula:

k = q X n , donde "q" = 0.99 para el Percentil 99, y "n" corresponde al número de valores efectivamente medidos. El valor "k" se aproximará al número entero más próximo

j. *Situaciones de emergencia ambiental declarada por pronóstico de superación de niveles*: Son aquellas que se declaran en base a los resultados de la metodología de pronóstico de calidad del aire.

k. *Situaciones de emergencia ambiental declarada por constatación de superación de niveles*: Son aquellas que se declaran en base a las mediciones constatadas en las estaciones de monitoreo de la calidad del aire.

III. Nivel de Norma Primaria de Calidad de Aire para Dióxido de Nitrógeno

Art.3.- La norma primaria de calidad de aire para dióxido de nitrógeno como concentración anual será de 53 ppbv.

Se considerará sobrepasada la norma primaria de calidad de aire para dióxido de nitrógeno como concentración anual, cuando la concentración anual en un año calendario, o en su defecto de 12 meses a partir del mes de inicio de las mediciones en cualquier estación monitora clasificada como EMRPG sea mayor o igual al valor indicado en el inciso precedente.

Art.4.-La norma primaria de calidad de aire para dióxido de nitrógeno como concentración de 1 hora será de 212 ppbv.

Se considerará sobrepasada la norma primaria de calidad de aire para dióxido de nitrógeno como concentración de 1 hora, cuando el percentil 99 del máximo diario de las concentraciones de 1 hora registradas durante un año calendario, o en su defecto de 12 meses a partir del mes de inicio de las mediciones, en cualquier estación monitora clasificada como EMRPG, sea mayor o igual al valor indicado en el inciso precedente.

Asimismo, se considerará sobrepasada la norma, si antes que concluya el año calendario, o en su defecto de 12 meses a partir del mes de inicio de las mediciones, se registrare en cualquier estación monitora clasificada como EMRPG, mas de cuatro días con mediciones de máximo diario de concentración de 1 hora de dióxido de nitrógeno igual o sobre el valor de la norma.

Art.5.- Los siguientes niveles originarán situaciones de emergencia ambiental para dióxido de nitrógeno en concentración de una hora:

Nivel 1: 600-1199 ppbv
Nivel 2: 1200- 1599 ppbv
Nivel 3: 1600 ppbv o superior

Las situaciones de emergencia ambiental para dióxido de nitrógeno se declararán en función de los niveles anteriores, los cuales podrán ser obtenidos mediante la aplicación de una metodología de pronóstico de calidad de aire aprobada por el Servicio de Salud correspondiente, o por medio de la constatación de las concentraciones del contaminante a partir de alguna de las estaciones monitoras de calidad de aire clasificadas como EMRPG.

La autoridad que realice la declaración de situación de emergencia ambiental podrá omitir tal declaración, dejarla sin efecto o adoptar las medidas correspondientes a los niveles menos estrictos, cumpliendo con las mismas formalidades a que está sujeta la declaración de estas situaciones. Ello sólo podrá realizarse si se detecta un cambio en las condiciones meteorológicas en forma posterior a la hora de comunicación del pronóstico o a la constatación de la superación de los niveles de calidad de aire, y siempre que dicho cambio asegure una mejoría tal en las condiciones de calidad de aire que invalide los resultados entregados por el pronóstico o que asegure la reducción de los niveles de calidad de aire por debajo de aquellos que definen situaciones de emergencia ambiental.

Los planes operacionales para enfrentar las situaciones de emergencia ambiental podrán considerar medidas de control diferentes ya sea se trate de situaciones de emergencia ambiental declaradas por pronóstico o situaciones de emergencia ambiental declaradas por constatación.

Art.6.- En el caso que el dióxido de nitrógeno fuese precursor de otro contaminante normado, los planes de descontaminación o prevención que se establezcan para el control de este último, podrán incluir medidas de reducción de emisiones del contaminante dióxido de nitrógeno, independientemente del cumplimiento de las normas de calidad de aire aquí establecidas.

IV. Metodología de Medición de la Norma

Art.7.- La medición de la concentración de dióxido de nitrógeno en el aire se realizará mediante los métodos de medición:

a) Quimiluminiscencia,
b) Los que se basen en el método modificado de Griess-Saltzmann,
c) Espectrometría de absorción óptica diferencial, con calibración in-situ,
d) Un método de medición cuya metodología de operación sea aprobada por un organismo internacional calificado para este fin.

El monitoreo deberá realizarse con instrumentos aprobados por un organismo internacioal calificado para este fin y en concordancia con los requerimientos para instalación, calibración y operación de los equipos de muestreo y análisis aprobados por el Servicio de Salud correspondiente.

Art.8.- Para efectos del emplazamiento de un colector de muestras en una estación monitora clasificada como EMRPG, se debe considerar los siguientes aspectos:

a) La toma de muestra deberá estar ubicada a una altura no inferior a 3 metros (m) ni superior a 15m, desde el nivel del suelo.

b) Obstrucciones espaciales:

i. La toma de muestra deberá estar ubicada a una distancia igual o mayor a 1m, verticalmente y horizontalmente desde la estructura que la soporta. Cuando la toma de muestras está localizada sobre techos, esta distancia de separación se refiere a paredes, cercos o habitaciones ubicadas sobre azoteas.

ii. La estación de monitoreo deberá localizarse a una distancia superior a 20m de cualquier edificación existente en el lugar y a una distancia no inferior a 10m de árboles que puedan actuar como obstrucción al flujo de aire.
iii. La toma de muestra deberá encontrarse a una distancia igual o superior al doble de la altura de la perturbación mas próxima en sentido horizontal, que sobresale por sobre la toma de muestra.
iv. El movimiento del aire no deberá estar restringido en un arco de 270° alrededor de la entrada de la toma de muestra.

V. Validación de la Información de Monitoreo de Calidad de Aire

Art.9.- La concentración anual se considerará válida, si para cada uno de los cuatro trimestres de un año calendario, o en su defecto de12 meses a partir del mes de inicio de las mediciones, se dispone de a lo menos un 75% de los datos horarios esperados para ese periodo.

La concentración de una hora se considerará válida, si a lo menos, el 75% de los datos para calcular el valor horario se encuentran disponibles.

Art.10- Podrán utilizarse técnicas exploratorias de medición pasivas o activas para establecer, de modo indicativo, la calidad de aire para dióxido de nitrógeno en un área determinada. Si los resultados de concentración de calidad de aire medida mediante estas técnicas son superiores al nivel de norma correspondiente, el Servicio de Salud deberá establecer en un plazo máximo de 3 años en dicha área, un monitoreo formal de acuerdo a la metodología de medición señalada en el artículo cuarto del presente decreto.

El monitoreo mediante técnicas exploratorias de medición activas o pasivas, deberá realizarse en concordancia con los requerimientos para instalación, calibración, operación y análisis aprobados por el Servicio de Salud correspondiente.

VI. Criterios de Priorización para el Establecimiento de Redes de Monitoreo de Calidad del Aire.

Art.11.- Para efectos de determinar los lugares prioritarios dentro del país en que se deberán instalar redes de monitoreo para de evaluar el cumplimiento de la presente norma, deberá considerarse lo siguientes:

1. Cantidad de población expuesta;
2. Volumen del parque automotor existente y proyectado;
3. Presencia de desarrollos industriales significativos emisores de dióxido de nitrógeno;
4. Valores absolutos, medidos, de concentraciones de dióxido de nitrógeno en aire, y tendencias históricas, positivas o negativas, de dichos valores;
5. Resultados del monitoreo realizado mediante técnicas exploratorias de medición activas o pasivas.

VII. Fiscalización de la Norma

Art.12.- Corresponderá a los Servicios de Salud del país y, en la Región Metropolitana al Servicio de Salud del Ambiente de la Región Metropolitana, fiscalizar el cumplimiento de las disposiciones de la presente norma.

VIII. Entrada en Vigencia

Art.13.- La presente norma entrará en vigencia el día 1º del mes siguiente a su publicación en el Diario Oficial quedando desde esa fecha sin efecto las normas primarias de calidad de aire para dióxido de nitrógeno vigentes a dicha fecha.

2.- Sométase a consulta el presente anteproyecto de norma.

Para tales efectos:

1. Remítase copia del expediente al Consejo Consultivo de la Comisión Nacional del Medio Ambiente, para que emita su opinión sobre el anteproyecto de revisión de norma de calidad. Dicho Consejo dispondrá de 60 días contados desde la recepción de la copia del expediente, para el despacho de su opinión. La opinión que emita el Consejo Consultivo de la Comisión Nacional del Medio Ambiente será fundada, y en ella se dejará constancia de los votos disidentes.

2. Dentro del plazo de 60 días, contados desde la publicación en el Diario Oficial, del extracto de la presente resolución, cualquier persona, natural o jurídica, podrá formular observaciones al contenido del anteproyecto de revisión de norma de calidad. Dichas observaciones deberán ser presentadas, por escrito, en la Comisión Regional del Medio Ambiente correspondiente al domicilio del interesado, y deberán ser acompañadas de los antecedentes en los que se sustentan, especialmente los de naturaleza técnica, científica, social, económica y jurídica.

Anótese, publíquese en extracto, comuníquese y archívese.

Adriana Hoffmann Jacoby
Directora Ejecutiva

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Comisión Nacional del
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REPUBLICA DE CHILE
COMISION NACIONAL DEL MEDIO AMBIENTE
ASR/PMC

APRUEBA ANTEPROYECTO DE REVISION DE NORMA PRIMARIA DE CALIDAD DE AIRE PARA ANHIDRIDO SULFUROSO (SO2)

SANTIAGO, 8 de septiembre de 2000

EXENTA N° 915

VISTOS:

El acuerdo N°67 de fecha 27 de marzo de 1998, del Consejo Directivo de CONAMA que aprobó el Tercer Programa Priorizado de Normas; La Resolución N°1215 de 1978, del Delegado de Gobierno en el Servicio Nacional de Salud, la Resolución Exenta N° 1514 de 1999; de la Dirección Ejecutiva de la Comisión Nacional del Medio Ambiente; lo dispuesto en el Decreto Supremo N°185 de 1991, del Ministerio de Minería; lo dispuesto en el Decreto Supremo N°93 de 1995, del Ministerio Secretaría General de la Presidencia que fija el procedimiento para la dictación de normas de calidad y emisión; y los demás antecedentes que obran en el expediente público.

RESUELVO

1.- Apruébase el siguiente Anteproyecto de Revisión de Norma Primaria de Calidad de Aire para Anhídrido Sulfuroso (SO2.

I. FUNDAMENTOS:

De acuerdo con lo preceptuado en la Ley 19.300, es deber del Estado dictar normas para regular la presencia de contaminantes en el medio ambiente, de manera de prevenir que estos puedan significar o representar, por sus niveles, concentraciones y periodos, un riesgo para la salud de las personas, la preservación de la naturaleza y la conservación del patrimonio ambiental.

El anhídrido sulfuroso es un gas soluble en agua, que al hidratarse da origen a la formación de ácidos sumamente agresivos. El anhídrido sulfuroso al ser inhalado se hidrata con la humedad de las mucosas conjuntival y respiratoria constituyendo un riesgo para la salud de las personas al producir irritación e inflamación de las mismas.

El anhídrido sulfuroso es un importante broncoconstrictor, desde los primeros minutos de exposición y su efecto aumenta con la actividad física, con la hiperventilación, al respirar aire frío y seco y en personas con hiperreactividad bronquial.

La exposición a este contaminante produce efectos agudos y efectos crónicos sobre la salud de las personas.

Los efectos agudos en la población se observan a los pocos minutos de exposición, 5 – 10 minutos y la exposición a un tiempo mayor no incrementa los efectos observados.

La Organización Mundial de la Salud (OMS) con el objetivo de proteger a la población más sensible de los efectos agudos producidos por el anhídrido sulfuroso recomienda que no se supere un nivel de 500 ug/m3N para un periodo de 10 minutos.

Si se analiza la información de calidad de aire para anhídrido sulfuroso disponible en el país para un periodo de una hora, se puede deducir que existen localidades en las cuales el nivel recomendado por la OMS para un periodo de 10 minutos se supera.

La OMS señala, que para un periodo de 24 horas y basado en los resultados de estudios epidemiológicos de morbilidad, mortalidad o cambios en la función pulmonar en grupos de población sensible se observan efectos en las personas a partir de un nivel de concentración de 250 ug/m3N, teniendo en consideración los efectos del material particulado en suspensión y otros contaminantes.

La OMS, aplicando un factor de incertidumbre de 2 y con el objeto de proteger la salud de la población, recomienda un nivel de concentración de 125 ug/m3N para un periodo de 24 horas y un nivel de concentración de 50 ug/m3N para un periodo de un año.

El anhídrido sulfuroso se origina de la combustión del azufre contenido en los combustibles fósiles (petróleos combustibles, gasolina, petróleo diesel, carbón, etc.), de la fundición de minerales que contienen azufre y de otros procesos industriales.

El anhídrido sulfuroso presenta efectos adicionales a los reportados a través de indicadores de salud. De la reducción en el ambiente de este contaminante, también se espera beneficios secundarios sobre los recursos naturales (cultivos y vegetación natural) cercanos a las comunidades a proteger, así como indirectamente a ecosistemas y materiales expuestos a este contaminante.

El anhídrido sulfuroso es un precursor de aerosoles secundarios, típicamente asociados a la fracción fina del material particulado.

Los estudios realizados en nuestro país demuestran que la mortalidad no es estadísticamente significativa, es decir, no relacionan este efecto al contaminante. Los daños a la salud identificados y asociados a exposiciones al anhídrido sulfuroso corresponden a un aumento de tos y un efecto en el flujo respiratorio forzado (FEV). No se encontró evidencia de efectos sinérgicos con otros contaminantes. En general, para ninguno de los modelos de mortatilidad el anhídrido sulfuroso resultó estadísticamente significativo, en particular cuando el modelo incluía el MP10.

A la fecha, el conocimiento de los efectos del anhídrido sulfuroso en la salud de la población permite realizar proposiciones de niveles objetivo para ser cumplidos a través de normas ambientales, así como niveles que definen las situaciones de emergencia ambiental por anhídrido sulfuroso, por lo que, los valores de normas de calidad primaria para anhídrido sulfuroso contenidos en la Resolución 1215 de 1978, del Delegado de Gobierno en el Servicio Nacional de Salud y en el Decreto N°185 de 1991, del Ministerio de Minería (80 ug/m3N como concentración media aritmética anual y 365 ug/m3N como concentración media aritmética de veinticuatro horas) deben ser revisados a la luz de tales resultados,

II. Disposiciones Generales y Definiciones

Art.1.- La presente norma tiene por objetivo proteger la salud de la población de aquellos efectos agudos y crónicos generados por la exposición a niveles de concentración de anhídrido sulfuroso en el aire.

Art.2.- Para efectos de lo dispuesto en la presente norma, se entenderá por:

a. *Efectos Agudos*: Aquellos producidos por la acción de concentraciones variables del contaminante en periodos cortos de exposición.

b. *Efectos Crónicos*: Aquellos producidos por la acción de concentraciones variables del contaminante en periodos prolongados de exposición.

c. *ppbv*: Unidad de medida de concentración en volumen, correspondiente a una milésima de parte por millón.

d. *Concentración de Anhídrido Sulfuroso*: Valor promedio temporal detectado en el aire expresado en partes por billón (ppbv).

e. *Concentración de 1 hora*: Media aritmética de los valores de concentración de anhídrido sulfuroso medidos en cada estación monitora en 1 hora.

f. *Concentración de 24 horas*: Media aritmética de los valores de concentración de anhídrido sulfuroso medidos en cada estación monitora en 24 horas.

g. *Concentración anual*: Media aritmética de los valores de concentración de anhídrido sulfuroso medidos en cada estación monitora en un año calendario, o en su defecto de 12 meses a partir del mes de inicio de las mediciones.

h. *Año calendario:* Período que se inicia el 1 de enero y culmina el 31 de diciembre del mismo año.

i. *Estación de monitoreo con representatividad poblacional para gas anhídrido sulfuroso (EMRPG)*: Una estación de monitoreo podrá clasificarse como EMRPG si existe a lo menos un área habitada en un radio de 2 kilómetros (km), medido desde la ubicación de la estación.

   Una estación EMRPG tendrá un área de representatividad para la población expuesta correspondiente a un radio de 2 km, medido desde la ubicación de la estación.

j. *Percentil*: Corresponde al valor "q" calculado a partir de los valores efectivamente medidos, aproximados al ug/m3N más próximo. Todos los valores se anotarán en una lista establecida por orden creciente para cada estación de monitoreo.

$$X1 \leq X2 \leq X3 .... \leq Xk \leq X\,n - 1 \leq Xn$$

   El percentil será el valor del elemento de orden "k", para el que "k" se calculará por medio de la siguiente fórmula:

   k = q X n , donde "q" = 0.99 para el Percentil 99, y "n" corresponde al número de valores efectivamente medidos. El valor "k" se aproximará al número entero más próximo.

i. *Situaciones de emergencia ambiental declarada por pronóstico de superación de niveles*: Son aquellas que se declaran en base a los resultados de la metodología de pronóstico de calidad de aire.

j. *Situaciones de emergencia ambiental declarada por constatación de superación de niveles*: Son aquellas que se declaran en base a las mediciones constatadas en las estaciones de monitoreo de calidad de aire.

III. Nivel de Norma de Calidad Primaria para Anhídrido Sulfuroso en Aire

Art.3.- La norma primaria de calidad de aire para anhídrido sulfuroso como concentración anual será de 30 ppbv.

Se considerará sobrepasada la norma primaria de calidad de aire para anhídrido sulfuroso como concentración anual, cuando la concentración anual en un año calendario, o en su defecto de 12 meses a partir del mes de inicio de las mediciones, en cualquier estación monitora clasificada como EMRPG, sea mayor o igual al valor indicado en el inciso precedente.

Art.4.- La norma primaria de calidad de aire para anhídrido sulfuroso como concentración de 24 horas será de 95 ppbv .

Se considerará sobrepasada la norma primaria de calidad de aire para anhídrido sulfuroso como concentración de 24 horas, cuando el percentil 99 de las concentraciones de 24 horas registradas durante un año calendario, o en su defecto de 12 meses a partir del mes de inicio de las mediciones, en cualquier estación monitora clasificada como EMRPG, sea mayor o igual al valor indicado en el inciso precedente.

Asimismo, se considerará sobrepasada la norma, si antes de concluir el año calendario, o en su defecto de 12 meses a partir del mes de inicio de las mediciones, se registrare en cualquier estación monitora clasificada como EMRPG, mas de cuatro días con mediciones de concentración de 24 horas igual o sobre el valor de la norma.

Art.5.- La norma primaria de calidad de aire para anhídrido sulfuroso como concentración de una hora será de 400 ppbv.

Se considerará sobrepasada la norma primaria de calidad de aire para anhídrido sulfuroso como concentración de 1 hora cuando el percentil 99 máximo diario de las concentraciones de una hora registradas durante un año calendario, o en su defecto de 12 meses a partir del mes de inicio de las mediciones, en cualquier estación monitora clasificada como EMPRG, sea mayor o igual al valor indicado en el inciso precedente.

Asimismo, se considerará sobrepasada la norma, si antes de concluir el año calendario, o en su defecto de 12 meses a partir del mes de inicio de las mediciones, se registrare en cualquier estación monitora clasificada como EMRPG, mas de cuatro días con mediciones de máximo diario de concentración de una hora de anhídrido sulfuroso igual o sobre el valor de la norma.

Art.6.- Los siguientes niveles originarán situaciones de emergencia ambiental para anhídrido sulfuroso, en concentración de una hora:

Nivel 1: 750 - 999 ppbv
Nivel 2: 1.000 – 1.499 ppbv
Nivel 3: 1.500 ppbv o superior

Las situaciones de emergencia ambiental para anhídrido sulfuroso se declararán en función de los niveles anteriores, los cuales podrán ser obtenidos mediante la aplicación de una metodología de pronóstico de calidad de aire aprobada por el Servicio de Salud correspondiente, o por medio de la constatación de las concentraciones del contaminante a partir de alguna de las estaciones monitoras de calidad de aire clasificadas como EMRPG.

La autoridad que realice la declaración de situación de emergencia ambiental podrá omitir tal declaración, dejarla sin efecto o adoptar las medidas correspondientes a los niveles menos estrictos, cumpliendo las mismas formalidades a que está sujeta la declaración de estas situaciones. Ello sólo podrá realizarse si se detecta un cambio en las condiciones meteorológicas en forma posterior a la hora de comunicación del pronóstico o a la constatación de la superación de los niveles de calidad de aire, y siempre que dicho cambio asegure una mejoría tal en las condiciones de calidad de aire que invalide los resultados entregados por el pronóstico o que asegure la reducción de los niveles de calidad de aire por debajo de aquellos que definen situaciones de emergencia ambiental.

Los planes operacionales para enfrentar las situaciones de emergencia ambiental podrán considerar medidas de control diferentes ya sea se trate de situaciones de emergencia ambiental declaradas por pronóstico o situaciones de emergencia ambiental declaradas por constatación.

Art.7.- En el caso que el anhídrido sulfuroso fuese precursor de otro contaminante normado, los planes de descontaminación o prevención que se establezcan para el control de este último, podrán incluir medidas de reducción de emisiones del contaminante anhídrido sulfuroso, independientemente del cumplimiento de las normas de calidad de aire aquí establecidas.

IV. Metodología de Medición de la Norma

Art.8.- La medición de la concentración de anhídrido sulfuroso en el aire se realizará mediante los métodos de medición:

- Fluorescencia ultravioleta
- Espectrometría de absorción diferencial con calibración in – situ
- Un método de medición cuya metodología sea aprobada por un organismo internacional calificado para este fin.

El monitoreo deberá realizarse con instrumentos aprobados por un organismo internacional calificado para este fin y en concordancia con los requerimientos para instalación, calibración y operación de los equipos de muestreo y análisis aprobados por el Servicio de Salud correspondiente.

Art.9.- Para efectos del emplazamiento de un colector de muestras en una estación monitora clasificada como EMRPG, se debe considerar los siguientes aspectos:

a) La toma de muestra deberá estar ubicada a una altura no inferior a 3 metros (m) ni superior a 15 m, desde el nivel del suelo.

b) Obstrucciones Espaciales:

i. La toma de muestra deberá estar ubicada a una distancia igual o mayor a 1 m, verticalmente y horizontalmente desde la estructura que la soporta. Cuando la toma de muestra esta localizada sobre techos, esta distancia de separación se refiere a paredes, cercos o habitaciones ubicadas sobre azoteas.

ii. La estación de monitoreo deberá localizarse a una distancia superior a 20 m de cualquier edificación existente en el lugar y a una distancia no inferior a 10 m de árboles que puedan actuar como obstrucción al flujo de aire.
iii. La toma de muestra deberá encontrarse a una distancia igual o superior al doble de la altura de la perturbación más próxima en sentido horizontal, que sobresale por sobre la toma de muestra.
iv. El movimiento del aire no deberá estar restringido en un arco de 270° alrededor de la entrada de la toma de muestra.

V. Validación de la Información de Monitoreo de Calidad de Aire

Art.10.- La concentración anual se considerará válida, si para cada uno de los cuatro trimestres de un año calendario, o en su defecto de 12 meses a partir del mes de inicio de las mediciones, se dispone de a lo menos un 75% de los datos horarios esperados para ese periodo.

La concentración de 24 horas se considerará válida, si a lo menos, el 75% de los datos promedios horarios para un periodo de 24 horas, se encuentran disponibles.

La concentración de 1 hora se considerará válida, si a lo menos, el 75% de los datos para calcular el valor horario se encuentran disponibles.

Art.11.- Podrán utilizarse técnicas exploratorias de medición pasivas o activas para establecer de modo indicativo la calidad de aire para anhídrido sulfuroso en un área determinada. Si los resultados de concentración de calidad de aire medida con estas técnicas son superiores al nivel de norma correspondiente, el Servicio de Salud deberá establecer en un plazo máximo de 3 años en dicha área, un monitoreo formal de acuerdo a la metodología de medición señalada en el artículo octavo del presente decreto.

El monitoreo mediante técnicas de medición exploratorias pasivas o activas, deberá realizarse en concordancia con los requerimientos para instalación, calibración, operación y análisis aprobados por el Servicio de Salud correspondiente.

VI. Criterios de priorización para el establecimiento de Redes de Monitoreo de Calidad del Aire.

Art.12.- Para efectos de determinar los lugares prioritarios dentro del país en que se deberán instalar redes de monitoreo a fin de evaluar el cumplimiento de la presente norma, deberá considerarse lo siguiente:

1. Cantidad de población expuesta;
2. Presencia de desarrollos industriales significativos emisores de anhídrido sulfuroso
3. Valores absolutos, medidos, de concentraciones de anhídrido sulfuroso en aire, y tendencias históricas positivas o negativas de dichos valores;
4. Resultados del monitoreo realizado mediante técnicas de medición exploratorias pasivas o activas.

VII. Fiscalización de la Norma

Art.13.- Corresponderá a los Servicios de Salud del país y, en la Región Metropolitana al Servicio de Salud del Ambiente de la Región Metropolitana, fiscalizar el cumplimiento de las disposiciones de la presente norma.

VIII. Entrada en Vigencia

Art.14.- La presente norma entrará en vigencia el día 1º del mes siguiente a su publicación en el Diario Oficial quedando desde esa fecha sin efecto las normas primarias de calidad de aire para anhídrido sulfuroso vigentes a dicha fecha.

2.- Sométase a consulta el presente anteproyecto de norma.

Para tales efectos:

1. Remítase copia del expediente al Consejo Consultivo de la Comisión Nacional del Medio Ambiente, para que emita su opinión sobre el anteproyecto de revisión de norma de calidad. Dicho Consejo dispondrá de 60 días contados desde la recepción de la copia del expediente, para el despacho de su opinión. La opinión que emita el Consejo Consultivo de la Comisión Nacional del Medio Ambiente será fundada, y en ella se dejará constancia de los votos disidentes.

2. Dentro del plazo de 60 días, contados desde la publicación en el Diario Oficial, del extracto de la presente resolución, cualquier persona, natural o jurídica, podrá formular observaciones al contenido del anteproyecto de revisión de norma de calidad. Dichas observaciones deberán ser presentadas, por escrito, en la Comisión Regional del Medio Ambiente correspondiente al domicilio del interesado, y deberán ser acompañadas de los antecedentes en los que se sustentan, especialmente los de naturaleza técnica, científica, social, económica y jurídica.

Anótese, publíquese en extracto, comuníquese y archívese.

COMISIÓN NACIONAL DEL MEDIO AMBIENTE
DIRECTORA EJECUTIVA

Adriana Hoffmann Jacoby
Directora Ejecutiva

CRF/RLCH
Distribución:
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Directores Regionales;
Consejo Consultivo de CONAMA;
Depto. Jurídico;
Depto. Descontaminación, Planes y Normas;
Unidad Economía Ambiental;
Oficina de Partes;
Archivo.

08 SEP 2000

Lo que transcribo a Ud.
para su conocimiento
saluda atentamente a Ud.
CARMEN V. LUNA B.
Oficial de Partes
Comisión Nacional del
Medio Ambiente (CONAMA)

000932

REPUBLICA DE CHILE
COMISION NACIONAL DEL MEDIO AMBIENTE
ASR/PMC

APRUEBA ANTEPROYECTO DE REVISION DE NORMA PRIMARIA DE CALIDAD DE AIRE PARA PARTICULAS TOTALES EN SUSPENSION (PTS)

SANTIAGO, 8 de septiembre de 2000

EXENTA N° 916

VISTOS:

El acuerdo Nº 67 de fecha 27 de marzo de 1998, del Consejo Directivo de CONAMA que aprobó el Tercer Programa Priorizado de Normas.; La Resolución N°1215 de 1978, del Delegado de Gobierno en el Servicio Nacional de Salud, la Resolución Exenta N° 1514 de 1999; de la Dirección Ejecutiva de la Comisión Nacional del Medio Ambiente; lo dispuesto en el Decreto Supremo Nº93 de 1995, del Ministerio Secretaría General de la Presidencia que fija el procedimiento para la dictación de normas de calidad y emisión; y los demás antecedentes que obran en el expediente público.

RESUELVO

1.- Apruébase el siguiente Anteproyecto de Revisión de Norma Primaria de Calidad de Aire para Partículas Totales en Suspensión.

I. FUNDAMENTOS:

De acuerdo con lo preceptuado en la Ley 19.300, es deber del Estado dictar normas para regular la presencia de contaminantes en el medio ambiente, de manera de prevenir que estos puedan significar o representar, por sus niveles, concentraciones y periodos, un riesgo para la salud de las personas, la preservación de la naturaleza y la conservación del patrimonio ambiental.

Históricamente se consideró que todas las partículas suspendidas en el aire (PTS) afectaban la salud de las personas de la misma forma. Sin embargo, recientemente se ha demostrado que las partículas que más la afectan son aquellas con un diámetro aerodinámico menor a 10 um (MP10) y más aún, aquellas con diámetro aerodinámico menor a 2.5 um (MP2.5).

La fracción del PTS mayor a 10 micrones corresponde a partículas no respirables. Estas se depositan en la traquea y son limpiadas por los cilios a través de la formación de mucus y expulsadas a través de la tos o de la deglución.

El documento de guías globales de calidad del aire de la Organización Mundial de la salud (OMS) sostiene que no puede establecerse un nivel umbral para los efectos del material particulado en la salud, por lo que las guías para material particulado son representadas por asociaciones estadísticamente significativas entre el incremento en los efectos observados y el incremento de las concentraciones, específicamente de MP10 y MP2.5. No estableciéndose ningún tipo de guía para aquella fracción mayor a 10 micrones.

No se cuenta con una evaluación de riesgo que evidencie relación entre la exposición a PTS y en particular a los compuestos tóxicos contenidos en éste y la ocurrencia de alguna enfermedad.

En Chile, se regulan los efectos en salud generados por la fracción respirable del material particulado inferior a 10 micrones, a través de una norma primaria de calidad de aire para material particulado respirable (MP10) como concentración de 24 horas.

Los fundamentos anteriores permiten concluir que no se requiere de una norma primaria de calidad de aire para las partículas totales en suspensión.

II. Dispone no Establecer Niveles de Concentración para las Partículas Totales en Suspensión.

Se dejan sin efecto los valores de concentración para las partículas totales en suspensión que hayan estado vigentes hasta esta fecha.

III. Entrada En Vigencia

Lo dispuesto entrará en vigencia el día 1° del mes siguiente de publicado en el Diario Oficial el decreto supremo que apruebe la presente revisión de norma.

2.- Sométase a consulta el presente anteproyecto de norma.

Para tales efectos:

1. Remítase copia del expediente al Consejo Consultivo de la Comisión Nacional del Medio Ambiente, para que emita su opinión sobre el anteproyecto de revisión de norma de calidad. Dicho Consejo dispondrá de 60 días contados desde la recepción de la copia del expediente, para el despacho de su opinión. La opinión que emita el Consejo Consultivo de la Comisión Nacional del Medio Ambiente será fundada, y en ella se dejará constancia de los votos disidentes.

2. Dentro del plazo de 60 días, contados desde la publicación en el Diario Oficial, del extracto de la presente resolución, cualquier persona, natural o jurídica, podrá formular observaciones al contenido del anteproyecto de revisión de norma de calidad. Dichas observaciones deberán ser presentadas, por escrito, en la Comisión Regional del Medio Ambiente correspondiente al domicilio del interesado, y deberán ser acompañadas de los antecedentes en los que se sustentan, especialmente los de naturaleza técnica, científica, social, económica y jurídica.

Anótese, publíquese en extracto, comuníquese y archívese.

COMISION NACIONAL DEL MEDIO AMBIENTE

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COMITÉ REGIONAL II REGION – ANTOFAGASTA
REVISION NORMAS DE CALIDAD PRIMARIA EN AIRE

Mediante Resolución Exenta N° 1514/99 de la Dirección Ejecutiva de CONAMA, publicada en el Diario Oficial con fecha 05 de enero de 2000 se dio inicio al proceso de revisión de Normas Primarias de Calidad de Aire para Anhídrido Sulfuroso (SO_2), Monóxido de Carbono (CO), Dióxido de Nitrógeno (NO_2), Ozono (O_3) y Partículas Totales en Suspensión (PTS). Todos estos contaminates normados en Resolución N°1215/78 del Ministerio de Salud.

CONAMA a través del Dpto. de Descontaminación, Planes y Normas inició el proceso de elaboración del anteproyecto para la Dictación de una nueva Norma Primaria de Calidad de Aire. Por su parte, CONAMA Segunda Región, formaliza un Comité Regional al que se le solicita estudiar, analizar los antecedentes existentes para cada contaminante en estudio y expresar las opiniones y realidades de la Región.

CONAMA consulta a instituciones del Estado con competencia reguladora, a las Direcciones Regionales, a instituciones privadas, academias y ONGs. respecto de las normas primarias de calidad del aire contenidas en la Resolución 1215. Se entiende como norma de calidad ambiental a aquella que establece valores de concentración máximas o mínimas de un elemento, compuesto, etc, cuya presencia o carencia en el ambiente pueda constituir un riesgo para la salud de la población y/o los recursos naturales y el patrimonio ambiental. Una Norma Primaria de Calidad tiene como objetivo la salud de la población.

En el proceso de elaboración del anteproyecto para la Revisión de Normas de Calidad Primaria en Aire, la Asociación de Industriales de Antofagasta (AIA), representada por su asociada Noranda Fundición Altonorte, se encuentra participando en el Comité Regional.

El Comité Regional de Revisión de Normas de Calidad Primaria en Aire queda integrado por todas las fuerzas vivas de la comunidad; uniones vecinales, empresas, asociaciones, universidades, municipalidades, gobernaciones, servicios, etc.

El Comité aceptó las responsabilidades para proponer y entregar antecedentes para la toma de decisiones; emitir observaciones y opiniones a las decisiones que sean tomadas por el Comité Operativo (Anteproyecto) y mantenerse informado del proceso de dictación de la norma

Para realizar con mayor eficiencia las actividades planteadas y de competencia de éste Comité Regional, se formaron dos sub-grupos de trabajos; uno para los contaminantes SO_2 y PTS y otro para O_3, CO y NO_2

El Sub-grupo de SO_2 y PTS quedo liderado por las representantes de Noranda; esta conformado por:

Juan Ugarte,	Pdte. Junta de Vecinos Vientos del Sur
Abel Reinoso,	Académico Universidad Católica del Norte
Luis Vallejos	Académico Universidad de Antofagasta
Alberto Rivera,	ONG ADEMAM
Fanny Zepeda,	Servicio Salud Antofagasta
Mónica Guiorguiadez,	Asociación de Industriales de Antofagasta
Yanett Omegna,	Asociación de Industriales de Antofagasta
Max Rafael Kobek	CODELCO – Chuquicamata
Rubén Alfaro Torrico	CODELCO – Chuquicamata
Como Asesoras y facilitadoras:	
María Angélica Ruiz-Tagle,	CONAMA II Región
María Clemencia Ovalle,	CONAMA II Región

A la fecha se han realizado seis sesiones de trabajo; la primera de presentación de participantes y del trabajo mismo; la segunda para revisión de información entregada por CONAMA; la tercera se efectúo en Altonorte y fue una sesión de trabajo de todo el día, aquí el Sub–grupo de SO_2 y PTS estudió el sistema de monitoreo y recabo de la información y analizó los documentos existentes, distribuyó la carga de trabajo y organizó la presentación del jueves 13 de julio. Después de éste encuentro, se continuó con el análisis de los nuevos datos que proporcionó CONAMA y la información que entregaban las fundiciones; la visión académica permitió una discusión rica y variada. La comunidad representada por don Juan Ugarte fue consultada en pleno, respecto de éstas y otras materias. El trabajo realizado a la fecha permite expresar las siguientes consideraciones, expresas a continuación:

I.- Del Material Particulado en Suspensión (PTS)

Se ha demostrado que las partículas que afectan a la salud son aquellas cuyo diámetro aerodinámico es menor a 10 um (PM 10) y más aún, aquellas con diámetro menor a 2.5 um. (PM 2.5); además, sabiendo que la fracción de partículas mayores a 10 micrones se depositan en la traquea y luego son limpiadas por los cilios a través de la formación de mucus y/o expulsadas por la tos o al tragar - no causan daños a la salud; es que la opinión de este sub- grupo acepta y apoya la propuesta de CONAMA en cuanto a derogar la actual norma de PTS, más aún conociendo la regulación D.S. N°59/98 y los nuevos esfuerzos en su revisión y en proposición que se esta efectuando.

II.- Del Anhídrido Sulfuroso (SO_2)

1. Norma anual.
   Los planes de las dos fundiciones e incluso de las termoeléctricas ubicadas en la II Región apuntan al cumplimiento de la norma de 80 ug/m^3, motivo por el que no se tendría objeciones al mantenimiento de ese nivel.

2. Norma diaria.

Se entiende que un valor de 250 ug/m^3 con percentil 99, permitiría la excedencia de ese valor solo tres veces al año, dado que la cuarta excedencia implicaría infracción; por otro lado, estas excedencias sólo estarían permitidas por mal funcionamiento de equipos y/o condiciones meteorológicas adversas.

Se reconocen los datos que proporciona la OMS en cuanto a que 250 ug/m^3 es un buen valor para salvaguardar la salud de la población; en este valor no esta considerado ningún factor de incertidumbre.

Por otra parte, el actual rango de 365 ug/m^3 (vigente en U.S.A,) ha permitido el desarrollo y la generación de Planes de Descontaminación y la proyección de nuevas inversiones en el área de fundiciones. Un cambio drástico en este valor puede significar incumplimientos y/o esfuerzos económicos no presupuestados (importante tener presente el precio del metal rojo) o inversiones difíciles de conseguir.

Las posibilidades de los proyectos en desarrollo en Chuquicamata apuntan a cumplir con una norma de 365 ug/m3, resultantes de obtener un valor promedio de 300 ug/m3 $\pm$ 20% dependiendo de las condiciones meteorológicas. Como a la autoridad le interesa el cumplimiento de las normas independiente de las condiciones meteorológicas, ello implica que hay que ubicarse en el peor escenario, es decir, 300 + 20 % o sea 360 ug/m^3. Si se implanta una norma inferior a 360 ug/m3 el incumplimiento de la norma sería inevitable, a menos que Chuquicamata sea declarada zona industrial, donde no sean exigibles las normas poblacionales.

Por lo anterior, la Sub-Comisión de la II Región propone mantener el actual valor del DSNº 185, es decir 365 ug/Nm^3, hasta diciembre del año 2003, fecha en que se cumple plazo para la implementación del Plan de Descontaminación Ambiental de CODELCO – Chuquicamata y además, se completan las inversiones aprobadas por E.I.A. para la Ampliación Fase III de Noranda Chile S.A. – Fundición Altonorte; a partir de enero del 2004 la región estaría en condiciones de comenzar con la aplicación de una nueva normativa, es decir 250 ug/Nm^3.

Es importante recordar que sobre la base de varios estudios y consideraciones, la EPA concluyó que el estándar de 365 ug/m^3 de 24 horas proporciona un margen de seguridad adecuado. Lo anterior, permite cautelar las acciones comprometidas en Plan de Descontaminación como de Modernización de las fundiciones.

3. Norma horaria.

El Sub- Comité no la justifica, la posible acción de corrección sólo se podría aplicar ante hechos consumados.

Aún conociendo que los picks en el país no sobrepasan los 1050 ug/m^3 hora, en los alrededores de las fundiciones los valores son bastantes más altos y las características de la localidad de la fuente y la meteorología del sector, hacen variar estos picks.

Entendemos que el criterio de proponer un mayor valor horario, se traduce en el fondo en una norma diaria más exigente, que no necesariamente se traduce en una mayor protección a la población.

Es muy difícil predecir el nivel de emisiones (en fundición Altonorte se ha podido observar una casi nula correlación entre emisión de SO_2 y concentraciones para calidad de aire, ver gráficos adjuntos) que permitan asegurar no sobrepasarse en la norma horaria.

Además, no es posible efectuar mediciones horarias de emisión con la tecnología que actualmente disponen las fundiciones.

Esta Sub-Comisión propone una normativa en cuanto a establecer una norma cuya concentración promedia este dada por tres horas en bloque. Se sabe que los efectos se han cuantificado en las revisiones que se han hecho de la norma y se ha encontrado un umbral alrededor de 1.300 $\mu g/m^3$, bajo el cual se detectan efectos en asmáticos más sensibles, que son una pequeña fracción de la población (<1%). La principal explicación a este guarismo esta dada en términos operativos ya que las megafuentes regionales con el lapsus señalado obtendrían el tiempo necesario de reacción para tomar las medidas operacionales que permitan mitigar el impacto de las emisiones a la atmósfera y poder dar de esta forma dar cumplimiento a la norma protegiendo efectivamente la salud de la población; una norma horaria no alcanza a entregar el tiempo operacional necesario para controlar el episodio.

De acuerdo a los estudios que entrego CONAMA, hay consenso en que existen efectos en la salud en grupos sensibles (asmáticos) por altas concentraciones de SO_2 por pequeños períodos de tiempo (10 min).

De los antecedentes estudiados se vio que el análisis económico para implementar un marco regulatorio horario indicó que existían mayores costos que beneficios al establecer una normativa nacional (USA) para exposición a SO_2 por períodos de 1 hora.

La Sub. Comisión desea destacar el siguiente párrafo:
Los actuales NAAQS para el SO_2 fueron ratificados por la EPA en mayo de 1996. El NAAQS primario para el SO_2 de 365 $\mu g/m^3$, promediado durante un período de 24 horas, no se debe transgredir más de una vez al año. La norma anual es una concentración media aritmética anual de 80 $\mu g/m^3$.

La reducción de esta norma limitará el desarrollo industrial de Mejillones; el reducir las normas de calidad de un país en vías de desarrollo limita la instalación de nuevos proyectos en determinadas áreas; se debe tener presente los niveles de cesantía de hoy, altos en el país.

No se ve sensato reducir los valores sólo por seguir los estándares recomendados en algunos países que tiene un nivel de desarrollo considerablemente superior al chileno o porque existe "espacio" para esa reducción..

Nota.:
Fundición Altonorte, como NORANDA CHILE S.A, y Chuquicamata, como División de Codelco, están participando en el proceso en Santiago, en las reuniones en que la CONAMA ha invitado a ambas empresas junto a otras representativas en el tema.

RESUMEN GENERAL - PROPOSICIONES SUB-COMITE SO_2 y PTS.

I.- Convenimos en la derogación de una normativa para PTS

II.- Sin objeciones al mantenimiento de la norma anual de 80 ug/Nm^3

III.- Se recomienda continuar con una norma diaria de 365 ug/Nm^3, hasta diciembre del año 2003, fecha en que se cumple plazo para la implementación del Plan de Descontaminación Ambiental de CODELCO – Chuquicamata y además, se completan las inversiones aprobadas por E.I.A. para la Ampliación Fase III de Noranda Chile S.A. – Fundición Altonorte. Es importante recordar que sobre la base de varios estudios y consideraciones, la EPA concluyó que el estándar de 365 ug/m^3 de 24 horas proporciona un margen de seguridad adecuado. De esta forma se permite cautelar las acciones comprometidas en Plan de Descontaminación como de Modernización de las fundiciones. A partir de enero del año 2004 la región podría comenzar con la implementación de una normativa de 250 ug/Nm^3 día.

IV.- No se acepta la norma horaria de 1050 ug/Nm^3; es imposible de cumplir con ellas en las inmediaciones de las megafuentes regionales. Proponemos una norma de 1300 ug/Nm^3 por períodos como promedios de tres horas (en bloque), con un percentil del 99%. Este tiempo (tres horas) permite reaccionar operativamente frente a un evento ambientalmente critico y mitigar el efecto en la salud de las personas que es lo que todos deseamos lograr.

FIRMAN EL PRESENTE DOCUMENTO:

Juan Ugarte,	Pdte. Junta de Vecinos Vientos del Sur	
Abel Reinoso,	Académico Universidad Católica del Norte	
Luis Vallejos	Académico Universidad de Antofagasta	
Alberto Rivera,	ONG ADEMAM	
Fanny Zepeda,	Servicio Salud Antofagasta	
Mónica Guiorguiadez,	Asociación de Industriales de Antofagasta	
Yanett Omegna,	Asociación de Industriales de Antofagasta	
Max Rafael Kobek	CODELCO – Chuquicamata	
Rubén Alfaro Torrico	CODELCO – Chuquicamata	

Se anexa alguna información proporcionada por los participantes.

ASOCIACION DE INDUSTRIALES DE ANTOFAGASTA

000942

PARA: Yanett Ormeño	**FAX:** 630143
DE : Sr. Juan Pablo León	**FAX:** 264179
FECHA: 18.08.2000	
Nº DE PAGINAS: 5	**(incluyendo esta presentación)**
MATERIA: En forma adjunta le envío comentarios respecto a revisión de norma SO2.	

Sucre 220 of. 410- Fonos-Fax: (56-55-)223827-251592-264179- Antofagasta Chile

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COMENTARIOS A NIVEL REGIONAL DE CHUQUICAMATA RESPECTO A REVISIÓN DE NORMAS DE SO2

1. Norma horaria.

No se justifica pues la posible acción de corrección sólo se podría aplicar ante hechos consumados

El criterio de aplicar el mayor valor horario de cada día, se traduce en el fondo en una norma diaria más exigente, que no necesariamente se traduce en una mayor protección a la población.

Tampoco es posible predecir el nivel de emisiones que permitan asegurar que no se sobrepase la norma horaria. Además, no es posible efectuar mediciones horarias de emisión con la tecnología que actualmente disponemos.

2. Norma diaria.

Las posibilidades de los proyectos en desarrollo en Chuquicamata apuntan a cumplir con una norma de 365 ug/m3, resultantes de obtener un valor promedio de 300 ug/m3 +- 20% dependiendo de las condiciones meteorológicas. Como a la autoridad le interesa el cumplimiento de las normas independiente de las condiciones meteorológicas, ello implica que hay que ubicarse en el peor escenario, es decir, 300 + 20 % = 360 ug/m3.

Si se implanta una norma inferior a 360 ug/m3 el incumpliento de la norma sería inevitable, a menos que Chuquicamata sea declarada zona industrial, donde no sean exigibles las normas poblacionales

3. Norma anual.

Los planes de Chuquicamata apuntan al cumplimiento de la norma de 80 ug/m3, motivo por el que no tendríamos objeciones al mantenimiento de ese nivel.

Respecto del resto de los contaminantes en revisión para la normativa de calidad primaria, estos no son pertinentes para las actividades desarrolladas por nuestra División.

Nota.:

Chuquicamata, como División de Codelco, está participando en el proceso en Santiago, en las reuniones en que la CONAMA ha invitado a CODELCO junto a otras empresas representativas en el tema. La posición oficial de CODELCO, será entregará a través de nuestra casa Matriz directamente a la CONAMA.

Atentamente,

Rubén Alfaro Torrico

DIVISION CHUQUICAMATA DIRECCION DIVISIONAL DE GESTION AMBIENTAL CODELCO CHILE

RUBEN PEDREROS QUIROGA
Director de Gestión Ambiental

Chuquicamata, 17 de Agosto del 2000

CONSULTAS

Los representantes de AIA del Sub-Comité SO_2 y PTS, han tomado contacto con los encargados ambientales de las termoeléctricas ubicadas en la II Región, para solicitarles sus proyecciones, vía modelación, de cuales serán sus emisiones futuras y cual podría ser su margen de cumplimiento respecto de una norma diaria para SO_2 de 250 ug/Nm^3.

Entre las consultas evaluadas están:

- ¿Qué implicaría cumplir una norma secundaria de 1.300 µg/Nm^3 de SO_2 como concentración promedia en bloques de 3 horas?

- ¿Qué impacto significaría en el año 2004, la aplicación de una norma diaria de 250 µg/Nm^3 para SO_2?; Chuquicamata tendrá implementado su Plan de Descontaminación y Altonorte sus innovaciones tecnológicas contempladas en Fase III. Se debe analizar teniendo presente que existirán termoeléctricas con petcoke y con otras modernizaciones.

COMENTARIOS DE EDELNOR S.A.

Cumplimiento de Normas Propuestas

La Central Termoeléctrica Mejillones de EDELNOR S.A., está constituida por dos Unidades de Generación del tipo combustible sólido (150 MW la Unidad I y 160 MW la Unidad II) y una tercera Unidad, tipo ciclo combinado gas natural/vapor, de 270 MW.

Tanto la Unidad I como la Unidad II fueron diseñadas de modo de operar con una amplia gama de combustibles, incluido el carbón, petróleo y mezclas de carbón con petcoke. A la fecha estas unidades operan con mezclas de carbón bituminoso y subbituminoso, emitiendo niveles de SO_2 acorde a los contenidos de azufre de los combustibles en uso.

Las instalaciones de EDELNOR S.A. se localizan al noreste de Mejillones, en el sector industrial del Puerto. Los niveles de SO_2 en el área poblada han sido históricamente muy bajos y con un amplio cumplimiento de toda la normativa vigente.

EDELNOR podría obtener en un futuro próximo una autorización ambiental para utilizar mezclas de carbón/petcoke, por lo que se le hace relevante la actual discusión en relación con las normas de calidad ambiental, sobretodo aquella referida al SO_2.

En consideración a lo anterior y teniendo como premisa básica que el cumplimiento de normas primarias debe verificarse para áreas pobladas, en este caso Mejillones, incluída la operación de las unidades I y II de EDELNOR operando con mezclas carbón/petcoke, cumpliría con el máximo promedio diario de SO_2 de 250 $\mu g/m^3$.

Lo anterior fue corroborado durante un mes en que la empresa realizó pruebas de mezclas de carbón con petcoke en la misma proporción a la evaluada ambientalmente y durante el cual se realizó un monitoreo continuo de SO_2 en Mejillones.

Con relación al cumplimiento de una posible norma primaria promedio de 3 horas de 1.300 $\mu g/m^3N$, las mediciones realizadas por EDELNOR indican que en Mejillones se cumpliría dicha norma, incluyendo la operaciónde las unidades I y II de EDELNOR S.A. operando con mezclas carbón/petcoke. Esta condición es difícil de evaluar con los modelos disponibles actualmente en el mercado, los que entregan máximas horarias para cada punto de una grilla seleccionada, pero no promedios de 3 horas. Sin perjuicio de esto y considerando que la zona poblada de Mejillones se localiza en dirección contraria a la pluma de dispersión de las emisiones de EDELNOR S.A., es muy posible que los promedios de 3 horas sean muy menores en comparación con el límite propuesto.

Opinión Respecto a las Normas Propuestas

Si bien es cierto, de acuerdo a los datos consignados anteriormente, el aporte de EDELNOR S.A. operando con mezclas de carbón/petcoke en Mejillones permite cumplir las normas propuestas, también es cierto que las reducciones de norma propuestas limitarán el desarrollo industrial futuro de Mejillones.

Es importante destacar que los valores actualmente normados en Chile son los que tiene hoy Estados Unidos.No parece para nada razonable que Chile, siendo un país con un nivel de desarrollo bastante menor al de Estados Unidos tenga restricciones ambientales más exigentes.

Sin perjuicio de lo anterior cabe preguntarse la conveniencia de reducir las normas de calidad en un país en vías de desarrollo. El reducir normas o imponer nuevas restricciones de calidad ambiental limita la instalación de nuevos proyectos en un área específica, aumentando los niveles de cesantía que hoy día en el país son altos.

Por otra parte se debe analizar por parte de los organismos competentes todos los costos y beneficios (menor actividad industrial, mayor cesantía, etc.) que implica dicha reducción de normas. No es sensato reducir los valores sólo por seguir los estándares recomendados en algunos países que tienen un nivel de desarrollo considerablemente superior al caso chileno.

Finalmente, tampoco es sensato que CONAMA justifique la reducción de los valores normados sólo porque existe "espacio" para esa reducción.

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EDELNOR S.A.
an affiliate of Southern Company

Facsimile Message
EDELNOR S.A.
Avenida Grecia 750
Casilla 1290
Antofagasta
Chile
Teléfono 56.55.24-8500
Fax 56.55.22-7911

SC.I./115/00

Date :	**18.08.00**	**Name :**	**René Tordoya M.**
Fax N° :	**055-223827**	**Total pages :**	**3**
To :	**JUAN PABLO LEÓN U.** **Comité Medio Ambiente AIA**	**Re :**	**ENVÍA COMENTARIOS**

Adjunto copia de informe preliminar de los comentarios de EDELNOR S.A., relacionados con la revisión de resolución 1215 del Ministerio de Salud.

Atentamente,

Hermosilla

Pablo Espinosa A.
Subgerente Ingeniería

Acta N°5: Comité Regional
Normas Primarias de Calidad del Aire
ACTA EN VISACIÓN

En Antofagasta a 25 días del mes de Agosto de 2000, se realiza la quinta reunión del Comité Regional de la "Revisión de Normas Primarias de Calidad del Aire para SO2, CO, PTS, O2 y NO2" realizada en la sala de reuniones de la SERPLAC de la Segunda Región.

Asistieron

Sandra Cortes C.	Servicio de Salud de Antofagasta
Juan Ugarte G.	Pdte. Junta de Vecinos "Vientos del Sur"
Jannet Omegna	Asociación de Industriales de Antofagasta.
Ruben Alfaro	Codelco Chuquicamata
Carlos Saavedra	ADEMAN
Uranía Nikiforos	Unión Comunal de Tocopilla
Rodolfo Cuadra	I.Municipalidad de Tocopilla
Danisa Galvez G.	Diremer
Carlos Troncoso G.	Unión Comunal Juntas de Vecinos de Antofagasta
Alberto Rivera O.	ADEMAN
Abel Reinoso Ferrera	Universidad Católica del Norte
Juana Diaz	Presidenta Junta de Vecinos N°38
Roberto Espejo	Universidad Católica del Norte
Luis Vallejos	Universidad de Antofagasta
María Angélica Ruiz-Tagle	Conama
María Clemencia Ovalle	Conama

Temas Abordados:

Se da inicio a la reunión solicitando a los líderes de cada grupo que de cuenta del contenido de los informes finales de cada grupo.

Grupo SO2 y PTS:

La Sra. Jannet Omegna lee los principales contenidos del informe del grupo, con el propósito de que el comité en pleno lo conozca y manifieste su opinión.

En relación al PTS el subgrupo está de acuerdo en derogarlo.

En relación al SO2 señala:

- La norma anual, la proposición del este grupo es de mantener los 80 ug/m^{3}N.
- En relación a la norma diaria el grupo propone mantener los 365 ug/m^{3}N a excepción que si la zona de Chuquicamata sea declarada como zona industrial.
- En relación a una norma de menor lapso de tiempo, este grupo acuerda una norma por bloque de tres horas de 1300 ug/m^{3}N.

Como fundamentos a los niveles acordados , la Sra. Jannet Omegna señala que:

- Si la norma fuese horaria y de 1050 ug/m^{3}N como propone CONAMA, Noranda habría tenido 20 episodios.
- Además para el caso de Noranda, señala que las gráficas que se tienen no señalan una relación directa entre las emisiones y la calidad.

- Para el caso de Chuquicamata, y considerando que hay un Plan de Descontaminación que tiene que cumplir esta megafuentes, consideran que si se baja la norma diaria las condiciones cambiarían para la empresa, lo que significaría hacer esfuerzos adicionales a los ya comprometidos para cumplir con una mayor exigencias.

La Srta. Sandra Cortes señala que la postura que tiene el Servicio de Salud de Antofagasta es la postura del Ministerio de Salud esto significa que está de acuerdo con la postura CONAMA.

La Sra. Jannet Omegna, señala que esto crea un conflicto debido a que en este grupo de trabajo ha estado desde un principio un representante del Servicio de Salud de Antofagasta.

Adicionalmente la Sra. Omegna lee algunas observaciones que le han hecho llegar las empresas.

Alberto Rivera señala que está de acuerdo con la propuesta de su grupo principalmente pensando en las megafuentes, los argumentos en base a los estudios de la salud de la población para disminuir el nivel diario de la norma considera que no son muy convincentes desde el punto de vista que son realizados bajo condiciones especiales.

Adicionalmente señala que hecha de menos un estudio económico - social.

CONAMA señala que el estudio del impacto social y económico se realiza después que ha sido elaborado el Anteproyecto.

El Sr. Vallejos señala que entre los antecedentes entregados se encuentra una evaluación del impacto economico-social.

La Srta. María Angélica Ruiz-Tagle, aclara algunos aspectos señalados en la propuesta del grupo (PTS y SO_2):

- En general la propuesta se basa en un tema económico, los que deberían abordarse en el análisis del impacto social y económico de la norma en la etapa siguiente.

- En relación a las fuentes nuevas, si tienen las reglas claras, desde el inicio, podrán ingresar con la mejor tecnología y no tendrán problema con el cumplimiento de la norma.

- El valor 365 ug/m3N para la norma diaria en EE.UU., corresponde a lo establecido por la EPA y Georgia. Pero es importante dejar claro que Florida y Washington tienen una norma de 260 ug/m3N y California tiene una norma de 105 ug/m3N.

- En general los valores de la EPA son valores máximos y los estados establecen sus niveles que son los que finalmente se exigen.

- En relación a Chuquicamata, se debe considerar el escenario real, que implica cumplimiento de la norma de Arsénico.

- En relación a Noranda si se considera la estación Sur, según lo señalado en la propuesta, no podría cumplir con el nivel diario de 250 ug/m3N pero tampoco podrá cumplir con el valor 365 ug/m3N.

- El valor 1310 ug/m3N (en tres horas), según lo señalado en la propuesta, corresponde a una norma secundaria, por lo cuál no tiene relación con la salud de la población. Además esa norma no es de todo EE.UU., y no es establecida por la EPA, solo corresponde al estado de Georgia. A su vez en Chile ya contamos con una norma secundaria.

- En cuanto a normas horarias de EE.UU., existen la de Washington y California que son 1050 y 655 respectivamente.

- Por lo cual si consideramos alguna norma de EE.UU. debemos considerar una primaria y no una secundaria, pues es otra norma con otros objetivos.

Sr. Luis Vallejos señala que el desierto de Atacama es un sector amplio, esto implicaría que podría pensarse que aquí se podría instalar cualquier industria que contamina y que en otra parte no puede instalarse. Por lo tanto considera que es importante no perder de vista que también el territorio se debe proteger y por lo tanto la normativa debe cumplir con este objetivo.

La Sra. Omegna señala que Noranda podría cumplir con el nivel diario de 250 ug/m3N, pero hay que pensar en otras megafuentes como es Chuquicamata.

Adicionalmente señala que una norma en bloque de 3 horas está avalado por un tema operacional, así cumple su función de proteger la salud de la población.

Alberto Rivera señala que le parece adecuado una norma en bloque de 3 horas porque es adecuado desde un punto de vista de control operacional. Esto significaría poder reaccionar a tiempo y así no sobrepasar los limites que le son dañinos a la salud de la población que es lo que finalmente importa.

A continuación se solicita la opinión de todos los presentes:

El Sr. Carlos Troncoso: pregunta que si el nivel 365 ug/m3N es dañino para la salud.

María Angélica Ruiz-Tagle responde que la OMS señala que al nivel 250 ug/m3N la población más sensible comienza a sentir efectos.

El Sr. Juan Ugalde hace referencia de la encuesta que realizó a los vecinos y dice que le contestaron muy pocos de 2500 volantes que se repartieron. Adicionalmente lee las observaciones que realizó la ciudadanía.

La Sra. Uranía Nikiforos pregunta por la situación de Tocopilla y porque contaminante se encuentra en situación de latencia.

El Sr. Vallejos indica que las recomendaciones internacionales tienen un buen fundamento por lo tanto deben ser consideradas.

Se realiza un votación por las siguientes propuestas, en torno al SO_2:

i) En torno al **nivel anual** se acuerda apoyar la mantención del nivel 80 ug/m3N.

ii) En relación a la **norma diaria** se propone 2 alternativas:

a) Bajar el nivel a 250 ug/m3N. Votan a favor de este alternativa:

Uranía Nikiforos
Danisa Galvez
Luis Vallejos.

b) Mantener el valor 365 ug/m3N hasta el 2003 y desde enero del 2004 bajar el nivel a 250 ug/m3N. Votan por esta alternativa:

Jannet Omegna
Juan Ugarte
Ruben Alfaro
Alberto Rivera
Abel Reinoso
Juana Diaz
Carlos Saavedra
Carlos Troncoso
Rodolfo Cuadra.

No votan por haberse retirado antes de la reunión:
Sandra Cortes
Roberto Espejo

iii) El relación a la **norma horaria** se proponen 2 alternativas:

a) 1050 ug/m3N horaria. Votan esta alternativa:

Luis Vallejos

b) 1300 ug/m3N en bloque de tres horas. Votan por esta alternativa:

Alberto Rivera
Jannet Omegna
Juan Ugarte
Ruben Alfaro
Abel Reinoso
Juana Diaz
Carlos Saavedra
Carlos Troncoso
Rodolfo Cuadra
Urania Nikiforos
Danisa Galvez

No votan por haberse retirado antes de la reunión:
Sandra Cortes
Roberto Espejo

Grupo NO2, O3, CO:

El Sr. Carlos Saavedra indica que su grupo ha acordado lo siguiente:

En relación al CO y O3: señala que se acoge la propuesta CONAMA.

En relación al NO_2:

Norma Anual.

Se acogería una nivel de 100 ug/m^{3}N pero en forma semestral para hacerla más restrictiva y no anual como es la propuesta CONAMA.

Norma Horaria.

El Sr. Saavedra señala que no se acoge la norma horaria propuesta de 400 ug/m^{3}N. Agrega que si bien la empresa en que el trabaja puede en la actualidad cumplir con esta norma horaria, no asegura que en el futuro se pueda cumplir debido principalmente a el envejecimiento de los equipos.

María Angélica Ruiz-Tagle señala que no se puede pensar que las empresas puedan emitir más en el futuro de lo que emiten ahora.

El Sr. Vallejos, adicionalmente agrega que para que las empresas no emitan más en el futuro se debe ir incorporando las tecnologías necesarias.

Acuerdos.

Grupo NO_2, CO, O_3.

Se acuerda para esta norma que el líder del grupo elabore un informe y lo envíe para su visación con las consideraciones realizadas en esta reunión en especial en relación a la norma horaria. Posteriormente este informe será visado por el resto del Comité Regional.

Grupo SO_2 y PTS.

Enviara informe con los siguientes acuerdos tomadas en esta sesión:

- PTS, Derogar
- SO_2 **Nivel Anual** : 80 ug/m^{3}N.
  Nivel diario: alternativas
  a) 365 ug/m^{3}N hasta diciembre de 2003 y 250 ug/m^{3}N a partir de enero del 2004. Con 9 votos.
  b) 250 ug/m^{3}N con 3 votos.
  Nivel por Bloques: alternativas
  a) 1050 ug/m^{3}N con 1 voto.
  b) 1300 ug/m^{3}N por bloque de 3 horas. Con 11 votos

GOBIERNO DE CHILE
COMISION NACIONAL
DEL MEDIO AMBIENTE

DEPTO. JURÍDICO

Memorándum N° 327/00.-

DE: Marie Claude Plumer Bodin
Jefe (S) del Depto Jurídico

A: Rodrigo Lucero
Jefe (S) Depto. de Descontaminación, Planes y Normas

ANT: Memo. N°418 de 20.9.00

MAT: Normas de calidad.

Fecha: 25 de septiembre de 2000

Se ha consultado sobre la aplicación de las normas de calidad y, en particular, sobre si estas son exigibles a las fuentes emisoras. Al respecto me permito informarle lo siguiente:

1.- Definición de norma de calidad.

- **Norma Primaria de Calidad Ambiental**: aquélla que establece los valores de las concentraciones y períodos, máximos o mínimos permisibles de elementos, compuestos, sustancias, derivados químicos o biológicos, energías, radiaciones, vibraciones, ruidos o combinación de ellos, cuya presencia o carencia en el ambiente pueda constituir un riesgo para la vida o la salud de la población;

- **Norma Secundaria de Calidad Ambiental**: aquélla que establece los valores de las concentraciones y períodos, máximos o mínimos permisibles de sustancias, elementos, energía o combinación de ellos, cuya presencia o carencia en el ambiente pueda constituir un riesgo para la protección o la conservación del medio ambiente, o la preservación de la naturaleza.

2.- Relación de la norma de calidad con la norma de emisión?

- **Norma de emisión**: la que establece la cantidad máxima permitida para un contaminante medida en el efluente de la fuente emisora

- La norma de emisión es uno de los medios para cumplir la norma de calidad.

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- La norma de emisión no es primaria ni secundaria, sin embargo sus valores están en armonía con los requerimientos de calidad, primarios como secundarios.

3.- Diferencia entre ambos tipos de normas.

- La norma de emisión es obligatoria para las fuentes de emisión.
- La norma de calidad no es obligatoria para las fuentes, pero constituye la base para el establecimiento de restricciones ambientales a las mismas.

4.- Rol de la norma de calidad en la gestión ambiental?

- Principal: Establece la presencia de un medio ambiente contaminado o libre de contaminación.

  Art. 2 Ley 19.300 letra m): *Medio Ambiente Libre de Contaminación*: aquél en el que los contaminantes se encuentran en concentraciones y períodos inferiores a aquéllos susceptibles de constituir un riesgo a la salud de las personas, a la calidad de vida de la población, a la preservación de la naturaleza o a la conservación del patrimonio ambiental.

- Definen los niveles críticos que originan situaciones de emergencia.(art. 32 de la ley)

- Normas de emisión: La dictación de estas requiere estudios que establezcan la relación entre las emisiones y la calidad ambiental.(Art. 34 D.S.Nº 93/95)

- Zona saturada o latente: Art. Nº 2 letras:
  t) Zona Latente: aquélla en que la medición de la concentración de contaminantes en el aire, agua o suelo se sitúa entre el 80% y el 100% del valor de la respectiva norma de calidad ambiental.
  u) Zona Saturada: aquélla en que una o más normas de calidad ambiental se encuentran sobrepasadas.

- Plan de Prevención y Descontaminación: Artículo 45.- Los planes de prevención y descontaminación contendrán, a lo menos:
  a) La relación que exista entre los niveles de emisión totales y los niveles de contaminantes a ser regulados;

- SEIA. Se requerirá la elaboración de un Estudio de Impacto Ambiental, si el proyecto generan o presentan uno de los siguientes efectos, características o circunstancias (art. 11):
  a) Riesgo para la salud de la población, debido a la cantidad y calidad de efluentes, emisiones o residuos;
  b) Efectos adversos significativos sobre la cantidad y calidad de los recursos naturales renovables, incluidos el suelo, agua y aire

Para los efectos de evaluar el riego indicado en la letra a) y los efectos adversos señalados en la letra b), se considerará lo establecido en las normas de calidad ambiental y de emisión vigentes. A falta de tales normas, se utilizarán como referencia las vigentes en los Estados que señale el reglamento.

6. Conclusiones

- La norma de calidad ambiental es un instrumento de gestión ambiental.
- No es obligatoria para los administrados, pero constituye la base para la aplicación de restricciones a las fuentes emisoras, mediante la aplicación de los instrumentos que establece la ley: normas de emisión o alguna medida contemplada en un Plan de Prevención o Descontaminación.

Sin otro particular, saluda atentamente a Ud.

Marie Claude Plumer Bodin
Jefe (S) Departamento Jurídico

CRF
Cc.
Archivo

GOBIERNO DE CHILE
MINISTERIO DE SALUD
SERVICIO DE SALUD TALCAHUANO
SUBDIRECCION DEL AMBIENTE
UNIDAD DE CONTROL INDUSTRIAL

000957

ORD. Nº 4157

ANT. : Ord. 3679/2000 CONAMA CENTRAL
MAT : Posición a propuesta de revisión de las normas primarias de calidad del aire.

Talcahuano, 21 SET. 2000

DE: SUBDIRECTOR DEL AMBIENTE (S)
SEVICIO DE SALUD TALCAHUANO

A: SRA. PATRICIA MATUS C.
JEFE DPTO. DESCONTAMINACIÓN PLANES Y NORMAS
COMISIÓN NACIONAL DEL MEDIO AMBIENTE

Habiendo revisado y analizado la materia de antecedentes y como consecuencia de nuestra participación en las reuniones de revisión de la Resolución Nº1215/78 del Ministerio de Salud, nuestra Subdirección puede informar a Ud. lo siguiente:

- En la comuna de Talcahuano tenemos problemas con muchos contaminantes, sin embargo la información más palpable indica que dentro de ellos, el anhídrido Sulfuroso (SO_2) ocupa un lugar de relevancia por los altos índices de concentración registrados a la fecha. Cabe señalar que, en un trabajo conjunto COREMA 8ªRegión-Servicio de Salud Talcahuano, existen datos y antecedentes de red de monitoreo desde 1997, además de información disponible del Convenio Petrox S.A. (refinería de petroleo)-S.Salud Thno, en función del Sistema Airviro y monitoreo desde 1996.

- Nuestra experiencia indica que en la zona de mayor impacto del contaminante SO2, se provocan efectos adversos en la población cuando los niveles de concentración promedio horario superan los 600 µg/m3. Sin embargo para las concentraciones promedio diarias (24 horas) del orden de 250 µg/m3, no se registran denuncias representativas del sector.

Por lo anterior, respecto a los niveles de calidad de aire propuestos para el SO_2:
1.- **Norma Anual**; 80 µg/m3N. Se comparte.

2.-**Norma Diaria**; 250 µg/m3N. Los datos registrados a la fecha y que refleja información recogida desde 1997, nos permite señalar que es un valor demasiado restrictivo para las características de los procesos y fuentes fijas(Megafuentes y Fuentes Puntuales) de nuestra comuna (Talcahuano), ya que las características climáticas y variables meteorológicas de la zona permiten un desplazamiento, dispersión y dilución de los contaminantes que hacen variar las zonas de máximo impacto, ya que dependiendo de la dirección de los vientos afectan la calidad de vida de las personas, indicando que la norma actual ha sido superada en 1 ocasión (365 µg/m3). Por lo anterior postulamos un valor parámetro de 300 µg/m3 en función de los proyectos comprometidos desde el año 1999 hacia 2001 por las principales fuentes emisoras de estos contaminantes, tendientes a reducir las emisiones se SO_2 a la atmósfera.

3.-**Norma Horaria**; 1050 μg/m3. A diferencia de la norma diaria, que la encontramos demasiada restrictiva por las caracteristicas de nuestra comuna, señalamos que la norma horaria es demasiado permisible. Lo anterior en virtud de episodios críticos asociados a este contaminante. (procesos de refinería y siderurgica). Hoy permiten precisar las denuncias de la comunidad por efectos adversos (olores ofensivos) a una con niveles de concentración de 600 μg/m3 de SO_2.
Al respecto queremos indicar que la información bibliográfica obtenida en las Guías de Salud de la OMS (2000), precisa que basado en los estudios controlados con asmáticos expuesto a SO2 para periodos cortos, se recomienda que el valor de 500 μg/m3 (0.175 ppm) no debe excederse encima del promedio para un periodo de 10 minutos.

En cuanto a experiencias, en las que se esta trabajando desde agosto de 1999 en episodios IRA en conjunto con el Consultorio Hualpencillo, caben los casos IRA agudos y que se relacionan con los episodios asmáticos con parámetros horarios del orden de 600 μg/m3.

Por último quisiera indicar la posiblidad de estudiar la instancia de modificar la normativa de calidad de aire primaria nacional, en el sentido de establecer la instancia de adaptarlas o que tengan un carácter regional de acuerdo a la realidad de la misma.

Sin otro particular, saluda atentamente a Usted.

Saluda Atte. A Usted

ANDREA ASTE VON BENNEWITZ
SUBDIRECTOR DEL AMBIENTE (S)
SERVICIO DE SALUD TALCAHUANO

SERVICIO DE SALUD
SUBDIRECTOR DEL AMBIENTE
TALCAHUANO

AAVB/ING(E) PR.HB/ING(CQ)SFG/ING(CQ)ACC/acc
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- La indicada
- Of. Partes
- Subdirección del Ambiente.
- UCIN.
- SEREMI SALUD OCTAVA REG.
- DISAM

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nuevas respuesta

COMISION NACIONAL DEL MEDIO AMBIENTE
OFICINA DE PARTES Y ARCHIVO
FAX
000959 2620
Nº INGRESO: ....
FECHA: 30 OCT 2000
DESPACHADO: ....
OBS.: P. Matus.

GOBIERNO DE CHILE
Comision Nacional del Medio Ambiente
Región de Atacama

ORD.: Nº 00799 /

ANT.: No hay.

MAT.: Solicita Expediente Público.

COPIAPO, 30 OCT 2000

DE : DIRECTOR REGIONAL COMISION NACIONAL DEL MEDIO AMBIENTE REGION DE ATACAMA

A : DRA. PATRICIA MATUS CORREA
... DEPARTAMENTO DESCONTAMINACION, PLANES Y NORMAS
... NACIONAL DEL MEDIO AMBIENTE

... presente vengo en solicitar a Ud., copia del Expediente Público del proceso ... ativo correspondiente a la Revisión de Normas Primarias de Calidad del Aire ... SO_2, O_3, NO_2, CO y PTS, a fin de tenerlo en nuestras dependencias para consulta de la ciudadanía.

... particular, saluda atentamente a Ud.,

DANIEL ALVAREZ PARDO
DIRECTOR REGIONAL
COMISION NACIONAL DEL MEDIO AMBIENTE

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COMISION NACIONAL DEL MEDIO AMBIENTE
OFICINA DE PARTES Y ARCHIVO
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FECHA: 31 OCT 2000
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OBS.: P. MATUS

000960

02 NOV 2000 2734

GOBIERNO DE CHILE
Comisión Nacional del Medio Ambiente
Región de Atacama

ORD.: Nº 00798 /

ANT.: No hay.

MAT.: Solicita Expediente Público.

COPIAPO, 30 OCT 2000

DE : DIRECTOR REGIONAL COMISION NACIONAL DEL MEDIO AMBIENTE REGION DE ATACAMA

A : DRA. PATRICIA MATUS CORREA JEFE DEPARTAMENTO DESCONTAMINACION, PLANES Y NORMAS COMISION NACIONAL DEL MEDIO AMBIENTE

Por el presente vengo en solicitar a Ud., copia del Expediente Público del proceso normativo correspondiente a la Revisión de Normas Primarias de Calidad del Aire para SO_2, O_3, NO_2, CO y PTS, a fin de tenerlo en nuestras dependencias para consulta de la ciudadanía.

Sin otro particular, saluda atentamente a Ud.,

Comisión Nacional del Medio Ambiente
DIRECTOR
ATACAMA

DANIEL ALVAREZ PARDO
DIRECTOR REGIONAL
COMISIÓN NACIONAL DEL MEDIO AMBIENTE

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Con Copias .
Destino : **SRA. ADRIANA HOFFMAN, DIR. EJECTVO.** Dpto./Unidad **DIRECCION EJECUTIVA**
Descripción : ENVIA INFORMACION SOLICITADA REFERENTE AL ANALISIS TÉCNICO ECONÓMICO DEL PROCESO DE REVISION DE LAS NORMAS PRIMARIAS DE CALIDAD DE AIRE PARA MATERIAL PARTICULADO SEDIMENTALBE Y OTROS....

Primera Derivación Anita Zúñiga / P. Matus

ENVIADO A JEFE DE		PARA		TIPO DE DOCUMENTO		PLAZO PARA GENERAR ACCIO
Dirección Ejecutiva	☐	Conocimiento	X	Secreto	☐	
Fiscalía	☐	Informar al Respecto	☐	Confidencial	☐	
Administración, Finanzas y Person	☐	Dar curso/Tramites	☐	Reservado	☐	
Evaluación de Impacto Ambiental	☐	Resolver	☐	Ordinario	☐	
Descontaminación, Planes y Norma	☐	Preparar Respuesta	☐			
Gestión SINIA y S. de informació	☐	Responder Directamente	☐	Observaciones :		
Recursos Naturales	☐	Acuse Recibo	☐			
Participación Ciudadana	☐	Biblioteca	☐			
Economía Ambiental	☐	Su Opinión	☐			
Unidad de Proyectos	☐	Dar Audiencia	☐			
Asesor Técnico	☐	Dar Difusión	☐	Exp. - de Cobre		
Relaciones Internacionales	☐	Reclasificar	☐			
Política	☐	Otro				
Regiones	☐					
Comunicaciones	☐					
Cooperación Internacional	☐					
Adquisiciones	☐					
Capacitación	☐					
Dirección Regional Conama	☐					
N° Región						

Segunda Derivación
ENVIADO A :
1.- [illegible]
2.-
3.-

PARA	1	2	3	UNA VEZ HECHO	1	2	3
Conocimiento	☐	☐	☐	Devolverme Dcto.	☐	☐	☐
Resolver	☐	☐	☐	Reportar Avance	☐	☐	☐
Preparar Respuesta	☐	☐	☐	Archivar	☐	☐	☐
Adjuntar Antecedentes	☐	☐	☐	Otro	☐	☐	☐
Acusar Recibo	☐	☐	☐				
Dar Difusión	☐	☐	☐	Plazo			
Visto Bueno	☐	☐	☐				

Observaciones

Tercera Derivación
ENVIADO A :

PARA		UNA VEZ HECHO		OBSERVACIONES
Conocimiento	☐	Devolverme Dcto.	☐	
Resolver	☐	Reportar Avance	☐	
Preparar Respuesta	☐	Archivar	☐	
Adjuntar Antecedentes	☐	Otro	☐	
Acusar Recibo	☐			
Dar Difusión	☐			
Visto Bueno	☐			

Referencia a : Archivado en :

Firma responsable 07 NOV 2000

ENAMI

VICEPRESIDENCIA EJECUTIVA N° 105/263 00962

COMISION NACIONAL DEL MEDIO AMBIENTE
OFICINA DE PARTES Y ARCHIVO
N° INGRESO: 2954 / 11832
FECHA: 06 NOV 2000
DESPACHADO:
CC.: Adriana Hoffmann
27770

OF. ORD. N° 123

ANT. : Su carta N° 029/004568 de fecha 2 de octubre de 2000.

MAT. : Entrega información modificación Resolución N° 215

SANTIAGO, 03 NOV 2000

A : SRA. ADRIANA HOFFMAN J.
DIRECTORA EJECUTIVA
COMISIÓN NACIONAL DE MEDIO AMBIENTE

DE : VICEPRESIDENTE EJECUTIVO
EMPRESA NACIONAL DE MINERIA

En Referencia a su carta N° 029/004568 en la cual se nos solicita información referente al análisis técnico económico del proceso de revisión de las normas primarias de calidad de aire para Material Particulado Sedimentable (PTS), Ozono (O3), Dióxido de Azufre (SO2), Dióxido de Nitrógeno (NO2) y Monóxido de Carbono (CO), tengo a bien indicar lo siguiente:

I y II Los datos solicitados de monitoreo de calidad de aire para SO2 en las áreas circundantes a las Fundiciones de Paipote y Ventanas y de emisiones históricas en Fundición Ventanas, han sido enviados vía e-mail directamente al señor Rodrigo Lucero por constituir estos archivos excel por más de 10 mb.

III y IV En lo referente a las medidas factibles de adoptar para reducir emisiones de SO2, es necesario hacer presente que según estimaciones derivadas de una evaluación conceptual se prevé que un nivel de captación que pueda asegurar un cumplimiento cabal de la normativa propuesta debe ser igual o superior a 95 %. La tecnología implementada a través de los Planes de Descontaminación de ambas fundiciones, permitiría teóricamente alcanzar valores algo superiores a 92% de captación, sin embargo, no es posible asegurar que un proyecto de aumento de captación permita alcanzar los niveles requeridos para cumplir la Normativa Horaria Propuesta.

Las alternativas de proyectos de aumento de captación de la Fundición Ventanas consideran aumentar de un 88 % promedio anual (1999) de captación a un valor sobre el 92 %. Considerando que una estimación de las inversiones se obtiene con la realización de la Ingeniería de Detalle (6 a 8 meses de estudio y 95 % de certeza), sólo fue posible realizar una estimación preliminar de Ingeniería Conceptual (2 meses y 80 % de certeza) que contempla, entre otros, las siguiente modificaciones al proceso de Fundición Ventanas:

Mejoras en campanas primarias
Instalación de Campanas Secundarias
Planta de Acido Sulfúrico de 20.000 M^3/hr (gases primarios)
Ductos de Manejo y Transporte de Gases
Lavador de Gases tipo Venturi Scruber (gases Secundarios)
Planta de tratamiento de Riles
Manejo y disposición de Lodos Planta Tratamiento Riles
Adecuaciones en sistema de insumo de agua industrial
Adecuaciones en Sistema Eléctrico.

Las medidas a implementar en el proyecto son innovadoras para la tecnología Teniente, no siendo probadas anteriormente en otra parte del mundo, motivo por el cual si bien se puede obtener un nivel de captación superior al 92 %, no se puede asegurar llegar a los niveles de captación requeridos.

Las inversiones establecidas para ejecutar el aumento de captación ascienden levemente sobre los US$ 44 millones.

Por su parte la fundición Hernán Videla Lira contempla la introducción de las siguiente modificaciones

Implementación de Doble Catálisis en la Planta de Ácidos N°2
Mejoras de Campanas primarias de gases y circuito transporte de gases
Ampliación de la actual planta de tratamiento de Riles
Mejoras y ampliación de depósito de lodos de planta Riles

La inversión requerida para realizar el proyecto considera valor de US$ 20 millones aproximadamente, inversión con la cual se puede llegar solo a un nivel de captación cercano al 92 %. La implementación de un proyecto con campanas secundarias y lavado de gases requiere de inversiones mayores no evaluadas, debido a las cuantiosas modificaciones estructurales de la nave de conversión para soportar dichas campanas.

V. Como se ha mencionado anteriormente la Empresa Nacional de Minería se encuentra en una delicada situación financiera, no teniendo actualmente posibilidad de acceder a los créditos necesarios para ejecutar los proyectos planteados. El nivel de endeudamiento de la Empresa asciende a un valor sobre los US$ 450 millones. (1.65 veces sobre su patrimonio).

Según las Proyecciones Financieras, de ser necesario realizar las inversiones indicadas, la Empresa no estaría en condiciones de iniciar los proyectos antes del año 2005, entrando en operaciones no antes del año 2009.

VI. Las alternativas a los proyectos mencionados tendrían que contemplar un manejo operacional aún más estricto que el aplicado actualmente, vía la disminución de los niveles de fusión en forma preventiva. Según las estadísticas de Fundición Ventanas la gran mayoría de los altos niveles de SO2 en el aire se presentan junto con la aparición de Vaguadas Costeras, las cuales en promedio se presenta en un número aproximado de 90 días por año, en especial durante las primeras horas del día y hasta pasado el medio día.

Tomando en cuenta el criterio de Superación de la Norma de SO2 establecido en el anteproyecto (Sólo 4 horas al año, percentil real de 99.95 %), y con el fin de asegurar el cumplimiento de la Norma la Fundición Ventanas se vería obligada a suspender sus actividades durante estos 90 días por un período de 8 horas cada vez (1 turno por día), sin asegurar el cumplimiento de la norma.

ENAMI

Lo anterior incluye necesariamente dos horas para reiniciar la fusión de concentrado, significando una disminución de fusión de aproximadamente 38.000 toneladas de concentrado al año. La disminución de fusión establecida afectaría los ingresos de la Empresa anualmente en US$ 3,04 millones, lo cual no considera el sobre consumo de combustible, la mayor generación de circulantes y el mayor desgaste de equipos por su trabajo discontinuo.

Al igual que en Fundición Ventanas, si Fundición Paipote efectúa reducción de fusión en forma preventiva, las que actualmente estipulan un total de 4 horas diarias como promedio diario y un promedio de 8 horas en invierno. Esta situación se vería acentuada con la propuesta de normativa horaria. (En anexo A se presenta el promedio de horas de operación con Plan Preventivo y disminución de fusión).

Es necesario mencionar que las estrategias expuestas de reducción de fusión en Fundición Paipote tienden a llevar los niveles de fusión al límite de la viabilidad económica de la Fundición, corriendo el peligro de que en algún momento no pueda ser económicamente autosustentable, afectando profundamente el desarrollo de la Pequeña y Mediana Minería de la zona de Atacama. (En anexo B se incluyen antecedentes de la Pequeña y Mediana Minería del cobre de la Región de Atacama).

VII. Actualmente la Pequeña y Mediana Minería copan alrededor de un 50% del abastecimiento de concentrados de las fundiciones, y este porcentaje debería tender a aumentar levemente por un aumento del precio del cobre (55 %). (Se incluye anexo C con antecedentes de la Pequeña y Mediana Minería abastecedora de ENAMI).

VIII. Con respecto a la consulta de la capacidad actual y proyectada de retención de SO2 en la planta de ácido, lamento informar a Usted que, debido al gran volumen de gases generados, las Plantas de ácido tienen un diseño de operación con flujo continuo, por lo que no existe capacidad de retención de gases.

IX. Por último, respecto a la proyección de precios de venta de cobre para los próximos 10 años solicitada, se considera que para los próximos tres años, el precio internacional de venta de cobre será como promedio de 90 ¢US$/lb, y 100 ¢US$/lb para los siguientes 7 años. Sin embargo, la Empresa Nacional de Minería por ser una Empresa que presta servicios a la Pequeña y Mediana Minería concreta sus ingresos por medio de aplicar un cargo por tratamiento (maquila) por las toneladas de concentrado tratadas y no por venta de cobre. Así las proyecciones de cargos por tratamiento corresponden a 90 US$/tonelada de concentrado de cobre procesada para los próximos 10 años.

Por su parte, las proyecciones de producción de la empresa se mantienen estables en los valores actuales (aproximadamente 665.000 toneladas de concentrado fundido y 310.000 toneladas de cobre catódico).

Le saluda atentamente,

JAIME PÉREZ DE ARCE A.
Vicepresidente Ejecutivo

ENAMI-SANTIAGO
DESPACHADO
- 3 NOV 2000
OFICINA DE PARTES

ANEXO

PROMEDIO DE HORAS OPERACI
CON PLAN PREVENTIVO Y
DISMINUCION DE FUSION

Promedio de horas con plan preventivo de disminución de Información
Fundición Hernán Videla Lira

Promedio Mensual

	Plan preventivo F.H.V.L.			
	Condición	Condición	Condición	Horas
Mes	**Regular**	**Mala**	**Extrema**	**Totales**
ENERO	0,84	0,37	0,00	1,21
FEBRERO	1,53	0,78	0,00	2,31
MARZO	1,64	0,32	0,00	1,96
ABRIL	2,17	0,56	0,00	2,73
MAYO	2,76	3,35	0,00	6,11
JUNIO	3,70	4,25	0,00	7,95
JULIO	3,88	4,92	0,00	8,80
AGOSTO	4,53	3,55	0,53	8,61
SEPTIEMBRE	4,28	3,47	0,15	7,90
OCTUBRE				0,00
NOVIEMBRE				0,00
DICIEMBRE				0,00
PROMEDIO	**2,81**	**2,40**	**0,08**	**5,29**

ANEXO B

PEQUEÑA Y MEDIANA MINERÍA DEL COBRE
REGION DE ATACAMA

ENAMI

PEQUEÑA Y MEDIANA MINERÍA DEL COBRE REGION DE ATACAMA

Características de la Pequeña y Mediana Minería

La PyMM afecta positivamente situación en el mercado regional de empleo por su manera de producción intensa en utilización de mano de obra. Se estima que más de 3000 personas, por lo menos temporalmente, reciben directa - o indirectamente sus ingresos gracias a las actividades de la PyMM, lo que asciende a 3% de la fuerza laboral total de la Región de Atacama. Además, la PyMM influye positivamente en los sectores secundario y terciario de la economía chilena, a diferencia de la Gran Minería, que en gran medida compra su equipo técnico y los servicios de ingeniería en el extranjero o en la Región Metropolitana. Se estima que cada puesto de trabajo en la PyMM genera 2 ó 3 empleos suplementarios en otros sectores de la economía. Por eso, la PyMM contribuye mucho en la reducción de la cesantía en la III Región, que es débil en su estructurado económica, y disminuye así la presión migratoria hacia los centros industriales del país.

La gama de producción en las aprox. 265 minas de la PyMM en la Región puede variar ampliamente. Más de 90% de los productores de minerales en la PyMM tienen una producción inferior de 200 toneladas de mineral por mes y solo 2% produce sobre de 1000 toneladas de mineral al mes. Lo mismo es válido para la gama de producción en las aprox. 55 plantas de beneficio en la PyMM de la Región. En esto 75% de los productores de concentrados y precipitados producen menos de 10 toneladas por mes y sólo 6% producen sobre de 50 toneladas por mes. En el promedio trabajan 7 – 8 personas directa o indirectamente en las minas de la Región y 30 personas promedio, directa o indirectamente, en las plantas de beneficio.

Situación actual

Por décadas, la pequeña y Mediana Minería (PyMM) ha sido un sector de permanente preocupación para el Estado Chileno, por la alta incidencia que, en términos económicos, sociales y culturales, tiene para la población de extensas zonas y numerosas localidades del país.

El fomento a la PyMM se ha desarrollado principalmente a través del apoyo técnico y crediticio y la compra subsidiada de sus minerales, para su procesamiento, por parte de la Empresa Nacional de Minería (ENAMI).

Como actividad sistemática y económica, la PyMM presta una contribución importante para el desarrollo socioeconómico de la Región de Atacama. El valor de la explotación y beneficio de minerales en la PyMM alcanzó en 1997 unos 27 millones de dólares US. En cerca de 320 faenas de la PyMM ubicada en la III Región de Atacama se explotó y beneficio ante todo minerales de cobre y oro, pero también minerales industriales.

EMPRESA NACIONAL DE MINERIA
MAC-IVER Nº 459
TELEFONO : 6375000
CASILLA : 100-D
SANTIAGO
CHILE

En contraste con la Gran Minería, la PyMM aparece como motor para las empresas locales de la Región con efectos importantes para la situación de empleo en las zonas mineras. Por su bajo umbral de entrada respecto al tiempo, capital y formación, la PyMM está presente en casi todas las comunes de la Región. A diferencia de la Gran Minería, que a menudo sólo es realizable con inversiones extranjeras, la PyMM puede ser iniciada con recursos financieros relativamente pequeños, proporcionados por bancos o particulares locales. La PyMM explota yacimientos pequeños, considerados no-explotables por la Gran Minería. De este modo, ella cumple una tarea importante en el marco de la utilización no-depredador de recursos naturales de la Región.

ANEXO C

ENAMI Y EL SECTOR DE LA PEQUEÑA Y MEDIANA MINERÍA

ENAMI Y EL SECTOR DE LA PEQUEÑA Y MEDIANA MINERIA

BREVE HISTORIA

El rol del Estado en la actividad minera nacional fue nulo hasta principios de siglo, no siendo regulador, ni a favor de los empresarios ni de los trabajadores, ni nacionales ni extranjeros. La política del Estado era "dejar hacer" completamente.

La primera institución formal, a nivel nacional, que se crea en apoyo al desarrollo de la minería en Chile es la Sociedad Nacional de Minería, SONAMI, la que nace el 26 de Septiembre de 1883, a partir de un grupo de empresarios mineros de la época, con el objetivo de lograr una mayor influencia sobre la legislación que regía y estructuraba la minería. Sus objetivos eran, además, la expansión de instituciones de educación minera, estudios estatales de reservas, soluciones a los problemas de transporte, créditos y capacidad de fusión.

La Caja de Crédito Minero se crea el 12 de enero 1927, sobre un proposición al Congreso de SONAMI, como una agencia de crédito estatal. Asimismo, también podía comprar y vender minerales, anulando el problema mineros-intermediarios. Sería dirigida por un consejo de 8 integrantes: 4 nombrados por el Presidente, 2 a proposición de SONAMI, 2 por el senado y 2 por la cámara de diputados, y un director nombrado por el Presidente de la República.

En julio de 1927 Osvaldo Martínez, director de la Caja, anunció el plan de construir una fundición de dos hornos y plantas de flotación en Chañaral, Copiapó y Coquimbo. La fundición estaría destinada a servir a la industria tradicional pequeña nacional entre Los Vilos y Tocopilla. Ya en esta época, los detractores de la construcción de Paipote argumentaban que la pequeña minería era una industria artificial e ineficiente, que debía desaparecer.

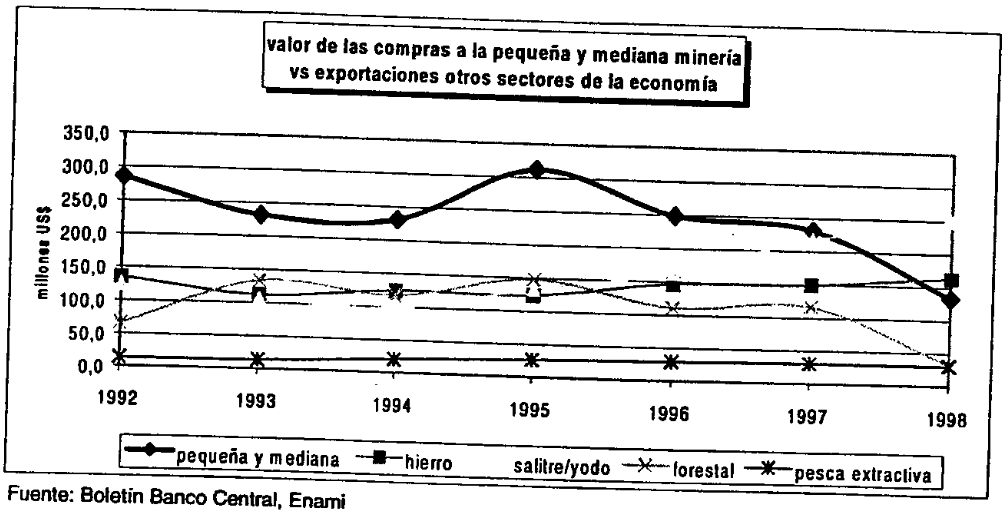
Luego de un prolongado y profundo debate a nivel nacional, finalmente, en diciembre de 1947, se creó la Fundición Nacional de Paipote Ltda. En 1948 comenzó derechamente su construcción y se encendió el horno de reverbero en octubre de 1951.

En la década del 50, con la idea de la creación de una fundición en la zona central, Fundición Nacional de Paipote Ltda. se transforma en la Empresa Nacional de Fundiciones, la que se refunde con la Caja de Crédito y Fomento Minero en abril de 1960, para formar la Empresa Nacional de Minería. Dicha Caja de Crédito y Fomento Minero había sido la sucesora de la Caja de Crédito Minero, y se creó en julio de 1953, teniendo como misión actuar como un organismo bancario, financiero y comercial, destinado al descubrimiento y fomento de la producción y del beneficio de toda clase de minerales existentes en el país.

El D.F.L. nº 153, que crea la Empresa Nacional de Minería, le asigna el objeto de fomentar la explotación y beneficio de toda clase de minerales existentes en el país, producirlos, concentrarlos, fundirlos, refinarlos e industrializarlos y comerciar con ellos. Es dentro de este marco regulador que se ha desarrollado la Pequeña y Mediana Minería.

La Pequeña y Mediana Minería, aunque a menudo se considera una actividad económica menor, debido a la coexistencia geográfica con el mundo de la minería exportadora chilena y su posicionamiento a nivel de la industria mundial de cobre, es de gran relevancia si se compara con otras actividades económicas que son vistas como de mayor relevancia en el contexto nacional, tal como se ve a continuación.

compara con otras actividades económicas que son vistas como de mayor relevancia en el contexto nacional, tal como se ve a continuación.



Fuente: Boletín Banco Central, Enami

Así, en el período, el valor de las compras que Enami efectúa hacia este sector ha sido mayor que el valor total de las exportaciones realizadas por los sectores de hierro, salitre y yodo, en el ámbito de otras actividades mineras. Asimismo, en relación con otras actividades industriales, es de mayor monto que las exportaciones asociadas a la pesca extractiva y al sector forestal.

PEQUEÑA Y MEDIANA MINERIA

En su relación comercial con el sector minero, Enami divide a los productores según su tamaño relativo en Pequeños Mineros: hasta 300 toneladas de concentrados al mes, Medianos Mineros: nacionales con dificultades para exportación autónoma e Independientes: nacionales y extranjeros con alta capacidad de exportación autónoma.

Pequeña Minería

Dentro del grupo de productores de Pequeña Minería se ubican dos niveles de productores, cuya diferencia radica en el hecho de poseer o no plantas de tratamiento.

El primero de ellos corresponde a los **pequeños productores de minerales**, cuya producción es comprada por Enami en los 12 poderes de compra que tiene para estos efectos entre la II y la V Regiones. En este grupo se encuentran los mineros de menor tamaño, con muy bajos grados de autonomía, en el sentido de no poder ofrecer sus productos en un mercado comprador de los mismos. Estos productores han tenido, en algunas localidades circunscritas y frente a niveles de precios relativamente altos, la posibilidad de vender sus minerales a plantas privadas, las que en general han comprado teniendo como techo la tarifa publicada por Enami.

Este grupo de productores de minerales representa a la gran mayoría de los abastecedores de ENAMI en términos de número de productores, siendo su número variable, por cuanto son de gran movilidad en términos de los productos que explotan. En un porcentaje importante trabajan en base a zonas de minas, denominados "puntos", los que arriendan a los dueños de las concesiones. Esto les permite trasladarse de un tipo de mineral a otro y de una región geográfica a otra, dependiendo de la situación de costos operacionales del punto en cuestión y de la relación de precios de los metales, que ofrezca Enami en sus tarifas de compra.

Adicionalmente, éstos corresponden a grupos de trabajo familiares, con niveles de tecnificación muy elementales, en faenas extractivas de tamaños pequeños y sin métodos modernos de administración de su negocio. Trabajan prácticamente sin reservas geológicas conocidas, las que van descubriendo a medida que van abriendo sus labores, por lo que su proyección, aún en el corto plazo, es muy inestable.

Su gran potencial está dado por el conocimiento práctico que poseen de la actividad, en términos de sus vivencias y la experiencia acumulada que han potenciado a lo largo de años de estar en dicho quehacer. Su labor genera la apertura de guías de prospección y en algunos casos prospectos potenciales, que pasan a alimentar el inventario de reservas hipotéticas de que dispone el resto de la actividad minera de mayor tamaño.

Enami incluye en este grupo a todo aquel productor que entrega menos de 10.000 toneladas de mineral mensualmente; pero la gran mayoría de ellos se ubica en niveles de producción definitivamente menores a las 400 toneladas al mes.

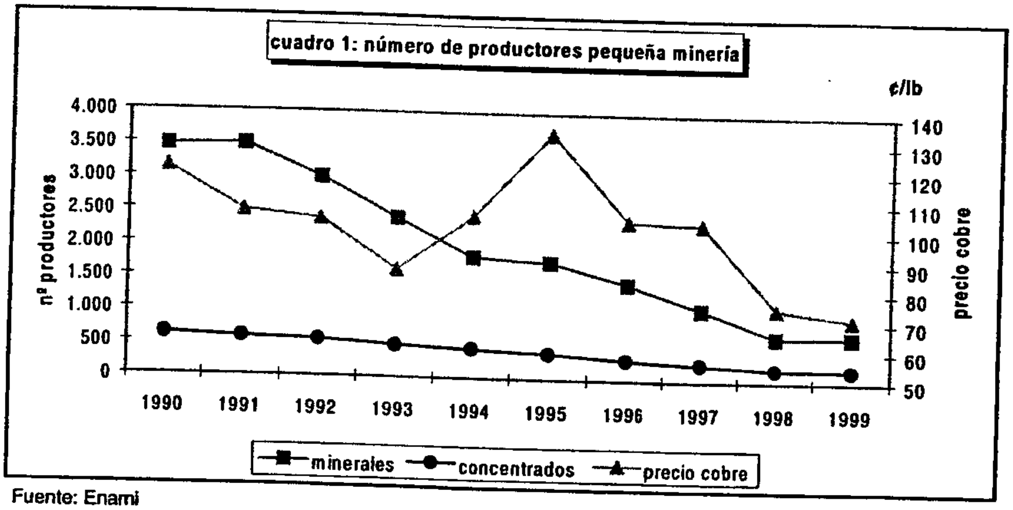
El segundo grupo al interior de la Pequeña Minería corresponde a **pequeños productores de concentrados y precipitados**, los que disponen de instalaciones para el beneficio de sus minerales, teniendo como única posibilidad la venta de sus productos a ENAMI, por cuanto no existen fundiciones privadas que hayan abierto poderes compradores para estos productos.

Son, en general, concesionarios de minas o arrendatarios de plazos superiores a los del grupo exclusivamente extractivo, con las que alimentan a sus plantas. Parte de ellos poseen organizaciones laborales formales. Ello los hace productores con más permanencia en el tiempo y por lo tanto con mayor estabilidad en la actividad. La utilización de tecnología es de mayor nivel que el grupo anterior, aunque en general no están profesionalizados, por cuanto sus ingresos no les permiten pagar este tipo de asesorías, además de no tener internalizadas las ventajas inherentes a ello.

Este grupo tiene más grados de autonomía de gestión que los productores de minerales frente a variaciones de precios de los metales, lo que unido a que logra un mayor valor agregado en sus productos, le ha permitido a algunos productores escalar sus producciones hasta llegar a ser mediano productor.

Enami incluye en esta categoría a todo aquel productor de concentrados de cobre que vende menos de 300 toneladas mensualmente, a los proveedores de concentrados de oro con entregas menores a las 150 tms y precipitados en volúmenes inferiores a las 100 toneladas mensuales.

La evolución del número de productores pequeños se muestra en el cuadro 1.



Fuente: Enami

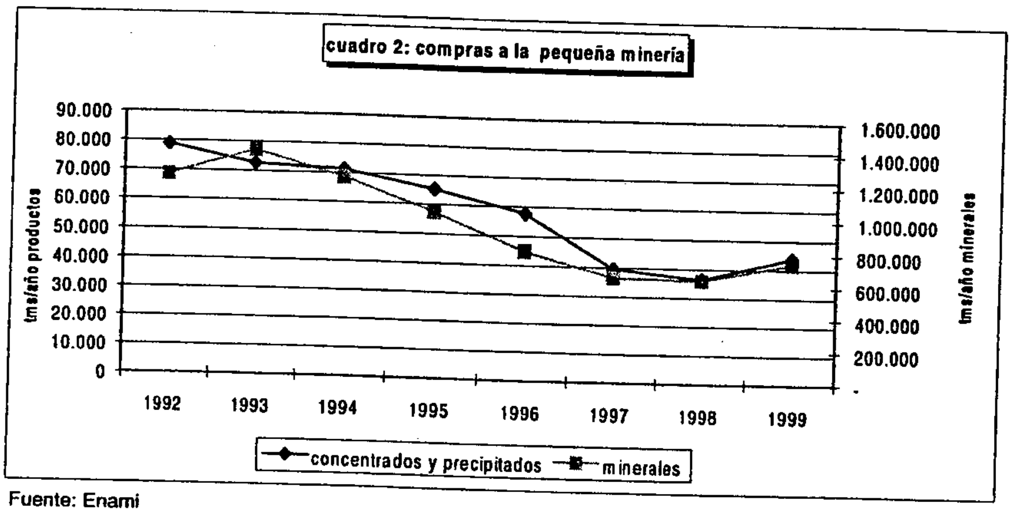
Los pequeños mineros han ido disminuyendo sostenidamente durante el período analizado, debido fundamentalmente a dos razones, complementarias entre sí. Por una parte, en términos reales los metales han tenido una disminución de valor, si se considera éste en términos de moneda del mismo momento. Por otra, la industria extractiva mundial del cobre, de la cual participan los pequeños mineros como los productores de más altos costos de la misma, ha ido disminuyendo sus costos de operación sistemáticamente a lo largo de los años a tasas significativamente mayores a las que han ido disminuyendo sus costos los agentes de la minería de menor tamaño, todo lo cual ha redundado en la baja real del precio mencionada, por una parte, pero también en una posición competitiva relativa cada vez más deteriorada para estos mineros, lo que ha obligado a muchos de ellos definitivamente salir del negocio, pese a las políticas de apoyo que se les pueden haber aplicado a fin de aminorar este efecto.

Los intentos de adecuación de los pequeños productores frente a esta dinámica se deducen de un análisis realizado para el período junio de 1989-junio de 1997, en el cual se midió la evolución del valor de los productos vendidos por productores de minerales, expresando la tarifa en unidades de fomento (UF) por cada tonelada, para productores de minerales de cobre lixiviación y flotación. Suponiendo que los productores tienen costos de producción menores o iguales a la tarifa a la que son capaces de vender sus productos, el estudio arrojó que éstos habrían disminuido en más de un 50%. Independiente de la mayor o menor bondad de los mecanismos estabilizadores adicionales a la tarifa que Enami haya aplicado, son estas variaciones las que explican la salida de un gran número de mineros del sistema.

Sin embargo, durante el último año, el número de productores que entregan minerales tuvieron un leve aumento, el que se considera se debió a que, frente a la crisis de empleo que vivió el país en el año recién pasado, la minería de pequeña escala operó como una buena alternativa de trabajo independiente, a partir del concepto de poder de compra abierto que Enami ofrece a estos productores, es decir, recibiendo todo el material entregado, sólo sujeto a un empadronamiento como productor. Esto también operó debido a que hubo medianos mineros que cerraron operaciones como tales, entregando parte de sus minas a pequeños productores para que las trabajaran bajo el sistema de regalías, lo que aumentó el inventario de reservas disponibles para ellos.

Este elemento indica también que debiera existir una correlación entre esta actividad minera y la existencia de actividades económicas alternativas, cuestión que debería tomarse en consideración en el diseño de políticas hacia este segmento.

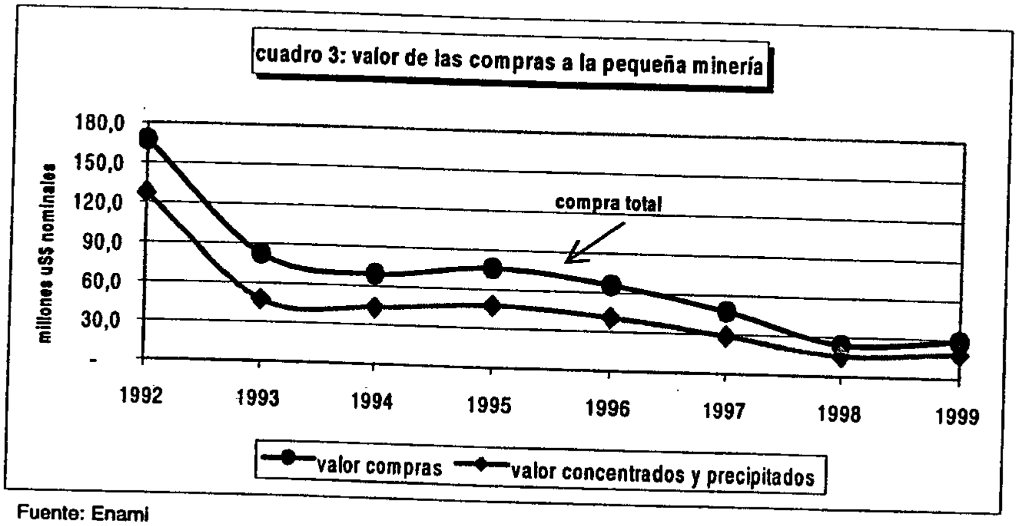
En términos de los volúmenes entregados a Enami, en toneladas anuales, este sector vende alrededor de 85.000 tms de concentrados y 15.000 tms de precipitados, ambas cifras equivalentes, considerando minerales y productos. Las evolución de las compras a la minería de menor tamaño ha tenido el comportamiento mostrado en el cuadro 2 en los últimos años, expresado en tms (toneladas métricas secas) para cada subsector. También en él se refleja una leve recuperación durante el año 1999.



Fuente: Enami

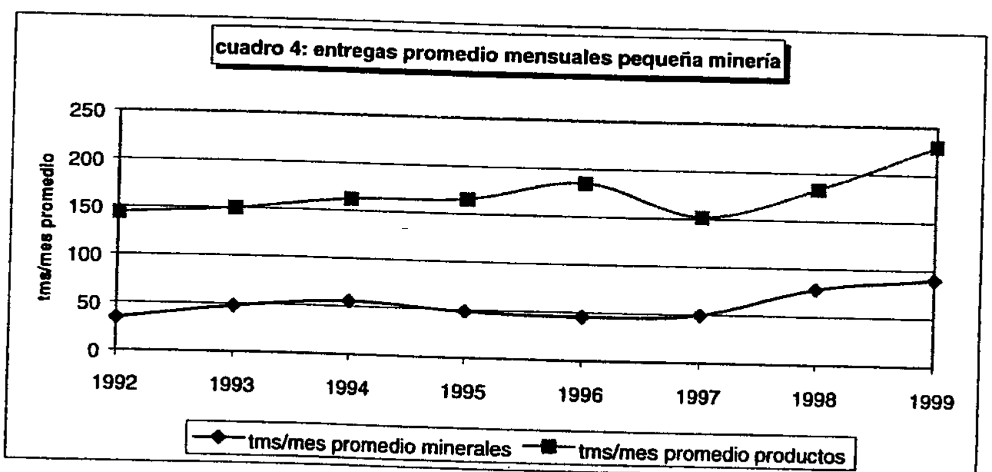
En todo caso, al interior del grupo de pequeña minería, los pequeños productores de concentrados y precipitados han tenido una participación relativa que ha crecido desde un 18% a un 28% del total del volumen de producción de este sector en el período 1992-1999.

El cuadro 3 expone la evolución del valor asociado a las compras que se realizaron a los mineros de menor tamaño, presentando tal evolución tanto para los productores de minerales como para aquellos que entregan concentrados y precipitados para fundición, el que conserva la tendencia antes explicada. Este valor de las compras no tiene incluido créditos ni otros valores adicionales entregados, siendo el valor estrictamente comercial de los minerales y productos. En él se observa que la leve recuperación del valor de las compras se debe fundamentalmente a un mayor valor proveniente de los vendedores de concentrados y precipitados. Hay que destacar que los valores pagados a los productores corresponden completamente a fondos que han ido directamente a dinamizar las economías locales de las regiones del norte del país.



Fuente: Enami

En todo caso, y como se observa en el cuadro 4, la disminución del valor de las compras se ha visto contrarrestada, desde el sector, por un importante aumento en la productividad promedio, definida ésta como la capacidad de producción promedio mensual de los mineros. Esto ocurre tanto en el caso de minerales como, de manera más importante, en los productores de concentrados y precipitados.



Fuente: Enami

Como veremos al revisar el tema de los precios de los metales, tanto la disminución del número de mineros como el aumento de las entregas promedio de ellos, unido al aumento de las leyes de finos contenidos, son algunas de las formas con que el sector minero de menor tamaño ha reaccionado tanto frente a la baja de los precios, en términos reales, como frente al

00977

aumento de los costos de producción, sobre todo para las pequeñas escalas a que estos productores están sujetos.

La relación comercial entre Enami y los productores de Pequeña Minería, en lo relativo a las tarifas de compra, es estrictamente comercial. Es decir, el sistema tarifario refleja precios y cargos de proceso con base al comportamiento de los mercados del cobre y de concentrados.

Sin embargo, complementariamente y atendiendo a las características de estos proveedores, se han utilizado sectorialmente mecanismos estabilizadores de los ingresos de los mineros, tales como la utilización de los mercados de futuro y opciones y mecanismos sustentadores del tipo crediticio y de subsidios.

Mediana Minería

Por sobre los límites de compras a la Pequeña Minería se sitúan los productores de la **Mediana Minería**, concepto que engloba actualmente a alrededor de 11 empresas establecidas.

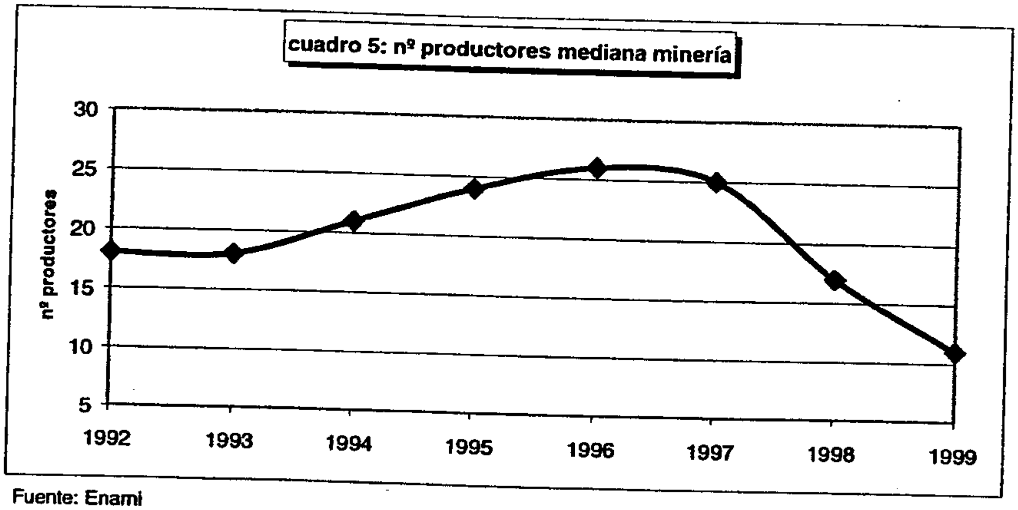
Aún cuando los límites para ser categorizados como medianos productores están explicados anteriormente, la producción promedio de estas empresas es superior a las 5.500 toneladas de cobre fino al año, equivalente a unas 22.000 toneladas de concentrado anuales. Las ventas totales desde este sector a Enami son del orden de las 240.000 tms de concentrados anuales.

Son organizaciones formales, profesionalizadas, con permanencia en el tiempo y altos grados de autonomía, la que se dificulta a medida que los márgenes comerciales se hacen más estrechos, dadas las fluctuaciones cíclicas del precio de los metales y sus costos de operación, estrechamente relacionados con la escala de sus instalaciones productivas. Una limitante, que a la vez la diferencia de la Minería Independiente, dice relación con la relativa dificultad de tales empresas de exportar directamente.

Hasta hace unos años Enami era la única alternativa de colocación de sus productos, pero a mediados del año 1999 apareció un poder comprador privado, con características similares a Enami en su proceso de compra. Esta, que corresponde a una empresa transnacional que opera también con este objetivo en Perú, efectivamente ha captado parte de la producción de concentrados de medianos mineros.

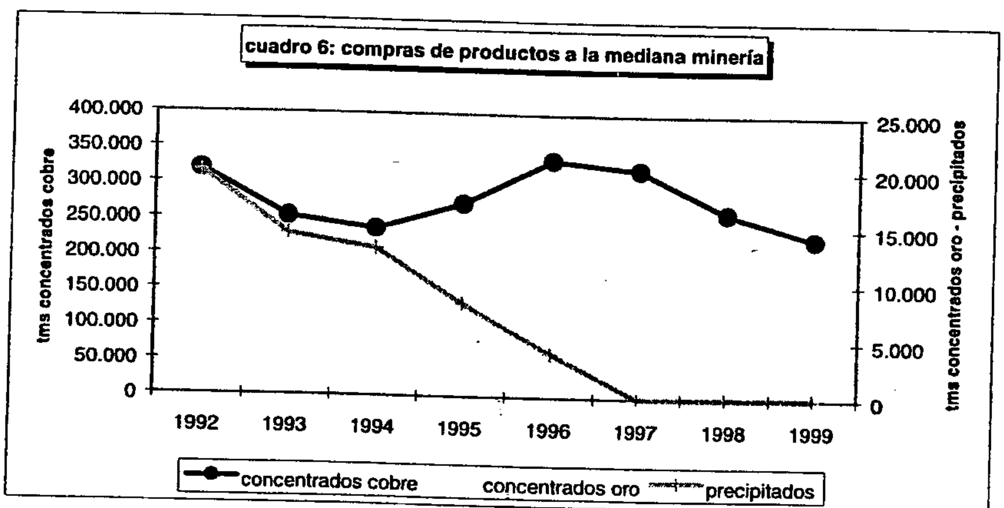
Aunque este fenómeno es muy incipiente y podría no ser exitoso en el mediano plazo, este elemento es sumamente importante de cara a las definiciones de política comercial que Enami debe generar para el largo plazo hacia la mediana minería, a fin de no perder sus ventajas comparativas históricas por una parte y, a la vez, mantener y fortalecer la viabilidad de largo plazo de estas compañías. En realidad, el éxito relativo de corto plazo que esta alternativa ha tenido se debe a que, por una parte, sólo algunas compañías podrían acceder a él y, por otra, si se considera que ella ha surgido en un momento en que el mercado de concentrados spot de exportación ha sido extremadamente atractivo para los productores, cuestión que no es proyectable a todo evento.

La evolución del número de productores medianos tuvo su máximo en 1996, luego de lo cual ha venido decreciendo en los últimos años, situación que se muestra en el cuadro nº 5.

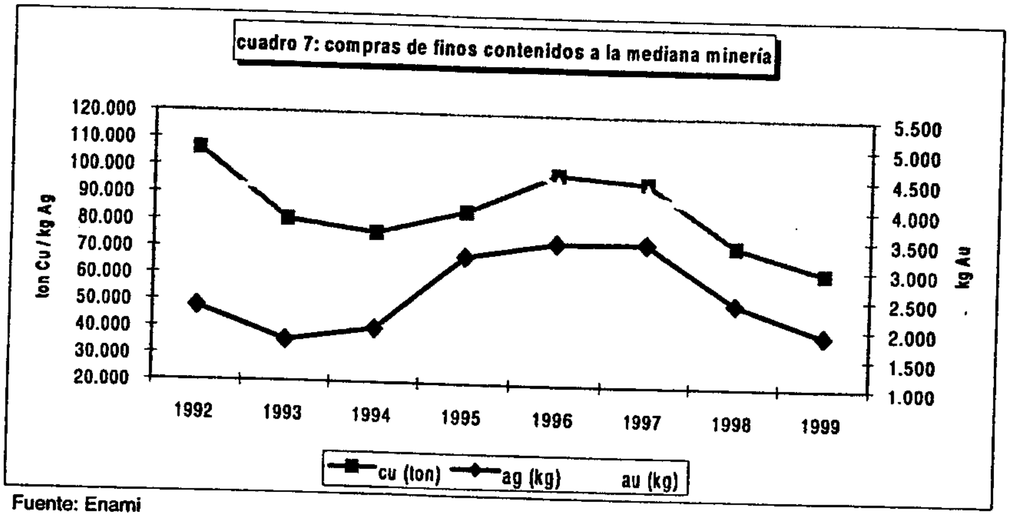


Fuente: Enami

Las empresas correspondientes a esta categoría entregan en volumen sobre un 90% concentrados de cobre, siendo el remanente productores de concentrados de oro. Adicionalmente, ha existido ventas de minerales desde medianos productores, los que corresponden a contratos de abastecimiento para planta Matta la que, por su capacidad de producción, está sujeta a la necesidad de pactar abastecimientos con empresas de mayor tamaño. La evolución de las ventas de productos de este sector se muestra en el cuadro 6 en términos de volumen de producto y en el cuadro 7 en finos de metales contenidos totales.



Fuente: Enami



Fuente: Enami

En el horizonte analizado la Mediana Minería, como un todo, mostró un dinamismo que se reflejó en un crecimiento por sobre el 30% entre 1993 y 1996. Sin embargo, en los años posteriores dicho crecimiento prácticamente se anuló, estando sus entregas para el año 1999 en cifras del orden de las que se materializaron en 1993.

Individualmente, no obstante, existen empresas que han tenido un crecimiento productivo sostenido a la fecha, mientras otras han disminuido sus entregas o, más dramáticamente, han desaparecido como productores, habiendo un caso que se ha mantenido prácticamente igual durante todo el período analizado.

El valor de las compras provenientes de estos productores, fuertemente determinado por los precios de los metales en el horizonte 1992-1999, dado que no cuentan con mecanismos estabilizadores sectoriales como los pequeños mineros, se muestra en el cuadro siguiente, donde se observa un importante incremento en el año 1995.

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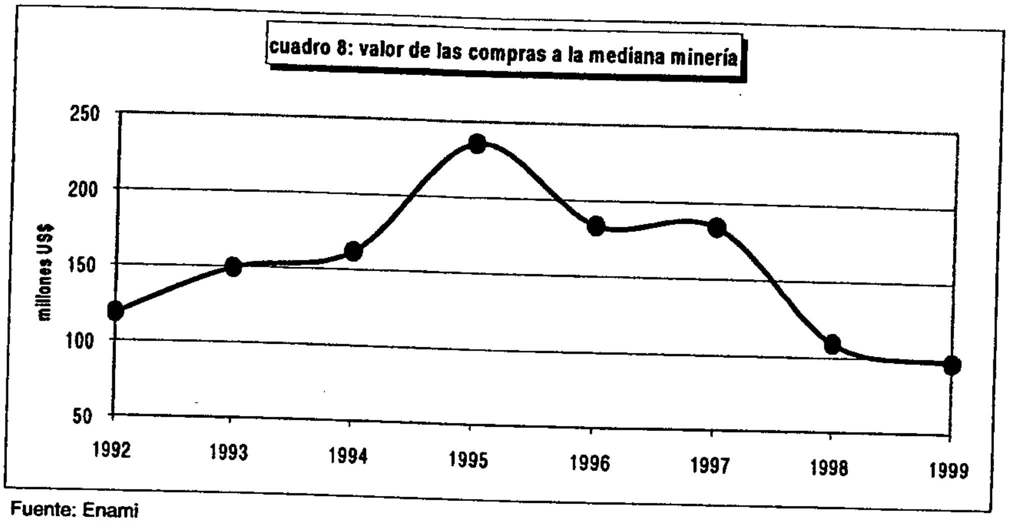


Fuente: Enami

Con estas empresas Enami tiene una relación estrictamente comercial, de mutua conveniencia, por cuanto a las compañías le asegura capacidad de tratamiento de sus productos y a la vez, bajo este mismo concepto, se asegura un importante porcentaje del abastecimiento de sus fundiciones. Sin embargo, dada la última crisis del precio del cobre, también se han utilizado con estos productores, aunque individualmente, apoyos crediticios que aminoraran el impacto de la baja de precios.

PEQUEÑA Y MEDIANA MINERIA Y ABASTECIMIENTO DE FUNDICIONES ENAMI

La pequeña y mediana minería abastece a Enami, en términos de concentrados de cobre, en alrededor de 340.000 tms anuales, equivalente a unas 85.000 a 90.000 ton de cobre, lo que es aproximadamente el 50% de la capacidad de fusión de la empresa.

Aún cuando en el origen de Enami ésta fue creada para comprar y procesar los minerales y productos mineros de la minería pequeña y mediana, desde el principio sus fundiciones y refinería tuvieron una escala tal que, una vez abastecidas con el total de productos provenientes de este sector, aún resta capacidad para ser completada con compras o abastecimientos provenientes de los productores independientes o grandes compañías.

Ello se definió así debido al necesario escalamiento de sus instalaciones, a fin de que éstas tuvieran costos de operación competitivos a nivel de la industria internacional.

Esta estructura de abastecimiento mixta queda ya evidenciada en cifras disponibles de los años '70 y '80, expresadas en toneladas de cobre refinado, como se muestra en la tabla siguiente, a partir de los cuales se puede deducir que el abastecimiento de la empresa siempre ha estado, en términos importantes, compartido entre la pequeña y mediana minería y los grandes productores.

00081

evolución de la compra por sectores (miles ton Cu/año)

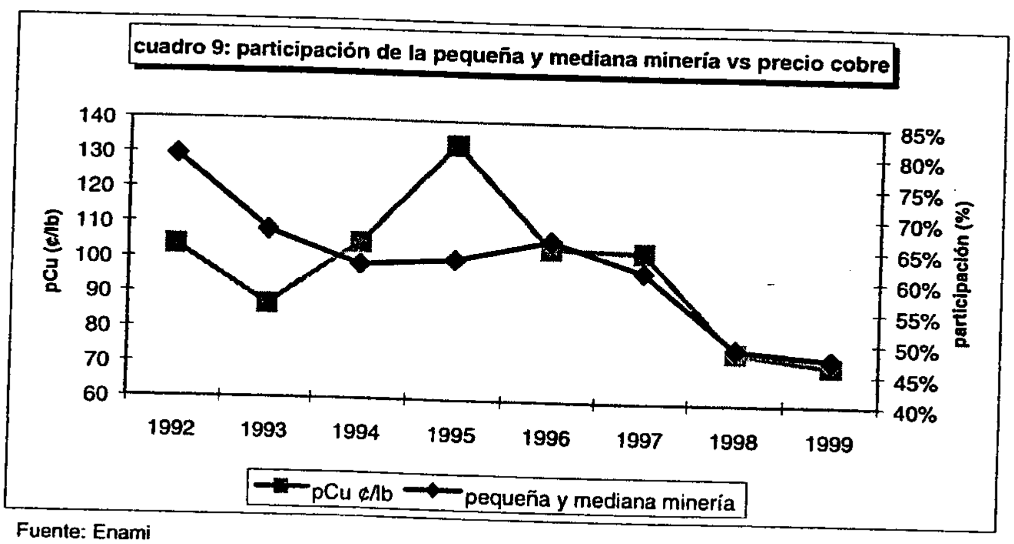
	pequeña minería	mediana minería	pequeña y mediana minería	% pequeña y mediana minería vs total	capacidad fundición*
1970	nd	nd	50	42%	120
1982	nd	nd	82	51%	160
1992	52	106	158	79%	200
1993	53	81	134	67%	200
1994	47	76	123	62%	200
1995	41	84	125	63%	200
1996	34	98	132	66%	200
1997	27	96	122	61%	200
1998	25	73	98	49%	200
1999	32	63	95	47%	200

nd: no disponible

*: capacidad expresada en cobre fino considerando ley media de abastecimiento

Cabe hacer notar que la cifra de participación de la pequeña y mediana minería ha sido bastante variable en el horizonte analizado, de cara al abastecimiento de Enami. Sin embargo, si bien el precio del cobre ha sido factor importante, también lo es el hecho de que existen productores que, perteneciendo a la mediana minería, han dejado de mantener una relación comercial regular con Enami, a partir de la aparición de otras fundiciones y compradores.

Estos porcentajes de participación se muestran en el cuadro 9 a continuación, en función del precio del cobre.



Fuente: Enami

Comisión Regional del Medio Ambiente
Región del Bio Bio

ORD. Nº 00703 **/2000**

00982

GOBIERNO DE CHILE
COMISION NACIONAL DEL MEDIO AMBIENTE

ANT.: No hay

MAT: Remite observaciones a Anteproyecto Revisión de Norma Primaria de Calidad de Aire para CO, NO_2, SO_2, O_3 y PTS.

Concepción, 10 NOV 2000

A: **JEFE DEPTO. DESC., PLANES Y NORMAS**
DRA. PATRICIA MATUS

DE: **DIRECCION REGIONAL CONAMA BIO BIO**

Por encargo del Director Regional me permito remitir a Ud. observaciones al documento de la referencia, en atención al periodo de consulta pública en que se encuentran.

Sin otro particular le saluda,

CONAMA
REGION DEL BIO BIO

GERMAN OYOLA
ING. CIVIL QUIMICO
DIRECCION REGIONAL CONAMA BIO BIO

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OBSERVACIONES
ANTEPROYECTO NORMAS DE CALIDAD DE AIRE

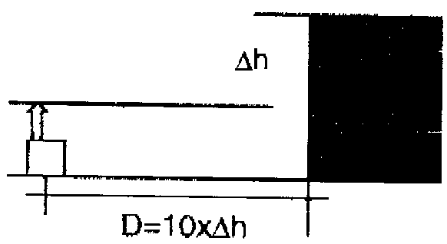
00983

1. En general a los 5 anteproyectos

- "Una EMRPG tendrá representatividad para la población expuesta correspondiente a un radio de 2 km., medido desde la ubicación de la estación."

  Lo anterior implica entonces que se podrá argumentar falta de representatividad de las redes actuales por una insuficiencia de estaciones monitoras de las redes urbanas y por lo tanto que la determinación de áreas o zonas saturadas no aplica o no es correcta, que existe discriminación o cualquier otro argumento. Por otro implica que para cumplir con una adecuada cobertura habrá que invertir en densificar las redes, costo que deberá ser asumido por el Estado.

- Respecto del emplazamiento de las estaciones monitoras creemos que el punto de indica distanciamiento de 20 m de cualquier edificación existente en el lugar y mas de 10 m de árboles no lo cumplen las actuales estaciones monitoras urbanas y no es necesario si se considera el siguiente punto de la siguiente forma:



  Donde: la distancia es 10 veces la diferencia de altura entre la toma muestra y la obstrucción de flujo de aire más cercana.

- Que pasará con la data histórica existente en el país, puesto que no se especifica si se consideraran válidos o no, si podrán utilizarse como referencia en la determinación de zonas geográficas, en los planes, en las declaraciones de zonas, etc.

- Creemos que siempre se deben aplicar promedios móviles al igual que en ozono puesto que se mejora la gestión de la calidad del aire, al tener constantemente nuevos promedios, además se asegura de estar cubriendo eventos que pudieran quedar fuera los periodos fijos tal como se señala a continuación:

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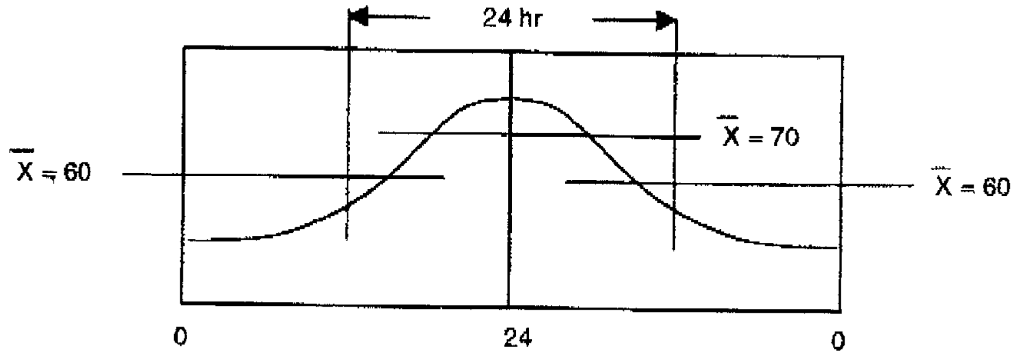
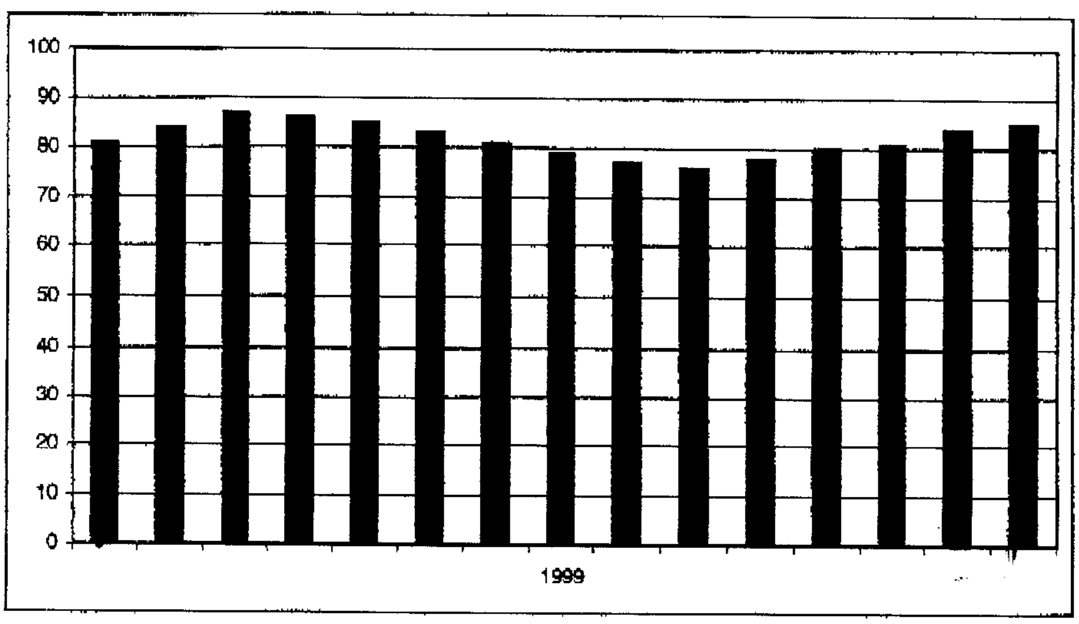


Por lo tanto si el criterio de salud es que se producen efectos a las 24 hr, bajo X concentración, entonces debe aplicarse promedio móvil.

La anterior es válido tanto para los promedios diarios como anuales puesto que por ejemplo, en el área de Talcahuano los mayores eventos críticos se producen en el periodo que de noviembre a marzo. Además la utilización de promedios móviles anuales por ejemplo hace más dinámica la gestión y no inhabilita la información de promedio año calendario.



Lo anterior representa promedios anuales móviles de SO2 donde el año calendario cumple norma pero claramente la población esta siendo afectada en periodos de largo plazo, puesto que esta sometida a niveles sobre la norma en la realidad.

2. Ozono

¿No hay antecedentes respecto de los efectos crónicos a la exposición de ozono?

3. NO2

4. SO2

No nos parece adecuado criterio de protección de la salud de la población que se considere sólo el valor máximo del día para contabilizar el número de excedencia de la norma, puesto que días con 12 horas sobre norma horaria por ejemplo, con valores muy por sobre la norma, sólo sería contabilizado como una superación de norma horaria y de seguro una superación de norma diaria, en circunstancias que se sabe que hay efectos significativos a valores de corto plazo mucho menores como lo reconoce la OMS.

5. CO

6. PTS

COMISION NACIONAL DEL MEDIO AMBIENTE
DEPTO. DESCONTAMINACION, PLANES Y NORMAS

Reunión Normas Primarias de Calidad de Aire
Santiago, 13 de noviembre 2000

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Análisis general del impacto económico y social *de los anteproyectos de norma de calidad primaria de aire para PTS, O_3, SO_2, CO y NO_2*

Sandra Moreira
Nicolás Chacón
Flavia Maldini (asesora)
Juan Ladrón de Guevara (coordinador responsable)
Unidad de Economía Ambiental, CONAMA

Exigencias de la normativa

Etapa de análisis técnico y económico

- "Elaborado el anteproyecto...el Director encargará un análisis general del impacto económico y social...plazo de 50 días."
- "En especial,...evaluar costos y beneficios para la población, ecosistemas o especies ***directamente afectadas o protegidas***; ... a el o los emisores que deberán cumplir la norma; y ...para el Estado como responsable de la fiscalización del cumplimiento..."

Uso del AGIES

- Art. 21 señala que "...***considerando*** los antecedentes contenidos en el expediente, las observaciones formuladas en la etapa de consulta y los resultados del estudio (AGIES)...., se elaborará el proyecto definitivo."

AGIES Revisión Res. 1215/78

Cambios propuestos

- **PTS** se elimina
- **SO_2** diaria disminuye (95 ppb), se crea horaria (400 ppb), se fijan valores de emergencia para planes y percentil 99.
- **O_3** se elimina horaria (80 ppb), se crea 8-horas (60 ppb), se fijan valores de emergencia en planes y percentil 99.
- **CO** horaria disminuye (27 ppb), se fijan valores de emergencia en planes y percentil 99.
- **NO_2** horaria disminuye (212 ppb), se fijan valores de emergencia en planes y percentil 99.

Parte 1

Evaluación costo beneficio

Zonas con probables niveles de concentración superiores al 80% del valor de cada norma (con o sin anteproyecto)

Zonas incluidas en la evaluación:

PPDA Región Metropolitana (0_3, CO)
PDA Talcahuano (SO_2)
Área de impacto emisiones Altonorte (SO_2)
Área de impacto emisiones Paipote (SO_2)
Área de impacto emisiones ENAMI y Chilgener Ventanas (SO_2)
Área de impacto Caletones (SO_2)
Sector de Hijuelas (O_3)

Consideraciones iniciales

- Los costos y beneficios se generan una vez que se implementan medidas que incentivan/obligan la reducción de emisiones. Esto ocurrirá en las áreas en donde se excede el mínimo sobre el cual el Estado tiene facultades de intervenir (80% de la norma).
- Evaluación social (diferentes precios que los utilizados en evaluación privada).
- Horizonte de evaluación a 25 años, ya que permite recoger adecuadamente beneficios medidos anualmente.
- Zonas para determinar excedencias en base a redes de monitoreo existentes.
- Zonas para la evaluación de beneficios: áreas de influencia de las emisiones, según modelos de dispersión o redes de monitoreo, independientemente de si estén o no sobre la norma.
- En general, se estima en 30% el error en la evaluación de costos para este tipo de análisis.

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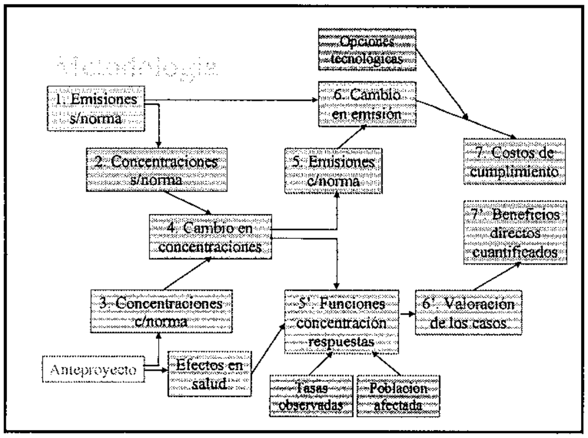


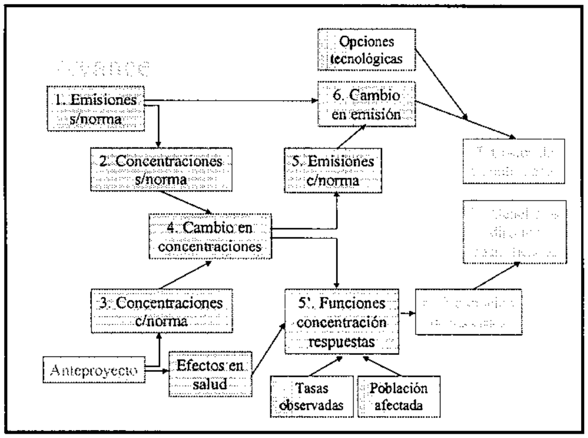
Resultados esperados

Parte cuantitativa

- N° casos de morbilidad y mortalidad evitados/producidos en las áreas de impacto
- Daños evitados/producidos en las áreas de influencia
- Reducción de emisiones requerida
- Opciones de mínimo costo para cumplimiento de la reducción de emisiones
- Costos directos de cumplimiento

Parte no cuantitativa

- Descripción de los efectos en salud, más allá de los efectos cuantificados.
- Efectos sobre opción de Certificación ISO 14001
- Restricciones y plazos para la implementación de modelos climáticos
- Posibles efectos para productores de cobre que entregan a ENAMI



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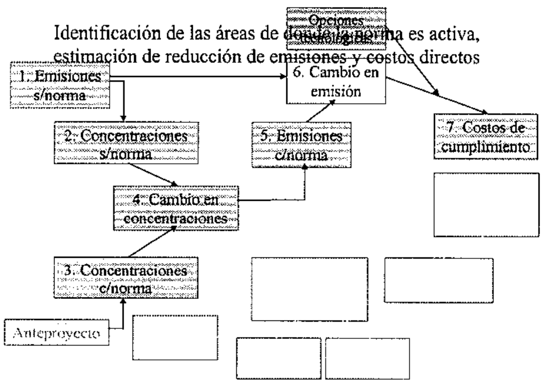
Metodologías específicas

Identificación de las áreas de donde la norma es activa, estimación de reducción de emisiones y costos directos (Nicolás Chacón)

Cuantificación de efectos en salud y valoración de los daños evitados (Sandra Moreira)

Identificación de las áreas de donde la norma es activa, estimación de reducción de emisiones y costos directos



Comparación Norma Actual con Norma Propuesta

	Norma O_3		Norma NO_2		Norma SO_2		Norma CO	
Periodo	**Actual ppb**	**Estudio ppb**	**Actual ppb**	**Estudio ppb**	**Actual ppb**	**Estudio ppb**	**Actual ppm**	**Estudio ppm**
1 hr	80		250	212		400	34	25
8 hr		60					9	9
24 hr					139	95		
anual			53	53	30	30		
Nivel 1		200		600		750		15
Nivel 2		400		1200		1000		30
Nivel 3		500		1600		1500		35
Percentil		99%		99%		99%		99%

Periodos de 1 hora
Periodos de 8 horas

Zonas de mayor Impacto por Ozono

Región	Localidad	Periodo	Estación	# de veces sobre norma Horaria de 80 ppb	8 Horas de 60 ppb	# de veces latencia N. Horaria 64 ppb	N. 8 Horas 48 ppb
RM	Santiago	1999	Providencia	3	0	9	4
			Recoleta	22	8	38	54
			La Florida	55	43	103	142
			Las Condes	141	117	170	181
			P. O'Higgins	29	23	64	98
			Pudahuel	5	3	11	49
			Cerrillos	16	14	31	68
			El Bosque	12	10	24	55
			MACAM	147	121	186	195
V	Hijuelas	Jul 99-Ago 00	Hijuelas	0	2	3	5
	Quillota	1999	Quillota	0	0	0	0

Zonas de mayor Impacto por Dióxido de Nitrógeno

Región	Localidad	Periodo	Estación	Promedio Anual 53 ppb	# de veces sobre norma horaria de 250 ppb	212 ppb	Latencia 168 ppb
I	Iquique	Jun 97-May 98	15 Puntos	11.1			
II	Mejillones	Jul 98-Jun 99	Enaex	2.3			
		Jun 98-May 99	Escuela E-10	9.2			
III	Huasco	1999	Bomberos		0	0	0
V	Valparaíso	Jun 97-May 98	15 Puntos	23.9			
	Viña del Mar	Jun 97-May 98	15 Puntos	18.8			
	La Calera	Sep 99-Ago 00	La Calera	10.9	0	1	1
	Hijuelas	Sep 99-Ago 00	Hijuelas	8.9	4	4	4
VI	Rancagua	Jun 97-May 98	15 Puntos	20.4			
IX	Temuco	Jun 97-May 98	17 Puntos	15.9			

Zonas de mayor Impacto por Dióxido de Azufre

Región	Localidad	Periodo	Estación	Promedio Anual 30 ppb	# de veces sobre norma Diaria de 114 ppb	Diaria de 95 ppb	Horaria de 400 ppb	# de veces latencia Diaria 76 ppb	Horaria 320 ppb
II	Antofagasta	1999	La Negra	8.5	0	0	11	2	16
			Coviefi	0.8	0	0		0	
III	Copiapo	1999	Copiapo	3.4	0	0	0	0	1
			Paipote	17.1	1	4	24	2	34
			T. Amarilla	9.4	0	0	4	0	11
V	Chagres	1999	Sta. Margarita	25.6	0	0	0	0	0
			Lo Campo	13.3	0	0	0	0	0
			Catemu	5.8	0	0	0	0	0
			Romeral	7.8	0	0	0	0	0
	Ventanas	1999	Los Maitenes	19.7	1	2	18	8	52
			La Greda	9.2	0	1	5	1	3
			V. Alegre	7.5	0	0	0	0	2
			Puchuncaví	11.3	0	0	0	0	0
VI	Caletones	1999	Coya Pob.	15.3	2	4	12	53	18
		Nov 98-Oct 99	Machalí	3.5	0	0	0	0	0
			Cal	2.3	0	0	0	0	0
VIII	Talcahuano	1999	C. Esquinas	23.1	1	9	0	52	1
			Bomberos	26.8	6	13	5	28	14

Zonas de mayor Impacto por Monóxido de Carbono

Región	Localidad	Período	Estación	# de veces sobre norma			# de veces latencia norma		
				horaria 34 ppm	horaria 25 ppm	8 horas 9 ppm	horaria 27 ppm	horaria 20 ppm	8 horas 7 ppm
RM	Santiago	1999	Seminario	0	0	0	0	0	0
			La Paz	0	0	0	0	0	[illegible]
			La Florida	0	0	0	0	0	1
			Las Condes	0	0	0	0	0	0
			P. O'Higgins	0	0	16	0	3	[illegible]
			Pudahuel	0	0	12	0	[illegible]	[illegible]
			Cerrillo	0	0	2	0	0	[illegible]
			El Bosque	0	0	2	0	0	[illegible]
III	Copiapó	May 98-Jun 99	Copiapó		0	0			
			Vallenar		0	0			
			Huasco		0	0			
V	Valparaíso	Jul-Oct 1993	Viña del Mar			0			
			Valparaíso			0			
		Feb-Mar 1994	Viña del Mar			0			
			Valparaíso			0			
VI	Rancagua	Ago-Sep 1996	Rancagua		0	33			

Relación Emisión - Calidad

Contaminante	Zona	Emisión		Calidad		
SO_2	Caletones	1998	1999	1997	-	1999
SO_2	Ventanas	1993	1999	1997	-	1999
SO_2	Chilgener			1997	-	1999
SO_2	Noranda	1998	1999	1999	-	May-00
SO_2	Paipote			1999		
SO_2	Chagres	1993	1999	1998	-	1999
SO_2	Talcahuano	Cat. Emi. 2(		1998	-	1999
CO, O_3	Santiago	Cat. Emi. 2(		1997	-	1999

Calidad Futura sin Norma

- Calculada de acuerdo al crecimiento de la población
- Ingreso de nuevas fuentes
- Cambios en las emisiones que no se deben a la implementación de la Norma
  - Caso Noranda y Caletones

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Cambios en la Emisión debido a la Norma

- Santiago plan de descontaminación
- En Talcahuano reducción de emisiones de las fuentes mas importantes
- Se estudian dos escenarios para las fundiciones:
  - Incorporación de tecnología de abatimiento
  - Control de episodios horarios por reducción de fusión

Reducción de Emisiones Santiago

- Caso CO la norma propuesta no afecta la situación actual y no se visualiza que la afecte a futuro.
- Caso O_3 la norma propuesta disminuye el número de episodios en un 16%, se evaluaran las medidas futuras del plan y el costo que estas tienen.

Medidas para disminuir COV en Santiago

- Implementar monitoreo continuo (PROCEFF)
- Declaración de emisiones de industrias y talleres que utilicen pinturas (PROCEFF)
- Introducir cambios tecnológicos en: lavasecos y industrias o talleres que utilicen pinturas (PROCEFF y Municipalidades)
- sustitución del uso de productos con alto contenido de COV por productos menos contaminantes (SESMA)
- fijar un limite máximo de emisiones de COV para la aplicación de pinturas. Entre 50 y 120 g/m^2 (SESMA)

Reducción de Emisiones Talcahuano

- Identificación de las principales fuentes (Catastro de emisiones 2000)
- Relación Emisión-Calidad
- Definir reducción de emisiones necesaria
- Asignación de reducción de emisiones por fuente

Opciones de Reducción de Emisiones para Fundiciones

- Implementación de un modelo climático, que permita predecir periodos de alta estabilidad atmosférica. En los cuales se deberá reducir fusión al nivel que evite la ocurrencia de episodios horarios
- Incorporación de Tecnología de Abatimiento (control de emisiones fugitivas)
- Solución mixta

Control de Episodios Horarios y Diarios

- Relación emisión mensual contra episodios horarios y diarios mensuales
- Se define nivel de emisiones que cumplen con percentil norma horaria y diaria
- Se aplica esta reducción a los días que actualmente presentan un 80% de la norma horaria y diaria propuesta en las zonas de impacto

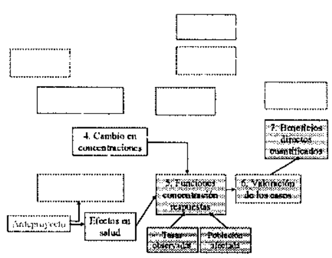
Incorporación de Tecnologías de Abatimiento

- Se evalúa el costo que la implementación de tecnología de captación de emisiones fugitivas tiene en el horizonte de evaluación de la norma
- En caso que no se logre reducir a un nivel de emisiones que cumpla con norma deberá reducir fusión, escenario mixto

Estimación de Costos

- Costos directos de emisores
  - Control de emisiones
  - Implementación y operación de un modelo de producción climático
- Costos del estado
  - Costos de Monitoreo

Beneficios Sociales en Salud, Revisión Normas Primarias de Calidad de Aire



Sandra Moreira B.
16 de Octubre de 2000

Indice

- Introducción
- Metodología Propuesta
- Caso de Estudio: Nuevas Normas de Calidad Primaria en Chile

Motivación

Contaminantes atmosféricos primarios y sus principales efectos en salud:

O3
- Irritación en la nariz, garganta, congestión del pecho.
- Empeoramiento en condición de pacientes asmáticos. Aumento de infecciones respiratorias y adm. hospitalarias. Disminución de la capacidad pulmonar.

CO
- Adm. hospitalarias cardiovasculares, isquémicas y cardiorespiratorias.

SO2
- Admisiones hospitalarias respiratorias. Bronco constricción (>= 5ppm). Reducción de un 10% del FEV (0,4ppm).

NO2
- Irritante, fibrosis pulmonar crónica, bronquitis en niños..
- Disminuye el funcionamiento pulmonar en asmáticos.

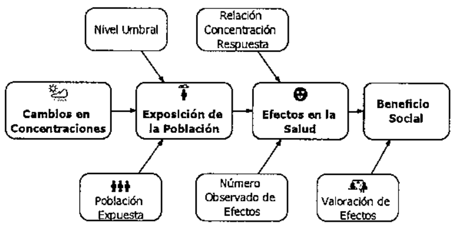
Objetivo Específicos: Beneficios Sociales en Salud

- **Estimar los daños o beneficios sociales en salud a partir de las variaciones en las concentraciones de los contaminantes atmosféricos producto de la norma de calidad primaria propuesta.**
- **Estimar el riesgo social debido a variaciones en las concentraciones ambientales del contaminante.**
- **Caracterizar cuantitativamente la incertidumbre de las estimaciones.**

Metodología

Evaluación de Beneficios Sociales en Salud

- Análisis de riesgo cuantitativo



Metodología

Evaluación de Beneficios Sociales

- Concentraciones

Caso Base { Escenario: Concentraciones actuales
Ej.:Proyección de concentraciones, cumplimiento de actuales normas de Res 1215/78

vs

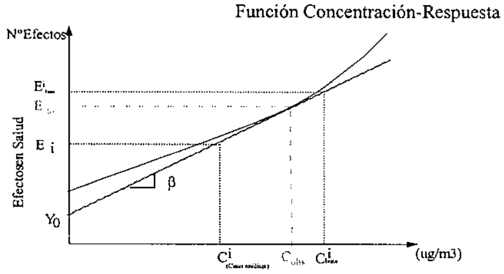
Casos de análisis { Concentraciones a evaluar
Ej.:Proyección de concentraciones con nueva normativa

Concentración Observada { (Concentración base observada , Número base de efectos observados)

Metodología

Evaluación de Beneficios Sociales

Función Concentración-Respuesta

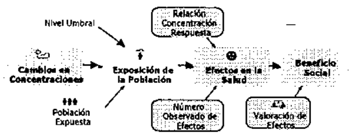


Metodología

Evaluación de Beneficios Sociales

Exposición

- Delta de concentraciones entre concentraciones de análisis y la concentración observada.
- Población expuesta.



Metodología

Evaluación de Beneficios Sociales

Exposición

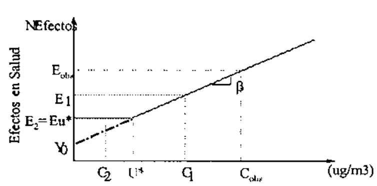
- Población expuesta: Corresponde a la población de la cada lugar estudiado.
  - Grupos de Población:
    - » Niños (< 18 años)
    - » Adultos (18-64)
    - » Mayores 65

Metodología

Evaluación de Beneficios Sociales

- Exposición diaria

$$\Delta Exp(C_i - C_{obs}) = Pob_{exp} * (Max(C_i, U^*) - Max(C_{obs}, U^*))$$



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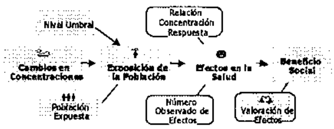
Metodología

Evaluación de Beneficios Sociales

- Efectos en salud

$$\Delta Efectos_{Anuales}(C_i - C_{obs}) = Efectos_{observados} * \beta * \Delta Exposición_{Anual}$$

–Exposición
–Número de efectos observados
–Relaciones Concentración Respuesta



Metodología

Evaluación de Beneficios Sociales

Coeficientes Funciones Concentración-Respuesta O3

Efecto	Grupo de Edad	Coef. Valor medio	Std Err	Medida	Otros Cont. Modelo	Fuente
Muertes Prematuras	All	0.00020	0.00010	Max 1h		Pooled Ito et al 1995, Loomis 1996, Morgan 1996
Muertes Prematuras	All	0.00078	0.00017	24h	TSP	Pooled Hoek 1997, Moolgavkar 1995, Samet 1997
Muertes Prematuras	All	0.00113	0.000273	8h	BS	Anderson et al. 1996 ()
Adm Hosp RSP (ICD 460-519)	> =65	0.00080	0.000327	Max1h		Pooled Schwartz 1996 (Spokane, Cleveland)
Adm Hosp RSP (ICD 460-519)	> =65	0.00171	0.000539	8hr average	-	Ponce et al. 1996 (London)
Adm Hosp RSP (ICD 460-519)	0-14	0.00102	0.000631	8hr average	-	Ponce et al 1996 (London)
Adm Hosp RSP (ICD 460-519)	15-64	0.00201	0.000574	8hr average	-	Ponce et al, 1996 (London)
Adm Hosp RSP (ICD 460-519)	All	0.00106	0.000347	8hr average	SO2	Ponce et al 1996 (London)
Adm Hosp RSP (ICD 460-519)	> =65	0.00368	0.001229	24hr	PM10	Pooled Schwartz 1995 (New Haven, Tacoma)
Adm Hosp RSP (ICD 464, 466, 480-487 4941	All	0.00196	0.000620	24h	PM2.5, NO2	Burnett et al. 1999 (Toronto)
Adm Hosp RSP (ICD 466,480-482,485,490-493)	All	1.85E-08	9.71E-09	Max1h	PM2.5	Thurston et al, 1994 (Canada)
Adm Hosp Asma (ICD 493)	All	0.00250	0.000714	24h	CO, PM2.5-10	Burnett et al., 1999 (Toronto)
Adm Hosp Asma (ICD 493)	All	0.00000	0.000000	Max1h	PM2.5	Thurston et al., 1994 (Toronto)
Adm Hosp Pulmonar Obstructiva (ICD 490-492 496)	All	0.00300	0.001100	24h	CO, PM2.5-10	Burnett et al., 1999 (Toronto)
Adm Hosp COPD (ICD 490-491, 494-496)	> = 65	0.00549	0.002050	24h	PM10	Schwartz et al, 1994 (Detroit, MI)
Adm Hosp COPD (ICD 490-496)	> = 65	0.00274	0.001700	24h	PM10, SO2, NO2	Moolgavkar et al, 1997 (Minneapolis)
Adm Hosp COPD (ICD 490-496)	> = 65	0.00467	0.007730	Max1h	-	Schwartz et al, 1996 (Spokane)
Adm Hosp Neumonia (ICD 480-487)	> = 65	0.00965	0.006008	Max1h	-	Schwartz et al, 1996 (Spokane)
Adm Hosp Neumonia (ICD 480-487)	> = 65	0.00370	0.001030	24h	PM10, SO2, NO2	Moolgavkar et al, 1997 (Minneapolis, MN)
Adm Hosp Neumonia (ICD 480-487)	> = 65	0.00433	0.001037	24h	PM10	Pooled (Schwartz 1994 (Spokane Minneapolis))
Adm Hosp Dysrhythmias (ICD 427)	All	0.00168	0.001030	24h	CO, PM2.5	Burnett et al., 1999 (Toronto)
Visitas Sala Emergencia Asma	All	0.00350	0.001800	Max1h	-	Stieb et al 1996 (Canada)
Ataques de Asma	Asmáticos	0.00184	0.000715	Max1h	TSP	Whittemore & Korn, 1980 (Los Angeles)
Días de Actividad Restringida Menor (MRADs)	18-65	0.00220	0.000658	Max1h	PM2.5	Ostro & Rothschild, 1989
Síntomas Respiratorios	18-65	0.00014	0.000067	Max1h	SO2, O3	Krupnick, 1990

Metodología

Evaluación de Beneficios Sociales

Coeficientes Funciones Concentración-Respuesta SO2

Efecto	Grupo de Edad	Coef. Valor medio	Std Err	Medida	Otros contaminantes en el modelo	Fuente
Hospital Admissions RSP (ICD 460-519)	15-64	0.00049	0.000243	ug/m3 (24h)	-	Vigotti et al, 1996 (Milan)
Hospital Admissions RSP (ICD 460-519)	> =65	0.00039	0.000220	ug/m3 (24h)	-	Vigotti et al, 1996 (Milan)
Hospital Admissions RSP (ICD 466,480-482,485,490-493)	All	0.00446	0.002934	ppb (Max 1h)	PM2.5-10, NO2, O3	Burnett et al, 1997 (Canada)
Hospital Admissions COPD (ICD 490-491-492-496)	All	0.00044	0.000371	ppb (24h)	-	Anderson et al. 1997 (Europa)
Hospital Admissions COPD (ICD 490-491-492-496)	All	0.00022	0.000177	ppb (Max 1h)	-	Anderson et al. 1997 (Europa)
Hospital Admissions Ischemic heart failure (ICD 410-414)	All	0.00177	0.000854	ppb (24h)	NO2	Burnett et al, 1999 (Toronto)
Hospital Admissions Pneumonia (ICD 480-487)	> =65	0.00143	0.002901	ppb (24h)	O3, NO2, PM10	Moolgavkar et al. 1997 (Minneapolis)
Hospital Admissions-Asthma (ICD 493)	<15	0.00145	0.000560	ug/m3 (24h)	NO2	Sunyer et al. 1997

Metodología

Evaluación de Beneficios Sociales

Coeficientes Funciones Concentración-Respuesta CO

Efecto	Grupo de Edad	Coef. Valor medio	Std Err	Medida	Otros Cont. en el modelo	Fuente
Hospital Admissions Cardiovascular (ICD-9 390-429)	65+	0.01271	0.002552	Max h	PM10	Schwartz 1999 (Eight Counties)
Hospital Admissions Cardiovascular (ICD-9 390-429)	65+	0.01388	0.007085	Max 1h	PM10	Schwartz 1997 (Tucson)
Hospital Admissions Ischemic Heart Failure (ICD 410-414)	65+	0.00467	0.004354	Max 1h	PM10	Schwartz and Morris, 1995 (Detroit)
Hospital Admissions Congestive heart failure (ICD 428)	65+	0.01700	0.004680	Max 1h	PM10	Schwartz and Morris, 1995 (Detroit)
Hospital Admissions Congestive heart failure (ICD 428)	All	0.03397	0.016332	24hr	NO2	Burnett et al. 1999 (Toronto)
Hospital Admissions COPD (ICD 490-496)	65+	0.05734	0.032880	24hr	O3, PM10	Moolgavkar et al, 1997 (Minneapolis)
Hospital Admissions Asthma (ICD-9 493)	All	0.03324	0.008611	24hr	PM2.5-O3	Burnett et al, 1999 (Toronto)
Hospital Admissions Obstructive Lung (ICD-9 490-492, 496)	All	0.02505	0.016480	24hr	PM2.5-10, O3	Burnett et al, 1999 (Toronto)
Hospital Admissions Asthma (ICD-9 493)	<65	0.05280	0.018501	24hr	PM2.5	Sheppard, 1999 (Seattle)
Hospital Admissions Dysrhythmias (ICD-9 427)	All	0.05734	0.022835	24hr	PM2.5, O3	Burnett et al, 1999 (Toronto)

Metodología

Evaluación de Beneficios Sociales

Selección de estudios:

•Estudios con sólida base científica, de un diseño estadístico apropiado y que han considerado ajuste por distintos factores confundentes tales como el clima, edad, patrones de comportamiento, etc.
•Se seleccionaron aquellos estudios en que los contaminantes analizados corresponden específicamente a los considerados en el presente estudio Ozono, SO2, CO, es decir, se trató de evitar el tener que convertir de otros contaminantes o medidas de éstos a los evaluados en el presente análisis).

•Estudios que indicaban los efectos específicos evaluados (ICD) para cada una de las relaciones concentración respuesta.

Metodología

Evaluación de Beneficios Sociales

Selección de estudios:

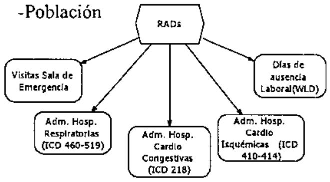
•Han sido consideradas solamente publicaciones que estudian efectos que pueden ser valorados monetariamente. Otros efectos, como son todos los efectos fisiológicos menores, como cambios en la capacidad expiratoria forzada, y otros cambios de la función pulmonar que influirían en el beneficio social resultante deberían ser incorporados en un análisis futuro cuando sea posible su valoración

•Estudios que contienen funciones C-R linearizables e independientes de concentraciones base.

Metodología

Evaluación de Beneficios Sociales

- •Agregación de estudios
- •Eliminación de Doble Conteo por:
  - -Efectos
  - -Población

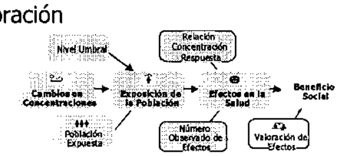


Ej..: Doble-conteo en Días de Actividad Restringida

Metodología

Evaluación de Beneficios Sociales

- Estimación de los efectos totales para cada caso de análisis y para el caso base.
- Cálculo del delta de efectos entre cada uno de los casos de análisis y el caso base
- ....Valoración



Metodología

Evaluación de Beneficios Sociales

Ej.: Valoración unitaria para año 2000 (US$/Efecto)

Efecto	Grupo de Edad	Escenario de Valoración
Muertes Prematuras	Total	407798
Adm. Hosp. RSP	> 65 yrs	3191
Adm. Hosp. COPD	> 65 yrs	4106
Adm. Hosp. Cardio Congestiva	> 65 yrs	4342
Adm Hosp Cardio Isquémica	> 65 yrs	5387
Adm. Hosp. por Neumonía	> 65 yrs	4158
Ataques de Asma	Asmáticos	8
Bronquitis Aguda	Niños	11
Visitas Sala Emergencia	All	60
Consultas médicas IRA baja	Niños	23
Días con Dificultad Resp	Niños	1
Días Perdida Trabajo	Adultos	22
Días Actividad Restringida	Adultos	10
Días de MRADs	Adultos	9

Escenario Valoración: Transferencia de valores; método disposición al pago.Método del costo de la enfermedad.

Metodología

Evaluación de Beneficios Sociales

- Beneficio social
  - Una vez obtenido el número de efectos entre el caso de análisis normativa propuesta y el normativa vigente, se multiplica por los escenarios de valoración. Se obtiene de esta forma el beneficio social por la disminución en la concentración para cada uno de los lugares en estudio.

Contaminante: NO2

- **Los efectos en salud asociados al NO2 no fueron cuantificados debido a las siguientes razones:**
  - No hay información relativa a la existencia de lugares donde se exceda la normativa propuesta.
  - Funciones dosis respuesta que miden efectos valorables están en función de concentraciones intradomicilarias del contaminante.
  - Finalmente si se reducen de las emisiones de NO2, se esta reduciendo la concentración ambiental de O3. Los beneficios de reducir NO2 corresponden en gran parte a los obtenidos para el O3

Caso de Estudio

Area geográfica de influencia

Se plantea la utilización de dos escenarios:

- *Area de influencia mínima* que corresponde a los lugares adyacentes a las fuentes contaminantes.
- *Area de influencia* definida a través del modelo de dispersión de contaminantes atmosférico desarrollado por CONAMA. (Para las zonas…..)

Zonas/Fuentes:	Estación	Area Influencia Mínima	Area de Influencia
Región Metropolitana (O3, CO)	MACAM	RM	-----
Emisiones Altonorte (SO2)	La Negra	La Negra	-----
Emisiones Paipote (SO2)	Paipote	Copiapó, Tierra Amarilla	-----
Sector [illegible]	[illegible]	[illegible]	-----
Emisiones ENAMI y Chilgener Ventanas (SO2)	Los Maitenes	Puchuncaví	Valparaíso, Viña del Mar, Villa Alemana
Emisiones Caletones (SO2)	Coya Pob	Machalí, Codegua, [illegible] Requínoa	Provincia Cachapoal (Rancagua, Graneros,etc.)
Talcahuano (SO2)	Bomberos	Talcahuano	-----

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Se deja constancia que al revisar el expediente se extravió esta hoja

3. Respecto de la proposición de norma para el contaminante Dióxido de Azufre, es opinión de esta Secretaría de Estado, que dicha proposición presenta tanto mejorías como retrocesos respecto del grado de protección que confiere la norma vigente para este contaminante. En efecto, por un lado, en ella se ha innovado al incluir un valor máximo horario, el cual tiene por objeto proteger a la población de los efectos agudos, y por otro lado, se propone reducir de 365 μg/m³N, como concentración máxima diaria, a 250 μg/m³N; sin embargo, los criterios de excedencia de dicha norma disminuyen el grado de protección de la población expuesta.

Lo anterior, debido a que en la actualidad, a pesar de que la concentración máxima diaria es 365 μg/m³N, la excedencia de dicho valor no puede ser más de una vez por año. Con la propuesta actual, es decir el criterio del percentil 99, es posible que durante 87 horas del año (equivalentes a cuatro días), se exceda el valor de 1050 μg/m³N, sin que ello signifique una excedencia a la norma horaria ni menos a la norma diaria propuesta. En efecto, la norma propuesta de 250 μg/m³N, diarios, puede ser excedida en cuatro días del año, lo cual permitiría que una población dada se viera expuesta por 87 horas consecutivas a valores tres, cuatro o hasta diez veces superiores al valor fijado por la norma actual (365 μg/m³N).

Por lo manifestado anteriormente, es opinión de esta Secretaría de Estado, que en el [illegible] de la propuesta de norma primaria para el contaminante Dióxido de Azufre, se considere un factor protector para la población que sea a lo menos igual al contenido [illegible] legislación vigente, así como disposiciones que permitan asegurar que las [illegible] tanto horarias como diarias estén equiespaciadas durante el año o período [illegible] modo tal que no se produzcan situaciones como las antes descritas.

4. En lo que a contaminantes gaseosos se refiere, en opinión de este Ministerio [illegible] habida cuenta que la proposición hecha por esa Comisión, sólo [illegible] los gases normados por la Resolución 1215, los valores de normas propuestos [illegible] tanto en microgramos por metro cúbico normal (μg/m³N), como [illegible] correspondan a concentraciones expresadas en términos de volumen a volumen [illegible] en partes por millón (ppm). Lo anterior, debido a que los equipos [illegible] las mediciones de concentraciones ambientales de gases entregan los valores [illegible] concentraciones en base a una relación volumen a volumen.

Saluda atentamente a usted.

Dra. MICHELLE BACHELET JERIA
MINISTRA DE SALUD

Dr.MHM/Ing.JMS/WFA

SG/6245
27/10/00

GOBIERNO DE CHILE
MINISTERIO DEL INTERIOR
INTENDENCIA REGION DE ATACAMA

01006

ORD.:Nº 769 /

ANT.:

MAT.: Informa preocupación por revisión de normas sobre calidad del aire.

COPIAPO, 25 OCT 2000

DE : INTENDENTE DE LA REGION DE ATACAMA

A : SEÑOR MINISTRO DEL INTERIOR
DON JOSE MIGUEL INSULZA SALINAS

Cumplo con informar a US. que el lunes 23 del mes en curso, se reunió con el suscrito una delegación encabezada por el Secretario Regional Ministerial de Minería, don Antonino Prado Castro, el Gerente de la Fundición Hernán Videla Lira, don José Sanhueza Reyes, el Relacionador Público, don Lorenzo Sotomayor Torreblanca, y el Encargado del Medio Ambiente, don Rubén Bastias Orellana, a fin de expresarme su grave preocupación por la revisión de normas sobre calidad del aire SO_2, actualmente en fase de consulta pública.

Al respecto, presentaron el documento que le agradeceré encontrar adjunto, que en esencia sostiene lo siguiente:

1.- Que de aprobarse la reducción a 250 µg/Nm^3, de la norma primaria diaria, la referida Fundición no podrá cumplir el nuevo valor límite, bajo ninguna circunstancia, en el poblado de Estación Paipote situado a 1 kms. de distancia.

Observan que la norma federal de USA sobre el particular, es de 365 µg/Nm^3 y data del año 1971, sin que hasta ahora se haya considerado fundamentos necesarios para modificarla.

2.- Se propone, asimismo, una nueva norma primaria horaria para SO_2, con valor de 1050 µg/Nm^3 y un percentil de 99%, también imposible de cumplir en áreas habitadas cercana a la Fundición, porque no depende del nivel de emisiones de ella sino de las variables climatológicas de la zona, difícilmente predecible por el relieve del sector.

Cabe señalar que USA con nivel de ingreso varias veces superior al nuestro, estimó innecesario establecer normas para períodos inferiores a 24 horas.

En suma, después de que ENAMI efectuó una inversión cercana a los US$ 90 millones para cumplir la normativa actual vigente, estaría expuesta a un inminente cierre de la Fundición, por una nueva normativa que le resulta imposible de cumplir a menos, que se efectúen nuevas inversiones que están fuera de su alcance.

01007

Aunque al Intendente que suscribe le parece extremadamente difícil que una autoridad pública pueda proceder en Chile en la forma antes indicada, salvo búsqueda de objetivos que escapan a la procedencia de interpretar, cumplo con informar a US. lo expresado para los fines a que haya lugar.

Saluda atentamente a US.

ARMANDO ARANCIBIA CALDERON
INTENDENTE DE LA REGION DE ATACAMA

INTENDENCIA ATACAMA
COPIAPO
CHILE

INCL.: Informe de ENAMI.

DISTRIBUCION:
- Ministro del Interior, don José Miguel Insulza Salinas
- Ministro Secretaría General de la Presidencia, don Alvaro García Hurtado
- Ministro de Economía, Minería y Energía, don José de Gregorio Rebeco
- Subsecretario del Interior, don Jorge Burgos Varela (c.i.)
- Subsecretario Secretaría General de la Presidencia, don Eduardo Dockendorff Vallejos (c.i.)
- Subsecretaria de Minería, Sra. Jacqueline Saintard Vera (c.i.)
- Archivo (2)
AAC/nlg

ENAMI

01008

NORMA DE CALIDAD DEL AIRE

PROCESOS REVISIÓN NORMATIVA PARA SO_2

ANTECEDENTES

Desde el año 1995 y hasta diciembre del año 1999, la Fundición Hernán Videla Lira, realiza el Plan de Descontaminación, el cual se traduce en una modernización de la Fundición con un costo cercano a los US$ 90 millones.

El Plan de Descontaminación persigue cumplir la actual normativa para SO_2:

Norma Primaria	Anual	:	80	µg/Nm³ de SO_2
	Diaria	:	365	µg/Nm³ de SO_2
Norma Secundaria	Horaria	:	1.000	µg/Nm³ de SO_2

De acuerdo al calendario priorizado, de revisión de normas de la Comisión Nacional de Medio Ambiente, durante el año 2000 se presenta un anteproyecto de revisión de la normativa existente de calidad del aire para SO_2, el cual en la actualidad se encuentra en la fase de consulta pública.

PROPOSICIÓN DE NUEVA NORMATIVA DE CALIDAD

Norma primaria	Anual	:	Se mantiene.		
	Diaria	:	250	µg/Nm³	(Aumenta restricción)
	Horaria	:	1.050	µg/Nm³	(No existía anteriormente)
Norma secundaria	Horaria	:	Se mantiene.		

NORMA DIARIA PARA SO2 : Se ha propuesto disminuirla de 365 a 250 µg/Nm³, con un percentil de cumplimiento de 99%. El valor límite propuesto no es posible de ser cumplido bajo ninguna circunstancia en el poblado de Estación Paipote, distante solo a 1 km, al N-O de la Fundición.

La proposición de ENAMI conlleva el criterio de la gradualidad, proponiéndose para los próximos 5 años un valor de la norma diaria de calidad del aire de 330 µg/Nm³ con un 99% de cumnplimiento, o bien 300 µg/Nm³ con percentil 98.

Como dato ilustrativo, la norma federal de USA, que data de 1971, es de 365 µg/Nm³; en 1996 fue objeto de revisión, concluyéndose que no existían méritos suficientes para modificarla.

SITUACIÓN ACTUAL BAJO ESTA NUEVA NORMATIVA

Al mes de septiembre del presente se habría sobrepasado en 7 oportunidades, todas ellas en Estación Paipote.

La actual normativa, se ha sobrepasado sólo en una oportunidad el presente año.

NORMA PRIMARIA HORARIA PARA SO_2: Se ha propuesto establecer una norma horaria, con un valor de 1.050 $\mu g/Nm^3$, con un percentil de cumplimiento de 99%. Se señala como justificación para esta nueva norma, la protección de la salud de la población en lo que respecta a aspectos agudos de corto plazo en personas sensibles, en especial asmáticos.

Una norma de este tipo, que permite sólo 4 excedencias al año, es técnicamente imposible de cumplir en áreas habitadas tan cercanas a la Fundición, como lo es la localidad de Paipote, ello porque no depende del nivel de emisiones, de la Fundición, sino de las variables meteorológicas de la zona, las que son difícilmente predecibles por el relieve del sector.

En la mencionada revisión de la norma federal de USA (1996), se estimó innecesario establecer normas para períodos inferiores a 24 horas.

SITUACIÓN ACTUAL BAJO ESTA NUEVA NORMATIVA

Al mes de septiembre del presente, se habría sobrepasado en 36 oportunidades

NORMA SECUNDARIA PARA SO_2

Esta normativa, no se modifica en esta oportunidad. Tiene relación con el resguardo con los recursos silvio agropecuarios.

En lo que va corrido, se ha sobrepasado en 6 oportunidades en el sector de Tierra Amarilla.

El cobre es un "commodity" transado en los mercados internacionales, donde las exigencias de certificación están siendo un requisito indispensable si se quiere ser un actor relevante en el mercado, por lo que al momento de generar una normativa nacional hay que tener presente el impacto que puede tener ésta en la comercialización del producto. La certificación exige el cumplimiento de la normativa nacional y cambios demasiado seguidos dificultan su satisfacción.

FUNDICION "HERNAN VIDELA LIRA" • Camino Público S/N° • Fax: (52) 229128 - 229133 • Fonos (52) 229102 - 229103 • Casilla 483
COPIAPO - CHILE

ANEXOS

- **Episodios críticos por concentración de SO_2:**

  * Detalle de los episodios críticos durante el año 2000.
  * Estadística episodios críticos desde el año 1993.

01010

- **Normativa diaria para SO_2:**

  * Estadística del N° de veces que se supera la norma desde 1993.

- **Normativa diaria propuesta para SO_2:**

  * Estadística del N° de veces que se habría superado la normativa propuesta, durante el año 2000.

- **Nueva normativa de calidad primaria (horaria):**

  * En la legislación actual esta normativa no existe.
  * Estadística del N° de veces que se habría superado la nueva normativa durante el año 2000.

- **Normativa secundaria para SO_2:**

  * Estadística de la superación de la norma secundaria (protege los recursos agrícolas) durante el año 2000.

- **Concentración de SO_2 $\mu g/Nm^3$ por estaciones:**

  * Normativa anual actual se cumple en todas las estaciones (80 $\mu g/Nm^3$) desde el año 1997.
  * Estadística de concentración de SO_2, por estación de monitoreo desde el año 1993.

- **Plan operacional preventivo:**

  * Detalle de las horas diarias de restricción operacional que se aplican en la Fundición por condiciones meteorológicas adversas para dispersión de los contaminantes.

RBO/gpa
23.10.2000

Episodios Críticos por SO_2 en los entornos de la F.H.V.L. durante año 2000

Fecha	Día	Estación	Tipo	Concentración	Hora	Peak	Promedio Día
28/04/00	Viernes	E. Paipote	Alerta	2.045 μg/Nm^3	09 - 10	4.836 μg/Nm^3	166 μg/Nm^3
12/07/00	Miércoles	E. Paipote	Alerta	1.984 μg/Nm^3	10 - 11	3.805 μg/Nm^3	341 μg/Nm^3
23/07/00	Domingo	E. Paipote	Alerta	1.979 μg/Nm^3	09 - 10	3.936 μg/Nm^3	259 μg/Nm^3
12/08/00	Sábado	E. Paipote	Alerta	2.404 μg/Nm^3	09 - 10	5.608 μg/Nm^3	208 μg/Nm^3
16/09/00	Sábado	E. Paipote	Advertencia	3.016 μg/Nm^3	09 - 10	7.700 μg/Nm^3	160 μg/Nm^3

Alertas: 4
Advt.: 1
Emerg.: 0
Total: 5

E. Paipote:	**5**
T. Amarilla:	**0**
S. Fndo :	**0**
Copiapó:	**0**
L. Volcanes:	**0**
Pabellón:	**0**
Total:	**5**

L : 0
M: 0
M: 1
J: 0
V: 1
S: 2
D: 1
Total: 5

9 - 10 Hrs.: 4
10 - 11 Hrs.: 1
Total: 5

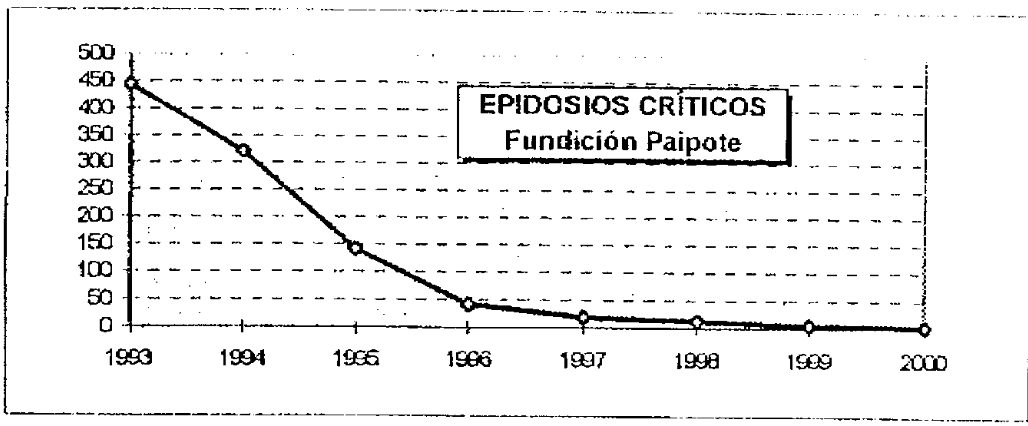
Superación Norma Diaria de SO_2 en los entornos de la F.H.V.L. durante año 2000

Fecha	Día	Estación	Promedio Día	Máx. Promedio Hora
16/07/00	Domingo	E. Paipote	493 μg/Nm^3	1.824 μg/Nm^3

01011

EPISODIOS CRÍTICOS SO2 (> 1963 µg / Nm3)

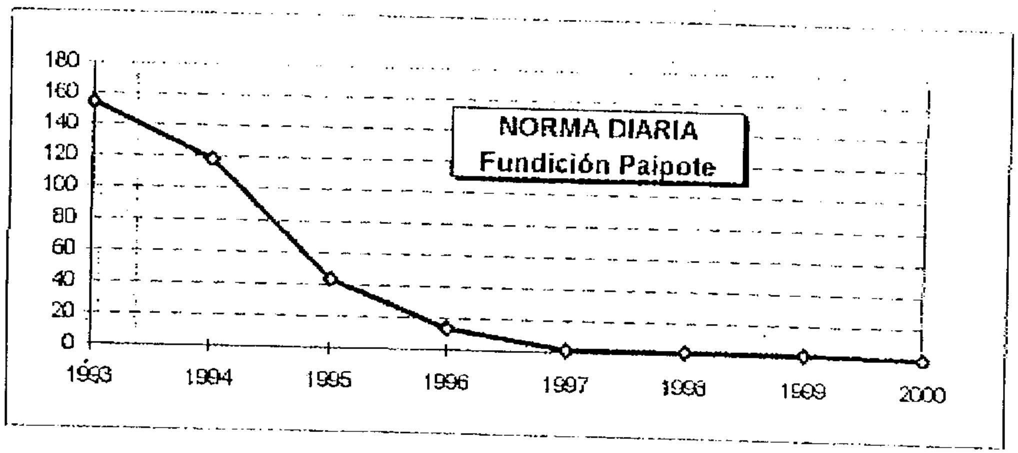
MES	1993	1994	1995	1996	1997	1998	1999	2000
ENE	7	18	10	3	3	1	0	0
FEB	13	16	13	2	4	1	0	0
MAR	32	16	27	1	1	1	2	0
ABR	19	38	33	1	0	4	0	1
MAY	25	42	21	7	1	0	1	0
JUN	68	60	10	4	3	0	2	0
JUL	88	34	11	3	1	1	0	2
AGO	94	34	11	0	2	2	2	1
SEP	52	24	2	5	2	2	0	1
OCT	20	12	3	4	2	2	0	
NOV	14	23	2	6	1	0	0	
DIC	13	6	0	7	0	0	0	
TOTAL	445	323	143	43	20	14	7	5



01012

VECES SOBRE LA NORMA DIARIA SO_2 (> 365 µg / Nm3)

MES	1993	1994	1995	1996	1997	1998	1999	2000
ENE	0	4	1	0	0	0	0	0
FEB	2	3	3	1	0	0	0	0
MAR	6	2	5	0	0	0	0	0
ABR	7	14	10	0	0	1	0	0
MAY	11	16	7	2	1	0	1	0
JUN	34	25	4	4	0	0	0	0
JUL	36	18	10	3	1	0	0	1
AGO	33	16	3	1	0	0	1	0
SEP	17	9	0	2	0	0	0	0
OCT	3	3	1	1	0	1	0	
NOV	4	8	0	0	0	0	0	
DIC	2	1	0	0	0	0	0	
TOTAL	155	119	44	14	2	2	2	1



Fundición Hernán Videla Lira

Proposición Normativa Diaria para SO_2

Veces en que el promedio diario de SO_2 supera 250 ug/Nm^3

Año 2000

	Estaciones de Monitoreo						
	Copiapó	*S. Fernando*	*Los Volcanes*	*Paipote*	*Pabellón*	*T.Amarilla*	*Total*
Enero	0	0	0	0	0	0	0
Febrero	0	0	0	0	0	0	0
Marzo	0	0	0	0	0	0	0
Abril	0	0	0	0	0	0	0
Mayo	0	0	0	1	0	0	1
Junio	0	0	0	5	0	0	5
Julio	0	0	0	1	0	0	1
Agosto	0	0	0	0	0	0	0
Septiembre	0	0	0	0	0	0	0
Octubre							
Noviembre							
Diciembre							
Total	0	0	0	7	0	0	7

Red de Monitoreo Ambiental Fundición Hernán Videla Lira

Frecuencia mensual superación futura Proyecto Norma Horaria Primaria de SO_2 (>1.050 ug/Nm^3)

Año 2000

	Estaciones de Monitoreo						
	Copiapó	S. Fernando	Los Volcanes	Paipote	Pabellón	T.Amarilla	Total
Enero	0	0	0	0	0	0	0
Febrero	0	0	0	2	0	1	3
Marzo	0	0	0	1	0	0	1
Abril	0	0	0	1	0	0	1
Mayo	0	0	1	1	0	0	2
Junio	0	0	0	5	0	1	6
Julio	0	0	0	10	0	3	13
Agosto	0	0	0	7	0	1	8
Septiembre	0	0	0	2	0	0	2
Octubre							
Noviembre							
Diciembre							
Total	0	0	1	29	0	6	36

1015

01016

Red de Monitoreo Ambiental Fundición H. Videla L.

Frecuencia mensual superación Norma Secundaria de SO_2 (> 1.000 µg/Nm3)

2000

MES	T. Amarilla	S. Fernando	Pabellón	TOTAL
ENE	0	0	0	0
FEB	1	0	0	1
MAR	0	0	0	0
ABR	0	0	0	0
MAY	0	0	0	0
JUN	1	0	0	1
JUL	3	0	0	3
AGO	1	0	0	1
SEP	0	0	0	0
OCT				
NOV				
DIC				
TOTAL	6	0	0	6

01017

CONCENTRACIÓN DE SO_2 (µg/Nm^3)

AÑO	COPIAPO	S. FERNANDO	PAIPOTE	T. AMARILLA	Los VOLCANES
1993	78.1	125.5	275.5	148.2	-
1994	62.2	95.8	234.5	148.3	-
1995	56.4	56.6	134.1	128.8	52.4
1996	43.2	38.5	104.6	84.4	42.4
1997	18.6	23.4	67.1	44.3	19.9
1998	14.0	17.4	57.0	36.2	18.0
1999	9.0	15.3	45.0	24.8	5.1
2000 (*)	4.8	9.2	52.6	26.9	14.0

(*): Promedio al mes de Septiembre

Plan Operacional Preventivo 2000

Sugerencias del Servicio de Meteorología

Horas Promedio Diario

Mes	Plan preventivo F.H.V.L.			
	Condición Regular	Condición Mala	Condición Extrema	Horas Promedio Diario
ENERO	0.84	0.37	0.00	1.21
FEBRERO	1.53	0.78	0.00	2.31
MARZO	1.64	0.32	0.00	1.96
ABRIL	2.17	0.56	0.00	2.73
MAYO	2.76	3.35	0.00	6.11
JUNIO	3.70	4.25	0.00	7.95
JULIO	3.88	4.92	0.00	8.80
AGOSTO	4.53	3.55	0.53	8.61
SEPTIEMBRE	4.28	3.47	0.15	7.90
OCTUBRE				0.00
NOVIEMBRE				0.00
DICIEMBRE				0.00
PROMEDIO	2.81	2.40	0.08	5.29

CORPORACION NACIONAL DEL COBRE DE CHILE
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CODELCO

COMISION NACIONAL DEL MEDIO AMBIENTE
OFICINA DE PARTES Y ARCHIVO
Nº INGRESO: 12679 / 11581
FECHA:
DESPACHADO: 31 OCT 2000
OBS.: P. MATUS

GMA-447/00

Santiago, 30 de octubre de 2000

27437

Señora
Patricia Matus C.
Jefe Departamento
Descontaminación, Planes y Normas
Comisión Nacional del Medio Ambiente
Presente

Ref: **Observaciones a Anteproyecto Revisión Norma de Calidad del Aire. Entrega de Antecedentes Adicionales.**

Estimada señora Matus:

Por intermedio de la presente queremos reiterar nuestras observaciones al Anteproyecto de la referencia contenidas en nuestra nota GMA-372/00, del 21.08.00, cuya copia adjunto, en relación a la imposibilidad de dar cumplimiento en nuestras operaciones a la norma de calidad horaria del aire para SO2, tanto por los valores propuestos como por la factibilidad práctica de su aplicación.

A los antecedentes anteriormente entregados, adjuntamos documento con respuestas a las preguntas específicas enviadas por esa Comisión en su Car.UEA N°029/004568, que permitirán cuantificar el enorme daño económico que la aplicación de dicha Norma infligiría a nuestra Corporación.

En resumen, la situación que planteamos es la siguiente:

1. La División, en su Plan de Desarrollo, considera un aumento de su capacidad de fusión desde 1.25 a 1.6 millones de toneladas de concentrado al año y ha incluido para ello proyectos adicionales de captación de sus gases, concordantes con los límites de emisión establecidos en su Plan de Descontaminación (Nuevo Módulo de Planta de Limpieza de Gases N°1 y Tratamiento de Gases Secundarios de Convertidor Teniente y Convertidores Peirce-Smith).

2. La materialización del Plan de Descontaminación y el cumplimiento de las emisiones de SO2 consignadas en él permitirá dar cumplimiento con holgura a la norma anual vigente y en forma muy ajustada a la norma de 24 horas propuesta (250 ugr SO2/Nm3). La incorporación de una norma horaria en los valores propuestos en el Anteproyecto, no tiene posibilidad alguna de ser cumplida, proyectándose excedencias en un 10% de los días del año.

3. Las excedencias horarias son resultado exclusivamente de variaciones meteorológicas ante las cuales no es posible reaccionar oportunamente para evitarlas. Se haría necesario operar con modelos meteorológicos predictivos que obligarían a bajas de fusión con 8 horas de anticipación a la posible ocurrencia del fenómeno, muchas veces sin que ello sea necesario a causa del alto nivel de incerteza de estos modelos. Ello, en su oportunidad, fue bien entendido por CONAMA con ocasión de la dictación del Plan de Descontaminación.

01020

4. La única forma de asegurar el cumplimiento de la normativa horaria propuesta es no materializando la expansión proyectada, pero sí realizando los proyectos adicionales de captación de gases que se han diseñado para permitirla.

5. CODELCO insiste en que la situación de impactos agudos debe ser abordada a través del manejo de episodios críticos incluidos en el mismo Anteproyecto de Revisión de la Norma.

De acuerdo con lo anterior, el costo económico para la Corporación consiste en la no ampliación de la capacidad productiva de la Fundición Caletones, incurriendo además en los costos de inversión considerados para dicha expansión (ampliación de la planta de limpieza de gases y tratamiento de gases secundarios).

La Corporación pone a su disposición estos antecedentes para ser considerados en el proceso de consulta pública que esa Comisión está realizando y en el proceso de evaluación socio-eonómica del Anteproyecto de la referencia.

Sin otro particular, saludo atentamente a Ud.

Santiago Torres E.
Gerente de Medio Ambiente

CODELCO-CHILE

CORPORACION NACIONAL DEL COBRE DE CHILE

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01021

GMA-372/00

Santiago, 21 de Agosto de 2000

Sra.
Patricia Matus C.
Jefe Depto. Descontaminación,
Planes y Normas
Comisión Nacional del Medio Ambiente
PRESENTE

Ref: **Revisión de Normas Primarias de Calidad del Aire**

Estimada Sra. Matus:

Hemos tomado conocimiento de la propuesta de Anteproyecto para la Revisión de la Norma en referencia, que incluye algunos cambios en ella que son de nuestra preocupación.

La Corporación ha realizado un importante esfuerzo en la realización de proyectos diseñados para dar cumplimiento a los Planes de Descontaminación de sus Fundiciones, los que han sido concebidos sobre la base de la normativa actualmente vigente. Estos Planes, por sí solos, no están en condiciones de dar respuesta apropiada a los nuevos límites de concentración que impondría la nueva Norma y, aún con la ejecución de proyectos complementarios, sus operaciones quedarían en una situación bastante vulnerable para la seguridad de su cumplimiento.

A continuación nos referimos a los principales cambios considerados en la revisión:

1. **Partículas Totales en Suspensión:** la propuesta elimina este parámetro, idea con la cual concordamos plenamente, al existir otras normas que controlan en mejor forma el material particulado.

2. **Norma Anual SO2:** la propuesta mantiene el valor de este parámetro, posición con la que concordamos, pues no existen antecedentes que ameriten modificarlo.

3. **Norma SO2 24 horas:** se ha propuesto disminuirla de 365 a 250 ugr/Nm3, con un percentil de cumplimiento de 99%. El valor límite propuesto no es posible de ser cumplido bajo ninguna circunstancia en el campamento de Chuquicamata, ni ser cumplida a cabalidad en el Centro de Alojamiento de Potrerillos (División Salvador) o en Coya Club de Campo y en lugares residenciales de Coya cercanos a él (División El Teniente). Ante un eventual traslado del campamento de Chuquicamata, estaríamos corporativamente en condiciones de cumplir una Norma no inferior a 300 ugr/Nm3, con un percentil de cumplimiento de 98%.

4. **Norma Primaria Horaria de SO2:** aquí se ha propuesto, contra la opinión del consultor de CONAMA sobre esta materia, establecer una Norma Horaria, fijándola en un valor de 1050 ugr/Nm3, con un percentil de cumplimiento de 99%. Al margen de las consideraciones de beneficio-costo realizadas por el consultor, se debe tener en cuenta lo poco práctico de una norma de este tipo, pues las acciones de control operacional a adoptar de tipo reactivas no tendrían efectos dentro de este corto período. Para evitar su ocurrencia, las medidas necesariamente deberían ser de tipo preventivas, lo que obligaría a operar las fundiciones en base a complejos modelos meteorológicos predictivos (que han revelado ser de escasa exactitud), que las llevaría a significativas pérdidas productivas, muchas veces innecesarias. Nos parece que las situaciones de impactos agudos de corto tiempo pueden ser mucho mejor manejados a través de las medidas establecidas para el manejo de episodios críticos, los que se pueden establecer aún cuando no existan Planes de Descontaminación en vigencia (Ejemplo: restricciones de circulación de vehículos y paralización de fábricas en Santiago desde mucho tiempo antes que se estableciera un Plan de Descontaminación al respecto).

   Si se mantuviera la idea de manejar estas situaciones a través de una Norma de Calidad, nos parece más lógico establecer una que regule el promedio móvil de tres horas, período en el cual sí se puede reaccionar con medidas de control operacional efectivas. El valor podría ser el mismo propuesto, pero con un percentil de cumplimiento de 98%.

No entendemos la razón de aplicar para este contaminante percentiles de cumplimiento de 99%, en circunstancias que para PM10 este percentil es de 98%. A nuestro juicio, este nivel de percentil debería igualarse para todas las normas y no definir este valor en forma arbitraria para cada una de ellas.

Finalmente, queremos hacer llegar a Ud. una preocupación respecto del proceso normativo ambiental, en general. La globalización del comercio internacional ha llevado a establecer modelos de comportamiento ambiental aceptables internacionalmente, para evitar discriminaciones arbitrarias al respecto. Las empresas chilenas que basan su gestión en el comercio internacional de sus productos, están siendo presionadas progresivamente por el mercado a establecer estos modelos de gestión ambiental consensuados. Codelco, así como otras empresas exportadoras, están implementando sistemas de gestión ambiental para ser certificados por la Norma ISO-14001. Esta Norma tiene como su principal exigencia, el cumplimiento del marco regulatorio aplicable. Un no cumplimiento de este marco es razón suficiente para no certificar o, peor aún, para perder una certificación alcanzada. Ello lleva a la necesidad de ser muy cuidadosos al definir la normativa a aplicar, teniendo en consideración sus posibilidades reales de cumplimiento, a fin de no dejar fuera del mercado internacional a volúmenes importantes de la producción nacional.

Esperando que nuestras observaciones puedan ser acogidas en el Anteproyecto de Revisión de las Normas Primarias de Calidad de Aire, la saluda muy atentamente,

Santiago Torres E.
Gerente de Medio Ambiente

Antecedentes solicitados por CONAMA a CODELCO con relación al proceso de revisión de las normas primarias (carta UEA Nº 4568).

1. Serie de datos de emisiones mensuales de SO_2 para la Fundición de Caletones, anteriores a enero de 1998.

Las emisiones mensuales de SO2 son las siguientes (tSO2/mes):

	Ene	Feb	Mar	Abr	May	Jun	Jul	Ago	Sep	Oct	Nov	Dic	Total t/año
1994	66747	49515	69387	66336	69274	59664	64005	67622	56567	67860	64162	66060	767200
1995	56085	61651	66505	64259	67538	67974	63916	66462	63513	49952	65986	66477	760316
1996	64535	50049	69095	64022	63122	64813	67439	64198	58727	66643	64390	62997	760032
1997	60976	61102	62677	45107	66587	56556	60197	67608	64807	65313	61049	67792	739771

Como antecedente adicional, se aporta el hecho que en el D.S. Nº 81/98 (punto tercero) ya se indicaba que los promedios anuales de emisiones de SO_2 para el periodo 1993 a 1995 habían sido similares, con valores que fluctuaban en el rango de 760.000 a 788.750 tpa, y que la emisión mensual fluctuaba entre 48.000 y 74.000 t/mes con medias en el rango 62.000 a 66.000 t/mes, dependiendo del año considerado.

2. Medidas factibles de aplicar, en caso de ser necesario, para reducir las emisiones de SO2, en el escenario de las normas propuestas en el anteproyecto, en particular respecto al cumplimiento de la norma horaria.

a) Antecedentes:

Como es sabido, el Plan de Descontaminación vigente para el área circundante a la Fundición de Caletones, incluyendo el proyecto de manejo de gases secundarios, involucra una inversión de US$ 237 millones y está diseñado para lograr el cumplimiento, a partir de año 2003, de las actuales normas de calidad ambiental de SO2 establecidas en el D.S. Nº 185, considerando un nivel de fusión anual de 1250 kta de concentrado.

Sin embargo, dado el escenario de desarrollo Divisional PDT (Plan de Desarrollo Teniente), el CBV2001 (Caso Base Vigente del año 2001) ha incorporado el incremento de capacidad de la Fundición desde 1250 a 1.600 kta de concentrado fundido a partir del año 2003. Esto significa requerimientos de inversiones para las soluciones tecnológicas que permitan el cumplimiento de las actuales normativas ambientales de calidad y estas inversiones, adicionales al Plan de Descontaminación, serían las siguientes:

- Instalación de un nuevo módulo a la PLG N°1............................ kUS$30.000
- Tratamiento de los gases secundarios de CT y CPS......................kUS$ 5.700

Lo anterior implica además costos de operación asociados a la mayor producción de ácido y de la operación del Scrubber para el lavado de gases, que en general impactan negativamente en el negocio.

Ahora bien, la Ley de Bases del Medio Ambiente, en sus artículos Nº 43 y Nº 44, establece que en caso de verificarse con mediciones fundadas, la condición de zona latente o saturada, procede primero la declaración de la zona como tal y luego, el establecimiento, según corresponda, de planes de prevención o descontaminación, cuyo cumplimiento es obligatorio.

Considerando todos estos antecedentes, las respuestas a las preguntas que se han realizado se situarán en el año 2003, lo que significa analizar la situación con emisiones e inmisiones proyectadas mediante modelaciones.

b) Resultados de la modelación de la calidad del aire

- **Situación norma anual:**

Al modelar la calidad del aire, en función de la emisión anual de SO2 esperada una vez concluido el plan de descontaminación, se obtienen los siguientes resultados en las estaciones sujetas al cumplimiento de las normas primarias:

	Coya Club	Coya Poblacional
Concentración **anual** ug/Nm^3	27	5
Norma (ug/Nm^3)	80	80

Estos resultados indican, que en términos anuales, se cumpliría la norma dispuesta en el anteproyecto

- **Situación norma diaria:**

Para estimar la situación diaria, es necesario considerar que por razones operacionales las emisiones diarias tienen una variabilidad y en algunos días las emisiones alcanzarán valores superiores a la emisión diaria media. Al modelar la calidad del aire bajo esta consideración e incorporando el error propio de la estimación, se obtienen los siguientes resultados:

	Coya Club	Coya Poblacional
Nº de excedencias diarias, **sobre 250** $ugSO2/Nm^3$	3	0

Estos resultados indican, que en términos diarios, estaría comprometido el cumplimiento de la norma diaria de 250 $ugSO2/Nm^3$ dispuesta en el anteproyecto.

Situación norma horaria:

En términos similares a la situación anterior, al modelar la situación horaria con la variabilidad esperada de las emisiones horarias y el error de la estimación, se obtienen los siguientes resultados:

	Coya Club	Coya Poblacional
Concentración **horaria** máxima (ug SO2/Nm^3)	1172	396
N° de excedencias diarias, **sobre 1000** ugSO2/Nm^3	36	0
Norma propuesta 400 ppbv (ug/Nm^3)	1050	1050

Estos resultados indican que en la estación de Coya Club, en términos horarios, no se cumpliría la nueva norma horaria dispuesta en el anteproyecto.

Finalmente, es importante considerar que es posible también la existencia de otras zonas aledañas a la Fundición, como las poblaciones Bellavista, Serviu y otras, donde actualmente no existen estaciones de monitoreo en que las normas señaladas en el Anteproyecto sean sobrepasadas. Esto es importante, considerando el artículo N° 11 del Anteproyecto de norma en que se señala que si "en un área determinada los resultados de concentración superan la norma, el Servicio de Salud deberá establecer, en un plazo máximo de 3 años, un monitoreo en dicha área".

c) Medidas factibles de aplicar

Dada la geografía, meteorología y lejanía de los sectores poblados aledaños a la Fundición Caletones, es difícil asegurar un cumplimiento de las nuevas normativas horarias, por lo que las medidas factibles de aplicar pasan por la reducción significativa de emisiones a niveles de fijación mayores al 96%, estándar difícil de alcanzar sin quiebres tecnológicos a los procesos.

Bajo lo anteriormente indicado, las medidas factibles para reducir emisiones de SO_2 en el escenario de cumplir las normas propuestas, son las siguientes:

- Tratamiento de gases de cola PLG's
- Manejo de gases baja altura nave (lucarna)

3. Estimación detallada de los costos para cada una de las medidas consideradas

Las inversiones asociadas son las siguientes:

- Tratamiento de gases de cola PLG's............................kUS$15.000
- Manejo de gases baja altura nave (lucarna).................kUS$ 3.000

4. Plazos requeridos para la implementación de las medidas

Los plazos asociados a estas alternativas desde el momento de la aprobación de las respectivas inversiones, se estiman no inferiores a 3 años a partir del año 2004, y pasan por interferencias a la Fundición y detenciones en las PLG para su modificación (doble contacto o tratamiento gases cola), que en general pueden representar costos de interferencias bastante significativos.

5. En la eventualidad que la Fundición deba controlar o prevenir la excedencia de la norma horaria, a través de la reducción de fusión de concentrados:

a) ¿Con cuánto tiempo debe reducir fusión para llegar a la condición de operación que controlará dicha excedencia?

b) ¿Cuál es el tiempo requerido para volver a carga completa una vez que la condición atmosférica adversa ha finalizado?

Una estimación basada en las velocidades del viento y la distancia entre la Fundición y Coya Club, determina que el tiempo de viaje del SO2 es de aproximadamente 4-5 horas para las zonas altas de Coya y 6-7 horas para las zonas bajas de Coya. Esto, significa que una vez tomadas las medidas, el efecto se produciría después de 6 a 7 horas. Esta situación fue reconocida en el Plan de Descontaminación, en donde no se exigió a la Fundición tomar medidas operacionales en el caso de sobrepasar las normas sino que sólo ante la existencia de episodios críticos en el caso de Sewell.

En el caso de que la Fundición requiera controlar o prevenir la excedencia de la norma horaria, a través de la reducción de fusión, se requeriría contar con un modelo de predicción horaria de altísima exactitud y además tomar las medidas con al menos 7 a 8 horas de antelación. A saber no se conoce la existencia de un modelo de estas características y por lo tanto se considera que esta alternativa debe ser descartada en el caso de la Fundición de Caletones.

6. Capacidad actual y proyectada para retención diaria/horaria de SO_2 en la Planta de Acido

De acuerdo a los diseños, las capacidades de procesamiento de SO_2 en las Plantas de Ácido actuales son los siguientes:

Características de Diseño de Proceso Original de la PLG N° 1

- Flujo de gases de proceso: 150.000 – 174.000 Nm^3/h b.h.
- Producción de Acido Sulfúrico: 1.500 t/día (174.000 Nm^3/h; 8,7% SO_2 b.h.)
- Composición SO2 (b.h.), %vol: 9,8 – 8,7
- Eficiencia conversión 97.5% (simple contacto)

Características de Diseño de PLG N° 1, con Nuevo Módulo (etapa II PDT)

- Flujo de gases de proceso: 250.000 Nm^3/h b.h.
- Producción de Acido Sulfúrico: 2.500 t/día
- Composición SO2 (b.h.), %vol: 9,8 – 8,7

Características de Diseño de Proceso Original de la PLG N° 2

El proyecto de instalación de la PLG Nº 2 se conceptualizó para procesar 280.000 Nm^3/h de gases, equivalentes a los flujos de gases producidos por 1 CT y 2 CPS en etapa de soplado. Con este esquema, la producción equivalente de H_2SO_4 de esta planta alcanzaría inicialmente 2.350 t/d, y 3.100 tpd como capacidad máxima.

- Flujo de gases de proceso: 235.000 – 280.000 Nm3/h b.h.
- Producción media de Acido: 2.700 t/día
- Composición SO2 (b.h.), %vol: 9,8 – 8,0
- Eficiencia conversión 98.2% (simple contacto)

7. ***Proyecciones de producción y de precios de venta de cobre para los próximos 10 años***

a) **Proyecciones de producción de cobre para los próximos 10 años (Kt/año) Fundición Caletones, según situación de CBV2001 que incrementa capacidad a partir del 2003:**

Año	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Producción	383	382	443	494	490	487	483	484	485	485

b) **Precios de venta de cobre para los próximos 10 años.**

Se estima que esta respuesta puede ser entregada con mayor precisión por el área de Gestión Estratégica de la Corporación. No obstante, para responder a esta consulta la División ha recurrido a las siguientes fuentes de información:

En el mediano plazo, hasta el año 2005, a las estimaciones que realiza la Gerencia de Estudios y Gestión estratégica de CODELCO Chile y que son las siguientes:

Año	2000	2001	2002	2003	2004	2005
Precio (US$c/lb)	80.0	90.0	100.0	115.0	120.0	110.0

En el largo plazo, desde el año 2006 en adelante, al trabajo desarrollado por I. Marshall y E. Silva denominado "Evolución futura del precio del cobre", en donde se ha proyectado que el precio del cobre oscilaría entre los 95 y 110 US$c/lb.

COMISION NACIONAL DEL MEDIO AMBIENTE
OFICINA DE PARTES Y ARCHIVO
Nº INGRESO: 12873/11454
FECHA: 03 NOV 2000
DESPACHO:
R. Lucero
2 7664

MEMORANDUM Nº 0265

CONAMA
COMISION NACIONAL DEL MEDIO AMBIENTE

Valparaíso, 30 de octubre del 2000

DE : Director Regional

A : Rodrigo Lucero C.

De mí consideración:

Adjunto envío observaciones y comentarios al anteproyecto para la norma primaria de ozono.

Se despide atentamente a Usted,

COMISION NACIONAL DEL MEDIO AMBIENTE
DIRECTOR
QUINTA REGION

Gerardo Guzmán Grimaldi
Directora Regional
Comisión Nacional del Medio Ambiente

GGG/MCF/mhm

C.c.: Archivo CONAMA

COMISION NACIONAL DEL MEDIO AMBIENTE
REGION DE VALPARAISO

01029

OBSERVACIONES ANTEPROYECTO DE REVISION DE NORMA PRIMARIA DE CALIDAD DE AIRE PARA OZONO (O_3)

Punto II. Disposiciones Generales y Definiciones

Articulo 2 letra a.

¿Qué se entenderá por "períodos cortos de exposición" ¿no importa la frecuencia con que el individuo se expondrá a estos periodos corto?

Se propone especificar los rangos de tiempo que se entenderán como exposición en periodos cortos. Lo anterior se consulta debido a lo que se entenderá como el límite permisible de exposición sobre el cual el contacto con este contaminante significa un riesgo.

Por ejemplo:

a. *Efectos Agudos*: Aquellos producidos por la acción de concentraciones variables del contaminante en períodos de 1 a 8 horas continuas de exposición.

Artículo 2 letra f.

1. Se requiere definir si los criterios consignados en las letra i) e ii) se deben cumplir en forma simultánea, para lo cual se propone el siguiente texto:

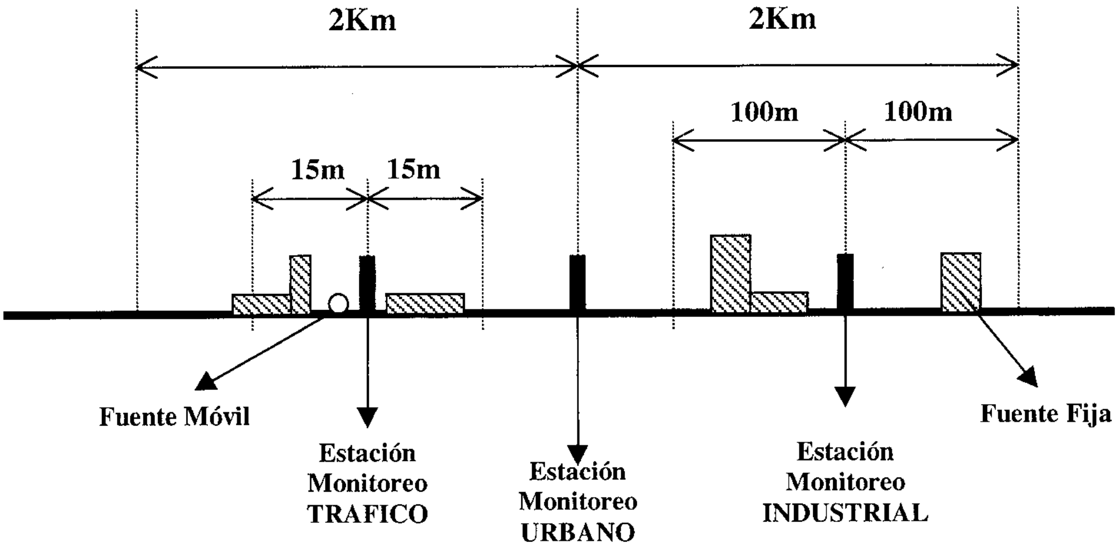
   EMRPG: Una estación de monitoreo podrá clasificarse como EMRPG si se cumplen simultáneamente los siguientes criterios:

2. Se sugiere especificar bajo que criterio se estableció la representatividad de la estación en un radio de 2Km. debido a que el radio de 2 Km. (el mismo usado en el decreto 59 de norma primaria de material particulado) esta determinado para una estación de muestreo Urbano con un área de representatividad en torno a la estación que va desde los 100m. a 2Km.

   Si en el área de 2Km hay una fuente de óxidos de nitrógeno en algún punto de esta área por ejemplo fuentes móviles ¿la muestra tomada por esta estación pierde su representatividad?

   ¿Es posible la instalación de distintas estaciones de monitoreo (distinta representatividad) dentro del área de la estación EMRPG? Ver figura N°1.

Figura N°1: Instalación de estaciones de muestreo



Criterios de representatividad para estaciones de muestreo:

Area de representatividad (radio) para diferentes tipos de estaciones. Datos entregados por la ETC-AQ y la EUROAIRNET/AIPBASE

Tipo de estación	Radio representatividad en torno a la estación
de Tráfico	< 10 - 15 m
Industrial	10 - 100 m
Urbana	**100 m a 2 km**
Cercana a la ciudad	2-10 km
Regional	25 - 150 km
Remota	200 - 500 km

Fuente: Criteria for EUROAIRNET, Final Draft 1998

En general la condición de representatividad puede decir:

Una estación EMRPG tendrá un área de representatividad para la población expuesta equivalente a una estación de monitoreo de tipo Urbana correspondiente a un radio de 2Km, medido desde la ubicación de la estación, según las especificaciones entregadas por la ETC-AQ y la EUROAIRNET/AIPBASE.

3. Se sugiere definir "Area Habitada", como propuesta se presenta lo siguiente:

   Area Habitada: Area del territorio donde permanece habitualmente una o más personas durante un periodo igual o superior a 8 horas, ya sea para vivir o realizar su jornada de trabajo.

3. Se requiere definir como se va a establecer la distancia mínima que asegure que no existan interferencias sistemática por sumideros de ozono.

   Para lo anterior, se sugiere establecer en la Norma que será el Servicio de Salud respectivo quien lo definirá, para esto se propone utilizar parte del Art. 6º de la Norma de PM-10 de tal forma de incluir el siguiente texto como otro artículo:

   El Servicio de Salud respectivo mediante resolución fundada, deberá aprobar la clasificación de una EMRPG, de acuerdo a las condiciones establecidas en la definición que se indica en el artículo 2º de la presente Norma.

4. ¿Que se entenderá por Sumidero de Ozono?

Se propone agregar lo siguiente (o algo similar):

Sumidero de Ozono: Se entenderá como un sumidero de ozono a todo elemento (orgánico o inorgánico,...etc), que a través de algún proceso físico o químico genere el retiro de este contaminante desde la atmósfera.

Artículo 2, letra g.

1. Se debe cambiar ug/m^{3}N por ppbv.
   El texto debiera decir:

   Percentil: Corresponde al valor "q" calculado a partir de los valores efectivamente medidos de la concentración de ozono en ppbv.Todos los ...

Se sugiere agregar a las definiciones del Art. 2 el siguiente concepto:

Área de representatividad: Se entenderá por área de representatividad de una estación de monitoreo, al área en donde las concentraciones del contaminante, en cualquier punto, está representada por el valor promedio de concentración medido en la estación de muestreo.

Letra h. Se requiere que primero se defina lo que se entenderá por situación de emergencia y luego se describa cuales son los métodos a través de los cuales se determinará alcanzada esta situación.

Por ejemplo:

Situación de Emergencia Ambiental: Se entenderá como situación de emergencia ambiental cuando se constate en alguna estación de monitoreo clasificada como EMRPG la superación de la norma primaria de calidad de aire para ozono establecida en el Art. 4 de esta resolución.

TÍTULO III

Artículo 3

Se sugiere cambiar el Art. 3 por el siguiente texto:

La norma primaria de calidad de aire para ozono como concentración de 8-Horas será de 60 ppbv.

Se considerará sobrepasada la norma primaria de calidad de aire para ozono como concentración de 8-Horas, cuando el percentil 99 de las concentraciones promedio de 8-Horas registradas durante un año calendario, o en su defecto de 12 meses a partir del mes de inicio de las mediciones, en cualquier estación monitora clasificada como EMRPG sea mayor o igual al valor indicado en el inciso precedente.

Asimismo, se considerará sobrepasada la norma, si antes que concluya el año calendario, o en su defecto de 12 meses a partir del inicio de las mediciones, se registrare en cualquier estación monitora clasificada como EMRPG, más de cuatro días con mediciones de concentración de 8-Horas igual o sobre el valor de la Norma.

Respecto del párrafo anterior se solicita aclarar:

Dice: ......*más de cuatro días con mediciones de concentración de 8-Horas igual o sobre el valor de la Norma.*

Debe decir: ......*más de cuatro valores promedio móviles de 8-Horas con un valor de concentración igual o superior al valor de la Norma.*

Recordar que se esta proponiendo el percentil 99, por lo tanto, el valor de la norma sólo podrá superarse en cuatro ocasiones, en un año calendario.

TÍTULO IV

Art. 6 Letra a.

¿Qué pasará si las estaciones que actualmente están en operación no pueden dar cumplimiento a esta especificación?

01031

¿Qué pasa en el caso de que la estación este emplazada en una pendiente? Por ejemplo en Valparaíso. Ver fig. 2

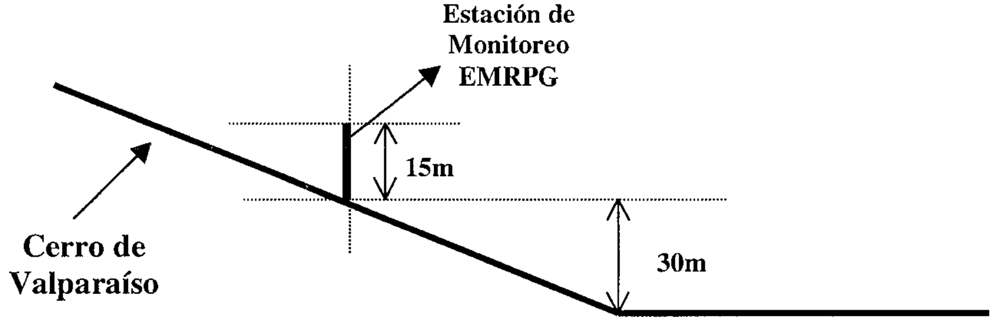


Figura 2. Emplazamiento de estación de Monitoreo en una Pendiente

Sería interesante consignar la fuente usada de referencia para la determinación de estas especificaciones técnicas.

Letra b. iv: no queda suficientemente claro esta exigencia.

Se propone:

iv. La toma de muestra no deberá presentar obstrucciones que restringan la libre circulación del aire, a lo menos en un arco de 270° respecto a su eje de posición normal a la superficie.

TÍTULO V

Art. 7

¿Cuál es el criterio estadístico para consignar el 75% de los valores medidos?

¿Qué hay respecto a la calibración de los equipos y el control de calidad de los datos?

¿Qué se entiende por disponible?

> El controlador de la estación puede eliminar los datos promedios horarios que hacen que su promedio móvil de ocho horas alcance los límites de la norma, pudiendo dejar sólo el 75% de los datos disponibles. En otras palabras la definición no detallada de lo que significa un dato valido puede permitir la manipulación de los mismos.

TÍTULO VI

Se considera que este Título no es exigible dentro de la norma, más se puede hacer referencia a que el diseño de las redes de monitoreo deberán ajustare a los criterios y estándares internacionales adoptados en Chile y que son aprobados por el servicio competente.

Respecto a los lugares prioritarios ¿cómo se determinarán estos?, es preferible que se revisen los procedimientos que la ley establece para la determinación de zonas latentes y saturadas, y ahí se consigne la conveniencia de considerar los criterios expuestos en este título.

Por lo tanto no se considera necesaria su incorporación dentro de esta norma.

ENAMI

VICEPRESIDENCIA EJECUTIVA N° 106/237

01032

COMISION NACIONAL DEL MEDIO AMBIENTE
OFICINA DE PARTES Y ARCHIVO
Nº INGRESO: 12753/11832
FECHA: 06 NOV 2000
DESPACHADO:
Ecomas
Adriana Hoffmann

OF. ORD. N° 124

ANT. : No hay.

MAT. : Observaciones proceso de evaluación costo beneficio modificación Resolución 1215.

SANTIAGO, 03 NOV 2000

A : SRA. ADRIANA HOFFMAN J.
DIRECTORA EJECUTIVA
COMISIÓN NACIONAL DE MEDIO AMBIENTE

DE : VICEPRESIDENTE EJECUTIVO
EMPRESA NACIONAL DE MINERIA

En referencia al proceso de revisión de las normas primarias de calidad de aire para Material Particulado Sedimentable (PTS), Ozono (O_3), Dióxido de Azufre (SO_2), Dióxido de Nitrógeno (NO_2) y Monóxido de Carbono (CO) , con fecha 10 de Octubre se realizó una presentación de la metodología a utilizar en la evaluación técnico-económica, en la cual se individualizó el origen de los costos y beneficios asociados a la modificación de la norma, tengo a bien indicar las siguientes observaciones a dicha metodología :

I. Las áreas de estudio de las distintas normas fueron divididas en áreas mínimas (de impacto directo) y áreas complementarias. Para la selección de las áreas mínimas en cuestión se utilizó el criterio de incluir aquellas áreas que se encuentren en categoría de zona latente y/o saturada.

Según estudio estadístico de los datos proporcionados de monitoreo de calidad de aire, dentro del estudio de la normativa de SO_2 se seleccionaron algunas áreas que no se encuentran en esta categoría, estando muy por debajo de los niveles requeridos según el criterio utilizado.

En efecto, para el área circundante a la Fundición Ventanas se consideró dentro de la zona mínima la localidad de Puchuncaví, siendo que las estadísticas de 1999 indican que no se ha sobrepasado ninguna vez el 80 % de los valores diarios y horarios propuestos. Por su parte para la Fundición Paipote, en las estaciones de Copiapó y Los Volcanes no se sobrepasa la norma y tan solo en una ocasión se sobrepasa el valor establecido de latencia horaria 320 (ppb) (ver anexo 1). En igual condición se encuentra la estación Cal de Caletones.

Es nuestro parecer que las zonas mínimas afectadas debieran circunscribirse a las localidades de Los Maitenes y La Greda en Fundición y Refinería Ventanas y a Estación Paipote y Tierra Amarilla para Fundición Paipote.

II. Cabe hacer notar que el mercado del Cobre considera en forma creciente los aspectos ambientales de los procesos de obtención de este metal, es por ello que la gran mayoría de las fundiciones chilenas se encuentran implementando Sistemas de Gestión Ambiental bajo el estándar de ISO 14000. Una de las exigencias básicas en este estándar, corresponde al cumplimiento de la legislación ambiental. En este contexto, la introducción de normas altamente restrictivas retrasaría en varios años las opciones de certificación de la Norma ISO 14.000, lo cual debe ser evaluado en términos económicos como una potencial pérdida de mercado del principal producto de exportación del país.

III. Dentro de las alternativas de reducción de emisiones de SO_2 en las fundiciones de Cobre en Chile se menciona la implementación de un modelo climático, que permita predecir periodos de alta estabilidad atmosférica sobre los cuales se deberá reducir fusión al nivel que evite la ocurrencia de episodios horarios.

Al respecto cabe señalar que las experiencias existentes no han tenido buenos resultados en Chile, la Fundición Paipote implementó por imposición del Decreto Nº180 del Ministerio Secretaria General de la Presidencia del año 1995 un modelo climático predictivo con alto costo (Inversión de US$ 1.000.000 aproximadamente y costo anual de US$ 70.000), con resultados que determinan una certeza de sólo un 50 %.

Los resultados de modelos climático predictivos han tenido resultados satisfactorios para el manejo de episodios de alta concentraciones de contaminantes como **promedio diario**, sin embargo, el manejo de la situación horaria requiere bajar la fusión en forma preventiva, lo que depende de cada cuenca atmosférica. Las decisiones operativas asociadas para prevenir un evento, pueden iniciarse hasta 12 horas de anticipación de un posible evento, sin asegurar un resultados positivo de la gestión.

IV. La incorporación de una norma horario deriva de la recomendación de la OMS, que establece una condición deseada, que puede ser interpretada de largo plazo, especialmente en países en desarrollo. Además, en las normas EPA de Estados Unidos, a nivel federal sólo se establece una recomendación de norma diaria, equivalente a la vigente en Chile, dejando en libertad de acción a cada estado para la incorporación de norma horaria, para estos efectos, de acuerdo a los antecedentes disponibles, solo en algunos estados se ha legislado al respecto, específicamente, en los estados en que no existen fundiciones de cobre, para otros estados que si poseen fundiciones de cobre y a nivel federal no se han establecido normas de calidad horaria para SO_2.

V. En concordancia con lo expresado en el punto IV, en el informe de la Consultora SGA Soluziona, contratado por la CONAMA para la preparación del Proyecto de Ley, se recomienda claramente no incorporar una norma horaria para SO_2.

En atención a lo expresado anteriormente, se solicita formalmente no incorporar una Norma de Calidad Horaria, en la revisión que actualmente se realiza, como también, aplicar en forma gradual, la mayor exigencia de Norma Diaria para SO_2.

Le saluda atentamente,

EMPRESA NACIONAL DE MINERIA
Vice Presidente Ejecutivo

JAIME PÉREZ DE ARCE ARAYA
Vicepresidente Ejecutivo

ENAMI - SANTIAGO
DESPACHADO
- 3. NOV. 2000
OFICINA DE PARTES

Fundición Hernán Videla Lira

Máximas concentraciones de SO_2 en Estaciones Copiapó y Volcanes ($\mu g / Nm^3$)

1999

	Valores norma	Valores Latencia
Diaria	250 ugr/Nm3	200 ugr/Nm3
Horaria	1050 ugr/Nm3	840 ugr/Nm3

	Copiapó		Volcanes	
MES	**Máx. horarios**	**Máx. diarios**	**Máx. horarios**	**Máx. diarios**
ENE	400	-	305	-
FEB	855	-	698	-
	431	-	415	-
	390	-	-	-
MAR	521	100	511	-
	454	-	372	-
	339	-	-	-
	444	-	-	-
	324	-	-	-
ABR	-	-	-	-
MAY	313	-	826	107
	487	-	507	-
	343	-	374	-
	366	-	491	-
	-	-	822	-
	-	-	879	-
	-	-	599	-
	-	-	450	-
	-	-	801	-
	-	-	356	-
JUN	-	-	-	-
	-	-	-	-
	554	-	-	-
JUL	-	-	-	-
AGO	366	-	593	-
	305	-	569	-
	-	-	362	-
	-	-	360	-
	-	-	342	-
SEP	-	-	-	-
OCT	-	-	-	-
NOV	-	-	-	-
DIC	419	-	328	-

-: No existen valores superiores a 300 $\mu g/Nm^3$, promedio horario y/o a 100 $\mu g/Nm^3$, promedio diario.

Fundición y Refineria Ventanas

Máximas concentraciones de SO_2 en Estacion Puchuncaví ($\mu g / Nm^3$)

1999

	Valores norma	Valores Latencia
Diaria	250 ugr/Nm3	200 ugr/Nm3
Horaria	1050 ugr/Nm3	840 ugr/Nm3

Puchuncaví	
MES	Máx. horarios
ENE	338
	317
	335
	446
	345
	398
	421
	444
	324
FEB	-
MAR	312
	318
	377
	321
	687
ABR	469
	350
MAY	308
	349
	305
	685
	570
	326
JUN	384
	350
	821
	816
	603
	378

Puchuncaví	
MES	Máx. horarios
JUL	321
	307
	368
	319
	340
	367
	433
	319
	339
	364
AGO	532
	328
	400
	358
	569
	365
	416
SEP	339
	331
OCT	-
NOV	301
DIC	646
	468
	621
	745
	756
	414

NOTA : NO existen valores sobre 840 ugr/nm3 en 1999

COMISION NACIONAL DEL MEDIO AMBIENTE
OFICINA DE PARTES Y ARCHIVO
Nº INGRESO: 13397 / 12055
FECHA:
DESPACHADO: 13 NOV 2000
OBS.: A. Hoffmann

23068

01036

GOBIERNO DE CHILE
MINISTERIO DE EDUCACION
SECRETARIA MINISTERIAL EDUCACION
REGION DE LOS LAGOS
DEPTO. EDUCACION

Nº 2536 /

ANT. : Proceso de Consulta Pública de Normas de calidad de Aire.

MAT : RESPONDE CONSULTA.

PUERTO MONTT, 07 NOV 2000

DE: SR. SECRETARIO REGIONAL MINISTERIAL DE EDUCACION
DECIMA REGION DE LOS LAGOS

A: SRA. ADRIANA HOFFMANN JACOBY
COMISION NACIONAL DE MEDIO AMBIENTE
OBISPO DONOSO N° 6, PROVIDENCIA
SANTIAGO.

1.- Tengo el agrado de dirigirme a Ud., para acusar recibo del expediente de Consulta Pública de las Normas Primarias de Calidad de Aire.

2.- Al respecto, me permito expresar a Ud., nuestro beneplácito por la loable iniciativa de regular estas temáticas a través de normas que respondan a los actuales imperativos del Medio Ambiente y de la calidad de Vida de la población.

3.- No obstante, por no contar en nuestro Servicio con los recursos humanos calificados, No enviamos observaciones técnicas acerca de las normas en consulta.

4.- Junto con agradecer su gentileza, le deseamos pleno éxito en esta nueva iniciativa de CONAMA.

Saluda atentamente a Ud.,

MINISTERIO DE EDUCACION
REGION DE LOS LAGOS
Secretaría Regional Ministerial

JUAN DOMINGO GALLEGUILLOS HERRERA
PROFESOR DE ESTADO
SECRETARIO MINISTERIAL DE EDUCACION

JDGH/CWM/APA/isb.
Distribución:
- Sra. Adriana Hoffmann, Directora Ejecutiva Comisión Nacional del Medio Ambiente, Santiago.
- Coord. Regional Medio Ambiente, Secreduc.
- Ofpartes Secreduc.

Comisión Regional del Medio Ambiente
Región del Bio Bio

COMISION NACIONAL DEL MEDIO AMBIENTE
OFICINA DE PARTES Y ARCHIVO
Nº INGRESO: 13374 / 12036
FECHA:
DESPACHADO: 13 NOV 2000
OBS.:
P. MATUS
28051

01037

GOBIERNO DE CHILE
COMISION NACIONAL
DEL MEDIO AMBIENTE

ORD. Nº 00703 **/2000**

ANT.: No hay

MAT: Remite observaciones a Anteproyecto Revisión de Norma Primaria de Calidad de Aire para CO, NO_2, SO_2, O_3 y PTS.

Concepción, 10 NOV 2000

A: JEFE DEPTO. DESC., PLANES Y NORMAS
DRA. PATRICIA MATUS

DE: DIRECCION REGIONAL CONAMA BIO BIO

Por encargo del Director Regional me permito remitir a Ud. observaciones al documento de la referencia, en atención al periodo de consulta pública en que se encuentran.

Sin otro particular le saluda,

CONAMA
REGION DEL BIO BIO

GERMAN OYOLA
ING. CIVIL QUIMICO
DIRECCION REGIONAL CONAMA BIO BIO

Distribución:
- Archivo CONAMA Bio Bio
- Calidad de Aire - Bio Bio

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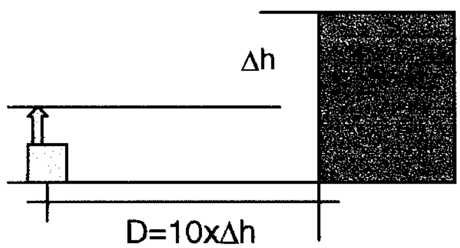
Aire238.doc

OBSERVACIONES
ANTEPROYECTO NORMAS DE CALIDAD DE AIRE

1. En general a los 5 anteproyectos

- "Una EMRPG tendrá representatividad para la población expuesta correspondiente a un radio de 2 km., medido desde la ubicación de la estación."
  Lo anterior implica entonces que se podrá argumentar falta de representatividad de las redes actuales por una insuficiencia de estaciones monitoras de las redes urbanas y por lo tanto que la determinación de áreas o zonas saturadas no aplica o no es correcta, que existe discriminación o cualquier otro argumento. Por otro implica que para cumplir con una adecuada cobertura habrá que invertir en densificar las redes, costo que deberá ser asumido por el Estado.

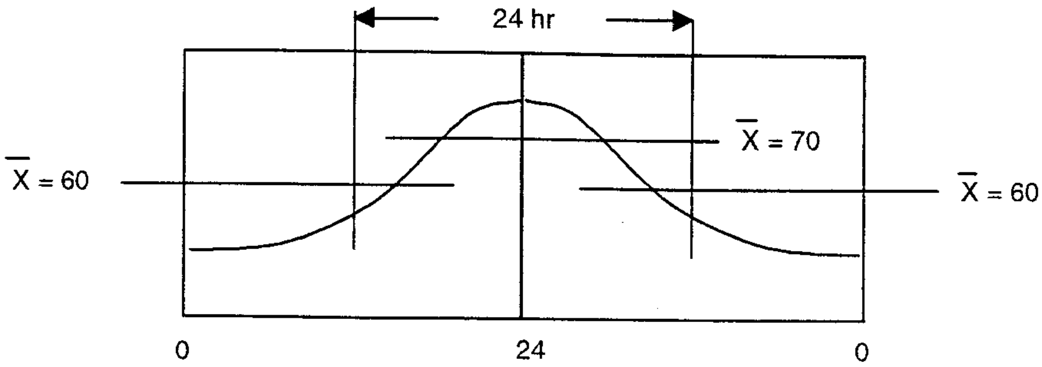
- Respecto del emplazamiento de las estaciones monitoras creemos que el punto de indica distanciamiento de 20 m de cualquier edificación existente en el lugar y mas de 10 m de árboles no lo cumplen las actuales estaciones monitoras urbanas y no es necesario si se considera el siguiente punto de la siguiente forma:



  Donde: la distancia es 10 veces la diferencia de altura entre la toma muestra y la obstrucción de flujo de aire más cercana.

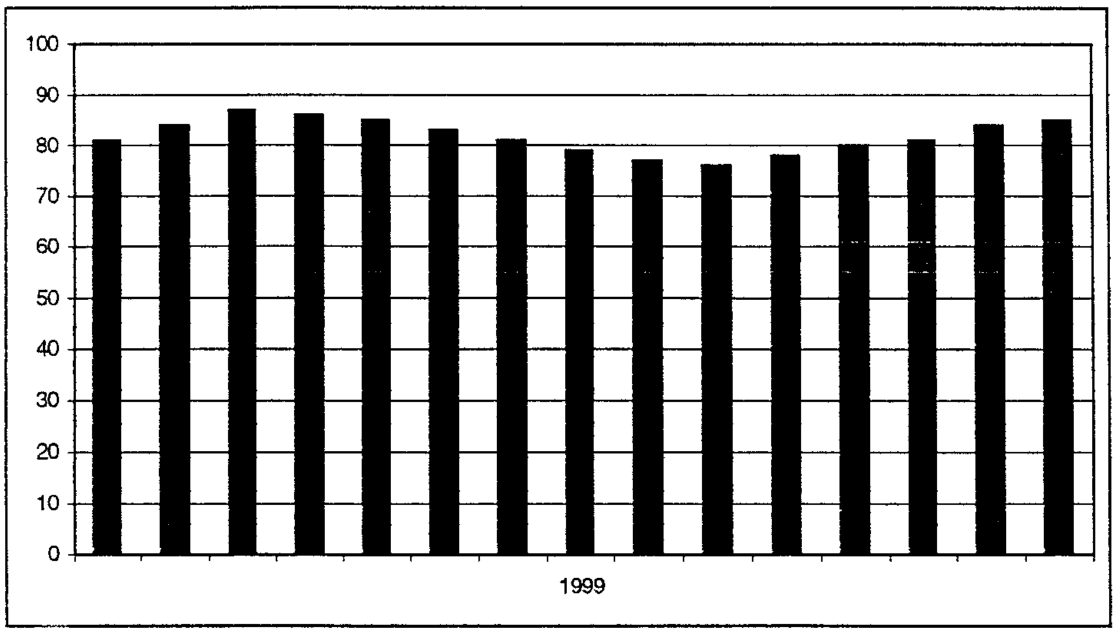
- Que pasará con la data histórica existente en el país, puesto que no se especifica si se consideraran válidos o no, si podrán utilizarse como referencia en la determinación de zonas geográficas, en los planes, en las declaraciones de zonas, etc.

- Creemos que siempre se deben aplicar promedios móviles al igual que en ozono puesto que se mejora la gestión de la calidad del aire, al tener constantemente nuevos promedios, además se asegura de estar cubriendo eventos que pudieran quedar fuera los periodos fijos tal como se señala a continuación:



Por lo tanto si el criterio de salud es que se producen efectos a las 24 hr, bajo X concentración, entonces debe aplicarse promedio móvil.

La anterior es válido tanto para los promedios diarios como anuales puesto que por ejemplo, en el área de Talcahuano los mayores eventos críticos se producen en el periodo que de noviembre a marzo. Además la utilización de promedios móviles anuales por ejemplo hace más dinámica la gestión y no inhabilita la información de promedio año calendario.



Lo anterior representa promedios anuales móviles de SO2 donde el año calendario cumple norma pero claramente la población esta siendo afectada en periodos de largo plazo, puesto que esta sometida a niveles sobre la norma en la realidad.

2. Ozono

¿No hay antecedentes respecto de los efectos crónicos a la exposición de ozono?

3. NO2

4. SO2

No nos parece adecuado criterio de protección de la salud de la población que se considere sólo el valor máximo del día para contabilizar el número de excedencia de la norma, puesto que días con 12 horas sobre norma horaria por ejemplo, con valores muy por sobre la norma, sólo sería contabilizado como una superación de norma horaria y de seguro una superación de norma diaria, en circunstancias que se sabe que hay efectos significativos a valores de corto plazo mucho menores como lo reconoce la OMS.

5. CO

6. PTS

01041

GOBIERNO DE CHILE
MINISTERIO DE MINERIA
SECRETARIA REGIONAL MINISTERIAL
DE MINERIA REGION DE ATACAMA

Copiapó 13 de Noviembre de 2000
Oficio N° 216/00

28065

COMISION NACIONAL DEL MEDIO AMBIENTE
OFICINA DE PARTES Y ARCHIVO
FAX: ....
Nº INGRESO: 2781
FECHA: 13 NOV 2000
DESPACHADO: ....
OBS.: D. Hoffmann

Sra. Adriana Hoffman J.
Directora Ejecutiva
Comisión Nacional del Medio Ambiente
Presente

En relación con el proceso de [illegible] del Anteproyecto de Norma de Calidad Primaria de Anhídrido Sulfuroso [illegible] lo estipulado, la Secretaría Regional Ministerial de Minería de Atacama [illegible] lo siguiente:

1.- En la Región de Atacama funciona el servicio de la Pequeña y [illegible] Fundición Hernán Videla Lira, la cual a partir del año 1995 y hasta [illegible] inversiones por un monto superior a los 90 Millones de Dólares, [illegible] al Plan de Descontaminación de dicho Plantel

2.- Dicho Plan de Descontaminación significó adecuarse [illegible] normas primarias y secundarias de calidad de aire de 80 [illegible] ug/Nm^3 de SO_2 y secundaria de horaria 1000 ug/Nm^3 de SO_2 [illegible] han cumplido

3.- Las condiciones meteorológicas que [illegible] se encuentra ubicada la Fundición y la cercanía de [illegible] que también inciden fuertemente en el cumplimiento de [illegible]

4.- Nos parece imprudente y una señal poco [illegible] la norma, a pocos meses de la implementación [illegible] considerando la inversión ejecutada [illegible] de descontaminación [illegible]

5.- Los antecedentes técnicos que [illegible] son compartidos en el Informe [illegible] Minería mediante [illegible] a dicho Oficio.

01042

6.- Los antecedentes entregados al Sr. Intendente de la Región de Atacama el día 23 de Octubre por el Sr. Gerente de al Fundición Hernán Videla Lira y lo informado a Ud., en reunión de la COREMA en día 25 de Octubre por el suscrito y la información entregada en su visita a la Fundición el 25 de Octubre, demuestran la importancia que para la región significa la existencia de Plantel productivo y las enormes dificultades que acarrearía para Atacama y sus habitantes un eventual cierre del Plantel

7.- Sra. Directora tal como Ud., lo planteó en dicha oportunidad, es [illegible] que en la definición del anteproyecto se consideren todas las variables que [illegible] ella, tanto técnicas como productivas que ameriten una solución que sea [illegible] por la comunidad de Atacama.

Saluda Atte. A Ud

MINISTERIO DE MI[illegible]

ANTONINO PRADO CASTRO
SECRETARIO REGIONAL MINISTERIAL
DE MINERIA REGION DE ATACAMA

APC/mma

c.c. - Sr. Ministro de Mineria
- Sra. Subsecretaria de Mineria
- Sr. Intendente Regional
- Sr. Director Regional de CONAMA
- Archivo

001043

Santiago, 13 de Noviembre de 2000
28116/7 N° 710/2000

COMISION NACIONAL DEL MEDIO AMBIENTE
OFICINA DE PARTES Y ARCHIVO
Nº INGRESO: 13436/12091
FECHA: 14 NOV 2000
DESPACHADO:
ORD.:
A. Hoffmann

Señora
Adriana Hoffmann Jacoby
Directora Ejecutiva
Comisión Nacional del Medio Ambiente
Presente:

Ref.: COMENTARIOS REVISIÓN NORMAS DE CALIDAD DE AIRE

Estimada señora Adriana:

La Sociedad Nacional de Minería agradece la oportunidad otorgada por la Comisión Nacional del Medio Ambiente para hacer entrega de nuestros comentarios respecto al anteproyecto de la referencia, específicamente para el anhídrido sulfuroso (SO_2).

De acuerdo a los antecedentes disponibles en el anteproyecto, se concluye que el anhídrido sulfuroso no presenta efectos tóxicos en las personas, no es carcinogénico y tampoco presenta limitantes para el desarrollo normal de las personas.

Asimismo, es posible concluir que en nuestro país no existe una relación directa entre la presencia de este contaminante y la mortalidad, ya que los efectos causados por éste son un aumento de la tos y una disminución del flujo respiratorio forzado (FEV).

De acuerdo a lo anterior, la OMS sólo recomienda que no se superen ciertos límites de concentración de este gas, con el propósito de proteger a la población más sensible a este contaminante.

Efectos en la industria minera

La norma horaria propuesta en el anteproyecto para el anhídrido sulfuroso (SO_2) puede poner en serio riesgo la viabilidad de algunas fundiciones de cobre estatales y privadas.

En efecto, no se ha estimado el impacto económico que representan las inversiones que deberán implementarse, ni el impacto de las acciones de prevención que deberán adoptar las fuentes emisoras para intentar cumplir con la norma propuesta. Al respecto, cabe señalar que se ha demostrado que en ocasiones ni siquiera la eliminación de las emisiones por detención de la operación de la fuente emisora logra cumplir con el límite promedio horario propuesto. Ello, porque el plazo de una hora para el cálculo del promedio es muy breve bajo ciertas condiciones meteorológicas, condiciones que están fuera del alcance de cualquier control operacional que pudiera implementarse.

Apoquindo 3000-5º Piso-Teléfono: 3359300-Fax: (562) 3349700-Santiago-Chile

Al respecto, cabe señalar que Estados Unidos, uno de nuestros principales "socios económicos" y definitivamente con recursos muy superiores a los nuestros, ha evaluado y desistido de implementar una norma horaria, o de menor período, para el SO2, por considerar que un límite tan estricto no se justifica técnica ni económicamente. En efecto, la EPA de USA establece un límite promedio de 3 horas, y aún así dicho límite es de 1300 ug/Nm3, superior a los 1050 ug/Nm3 del anteproyecto de norma propuesto. La implementación del límite horario propuesto definitivamente colocará a la industria nacional en una posición desmedrada frente a nuestros competidores, que, como se señaló, aún cuando disponen de más recursos técnicos y económicos que nuestro país, y de ser reconocidos como ambientalmente "estrictos", consideran que no se justifica un límite como el propuesto.

Confiando que nuestros comentarios sean bien recibidos y contribuyan al perfeccionamiento de nuestra normativa nacional,.

Saluda atentamente a usted,

Roberto Salinas Morán
Vicepresidente

c.c. Sra. Patricia Matus - Jefa Depto. Planes y Normas de Conama

Apoquindo 3000-5º Piso-Teléfono: 3359300-Fax: (562) 3349700-Santiago-Chile

COMISION NACIONAL DEL MEDIO AMBIENTE
OFICINA DE PARTES Y ARCHIVO
Nº INGRESO: 3509 / 12132
FECHA: 15 NOV 2000
DERIVADO A: A. HOFFMAN
28212

01047

GOBIERNO DE CHILE
MINISTERIO DE VIVIENDA Y URBANISMO
SEREMI REGION DE LA ARAUCANÍA

ORD. Nº 001381 /

ANT.: Res (Ex) N° 912 – 913 – 914 – 915 – 916 de Fecha 02/11/2000 CONAMA IX Región.

MAT.: Proceso de Consulta Pública Anteproyectos de Revisión para Calidad del Aire".

TEMUCO, 14 NOV. 2000

A : SRA. ADRIANA HOFFMANN J.
DIRECTORA EJECUTIVA CONAMA NACIONAL

DE : SRA. SECRETARIO REGIONAL MINISTERIAL DE VIVIENDA Y URBANISMO IX REGIÓN

En relación al Proceso de Consulta Ciudadana que dice relación a los "**Anteproyectos de Revisión de Normas Primarias de Calidad del Aire para SO2, O3, NO2, CO** y **PTS**", comunico a Ud. que está SEREMI no presenta mayores observaciones a dicho documento, respaldando la regulación sobre la presencia de contaminantes en el medio Ambiente, a fin de prevenir un riesgo para la salud de las personas.

Saluda atentamente a Ud.,

MINISTERIO DE VIVIENDA Y URBANISMO
IX REGION
Secretario Ministerial

VIVIANA HERNÁNDEZ PÉREZ
ARQUITECTO
SECRETARIO REGIONAL MINISTERIAL
VIVIENDA Y URBANISMO IX REGION

MEHA/GAC.

DISTRIBUCIÓN:
CONAMA-Obispo Donoso 6 Stgo.
CONAMA IX Región.
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Oficina de Partes.

DEPTO. DESARROLLO URBANO E INFRAESTRUCTURA INGRESO N° 10529 INTERNO N° 50.1860

COMISION NACIONAL DEL MEDIO AMBIENTE
OFICINA DE PARTES Y ARCHIVO
FAX:
Nº INGRESO: 2812
FECHA: 15 NOV 2000
DESPACHADO:
OBS.: Adriana Hoffmann
2848

REPUBLICA DE CHILE

MINISTERIO DE MINERIA

001045

OF. ORD. Nº 605

ANT.: No Hay

MAT.: Norma de calidad primaria anhídrido sulfuroso.

SANTIAGO, 14 NOV 2000

DE : SRA. JACQUELINE SAINTARD VERA
MINISTRA DE MINERIA (S)

A : SRA. ADRIANA HOFFMANN JACOBY
DIRECTORA EJECUTIVA CONAMA

Como es de su conocimiento, el anteproyecto de revisión de norma primaria de calidad de aire para anhídrido sulfuroso, salió a consulta pública el 15 de septiembre del año en curso, con el fin de realizar observaciones al respectivo documento.

Sobre el particular, esta Secretaría de Estado ha realizado una serie de comentarios basados en el estudio de soporte técnico de la consultora contratada por CONAMA para la elaboración de la norma, donde se señala en forma explícita, que **no** debe ser considerada una norma horaria.

En este sentido quiero señalar a Ud. que:

a) Deben considerarse los Planes de Descontaminación realizados por las fundiciones del país, con sus correspondientes inversiones.

b) Las decisiones tomadas por las empresas respecto a las tecnologías de fusión y las inversiones asociadas, se contemplaron en un horizonte de 25 años, por lo que resulta difícil terminar un plan de descontaminación y entrar nuevamente a otro por los mismos contaminantes, estimándose que deban realizar nuevos cambios tecnológicos.

c) La norma horaria conlleva a dificultades operacionales complicadas de resolver en periodos cortos de tiempo.

d) Los modelos de dispersión de contaminantes atmosféricos, han resultado ser una herramienta útil y complementaria a los planes de descontaminación. Sin embargo, han demostrado no ser del todo confiables, por lo que resulta que en ocasiones las empresas tienen considerados todos estos factores y aún así, sobrepasan las normas en casos puntuales.

e) El Estado de Arizona en U.S.A. donde existen fundiciones, no tiene norma horaria, por considerar que esta medida resulta excesivamente restrictiva.

f) Los impactos agudos que pudieran presentarse en las operaciones, pueden ser abordados a través de un plan de manejo de episodios críticos.

Con respecto a la norma diaria, cabe señalar que:

001046

REPUBLICA DE CHILE

MINISTERIO DE MINERIA

a) A nivel federal, en Estados Unidos se exige un valor de 365 ug/m3, el mismo valor que hoy se exige en Chile. El valor que propone CONAMA de 250 ug/m3, corresponde a una recomendación internacional de la O.M.S.

b) En el entendido que es un recomendación, sugerimos establecer una aplicación gradual para su cumplimiento.

Cabe señalar además, que el reglamento N° 93/95 de la SEGPRES, para la dictación de normas de calidad ambiental y de emisión, señala que deben ser considerados estudios técnicos, científicos y económicos, entendiendo que con esta gama de criterios, estamos en condiciones de tomar la mejor decisión para la elaboración de normas ambientales.

Sin otro particular, saluda atentamente a Ud.,

REPUBLICA DE CHILE - MINISTERIO DE MINERIA - MINISTRO -

JACQUELINE SAINTARD VERA
Ministra de Minería (S)

REPUBLICA DE CHILE - MINISTERIO DE MINERIA - Jefe División Jurídica

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1. Directora Ejecutiva de CONAMA
2. Partes y Archivos.

DISPUTADA 28219

31048

COMISION NACIONAL DEL MEDIO AMBIENTE
OFICINA DE PARTES Y ARCHIVO
Nº INGRESO: 13537 / 12151
FECHA: 16 NOV 2000
DESPACHADO:
OBS.:
P. MATUS

Chagres, 14 de Noviembre de 2.000

Señores
COMISION NACIONAL DE MEDIO AMBIENTE
CONAMA CENTRAL
Presente

At. : Sra. **Patricia Matus C.**
Directora Departamento Planes y Normas

Ref: ***Anteproyecto de norma Revisión Resolución 1215***.

De nuestra consideración:

La Fundición Chagres se rige actualmente por el DS-185 de1991del Ministerio de Minería, en el cual se establecen límites de norma primaria (diario, anual) y secundaria (límite horario) para el Anhídrido Sulfuroso (SO_2). La actual revisión de la Resolución 1215 incorporaría una nueva norma primaria para un período de una hora, de la misma forma que lo considera el DS-185, pero como norma secundaria.

Al respecto, hacemos notar a Ud. dos aspectos que inciden en la factibilidad técnica de cumplir con la norma propuesta:

1. El plazo de cálculo de la concentración promedio, de una hora, hace muy difícil de cumplir con la norma, por cuanto el factor que tiene mayor incidencia en la concentración horaria es la meteorología, factor que está fuera del control de las unidades operativas, en este caso la fundición. Está demostrado que ocasionalmente se dan condiciones meteorológicas en que la inercia propia del sistema emisión-concentración impide cumplir con la concentración promedio límite, a pesar de tomar todas las medidas posibles para minimizar la emisión. Por esta razón sugerimos que la nueva norma primaria considere un promedio de tres horas, igual a la norma de la EPA de USA, en lugar de una hora como se propone.

2. Para nuestra Fundición, operacionalmente y por razones prácticas preocupa el hecho que podrían existir dos valores de norma diferentes para un mismo período de tiempo (norma horaria) como sería la norma primaria propuesta y la norma secundaria existente del DS

COMPAÑIA MINERA DISPUTADA
DE LAS CONDES LTDA.
Av. Pedro de Valdivia 291
Casilla 16178
Santiago, Chile
Teléfono: 2306000
Fax: 2306700
Télex: 341621 CMDLC

185. En nuestra opinión, sería preferible contar con sólo un valor a cumplir como promedio horario (o promedio de tres horas según el párrafo anterior). De hecho, confiamos que el estándar secundario existente sea revisado a la brevedad posible para asimilarlo al estándar que finalmente se defina en esta revisión de la Resolución-1215.

Sin otro particular, saluda atentamente a Ud.

Miguel Angel Duran V.
Gerente General Fundición Chagres

CSP/ CG80089.00

01050

Observaciones al proyecto de
"Normas primarias de calidad de aire para SO_2, CO, NO_2, O_3, PTS".

1. Existe poca claridad en la definición del concepto Estación de monitoreo con representatividad poblacional (EMRP), debido a que esta norma establece que una estación de monitoreo podrá clasificarse como EMRP si existe a lo menos un área habitada en un radio de 2 km., medido desde la ubicación de la estación. En este sentido no queda claro que se entiende por *área habitada*, ya que conceptualmente al parecer bastaría una vivienda para justificar la implementación de dicha estación. Por otra parte, esta definición no incluye a los demás potenciales afectados que se desplazan por el sector contaminado, y que no necesariamente habitan dentro del radio definido.

2. Como parte de la metodología se sugiere que la medición de la concentración de los contaminantes mencionados en los anteproyectos de normas, pueda realizarse mediante un método de cuya metodología de operación sea aprobada por un organismo **nacional** [1]calificado para este fin, en subsidio de los internacionales.

3. Por otra parte, estamos de acuerdo que la norma para PTS no se justificaría debido a que actualmente está legislado el PM_{10}.

4. Es importante evaluar el grado de aplicabilidad de las normas y standards propuestos, calculando con precisión el costo que tendría la paralización de las empresas o fuentes contaminantes cuando se sobrepasen las normas, o en su defecto los costos que implicaría la reconversión de los procesos productivos (cambio en los equipos, utilización de otros combustibles menos contaminantes, etc.)

5. Además se hace necesario estudiar a fondo el costo que tendría implementar las estaciones y equipos de monitoreo (estaciones, personal a cargo, transporte, etc.), versus los beneficios factibles de obtener en función de la localización en que se emplace la estación.

COMISION NACIONAL DEL MEDIO AMBIENTE
OFICINA DE PARTES Y ARCHIVO
Nº INGRESO: 13468 / 12108
FECHA: ...
DESPACHADO: 15 NOV 2000
OBS.:
D. Ejecutiva
28150

MUNICIPALIDAD DE PROVIDENCIA
JEFE
DEPTO. HIGIENE Y CONTROL AMBIENTAL

HERNAN VARAS MUÑOZ
JEFE DPTO. HIGIENE Y C. AMBIENTAL

[1] Recordar que el ISP está constituído como organismo de referencia nacional y que posee laboratorios del ambiente en pleno desarrollo.

REPUBLICA DE CHILE
COMISIÓN NACIONAL DEL MEDIO AMBIENTE
REGIÓN DE ANTOFAGASTA

01051

28384

COMISION NACIONAL DEL MEDIO AMBIENTE
OFICINA DE PARTES Y ARCHIVO
Nº INGRESO: 13685/12270
FECHA: ....
DESPACHADO: 20 NOV 2000
OBS.: Patricia Matus

ORD. Nº : 0734 /2000

ANT. : No Hay

MAT. : Lo que se indica

Antofagasta, 16 de Noviembre del 2000

DE : Director Regional (s)
Comisión Nacional del Medio Ambiente
Segunda Región de Antofagasta

A : Sra. Patricia Matus
Jefe Depto.Descontaminación Planes y Normas
Comisión Nacional del Medio Ambiente

De mi consideración:

A través del presente, adjunto sírvase encontrar informe con las observaciones a los Anteproyectos de Normas de Calidad del Aire (SO_2, NO_2, PTS, CO, O_3), del Comité Regional.

Sin otro particular, saluda atentamente a usted,

COMISION REGIONAL DEL MEDIO AMBIENTE ANTOFAGASTA SECRETARIO

Alberto Acuña Cerda
Director Regional (S)
Comisión Nacional del Medio Ambiente
Segunda Región de Antofagasta

AAC/MOR/mem
Adjunto lo que se indica
c.c.:Archivo CONAMA II Región.

COPIA FIEL DE ORIGINAL

001052

COMISION NACIONAL DEL MEDIO AMBIENTE
14 NOV. 2000
ANTOFAGASTA
OFICINA DE PARTES

PROPUESTA REGIONAL
"REVISIÓN DE NORMAS PRIMARIAS DE CALIDAD DEL AIRE PARA SO_2, CO, PTS, O2 Y NO_2"
SEGUNDA REGIÓN DE ANTOFAGASTA

MOR 4686
14-11-00
-dar curso

Informe Comité Regional para la Revisión de las Normas Primarias de Calidad del Aire

Introducción:

En reunión del día 7 de Noviembre el Comité Regional acordó enviar una opinión en relación a los Anteproyectos publicados específicamente pronunciándose en torno al contaminante SO_2.

Los acuerdos tomados se encuentran incorporados en el acta de dicha sesión (Acta N°9). Los integrantes del comité que apoyan esta opinión son los que firman dicha acta.

Sin embargo debido a que no asistieron todos los miembros activos de este comité regional, se encuentran además sus observaciones adjuntas en este informe y firmadas por los integrantes que apoyan estas observaciones.

Se adjunta además un informe preparado por los representantes ante el Comité de la Asociación de Industriales de Antofagasta.

Acta N°9: Comité Regional
Normas Primarias de Calidad del Aire

01054

En Antofagasta a 07 días del mes de Noviembre de 2000, se realiza la Novena reunión del Comité Regional de la "Revisión de Normas Primarias de Calidad del Aire para SO2, CO, PTS, O2 y NO2" realizada en la sala de reuniones de la CONAMA de la Segunda Región.

Asistieron

Mónica Guiorgiadez	Asociación de Industriales de Antofagasta.
Hernán Flores Arrouch	Diremer II Región.
Priscilla Manzano	I.Municipalidad de Antofagasta
Roberto Espejo	Universidad Católica del Norte
Luis Vallejos	Universidad de Antofagasta
Jorge Fuenteseca S.	Universidad de Antofagasta
María Angélica Ruiz-Tagle	Conama
María Clemencia Ovalle	Conama

Temas Abordados:

1.- Metodología de evaluación económica.
2.- Exposición de un medico epidemiologo
3.- propuesta grupo SO_2 y NO_2

1.- Se da inicio a la reunión señalando que se ha invitado a participar a un médico epidemiologo el cual pertenece al Servicio de Salud de Antofagasta.

María Angélica Ruiz-Tagle presenta la metodología que CONAMA está ocupando para hacer la evaluación económica, señalando que esta evaluación estaría lista para el día 13 o 14 del presente mes.

Srta. Mónica Guiorgiadez pregunta si esta evaluación económica estará para ser analizada por este grupo en esta etapa de consulta pública.

CONAMA señala que no, pues este proceso se realiza paralelamente con la etapa de consulta pública.

2.- El medico invitado a participar no asistió a esta reunión.

3.- Srta. Mónica Guiorgiadez presenta la información relacionada con el cumplimiento de la norma horaria para el SO_2 que propone el Anteproyecto. Señala que con la reducción de emisión de un 27 % que tiene contemplada el proyecto Fase III de Fundición Altonorte, no se puede asegurar el cumplimiento de la norma horaria propuesta de 1050 ug/m^3N.

Don Roberto Espejo opina que si bien ahora las empresas no pueden cumplir con la normativa, en su planificación siempre deberían considerar mejorar sus condiciones ambientales en el entendido que la normativa cada vez se puede hacer mas estricta.

Don Luis Vallejos señala que los trabajos y/o estudios sobre la base de los cuales se fundamenta la norma horaria para el SO_2 son bastante serios y no hay duda que existe efectos sobre la salud de las personas. Adicionalmente señala que las empresas deberían considerar entre sus planes futuros el mejorar ambientalmente para poder cumplir con las nuevas normativas que se generen. Además señala que los planes de acción para cumplir con la norma deberían estar considerados en ella.

En relación al NO_2 no se presenta una propuesta debido a que no asistió la persona encargada de exponer este tema.

Acuerdos

En relación al NO_2:

- No se presenta propuesta.

En relación a la norma de SO_2:

- Se considera que los estudios realizados por CONAMA sobre los efectos del contaminante sobre la salud de las personas son serios.

1. **Norma diaria:** En la aplicación de una norma diaria de 250 ug/m^3N no hay dificultad por lo tanto se acoge el nivel propuesto en el anteproyecto.

2. **Norma horaria:** Se acoge el valor de 1050 ug/m^3N como norma horaria con las siguientes consideraciones:

   2.1 Como región consideramos que el Decreto Supremo deberá establecer o incluir el concepto de gradualidad para el cumplimiento de esta norma.

   2.2 Se adjunta la información de conflicto en términos operativo que la aplicación de la norma trae consigo a nivel de la realidad regional.

   2.3 Todas las observaciones y el análisis realizado por este Comité Regional han sido realizadas sin la información de la evaluación económica. Por lo tanto se solicita considerar el estudio económico para la determinación de los niveles de esta normativa.

   2.4 Se solicita que el Decreto Supremo incorpore que el organismo fiscalizador u otro, informe en forma periódica (anual,semestral, etc.) a la comunidad acerca del control y resultados de la fiscalización de la norma.

REPÚBLICA DE CHILE
COMISIÓN NACIONAL DEL MEDIO AMBIENTE
II REGIÓN DE ANTOFAGASTA

01656

PROPUESTA REGIONAL
"REVISION DE NORMAS PRIMARIAS DE CALIDAD DEL AIRE PARA SO2, CO, PTS, O2 Y NO2"
SEGUNDA REGIÓN DE ANTOFAGASTA

Nombre	Institución	Firma
HERMÁN FLORES ARROUCH	DIRECCIÓN REGIONAL DE EMERGENCIA II R.	
Luis R. Vallejo Delgado	Univ. de Antofagasta	
Jorge W. Fuentesecа Sierra	Universidad de Antofagasta	
Roberto Espejo Guasp	Universidad Católica del Norte	
* ~~Juan E. Ugarte Gomez~~	UNID. VECINAL Nº 2 COVIEFI ~~PRESIDENTE~~	
Alberto Rivera Olmedo	ADEMAM - MEJILLONES	

* Firmado por mala interpretación del lugar (Documento) que corresponde.

GOBIERNO DE CHILE
COMISION NACIONAL
DEL MEDIO AMBIENTE

01069

COMISION NACIONAL DEL MEDIO AMBIENTE
OFICINA DE PARTES Y ARCHIVO
Nº INGRESO: 13.744 /12316
FECHA: 21 NOV 2000
DESPACHADO:
OBS.:
Director Ejecutivo
28447

ORD. Nº: 1114

ANT. : -Memorandum PAC Nº458/2000, de fecha 25-09-2000, de Jefa Dpto. Participación Ciudadana, Información y Educación Ambiental.
-Ord. Nº978 del 14-11-2000, del Jefe Dpto. Programas sobre el ambiente del Servicio de Salud Coquimbo.

MAT. : Remite observaciones al "Anteproyecto de Norma Primaria de Calidad de Aire para Anhídrido Sulfuroso".

LA SERENA, NOV 2000

DE: DIRECTOR REGIONAL (S) CONAMA REGION DE COQUIMBO

A: SRA. ADRIANA HOFFMANN J., DIRECTORA EJECUTIVA CONAMA.

1. Adjunto al presente remito a Ud. observaciones al "Anteproyecto de Norma Primaria de Calidad de Aire para Anhídrido Sulfuroso"

Saluda atentamente a Ud.,

~~PEDRO VALENZUELA DIEZ DE MEDINA~~
DIRECTOR REGIONAL (S) CONAMA REGION DE COQUIMBO

PVD/RJB

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GOBIERNO DE CHILE
MINISTERIO DE SALUD

SERVICIO DE SALUD COQUIMBO

01070

ORD. : Nº 2C/ 978 /

ANT. : Anteproyecto de normas primarias de calidad de aire para Anhídrido Sulfuroso.

MAT. : REMITE OBSERVACION

LA SERENA, 14 NOV 2000

DE: DIRECTOR SERVICIO DE SALUD COQUIMBO

A : SR. ELIER TABILO VALDIVIESO
DIRECTOR CONAMA IV REGION

En relación al anteproyecto de norma primaria de calidad de aire para Anhídrido Sulfuroso (SO_2), informo a Ud. que este Servicio de Salud considera importante aclarar si dentro de los procesos de generación de Anhídrido Sulfuroso, se encuentra el lixiviado de minerales de cobre donde se utiliza ácido sulfúrico, de ser así se sugiere incorporar este proceso industrial dentro de los mencionados en el título I, párrafo 10º de la página 2, del citado anteproyecto.

Saluda Atentamente a Ud.,

"Por orden del Sr. Director del Servicio de Salud Coquimbo"

MINISTERIO DE SALUD
Departamento Programas del Ambiente
Dirección Servicio de Salud
SERVICIO DE SALUD COQUIMBO

DR. VICTOR CORREA ROMERO
JEFE DEPTO. PROGRAMAS SOBRE EL AMBIENTE

FGN/HCF

NACIONAL DEL MEDIO AMBIENTE
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15 NOV 2000
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  Director Regional CONAMA IV Región
- Depto. Programas sobre el Ambiente D.S.S.

O-CON73/14.11.2000

REPUBLICA DE CHILE

MINISTERIO DE MINERIA

COMISION NACIONAL DEL MEDIO AMBIENTE
OFICINA DE PARTES Y ARCHIVO
Nº INGRESO: 13511 / 12134
FECHA: ...
DESPACHADO: 15 NOV 2000
OBS.:
A. Hoffmann
28148

01071

OF. ORD. Nº 605 /

ANT.: No Hay

MAT.: Norma de calidad primaria anhídrido sulfuroso.

SANTIAGO, 14 NOV 2000

DE : SRA. JACQUELINE SAINTARD VERA
MINISTRA DE MINERIA (S)

A : SRA. ADRIANA HOFFMANN JACOBY
DIRECTORA EJECUTIVA CONAMA

Como es de su conocimiento, el anteproyecto de revisión de norma primaria de calidad de aire para anhídrido sulfuroso, salió a consulta pública el 15 de septiembre del año en curso, con el fin de realizar observaciones al respectivo documento.

Sobre el particular, esta Secretaría de Estado ha realizado una serie de comentarios basados en el estudio de soporte técnico de la consultora contratada por CONAMA para la elaboración de la norma, donde se señala en forma explícita, que **no** debe ser considerada una norma horaria.

En este sentido quiero señalar a Ud. que:

a) Deben considerarse los Planes de Descontaminación realizados por las fundiciones del país, con sus correspondientes inversiones.

b) Las decisiones tomadas por las empresas respecto a las tecnologías de fusión y las inversiones asociadas, se contemplaron en un horizonte de 25 años, por lo que resulta difícil terminar un plan de descontaminación y entrar nuevamente a otro por los mismos contaminantes, estimándose que deban realizar nuevos cambios tecnológicos.

c) La norma horaria conlleva a dificultades operacionales complicadas de resolver en períodos cortos de tiempo.

d) Los modelos de dispersión de contaminantes atmosféricos, han resultado ser una herramienta útil y complementaria a los planes de descontaminación. Sin embargo, han demostrado no ser del todo confiables, por lo que resulta que en ocasiones las empresas tienen considerados todos estos factores y aún así, sobrepasan las normas en casos puntuales.

e) El Estado de Arizona en U.S.A. donde existen fundiciones, no tiene norma horaria, por considerar que esta medida resulta excesivamente restrictiva.

f) Los impactos agudos que pudieran presentarse en las operaciones, pueden ser abordados a través de un plan de manejo de episodios críticos.

Con respecto a la norma diaria, cabe señalar que:

a) A nivel federal, en Estados Unidos se exige un valor de 365 ug/m3, el mismo valor que hoy se exige en Chile. El valor que propone CONAMA de 250 ug/m3, corresponde a una recomendación internacional de la O.M.S.

b) En el entendido que es un recomendación, sugerimos establecer una aplicación gradual para su cumplimiento.

Cabe señalar además, que el reglamento N° 93/95 de la SEGPRES, para la dictación de normas de calidad ambiental y de emisión, señala que deben ser considerados estudios técnicos, científicos y económicos, entendiendo que con esta gama de criterios, estamos en condiciones de tomar la mejor decisión para la elaboración de normas ambientales.

Sin otro particular, saluda atentamente a Ud.,

REPUBLICA DE CHILE - MINISTERIO DE MINERIA - MINISTRO -

JACQUELINE SAINTARD VERA
Ministra de Minería (S)

REPUBLICA DE CHILE - MINISTERIO DE MINERIA
Jefe División Jurídica

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FECHA:
DESPACHADO: 16 NOV 2000
OBS.:
A. HOFFMANN

28259

OFICIO NRO.: 045/2000.-

MAT.: Solicita Seminario

TALCAHUANO, 07 DE NOVIEMBRE DE 2000.-

DE: JOSE LAGOS VASQUEZ
PRESIDENTE UNION COMUNAL DE JUNTAS DE VECINOS THNO.

A : ADRIANA HOFFMANN J.
DIRECTORA EJECUTIVA
COMISION NACIONAL DEL MEDIO AMBIENTE

Presidente y Directorio saludan atte. a Usted y vienen a exponer y solicitar lo siguiente:

El día 07 de Noviembre de 2000 en la comuna de Concepción se realizó un Seminario denominado "Normas Primarias de Calidad de Aire para Anhídrido Sulforosos, Monóxido de Carbono, Dióxido de Notrógeno, Ozono, Particulas Totales en Suspensión."

Como Institución que cobijamos a 83 Juntas de Vecinos en Talcahuano, es que le solicitamos, tenga a bien, ver la factibilidad de realizar este mismo encuentro en nuestra Comuna, considerando que nuestro puerto, según las estadisticas nacionales e internacionales, somos la comuna con mas contaminación y creemos que es justo realizar éste tipo de seminarios donde mas lo necesitamos.

Se despiden muy cordialmente y en espera de una favorable acogida a nuestra petición,

CECILIA MUÑOZ SERRANO
TESORERA

UNION COMUNAL DE JUNTAS DE VECINOS TALCAHUANO

JOSE LAGOS VASQUEZ
PRESIDENTE

C.C.: Archivo

01074

Muñoz Sandoval Gerardo (Casa Matriz)

Para: jladron@conama.cl
Asunto: Antecedentes Adicionales Div. Teniente para Evaluación Norma Horaria SO2

282415

OFICINA DE PARTES Y ARCHIVO
N° INGRESO: 13542 / 12/54
FECHA: 16 NOV 2000
DESPACHADO:
R. Lucero

Sres.
Juan Ladrón de Guevara
Rodrigo Lucero
CONAMA
Presente

Estimados Sres.

Por la presente resumimos a Uds. algunas informaciones anteriormente entregadas y entregamos a Uds. nuevas informaciones que permitirán evaluar el real impacto económico de la Norma horaria establecida para SO2 en el Anteproyecto de Revisión de la Norma N° 1215 sobre Calidad del Aire.

1. Número de excedencias con emisiones máximas permitidas al término P. Descontaminación Caletones:
   - Monitor Coya Población: 0
   - Monitor Coya Club de Campo: 157

2. Número de excedencias con módulo adicional Planta Limpieza N°1 y Captación de Gases Secundarios:
   - Monitor Coya Población: 0
   - Monitor Coya Club de Campo: 0

3. Inversiones Asociadas a Planta Limpieza N°1 y Captación de Gases Secundarios:

Nuevo módulo Planta N°1:	US$ 30.000.000.-
Captación Gases Secundarios	5.700.000.-
Total Inversiones necesarias	US$ 35.700.000.-

4. Pérdidas por no ejecución de Proyecto Expansión Fundición de 1.25 a 1.6 millones de ton. concentrados por año:

VAN Caso Desarrollo (Escenario 5):	US$ 445.000.000.-
VAN Caso Base Actualizado (Escenario 3)	249.000.000.-
Pérdidas Valor Actualizado Neto	US$ 196.000.000.-

5. Costo total Norma Horaria para División El Teniente US$ 231.700.000.-

6. Representatividad Monitores en División El Teniente (para poblaciones intermedias):

N° de Viviendas en un radio de acción de 1.5 km de Monitor Club de Campo:	614 viviendas
Población en radio de acción de 1.5 km Monitor Club de Campo:	2350 personas
N° de Viviendas en un radio de acción de 1.5 km de Monitor Coya Población:	590 viviendas
Población en radio de acción de 1.5 km de Monitor Coya Población:	2330 personas

Se adjunta detalle en Anexo.

Por mano se hará llegar a Uds. plano de ubicación de monitores y viviendas.

Saluda a Uds. atentamente,

Gerardo Muñoz S.
Subgerente de Medio Ambiente
CODELCO-Chile

OBSERVACIONES A LOS ACUERDOS INDICADOS EN ACTA N°9 (REALIZADOS POR PARTICIPANTES DE LA SUBCOMISIÓN DE SO_2)

En relación a los acuerdos:
En relación al NO_2:

No se presenta propuesta.

En relación a la norma de SO_2:

Se considera que los estudios realizados por CONAMA sobre los efectos del contaminante sobre la salud de las personas contienen bastante información, pero que lamentablemente no se dio la oportunidad de constatar la información, desde el punto de vista médico o el que sostiene el SSA ya que dejaron de participar en las últimas reuniones por instrucciones de su institucionalidad central.

1. **Norma diaria:** En la aplicación de una norma diaria de 250 [μg/m^{3}N]. Existe dificultad pero se cree que con algunos esfuerzos operacionales podría ser cumplida. No se debe olvidar gradualidad y en esta región se deberá esperar por la implementación del Plan de Descontaminación de Chuquicamata y la Ampliación de la Fase III de Altonorte; ambas resoluciones fueron otorgadas bajo normas del Decreto N°185 y cubre hasta el 2003.

2. **Norma horaria:** Se realizo un esfuerzo serio por los participantes de la sub-comisión de SO2 para evaluar la factibilidad técnica de cumplimiento del valor de 1050 [μg/m^{3}N] como norma horaria; lamentablemente solo pudo trabajar con los datos que aportaron las fundiciones, quienes no pueden cumplir este requerimiento; no se obtuvieron las informaciones requeridas para fundamentar una respuesta económica ni médica. Es importante recordar que Japón, país fundidor de concentrados extranjeros, tiene una norma horaria de 2620 [μg/m^{3}N] y que USA tiene una norma secundaria móvil de tres horas, igual a 1300 [μg/m^{3}N]. Se sugiere tener presente consideraciones como las señaladas además de:

   2.1 Como región consideramos que el Decreto Supremo deberá establecer o incluir el concepto de gradualidad para el cumplimiento de esta norma.

   2.2 Se adjunta la información de conflicto en términos operativos que la aplicación de la norma trae consigo a nivel de la realidad regional.

   2.3 Todas las observaciones y el análisis realizado por este Comité Regional han sido realizadas sin la información de la evaluación económica. Por lo tanto, se solicita considerar el estudio económico para la determinación de los niveles de esta norma.

   2.4 Se solicita que el Decreto Supremo incorpore que el organismo fiscalizador u otro, informe en forma periódica (anual, semestral, etc.) a la comunidad acerca del control y resultados de la fiscalización de la norma.

Nota: Cabe señalar que las personas más activas del Comité Regional no asistieron en esta oportunidad, ocasión en que se redacto Acta N°9; considerada como Acuerdo R+egional.

ASOCIACION DE INDUSTRIALES
DE ANTOFAGASTA

Observaciones Realizadas por el
Comité Regional Normas Primarias de Calidad del Aire al Acta N° 9 del día 7 de Noviembre.

I.- Integrantes de la Comisión de Revisión de Normas Primarias de Calidad del Aire Para SO_2, CO, PTS, O_3 Y NO_2.

Señora Yanett Omegna San Martín, Asociación de Industriales de Antofagasta
Señora Mónica Guiorguiadez Olavaria, Asociación de Industriales de Antofagasta
Señor Jorge Díaz, Asociación de Industriales de Antofagasta
Señor Mack Kobec, CODELCO Chuquicamata
Señor Abel Reinoso Ferrada, Universidad Católica del Norte.
Señor Alberto Rivera, Ademan
Señor Juan Ugarte, Presidente de Junta de Vecinos Vientos del Sur.
Señor Rubén Alfaro, CODELCO Chuquicamata.
Señor Luis Vallejos, Universidad de Antofagasta.
Señor Roberto Espejo, Universidad Católica del Norte .
Señora Sandra Cortés, Servicio Nacional de Salud.
Señor Hernán Flores Arrrouch, Diremer II región.
Señora Priscilla Manzano, Ilustre Municipalidad de Antofagasta.
Señor Jorge Fuenteseca, Universidad de Antofagasta.
Señor Carlos Saavedra G, Enaex.

II.- La Comisión se dividió en dos sub-comisiones: una de ellas se dedicó al estudio y análisis de los contaminantes NO_2, O_3 y CO y la otra, trabajó con los antecedentes relativos a PTS y SO_2. Ambas sub-comisiones desarrollaron un trabajo serio, permanente y con mucha profesionalidad durante prácticamente todo el año.

III.-En la reunión del 07 de noviembre, lamentablemente solo asistieron las personas señaladas en el Acta N° 9; sin desconocer su valiosa opinión, es menester señalar que ellas solo asistieron en forma esporádica durante el trabajo de comisiones y que sus opiniones, señaladas en el Acta en comento, no representan la opinión de quienes trabajaron el la sub-comisión de SO_2.

IV.-La consideración del punto III.- obliga a la Asociación de Industriales de Antofagasta a hacerse partícipe de la de las observaciones que se realizan al Acta N°9, para tal efecto se adjuntan documentos técnicos sustentatorios (e-mail de CODELCO –Chuquicamata y alcances de Fundición Altonorte), que de alguna manera muestran las opiniones vertidas en Actas anteriores por el subcomité de SO_2. Junto con ello estamos incorporando una copia de la carta dirigida a la Sra. Hoffman en la cual manifestamos absoluto acuerdo en la participación junto a CONAMA, en la gradualidad de la aplicación de nuevas normativas y sugerimos respetuosamente tener presente las dificultades que implicaría cumplir lo que el anteproyecto de norma primaria para SO_2 implica. En lo específico, la norma horaria propuesta es técnicamente imposible de cumplir; las razones se exponen en los Anexos que acompañan a las Observaciones que

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ASOCIACION DE INDUSTRIALES
DE ANTOFAGASTA

realizaron los participantes de la sub-comisión de SO_2, al Acta N°9 y que firman en señal de conformidad del documento. A saber:

Fernando Rivas R.	Vicepresidente Asociación de Industriales de Antofagasta – Miembro del Consejo Consultivo de CONAMA.
Abel Reinoso F.	Académico Univ. Católica del Norte
Mónica Guiorguiadez O.	NORANDA – Fundición Altonorte
Juan Ugarte G.	Presidente U. Vecinal N°2- Vientos del Sur. COVIEFI
Yanett Omegna S.M.	Representante Asociación de Industriales de Antofagasta.

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APOYO A OBSERVACIONES A LOS ACUERDOS TOMADOS EN ACTA Nº 9 , REALIZADOS POR LA ASOCIACIÓN DE INDUSTRIALES DE ANTOFAGASTA

Nombre	Institución	Firma
Yanett Omegna S.M.	Fundación Altonorte	[firma]
Mónica Fernández	Fundación Altonorte	M. Fernández
Abel Reinoso Ferrera	U. Católica del Norte	[firma]
JUAN E. UGARTE GOMEZ	PRESIDENTE U.V. Nº 2 VTOS. DEL SUR. CONIEFI.	[firma]
FERNANDO RIVAS ROCES	VICE PRESIDENTE AIA Y MIEMBRO DEL CONSEJO CONSULTIVO II REGION	Fdo. Rivas Roc

De: Alfaro Torrico, Rubén (Chuquicamata) <ralfaro@gwsmtp.codelco.cl>
Para: dmaturana.2@conama.cl <dmaturana.2@conama.cl> 01061
CC: Pedreros Quiroga, Rubén (Chuquicamata) <rpedrero@gwsmtp.codelco.cl>
Fecha: Martes 14 de Noviembre de 2000 02:23 PM
Asunto: RESPUESTAS A CARTA COMITE REGIONAL DE NORMAS PRIMARIAS DE CALIDAD DEL AIRE

Mª Angélica:

La siguiente es la Nota de respuesta a la carta de la referencia:

Atentamente,

Rubén Alfaro T.
-----Mensaje original-----
De: Danica Maturana Ostoich [mailto:dmaturana.2@conama.cl]
Enviado el: Jueves, 09 de Noviembre de 2000 16:46
Para: yanett omegna; sandra cortes; ruben alfaro; roberto espejo; monica guiorgimadez; luis vallejos; jorge fuenteseca; hernan flores; carlos saavedra; alberto rivera; abel reinoso
Cc: abel reinoso; alberto rivera; carlos saavedra; hernan flores; jorge fuenteseca; luis vallejos; monica guiorgimadez; roberto espejo; ruben alfaro; sandra cortes; yanett omegna
Asunto: remite acta nº 9

conforme a lo acordado en reunión de fecha 07 del presente mes, sírvase encontrar Acta Nº 9, con los acuerdos tomados para que usted pueda revisarlos, y hacernos llegar a la brevedad sus observaciones.

Saluda Atentamente a usted,

María Angélica Ruiz-Tagle Bórquez
Directora Regional (S)

OBSERVACIONES A CARTA DEL COMITÉ REGIONAL PARA LA REVISION DE NORMAS DE CALIDAD PRIMARIA DEL AIRE

Observaciones Generales:

Para la discusión y análisis de las normas incluidas a la Res. Nº 1215, la Conama organizó una serie de reuniones a las que se invitó a representantes del área minero-industrial y a la comunidad organizada.

En estas reuniones se llegaron a conclusiones que posteriormente no se vieron reflejadas en el anteproyecto de normas publicado.

Esta situación provocó nuestras dudas respecto a la utilidad de nuestra asistencia a las reuniones de discusión, lo que también nos fue comentado por los representantes de otras empresas y de juntas de vecinos.

Observaciones a los acuerdos indicados en el Acta Nº 9

1.- Norma de SO2

a) No se cuestiona la seriedad de los informes, pero ellos no permiten estimar el número de pacientes con enfermedades asociadas a la exposición a SO2 que disminuirán producto de la implantación de la norma propuesta, es decir, no queda claro el beneficio en la salud de la población local.

b) Chuquicamata ha señalado la factibilidad de cumplir una norma de 300 ug/m3N +/- 20 %, esto quiere decir, la imposibilidad de cumplir con la norma propuesta. Ello agrega una causal adicional para reforzar la erradicación de nuestro campamento.

c) Insistimos en que la aplicación de una norma horaria no es factible ya que cualquier acción para bajar los niveles ambientales se efectuaría ante hechos consumados, derivados entre otros, por la meteorología de la zona. Esto constituye una realidad conocida por los distintos participantes del comité.

La gradualidad no soluciona este problema.

2.- Conclusiones:

En resumen, consideramos que el contenido del Acta Nº 9 no refleja los acuerdos alcanzados en las reuniones en que participo el suscrito.

Atentamente,

Rubén Alfaro Torrico
Analista de Gestión Ambiental

ANEXO

2.2 Conflictos en términos operativos

Observaciones realizadas por representantes de la Asociación de Industriales de Antofagasta:

I.- De ser necesario, medidas factibles de adoptar para reducir emisiones de SO2 en el escenario de las normas propuestas en el anteproyecto, en particular respecto del cumplimiento de la norma horaria.

Fundición Altonorte dispone de capacidad instalada para el tratamiento del total de los gases generados en el proceso. En esta condición el nivel de captura de SO2 ha alcanzado valores históricos del 82%. La diferencia corresponde a emisiones fugitivas durante el transporte y transferencia entre los diferentes equipos en la operación con materiales fundidos, eficiencia de las plantas de ácido y su disponibilidad. Con relación a la Norma Horaria, las situaciones de excedencia, están asociadas a fenómenos de carácter meteorológico, ya que no existe correlación entre el SO2 emitido y las concentraciones medidas en La Negra.

De acuerdo con lo anterior la factibilidad de reducir emisiones solo resulta viable mediante las siguientes alternativas:

Operación intermitente de la fundición deteniéndola en la noche:

La condición meteorológica nocturna, con régimen de calma, alta estabilidad y nivel de subsidencia muy bajo, dificulta la difusión de gases, acumulándose estos sobre la fundición. El cambio gradual producido al inicio del día rompe la capa de inversión, produciendo transporte vertical y horizontal. La dirección del desplazamiento horizontal y la estabilidad atmosférica son muy variables y a pesar de los análisis meteorológicos efectuados por especialistas, su pronóstico ha tenido bajo nivel de acierto. La única forma de asegurar con certeza que no se producirán promedios horarios sobre 1050 ug/m3 en la Negra es reducir al mínimo la emisión durante la noche. Esto solo puede lograrse deteniendo la operación , pero aun esta medida no significa cero emisión porque debe mantenerse la temperatura de los equipos de fusión.

Captura y tratamiento de los gases fugitivos.
Los sistemas de captura de gases fugitivos requieren de altas tasas de dilución y la concentración final de SO2 no permite su tratamiento en las plantas de ácido. La alternativa es recurrir a sistemas de scrubbers húmedos y a la neutralización con cal u otro tratamiento alternativo, previo a la disposición final de sus efluentes líquidos.

Aumentar restricción operacional , reduciendo nivel de alerta
Esta fundición estableció un programa interno, para no superar el promedio horario de 1000 ug/m3 que consiste en bajar la fusión y el flujo de aire en conversión cuando la concentración instantánea (promedio de un minuto) de SO2 en la Negra alcanza 500 ug/m3. En el presente año este plan se ha aplicado durante un total de 348 horas, no obstante lo cual se registraron veinte promedios horarios mayores que 1000 ug/m3 en la Estación de La Negra. (En Anexo N°4 , se adjunta información de respaldo). Bajar el nivel de alerta en este plan a niveles de 400 ug/m3, mejora las probabilidades de no producir excedencias horarias, sin embargo en el presente año se presentaron 890 horas con peacks sobre 400.

II.- Estimación detallada de los costos para cada una de las medidas consideradas

2.1 Detención nocturna de la Fundición:

Optar por esta alternativa significa mantener los costos fijos prácticamente en el nivel actual y reducir los ingresos en un 33.3 % . El costo que tendría esta opción equivale a US$ 16.000.000, que hace inviable económicamente esta Fundición.

2.2.- Inversión en sistemas de captura de gases fugitivos

2.2.1 Inversiones

Enclaustramiento de ollas, campanas secundarias y sistemas de extracción	US$	5.500.000
Sistemas de tratamiento de efluentes.	US$	300.000
Total	US$	5.800.000

2.2.2 Operación

Tratamiento de efluentes, insumos, etc.	US$	360.000
Disposición final de residuos	US$	200.000
Mantención	US$	100.000
Total (por año de operación)	US$	660.000

2.3.- Nivel de alerta más restrictivo en el Plan de Contingencia:

Durante el presente año hasta la fecha, la pérdida de fusión por aplicación de nuestro Plan de Contingencia con nivel de alerta en 500 ug/m3 durante 348 horas fue de 3.222 toneladas de concentrado y el menor ingreso de US$ 289.980, pero de todas maneras el promedio horario superó los 1000 ug/m3, en 20 oportunidades. En otras palabras, se habría superado el límite de la Norma Horaria que se está proponiendo. Con un nivel de alerta en 400 ug/m3, se habría activado la restricción operacional en 890 horas, equivalentes a 8240 toneladas de concentrado y un menor ingreso de US$ 741.600.
La hipótesis de usar 400 ug/m3, reduce las probabilidades de excedencia pero no las elimina, si el nivel se reduce a 300 ug/m3 la cantidad de horas se acerca a la alternativa mencionada en iv alternativa 1.

III.- Plazos requeridos para la implementación de las medidas.

No consideramos implementar la alternativa N° 1 por ser inviable económicamente y no se analizó.
La implementación de sistemas de captura y tratamiento de gases secundarios, (alternativa 2) requiere de 36 meses, como mínimo para la ingeniería, diseño, construcción y montaje.
La alternativa de aumentar la restricción en el plan de contingencia, debe necesariamente estar asociada a sistemas de pronóstico meteorológico mas rigurosos que los actuales, análisis de variables que esta fundición no maneja hoy. Estimaciones muy preliminares estiman en 24 meses el plazo necesario para la implementación de los sistemas, análisis de variables y aplicación.

IV.- En la eventualidad que la Fundición deba controlar o prevenir la excedencia de la norma horaria de SO2 a través de reducción de fusión de concentrados, ¿con cuanto tiempo de anticipación debe reducir fusión para llegar a la condición de operación que controlará dicha excedencia (independientemente de la duración de las condiciones adversas de dispersión atmosférica) y cual es el tiempo requerido para volver a carga completa una vez que la condición atmosférica adversa ha finalizado?

Como se indicó en el punto 1, esta Fundición ha estado aplicando exactamente este criterio, teniendo como objetivo no exceder 1000 ug/m3 promedio horario. Una vez superada la condición critica, volver a la condición normal toma entre una y tres horas, dependiendo de cuan larga o intensa haya sido la reducción y el enfriamiento de los equipos. El caso mayor se registró el 16 de Septiembre de 1998, cuando la Fundición detuvo completamente su operación a las 6.05 de la mañana. Sin embargo los promedios de las horas siguientes se mantuvieron sobre 1000, hasta las 10 horas. La vuelta a la operación normal tomó mas de 5 horas.
Entre la activación del Plan y la toma de acción transcurren normalmente 10 minutos o menos, sin embargo los resultados de esa acción solo serán detectados después de 30 minutos, siempre y cuando coincida con la condición de dirección de viento hacia La Negra. En régimen de calma la respuesta del sistema es mas lenta y es por eso que insistimos en la inviabilidad del manejo operacional en función de la media horaria. El objetivo exitosamente alcanzado con nuestro programa era cumplir la media diaria.

Se anexa además información de Chuquicamata de su postura ante el anteproyecto

J1067

ASOCIACION DE INDUSTRIALES
DE ANTOFAGASTA

Señora
Adriana Hoffmann
Directora Ejecutiva CONAMA
Santiago

De nuestra consideración:

La Asociación de Industriales de Antofagasta (AIA) fue invitada por Conama II Región a participar, conjuntamente con otros sectores de la comunidad, en un Comité Regional creado con el objetivo de fomentar el proceso participativo de la comunidad en la revisión de Normas de Calidad del aire.

Esta Asociación agradece y manifiesta su gran interés de estar presente, en esta y en todas las instancias que contribuyan a establecer, de una manera informada y participativa, la legislación ambiental adecuada que el país requiere para su inserción en el contexto mundial actual.

La Asociación de Industriales de Antofagasta, como Ud. debe saber, ha impulsado desde hace un tiempo la idea de generar un Cluster Minero, que potencie el desarrollo regional mas allá de la simple exportación de materias primas, evitando así la alternancia de períodos de auge y posterior decaimiento económico, sobradamente conocidos en la historia de esta región. De tal forma que, el recurso minero deberá servir de sustento para la creación de procesos de desarrollo de tecnologías mineras, productos, equipos y maquinaria, que mantengan la sustentabilidad regional mas allá de la duración del mismo.

Este objetivo puede verse seriamente comprometido por la implementación de Normas que superen las reales posibilidades de cumplimiento del sector productivo, que carezcan de un análisis costo-beneficio confiable, o que no consideren los factores regionales.

Estimamos que, con los antecedentes aportados durante la discusión en la instancia mencionada, no queda claramente establecida la viabilidad y conveniencia de reducir la Normativa de Anhídrido Sulfuroso. Por el contrario, creemos que esta iniciativa desincentivará el crecimiento de las actuales fundiciones de Cobre o la instalación de otras nuevas. Indudablemente, esta modificación a la norma inhibe la posibilidad de establecer nuevas fuentes productivas asociadas a la minería, desviando la opción de los eventuales inversionistas hacia países que compiten con el nuestro.

Es evidente que las fundiciones de cobre han hecho fuertes inversiones en el control de sus emisiones. A pesar de ello, aun subsisten situaciones que han debido ser reevaluadas, pero la reducción de la Norma en vigencia, comprometerá seriamente la sustentabilidad de estos establecimientos. Debe tenerse en cuenta que el Cobre genera aún el 50 % de nuestras exportaciones.

La Norma Diaria de SO2 vigente no está siendo cumplida en todo el país. Hacerla más restrictiva no contribuirá a disminuir el problema, y nos parece razonable focalizar los esfuerzos en lograr efectivamente su cumplimiento, para una vez alcanzado éste, dar el paso siguiente en términos de reducción.

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E-Mail: ASOCDEIN@CHILESAT.NET

ASOCIACION DE INDUSTRIALES
DE ANTOFAGASTA

2068

La aplicación de una Norma Horaria, resulta operativamente imposible de controlar o deja la operación sujeta a la aplicación de sistemas de predicción meteorológicos de carácter solamente probabilístico.

La AIA apoya el principio de gradualidad establecido en la Ley 19.300. De la misma forma cree imprescindible la racionalidad y cautela en la revisión de normas a fin de que ellas no representen barreras al logro de metas económicas y sociales. Es así que esta Asociación sugiere respetuosamente:

- No modificar la norma vigente en las concentraciones de anhídrido sulfuroso en los periodos Diarios y Anual.
- Eliminar la Norma horaria.

Esta propuesta se sustenta en los siguientes antecedentes:

- La norma actual ha obligado a las empresas a emprender acciones que hoy permiten cumplir con los niveles establecidos. Esto aparentemente contradice el punto que señala que la norma diaria no se estaría cumpliendo en todo el país

- Una disminución del nivel en el período Diario hace que las empresas deban realizar adquisición de nuevas tecnologías de alto valor.

- En el caso del nivel en el período Horario, que limita a una concentración menor en condiciones de ocurrencia más restringidas estadísticamente, lo hace tecnológicamente imposible.

- Lo anterior se traduce en una pérdida de competitividad comprometiendo a esas unidades productivas en cuanto a fuente laboral.

- El resultado de niveles más restrictivos induce a que los concentrados de cobre sean procesados fuera del país. En sentido opuesto, el procesar los concentrados en el país permite incorporar valor agregado al cobre, generar empleos y, de paso, incorporar las tecnologías que permitan a los procesos cumplir con las normas que ha establecido el país.

La valiosa experiencia obtenida en la discusión de la normativa en comento, hace recomendar que se continúe trabajando con la CONAMA y los representantes de la comunidad en la discusión de la normativa ambiental del país, en la certeza que es el camino correcto para alcanzar la sustentabilidad del desarrollo económico de la Región y del país.

Saluda atentamente a usted.

Iván Simunovic Petricio
Presidente
Asociación de Industriales de Antofagasta

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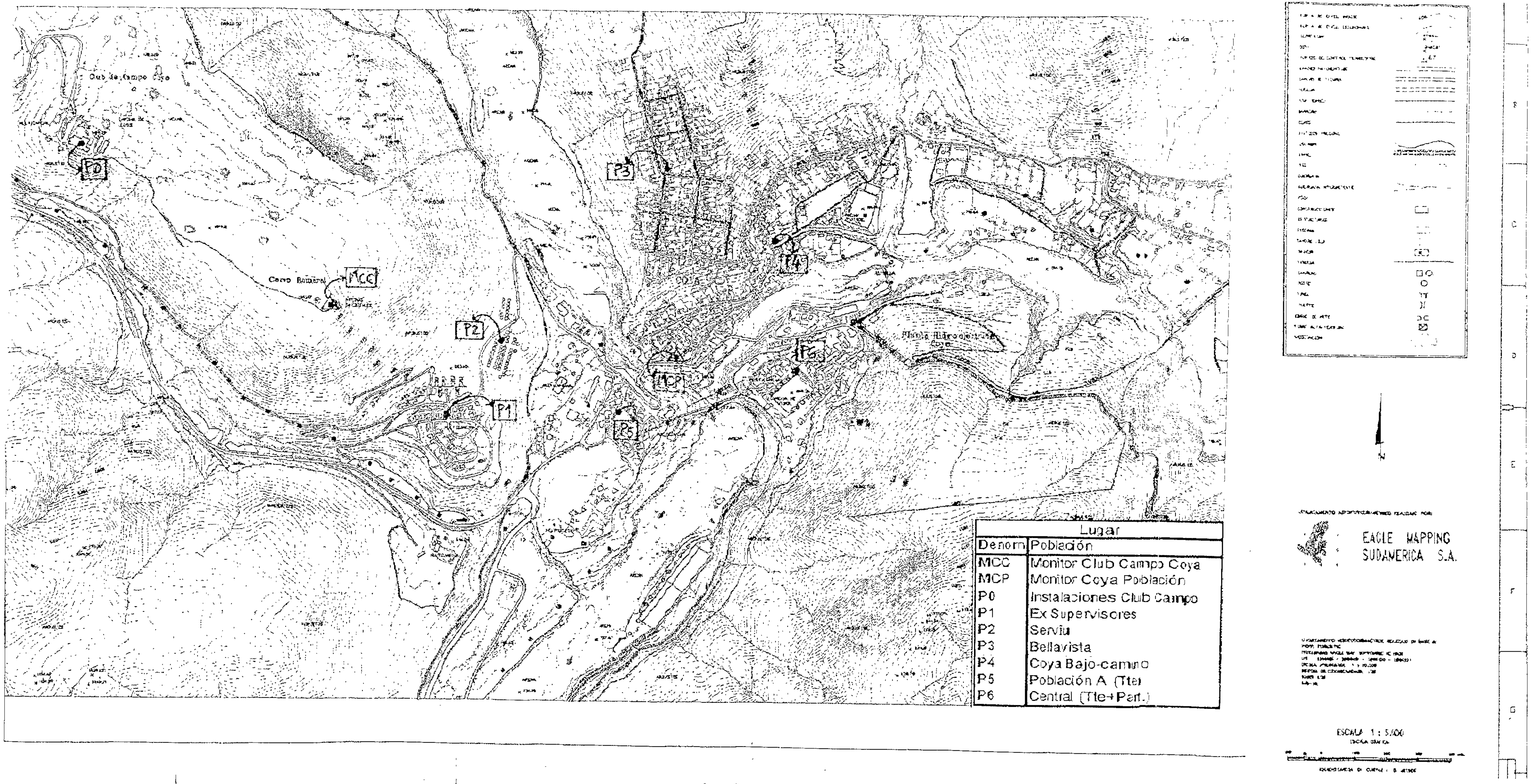
01075

Población de Coya y Relación Estaciones Monitoras Club Campo y Coya Población

Lugar		Dist Mon.CCC	Dist Mon. CP	Dif Alt Mon. CCC	Dif Alt Mon CP	Viviendas	Pob Estimada
Denom	Población	X1 (m)	X2 (m)	L1 (m)	L2 (m)	Nº	Nº
P0	Inst Club Campo	925	1975	10	245	24	20
P1	Ex Supervisores	500	750	-170	60	35	120
P2	Serviu	550	550	-200	40	50	200
P3	Bellavista	1175	600	-140	100	300	1200
P4	Coya Bajo-camino	1425	475	-230	10	150	600
P5	Población A (Tte)	975	250	-240	-10	15	50
P6	Central (Tte+Part.)	1475	375	-230	10	40	160
						Total	2350

(*) Población Teniente, solo las indicadas el resto particulares.


Club de Campo Coya
P0
P3
P4
Cerro Baliaire
MCC
P2
P1
MCP
P5
P6
Lugar
Denom Población
MCC Monitor Club Campo Coya
MCP Monitor Coya Población
P0 Instalaciones Club Campo
P1 Ex Supervisores
P2 Serviu
P3 Bellavista
P4 Coya Bajo-camino
P5 Población A (Tte)
P6 Central (Tte+Part.)
EAGLE MAPPING
SUDAMERICA S.A.
ESCALA 1 : 5.000

COMISION NACIONAL DEL MEDIO AMBIENTE
OFICINA DE PARTES Y ARCHIVO
Nº INGRESO: 13700/12281
FECHA:
DESPACHADO: 21 NOV 2000
OBS.:
A. Hoffmann
28396

GOBIERNO DE CHILE
SERVICIO NACIONAL DE GEOLOGIA Y MINERIA

001078

ORD. N° 1348 /

ANT.: Proceso de consulta pública de las normas primarias de Calidad de Aire para Anhídrido Sulfuroso (SO_2), Monóxido de Carbono (CO), Dióxido de Nitrógeno (NO_2), Ozono (O_3) y Partículas Totales en Suspensión (PTS).

MAT.: Emite observaciones.

14 NOV. 2000

DE : RICARDO TRONCOSO SAN MARTIN
DIRECTOR NACIONAL
SERVIVIO NACIONAL DE GEOLOGIA Y MINERIA

A : SRA. ADRIANA HOFFMANN JACOBY
DIRECTORA EJECUTIVA
COMISION NACIONAL DE MEDIO AMBIENTE

Mediante el análisis del documento mencionado en ANT., la Subdirección Nacional de Minería de este Servicio estima pertinente señalar los siguientes comentarios y observaciones:

1. **Oportunidad de la consulta.**
Por razones que desconocemos la "Consulta Pública" de las normas del ANT. no fue formulada a través de la Dirección Nacional del Servicio, único ente encargado por ley de emitir la opiniones oficiales del SERNAGEOMIN. Sólo se tomo conocimiento de dicha consulta a través de las direcciones regionales de Atacama y Coquimbo, las cuales fueron consultadas por las Conamas de dichas regiones. Por lo anterior, solamente llegó a nuestro poder la consulta en cuestión la segunda semana de noviembre, por lo cual no es posible entregar nuestras observaciones a todos los anteproyectos enviados. De todas maneras, se entrega observación de dos de ellos, solicitando, si es posible, que se amplíe el plazo para efectuar un estudio más profundo.

2. **Anteproyecto de Norma Primaria de Calidad de Aire para Partículas Totales en Suspensión (PTS).**
Dispone No Establecer Niveles de Concentración, dejando sin efecto los valores de concentración para las partículas totales en suspensión que hayan estado vigentes hasta la fecha. Dicha conclusión se fundamenta en que estudios recientes han demostrado que las partículas que más afectan la salud de las personas son aquellas con un diámetro aerodinámico menor a 10 um (PM10) y más aún, aquellas con diámetro aerodinámico menor a 2,5 um (PM2.5).

SERV. NAC. DE GEOLOGIA Y MINERIA · DEPTO. JURIDICO

El fundamento presentado en el documento sujeto a consulta es decisivo, en particular, porque existiría normativa aplicable para material particulado respirable, en donde actividades de la minería, tales como fundiciones, estarían reguladas. No obstante, se recomienda reflexionar respecto de la utilidad de mantener o dictar una norma equivalente de PTS, dado que existen áreas del territorio nacional que se encuentran más sensibles a este tipo de emisiones, y que generan otro tipo de fuentes, independientemente del tamaño de las partículas.

Nuestra preocupación apunta a un segundo grupo de actividades mineras que son potencialmente contaminadoras de la atmósfera por emisiones de polvo: Se sabe

que la minería emite partículas que tienen diámetros comprendidos entre 1 y 1.000 um, las cuales, en su mayor parte, se depositan por gravedad y tienen una composición muy variada según su procedencia. El polvo constituye la principal fuente de polución del aire en el sector minero, cuyo origen proviene de actividades de explotación de mineral, acción del viento sobre las canteras o rajos abiertos, depósitos de estériles, tranques de relaves, actividades relacionadas con la trituración del mineral (incluyendo áridos), transporte, etc.

Los efectos del polvo emitido por las actividades mineras son muy numerosos y variados, comenzando por molestias a la población que se encuentra cercana, incluyendo efectos sobre la salud debido a las partículas de tamaño respirable, problemas de oclusión de las estomas de las plantas, empeoramiento de la calidad del aire a nivel local, etc.

Finalmente, en cuanto a esta norma, pensamos que, en lugar de eliminarla, sería aconsejable estudiarla de tal manera de hacerla de más fácil aplicación y control. Se deja abierta la inquietud y nuestra voluntad para participar en cualquier estudio que se decida realizar al respecto.

3. **Anteproyecto de Norma Primaria de Calidad de Aire para Anhídrido Sulfuroso.**

3.1 La mayoría de las Fundiciones de Cobre del país se encuentran implementando o terminando sus Planes de Descontaminación, con esto han estado incorporando a los procesos consideraciones técnicas para cumplir con la Norma Primaria de Anhídrido Sulfuroso y Material Particulado, según el D.S. 185 de 1992 del Ministerio de Minería.

GOBIERNO DE CHILE
SERVICIO NACIONAL DE GEOLOGIA Y MINERIA

3.2 Estos Planes han significado grandes inversiones para las Empresas del Estado.

3.3 Según los antecedentes:
Situación Actual:
Norma Primaria: Anual : 80 ug/m^{3}N de SO_2

Diaria : 365 ug/m^{3}N de SO_2

Proposición
Norma Primaria: Anual : 80 ug/m^{3}N de SO_2
Diaria : 250 ug/m^{3}N de SO_2
Horaria : 1.050 ug/m^{3}N de SO_2

3.4 Se aumenta la restricción para la Norma primaria Diaria y se implementa la Norma Primaria Horaria.

3.5 Debido a la cercanía a poblados que se encuentran casi todas las Fundiciones de Cobre del país no es posible que se puedan cumplir tal restricción en forma tan determinante como lo es "el día 1° del mes siguiente a la publicación en el diario oficial".

3.6 La ocurrencia de episodios críticos, en la mayoría de las fundiciones de cobre no solamente esta supeditado a condiciones operacionales sino que en la mayoría y en un alto grado a condiciones de meteorología existentes.

3.7 La Norma Horaria según antecedentes no se podría cumplir en las actuales condiciones de las Fundiciones del país, es dependiente de muchas variables no controlables, como lo es en un alto grado con la meteorología local.

3.8 Se solicita sea implementada la Norma Diaria con GRADUALIDAD que es uno de los Principios de La Ley Base del Medio Ambiente, contenidos en el Mensaje del S.E. Presidente de la República, con el que envío al Congreso el Proyecto de Ley de Bases del Medio Ambiente en Septiembre de 1992.

Sin otro particular, saluda atentamente a Ud.

RICARDO TRONCOSO SAN MARTIN
DIRECTOR NACIONAL
SERVIVIO NACIONAL DE GEOLOGIA Y MINERIA

LSS/EYG/CAAakl
<u>DISTRIBUCION</u>
Dirección Nacional
Subdirección Nacional de Minería
Depto. Ingeniería y Gestión Ambiental
Oficina de Partes.

noranda

Noranda Chile S. A.
Fundición Altonorte

Avda. Rendic 5032, Casilla 740
Antofagasta, Chile
Fono (56) 55 - 630100

ANTOFAGASTA, Noviembre 02 de 2000
G.G.N123/2000

Señora
Adriana Hoffmann Jacoby
Directora Ejecutiva
Comisión Nacional de Medio Ambiente
PRESENTE

De nuestra consideración:

Adjuntamos a Ud. los antecedentes solicitados en su Carta UEA Nº 029/ 004568 de fecha 02 de Octubre de 2000, en la cual se solicita antecedentes respecto de las mediciones de concentración de calidad de aire para SO_2:

i. ***Serie de datos horarios de monitoreo de calidad de aire para el SO2 en el área circundante a la Fundición anteriores a 31 de diciembre de 1998*;**

La Red de Monitoreo; cuenta con tres estaciones, una en Antofagasta; otra en La Negra y la tercera a 1,5 Km hacia el sur-este. La Estación Meteorológica Central ubicada al interior de la planta mide dirección y velocidad del viento, radiación solar, humedad relativa, presión barométrica, pluviometría y temperatura.

Los registros de su interés se encuentran en los Anexos Nº 1 y Anexo Nº2, adjuntos que además están siendo enviados vía e-mail en los Archivos "Noranda 1.zip" (años 1994, ´96 y ´98) y "Noranda 2.zip" (años 1993, ´95 y ´97).

ii. ***Serie de datos de emisiones mensuales de SO2 para la Fundición anteriores a septiembre de 1997.***

En Anexo Nº3 - "Emisión de S años ´93 - ´97" se entregan datos solicitados como emisión anual de S. Solo a partir de junio de 1997 se llevó registros mensuales para la emisión de azufre.

iii. ***De ser necesario, medidas factibles de adoptar para reducir emisiones de SO2 en el escenario de las normas propuestas en el anteproyecto, en particular respecto del cumplimiento de la norma horaria.***

Fundición Altonorte dispone de capacidad instalada para el tratamiento del total de los gases generados en el proceso. En esta condición el nivel de captura de SO2 ha alcanzado valores históricos del 82%. La diferencia corresponde a emisiones fugitivas durante el transporte y transferencia entre los diferentes equipos en la operación con materiales fundidos, eficiencia de las plantas de ácido y su disponibilidad. Con relación a la Norma Horaria, las situaciones de excedencia, están asociadas a fenómenos de carácter meteorológico, ya que no existe correlación entre el SO2 emitido y las concentraciones medidas en La Negra.

De acuerdo con lo anterior la factibilidad de reducir emisiones solo resulta viable mediante las siguientes alternativas:

1 **Operación intermitente de la fundición deteniéndola en la noche**: La condición meteorológica nocturna, con régimen de calma, alta estabilidad y nivel de subsidencia muy bajo, dificulta la difusión de gases, acumulándose estos sobre la fundición. El cambio gradual producido al inicio del día rompe la capa de inversión, produciendo transporte vertical y horizontal. La dirección del desplazamiento horizontal y la estabilidad atmosférica son muy variables y a pesar de los análisis meteorológicos efectuados por especialistas, su pronóstico ha tenido bajo nivel de acierto. La única forma de asegurar con certeza que no se producirán promedios horarios sobre 1050 ug/m3 en la Negra es reducir al mínimo la emisión durante la noche. Esto solo puede lograrse deteniendo la operación , pero aun esta medida no significa cero emisión porque debe mantenerse la temperatura de los equipos de fusión.

2 Captura y tratamiento de los gases fugitivos.
Los sistemas de captura de gases fugitivos requieren de altas tasas de dilución y la concentración final de SO2 no permite su tratamiento en las plantas de ácido. La alternativa es recurrir a sistemas de scrubbers húmedos y a la neutralización con cal u otro tratamiento alternativo, previo a la disposición final de sus efluentes líquidos.

3 Aumentar restricción operacional , reduciendo nivel de alerta
Esta fundición estableció un programa interno, para no superar el promedio horario de 1000 ug/m3 que consiste en bajar la fusión y el flujo de aire en conversión cuando la concentración instantánea (promedio de un minuto) de SO2 en la Negra alcanza 500 ug/m3. En el presente año este plan se ha aplicado durante un total de 348 horas, no obstante lo cual se registraron veinte promedios horarios mayores que 1000 ug/m3 en la Estación de La Negra. (En Anexo N°4 , se adjunta información de respaldo). Bajar el nivel de alerta en este plan a niveles de 400 ug/m3, mejora las probabilidades de no producir excedencias horarias, sin embargo en el presente año se presentaron 890 horas con peacks sobre 400.

iv. Estimación detallada de los costos para cada una de las medidas consideradas

1.- **Detención nocturna de la Fundición**:
Optar por esta alternativa significa mantener los costos fijos prácticamente en el nivel actual y reducir los ingresos en un 33.3 % . El costo que tendría esta opción equivale a US$ 16.000.000, que hace inviable económicamente esta Fundición.

2.- **Inversión en sistemas de captura de gases fugitivos**

2.1. Inversiones

Enclaustramiento de ollas, campanas secundarias y sistemas de extracción	US$ 5.500.000
Sistemas de tratamiento de efluentes.	US$ 300.000
Total	US$ 5.800.000

2.2 Operación

Tratamiento de efluentes, insumos, etc.	US$ 360.000
Disposición final de residuos	US$ 200.000
Mantención	US$ 100.000
Total (por año de operación)	US$ 660.000

3.- **Nivel de alerta mas restrictivo en el Plan de Contingencia**:
Durante el presente año hasta la fecha, la pérdida de fusión por aplicación de nuestro Plan de Contingencia con nivel de alerta en 500 ug/m3 durante 348 horas fue de 3.222 toneladas de concentrado y el menor ingreso de US$ 289.980, pero de todas maneras el promedio horario superó los 1000 ug/m3, en 20 oportunidades. En otras palabras, se habría superado el límite de la Norma Horaria que se está proponiendo. Con un nivel de alerta en 400 ug/m3, se habría activado la restricción operacional en 890 horas, equivalentes a 8240 toneladas de concentrado y un menor ingreso de US$ 741.600.
La hipótesis de usar 400 ug/m3, reduce las probabilidades de excedencia pero no las elimina, si el nivel se reduce a 300 ug/m3 la cantidad de horas se acerca a la alternativa mencionada en iv alternativa 1.

v. ***Plazos requeridos para la implementación de las medidas.***

No consideramos implementar la alternativa N° 1 por ser inviable económicamente y no se analizó.

La implementación de sistemas de captura y tratamiento de gases secundarios, (alternativa 2) requiere de 36 meses, como mínimo para la ingeniería, diseño, construcción y montaje.

La alternativa de aumentar la restricción en el plan de contingencia, debe necesariamente estar asociada a sistemas de pronóstico meteorológico mas rigurosos que los actuales, análisis de variables que esta fundición no maneja hoy. Estimaciones muy preliminares estiman en 24 meses el plazo necesario para la implementación de los sistemas, análisis de variables y aplicación.

vi. ***En la eventualidad que la Fundición deba controlar o prevenir la excedencia de la norma horaria de SO2 a través de reducción de fusión de concentrados, ¿con cuanto tiempo de anticipación debe reducir fusión para llegar a la condición de operación que controlará dicha excedencia (independientemente de la duración de las condiciones adversas de dispersión atmosférica) y cual es el tiempo requerido para volver a carga completa una vez que la condición atmosférica adversa ha finalizado?***

Como se indicó en el punto iii 3, esta Fundición ha estado aplicando exactamente este criterio, teniendo como objetivo no exceder 1000 ug/m3 promedio horario. Una vez superada la condición critica, volver a la condición normal toma entre una y tres horas, dependiendo de cuan larga o intensa haya sido la reducción y el enfriamiento de los equipos. El caso mayor se registró el 16 de Septiembre de 1998, cuando la Fundición detuvo completamente su operación a las 6.05 de la mañana. Sin embargo los promedios de las horas siguientes se mantuvieron sobre 1000, hasta las 10 horas. La vuelta a la operación normal tomó mas de 5 horas.

Entre la activación del Plan y la toma de acción transcurren normalmente 10 minutos o menos, sin embargo los resultados de esa acción solo serán detectados después de 30 minutos, siempre y cuando coincida con la condición de dirección de viento hacia La Negra. En régimen de calma la respuesta del sistema es mas lenta y es por eso que insistimos en la inviabilidad del manejo operacional en función de la media horaria. El objetivo exitosamente alcanzado con nuestro programa era cumplir la media diaria.

vii. ***Capacidad actual y proyectada para retención diaria/horaria de SO2 en la planta de ácido.***

En Anexo N° 5 se adjunta tabla con las cuatro etapas que debe cumplir Fundición Altonorte, se indica la capacidad nominal en cuanto al flujo a tratar y la mejor estimación del SO2, promedio diario, que presentarán los gases.

viii. Proyecciones de producción y de precios de venta de cobre para los próximos 10 años.

No hay estimación por año, pero las evaluaciones económicas de Noranda para el largo plazo (10 años) consideran 90 c/lb de Cobre y 25 US$/ton de ácido sulfúrico puesto en nuestra Planta.
A partir del año 2004 la puesta en servicio de Fase III; permitirá disponer de una capacidad nominal para fundir 816.000 ton. de concentrado por año, producir 290.000 ton de Cobre y 700.000 ton/año de Acido Sulfúrico.

En Anexo N°6 se adjunta estimación de la producción del período de transición hacia la Fase III.

Sin otro particular, le saluda muy atentamente,

MW Petersmeyer

Mark Petersmeyer
Gerente General

Inc.: lo citado
cc.: Archivo Gerencia
Archivo Control Ambiental

GOBIERNO DE CHILE
MINISTERIO DE SALUD

SERVICIO DE SALUD COQUIMBO

001087

ORD. : **Nº 2C/** 978 /

ANT. : **Anteproyecto de normas primarias de calidad de aire para Anhídrido Sulfuroso.**

MAT. : **REMITE OBSERVACION**

LA SERENA, 14 NOV 2000

DE: DIRECTOR SERVICIO DE SALUD COQUIMBO

A : SR. ELIER TABILO VALDIVIESO
DIRECTOR CONAMA IV REGION

En relación al anteproyecto de norma primaria de calidad de aire para Anhídrido Sulfuroso (SO_2), informo a Ud. que este Servicio de Salud considera importante aclarar si dentro de los procesos de generación de Anhídrido Sulfuroso, se encuentra el lixiviado de minerales de cobre donde se utiliza ácido sulfúrico, de ser así se sugiere incorporar este proceso industrial dentro de los mencionados en el título I, párrafo 10° de la página 2, del citado anteproyecto.

Saluda Atentamente a Ud.,

"Por orden del Sr. Director del Servicio de Salud Coquimbo"

MINISTERIO DE SALUD
Departamento Programas del Ambiente Dirección Servicio de Salud
SERVICIO DE SALUD COQUIMBO

DR. VICTOR CORREA ROMERO
JEFE DEPTO. PROGRAMAS SOBRE EL AMBIENTE

FGN/HCF

DISTRIBUCION:
- Sr. Elier Tabilo Valdivieso
Director Regional CONAMA IV Región
- Depto. Programas sobre el Ambiente D.S.S.

O-CON73/14.11.2000

NACIONAL DEL MEDIO AMBIENTE
3686
15 NOV 2000
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OBSERVACION:

FROM : CONAMA IV REGION PHONE NO. : 21055 NOV. 17 2000 12:22PM P1

Paty Matas

GOBIERNO DE CHILE
COMISION NACIONAL
DEL MEDIO AMBIENTE

001086

ORD. N°: 1114

ANT. : -Memorandum PAC N°458/2000, de fecha 25-09-2000, de Jefa Dpto. Participación Ciudadana, Información y Educación Ambiental.
-Ord. N°978 del 14-11-2000, del Jefe Dpto. Programas sobre el ambiente del Servicio de Salud Coquimbo.

MAT. : Remite observaciones al "Anteproyecto de Norma Primaria de Calidad de Aire para Anhídrido Sulfuroso".

LA SERENA, 17 NOV 2000

DE: DIRECTOR REGIONAL (S) CONAMA REGION DE COQUIMBO

A: SRA. ADRIANA HOFFMANN J., DIRECTORA EJECUTIVA CONAMA.

1. Adjunto al presente remito a Ud. observaciones al "Anteproyecto de Norma Primaria de Calidad de Aire para Anhídrido Sulfuroso"

Saluda atentamente a Ud.,

PEDRO VALENZUELA DIEZ DE MEDINA
DIRECTOR REGIONAL (S) CONAMA REGION DE COQUIMBO

PVD/RJB

DISTRIBUCION:
-Directora Ejecutiva CONAMA.
-Archivo CONAMA Región de Coquimbo.

GOBIERNO DE CHILE
MINISTERIO DE MINERIA
SECRETARIA REGIONAL MINISTERIAL
DE MINERIA REGION DE ATACAMA

02088

COMISION NACIONAL DEL MEDIO AMBIENTE
OFICINA DE PARTES Y ARCHIVO
Nº INGRESO: 13933 / 12415
FECHA:
DESPACHADO: 23 NOV 2000 P.M.
OBS.: A. HOFFMAN

Copiapó 13 de Noviembre de 2000 18568
Oficio N° 216/00

Sra. Adriana Hoffman J.
Directora Ejecutiva
Comisión Nacional del Medio Ambiente
Presente

En relación con el proceso de consulta pública del Anteproyecto de Norma de Calidad Primaria de Anhídrido Sulfuroso, y dentro del plazo estipulado, la Secretaría Regional Ministerial de Minería de Atacama, expresa a Ud., lo siguiente:

1.- En la Región de Atacama funciona al servicio de la Pequeña y Mediana Minería, la Fundición Hernán Videla Lira, la cual a partir del año 1995 y hasta fines de 1999, realizó inversiones por un monto superior a los 90 Millones de Dólares, para dar cumplimiento al Plan de Descontaminación de dicho Plantel.

2.- Dicho Plan de Descontaminación significó adecuarse técnica y productivamente a las normas primarias y secundarias de calidad de anual de 80 ug/Nm^3 de SO_2 y diaria de 365 ug/Nm^3 de SO_2 y secundaria de horaria 1000 ug/Nm^3 de SO_2, las que gradualmente se han cumplido.

3.- Las condiciones meteorológicas que inciden fuertemente en la localidad en que se encuentra ubicada la Fundición y la cercanía de un área habitada al Plantel, son factores que también inciden fuertemente en el cumplimiento de las normas en cuestión.

4.- Nos parece imprudente y una señal poco afortunada el fijar nuevos parámetros en la norma, a pocos meses de la implementación y cumplimiento de la anterior, considerando la inversión ejecutada y el gradual cumplimiento de un plan de descontaminación ampliamente consensuado y discutido en la comunidad regional.

5.- Los antecedentes técnicos que motivan la preocupación de la Autoridades Regionales son compartidos en el Informe evaluado por la Unidad Ambiental del Ministerio de Minería mediante UAMM/88/2000 del 20 de Julio del 2000 y la documentación adjunta a dicho Oficio.

01089

6.- Los antecedentes entregados al Sr. Intendente de la Región de Atacama el día 23 de Octubre por el Sr. Gerente de al Fundición Hernán Videla Lira y lo informado a Ud., en reunión de la COREMA en día 25 de Octubre por el suscrito y la información entregada en su visita a la Fundición el 25 de Octubre, demuestran la importancia que para la región significa la existencia de Plantel productivo y las enormes dificultades que acarrearía para Atacama y sus habitantes un eventual cierre del Plantel.

7.- Sra. Directora tal como Ud., lo planteó en dicha oportunidad, es necesario que en la definición del anteproyecto se consideren todas las variables que puedan incidir en ella, tanto técnicas como productivas que ameriten una solución que sea compartida por la comunidad de Atacama.

Saluda Atte. A Ud.

ANTONINO PRADO CASTRO
SECRETARIO REGIONAL MINISTERIAL
DE MINERIA REGION DE ATACAMA

APC/mma

c.c. - Sr. Ministro de Minería
- Sra. Subsecretaria de Minería
- Sr. Intendente Regional
- Sr. Director Regional de CONAMA
- Archivo

001090

GOBIERNO DE CHILE
COMISION NACIONAL
DEL MEDIO AMBIENTE

Concentraciones atmosféricas de SO2 en el Gran Valparaíso y Rancagua v/s emisiones de megafuentes de SO2

Christian Santana
Claudio Corvalán

Noviembre de 2000

Concentraciones atmosféricas de SO2 en el Gran Valparaíso y Rancagua v/s emisiones de megafuentes de SO2

1.- Introducción y alcances

En la zona central del país se encuentran localizadas un conjunto de megafuentes industriales de emisión de dióxido de azufre (SO2). De ellas, las principales corresponden a fundiciones de cobre y termoeléctricas tales como la Fundición Ventanas y la Fundición Chagres, en la V Región, y la Fundición Caletones en la VI.

Producto de las exigencias establecidas, primero en el D.S. 185/92 de Minería, y después por medio de la Ley de Bases del Medio Ambiente (ley 19.300), tanto la Fundición Ventanas como la Fundición Caletones han debido implementar Planes de Descontaminación tendientes a reducir sus emisiones de SO2 y material particulado. Si bien esos planes aún no terminan, ya se han traducido en una importante reducción de los niveles de emisión de esas fuentes.

Dada la magnitud de las emisiones de SO2 de las megafuentes mencionadas, su impacto es de mediana a gran escala (al menos decenas de kilómetros). Este hecho, cuestionado previamente, está confirmándose a la luz de nuevos antecedentes.

Por una parte, el estudio "Aplicación de un modelo de escala regional sobre la zona Central de Chile" [4], elaborado en conjunto entre CONAMA y el Instituto de Meteorología e Hidrología Sueco, realizó una modelación de dispersión de las emisiones de azufre de megafuentes SO2 sobre las regiones V, VI y Metropolitana. Los resultados señalan un impacto sobre las concentraciones atmosféricas de SO2 de decenas de kilómetros.

Sumado al anterior, estudios que usan análisis con información empírica refuerzan la conclusión de un impacto de gran escala de las megafuentes. Entre esos se encuentra la aplicación de un modelo receptor sobre los resultados de la caracterización elemental del material particulado en Santiago [5, 6], el cual señala una influencia de la actividad de fundición de cobre en la generación de partículas secundarias. Esta conclusión es aún más clara en los resultados de un estudio similar, pero aplicado a la caracterización del material particulado presente en las ciudades de Valparaíso, Viña del Mar y Rancagua [2].

El presente informe, mediante un análisis simplificado de información empírica, entrega otras evidencias del impacto en la calidad de aire por SO2 en las zonas del Gran Valparaíso (Viña del Mar, Valparaíso, Quilpué y Villa Alemana) y Rancagua que generan megafuentes de SO2. Para ello se relacionan las emisiones de la Fundición Ventanas y de la Fundición Caletones con las concentraciones atmosféricas observadas en el Gran Valparaíso y Rancagua, respectivamente. Las concentraciones han sido obtenidas del "Estudio de la calidad del aire en regiones urbano industriales de Chile" [1], que realizó un monitoreo prospectivo de SO2 en las ciudades de Viña del Mar, Valparaíso y Rancagua, entre junio de 1997 a diciembre de 1999. Las emisiones de las funciones corresponden a las reportadas a los Servicios de Salud respectivos, en el contexto de sus planes de descontaminación.

2.- Gran Valparaíso v/s Fundición Ventanas

En el caso del Gran Valparaíso, representado por el monitoreo hecho en puntos de Viña del Mar y Valparaíso, el estudio mencionado en el párrafo previo encontró que los niveles de SO2 observados se encuentran por debajo de las normas anuales. Sin perjuicio de ello, es imposible afirmar empíricamente que no existan superaciones de la norma de máximos diarios vigente en el país o elevadas concentraciones horarias, debido a que las técnicas muestreales tienen una resolución mínima mensual.

Por otro lado, los siguientes elementos permiten argumentar una correlación positiva entre las emisiones de SO2 en la Fundición Ventanas y las concentraciones observadas en el Gran Valparaíso:

2.1.- Se observa una muy buena correlación en la evolución temporal de las concentraciones medidas en los distintos puntos de monitoreo.

Existe series completas de concentraciones atmosféricas mensuales de SO2 entre junio de 1997 a diciembre de 1999 para cinco puntos de la zona, con excepción de los meses de junio y julio de 1998. Estos puntos son: Nueva Aurora, Av. Ecuador, Miraflores Alto, Gómez Carreño y El Salto. El monitoreo en Nueva Aurora tiene ausencia de información entre los meses de junio a diciembre de 1998. Cada uno de estos puntos representa zonas muy diversas de la compleja topografía de Viña del Mar, desde Nueva Aurora en el extremo sur de la ciudad y a una altura de aproximadamente 300 m sobre el nivel del mar, pasando por Ecuador en pleno centro y Gómez Carreño en el extremo norte.

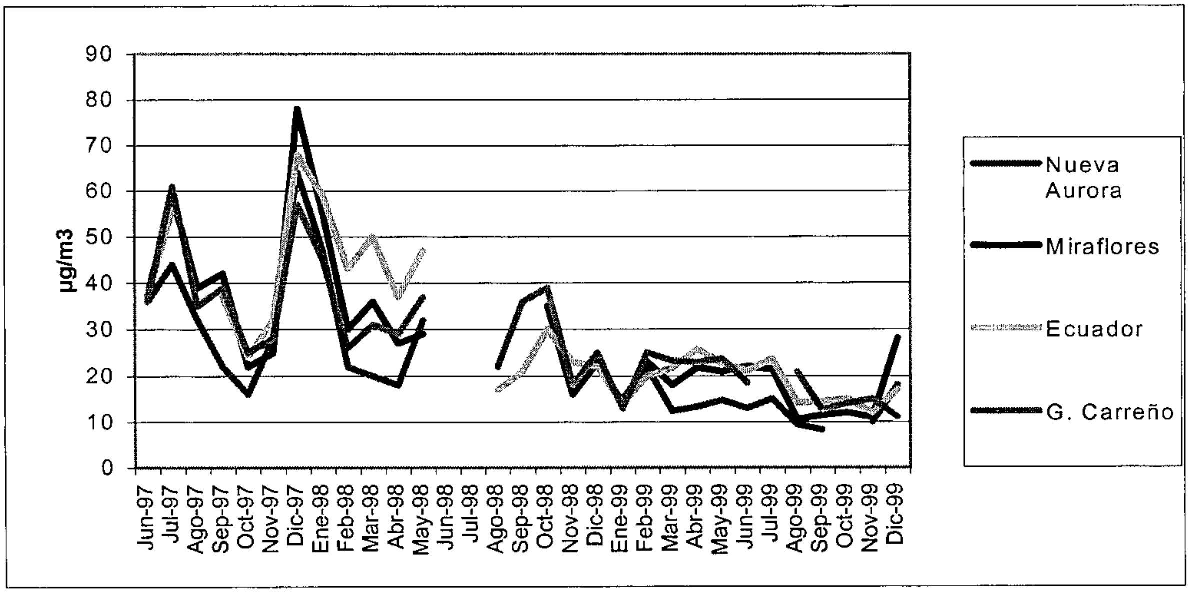

Figura1: Evolución temporal de concentraciones atmosféricas mensuales promedio de SO2 en 4 puntos del Gran Valparaíso, entre junio de 1997 y diciembre de 1999.

La figura 1 muestra la evolución mensual de las concentraciones de SO2 en los puntos seleccionados. Se puede observar una excelente correlación, con valores superiores al 95% entre sí o con el promedio de ellos. Esto señala la posibilidad de que el Gran Valparaíso se encontraría impactado por una fuente o conjunto de fuentes de SO2 comunes.

2.2.- Ausencia de fuentes importantes de emisión de dióxido de azufre en las cercanías de cada punto monitoreado.

Complementando el argumento anterior, no se han identificado fuentes relevantes de emisión de SO2 en las cercanías de cualquiera de los puntos considerados en el análisis, como tampoco grandes fuentes estacionarias de emisión de SO2 dentro de los límites urbanos.

El único conjunto de fuentes urbanas que a priori se puede identificar como relevante son las fuentes vehiculares. Sin embargo, no ha ocurrido ningún cambio tecnológico o de nivel de actividad de esas fuentes que pudiese explicar un impacto tan elevado en la reducción de las concentraciones de SO2 como el observado en el gráfico anterior.

Por lo tanto, el comportamiento de las concentraciones de SO2 en el Gran Valparaíso parece estar relacionado con una fuente de contaminación común que impacta todas las zonas de la ciudad en forma constante y que se encontraría fuera de los límites urbanos. Obviamente, la principal fuente de emisión que cumple estas características es la Fundición Ventanas.

2.3.- Existe una buena correlación entre las emisiones de la Fundición Ventanas y las concentraciones de SO2 en el Gran Valparaíso.

En el anexo 1 se presentan las concentraciones mensuales obtenidas en los puntos de monitoreo previamente mencionados, junto a las emisiones mensuales reportadas al Servicio de Salud Viña del Mar – Quillota en el contexto del Plan de Descontaminación de Ventanas.

Para analizar la correlación existente entre esos parámetros se procedió a obtener el promedio móvil anual de cada una de las series de datos, con excepción de la serie de concentraciones de SO2 en Nueva Aurora, por presentar una ausencia importante de datos. El uso de un promedio móvil anual, permite independizar parcialmente del impacto de las variaciones estacionales sobre las concentraciones atmosféricas de SO2.

La figura 2 muestra la evolución de los promedios móviles señalados. Se observa claramente la correspondencia entre la tendencia de reducción de emisiones en Ventanas y la reducción de las concentraciones en el Gran Valparaíso.

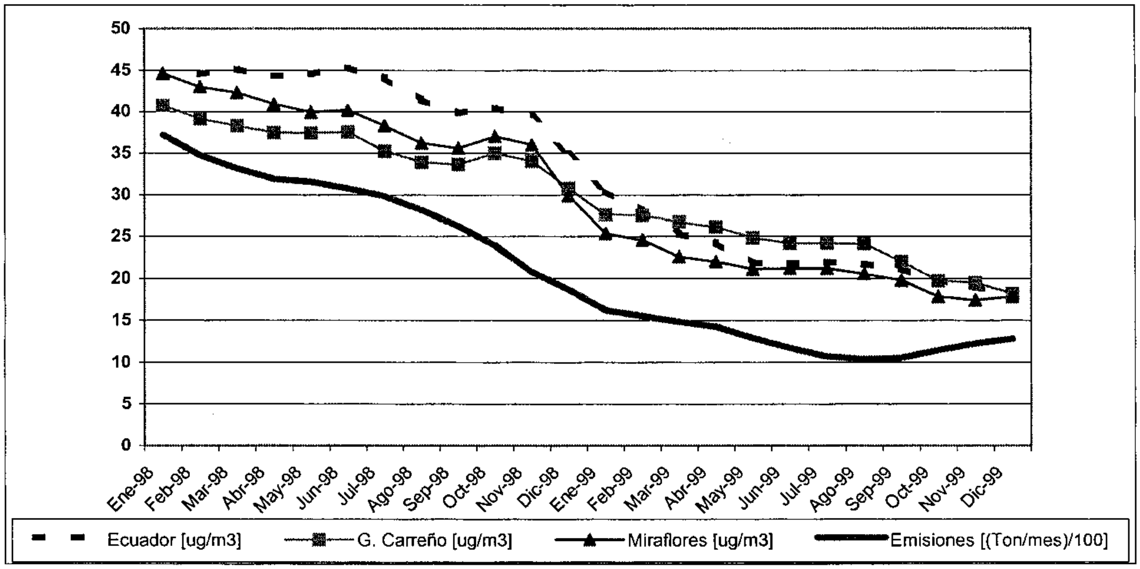

Figura 2: Promedios móviles de 12 meses de concentraciones de SO2 en 3 puntos del Gran Valparaíso y de emisiones de la Fundición Ventanas, entre enero de 1998 y diciembre de 1999. Las concentraciones se encuentran en (ug/m^3) y las emisiones en (Ton/mes)/100.

Por su parte, la figura 3 muestra los resultados de un ajuste lineal hecho entre las emisiones medias anuales de SO2 en Ventanas y las concentraciones medias anuales de SO2 en los puntos de monitoreo de Ecuador, Miraflores y Gómez Carreño. Los valores de correlación obtenidos son excelentes (señalados en la figura). Esto permite confirmar el supuesto de un impacto sobre la calidad del aire de la zona urbana del Gran Valparaíso de las emisiones de SO2 de la Fundición Ventanas.

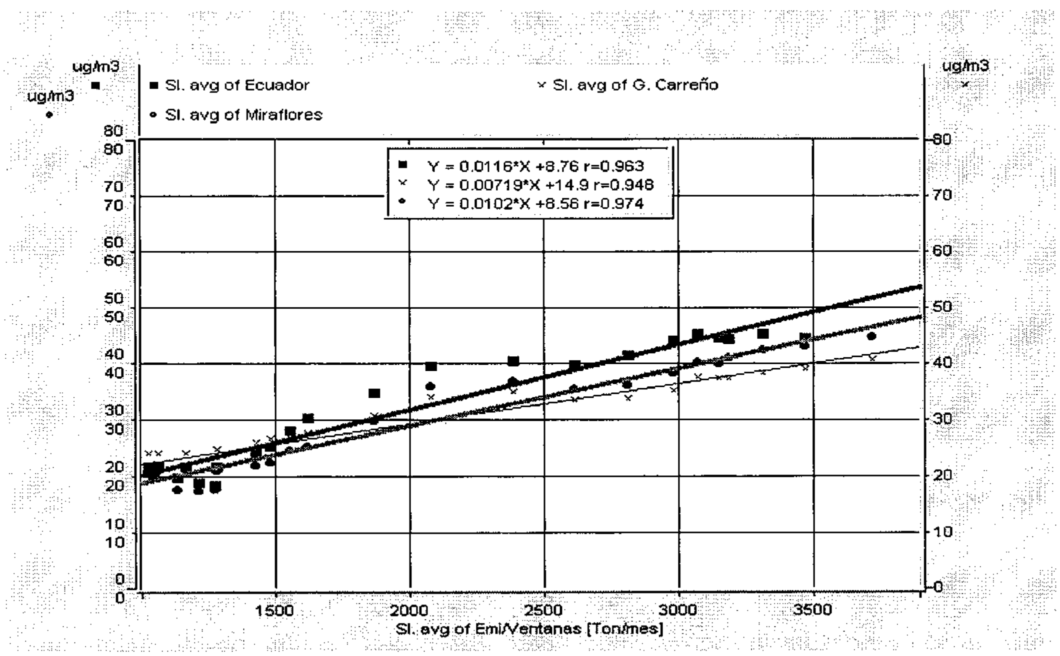

Figura 3: Ajuste lineal entre promedios móviles de 12 meses de concentraciones de SO2 en 3 puntos del Gran Valparaíso y respecto de emisiones de la Fundición Ventanas.

3.- Rancagua v/s Fundición Caletones

Al igual que lo que ocurre con las concentraciones ambientales de SO2 en el Gran Valparaíso y su relación con las emisiones de SO2 de la Fundición Ventanas, existe la hipótesis que la calidad del aire de la ciudad de Rancagua se encuentra influenciada por las emisiones de la Fundición de Caletones y, que por ende, reducciones de emisiones de esta última se traducirán en beneficios en la exposición de la población de esa ciudad a concentraciones de SO2.

Las razones que permiten sustentar esta hipótesis son similares a las vertidas en el caso del Gran Valparaíso, esto es, se observa una muy buena correlación en la evolución temporal de las concentraciones medidas en los distintos puntos de monitoreo, que sumado a la ausencia de fuentes importantes de emisión de dióxido de azufre en la zona urbana de Rancagua, permiten inferir el impacto en las concentraciones de SO2 de Rancagua de alguna fuente de gran escala.

No entraremos en detalle a analizar las afirmaciones anteriores, dado que para verificar la hipótesis anterior consideramos suficiente realizar un análisis de correlaciones entre las emisiones de la Fundición Caletones y las concentraciones ambientales de SO2 en Rancagua.

La información a la fecha disponible sobre concentraciones de SO2 en la ciudad obtenida por medio del "Estudio de la Calidad del Aire en Regiones Urbano – Industriales de Chile" [1], corresponde a 20 puntos de medición, con información entre junio de 1997 a septiembre de 1999. Sin embargo, de los 20 puntos sólo los puntos identificados como Fusat, Einstein-Ramírez y Cancha de Polo cuentan con series de datos prácticamente completas para el periodo monitoreado.

Por su parte, la información sobre el nivel de emisiones mensuales de la Fundición Caletones está disponible a partir de enero de 1998, dado que en esa fecha se hizo obligatorio la declaración de las emisiones de la Fundición al Servicio de Salud Rancagua. En el anexo 2 se presentan tanto las concentraciones mensuales en los puntos seleccionados para el análisis como las emisiones de SO2 reportadas por la Fundición.

El análisis de correlación se hizo en forma similar al caso del Gran Valparaíso, esto es mediante promedios móviles anuales que filtran en parte la variabilidad estacional de las concentraciones de SO2. Debido a que se cuenta con menos información de emisiones que en el caso de Ventanas, el análisis de correlación entre concentraciones en Rancagua y emisiones de SO2 en Caletones se limitó al periodo septiembre 98 – septiembre 99.

Para los meses de septiembre, octubre y noviembre de 1998 la media anual de emisiones se calculó con el promedio de 9, 10 y 11 meses respectivamente. Por su parte, debido a la ausencia de información de concentraciones para algunos meses en los puntos monitoreados, a que la serie de datos es de tamaño menor a la disponible que para el caso de Ventanas y que estos hechos influenciaban la calidad de los ajustes analizados, se procedió a estimar los vacíos de información como la interpolación entre las concentraciones medias mensuales entre los meses previo y siguiente.

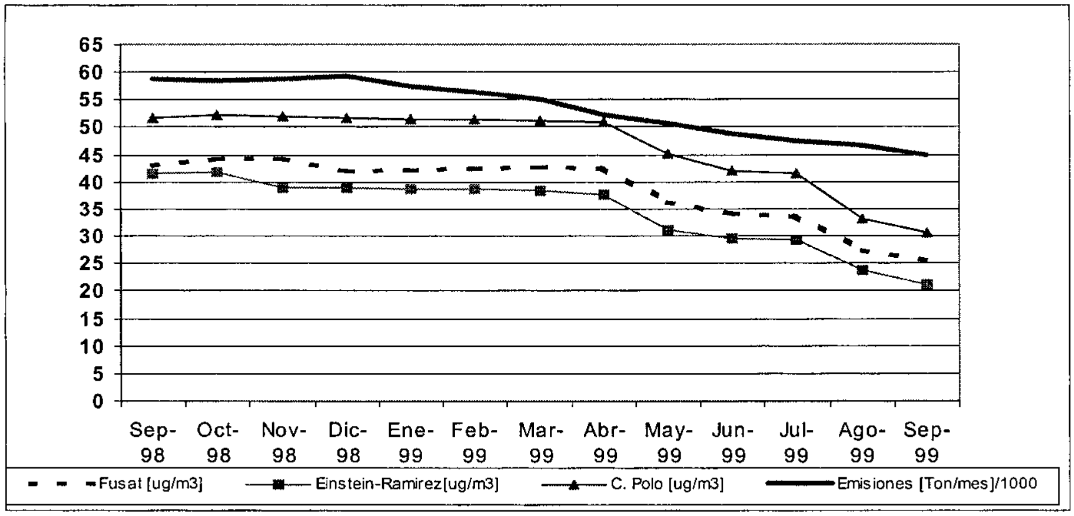

Figura 4: Promedios móviles de 12 meses de concentraciones de SO2 en 3 puntos de Rancagua y de emisiones de la Fundición Caletones. Concentraciones expresadas en (ug/m^3) y emisiones en (Ton/mes)/1000.

Las figuras 4 y 5 muestran el resultado del análisis anterior. En la primera de ellas se observa claramente la correspondencia entre las tendencias de concentraciones y de emisiones anuales de SO2. Por su parte la segunda figura refleja el alto grado de correlación entre las emisiones anuales de SO2 en Caletones y las concentraciones anuales de SO2 en los tres puntos de la ciudad de Rancagua analizados, con factores de correlación superiores a 0.9 en todos los casos.

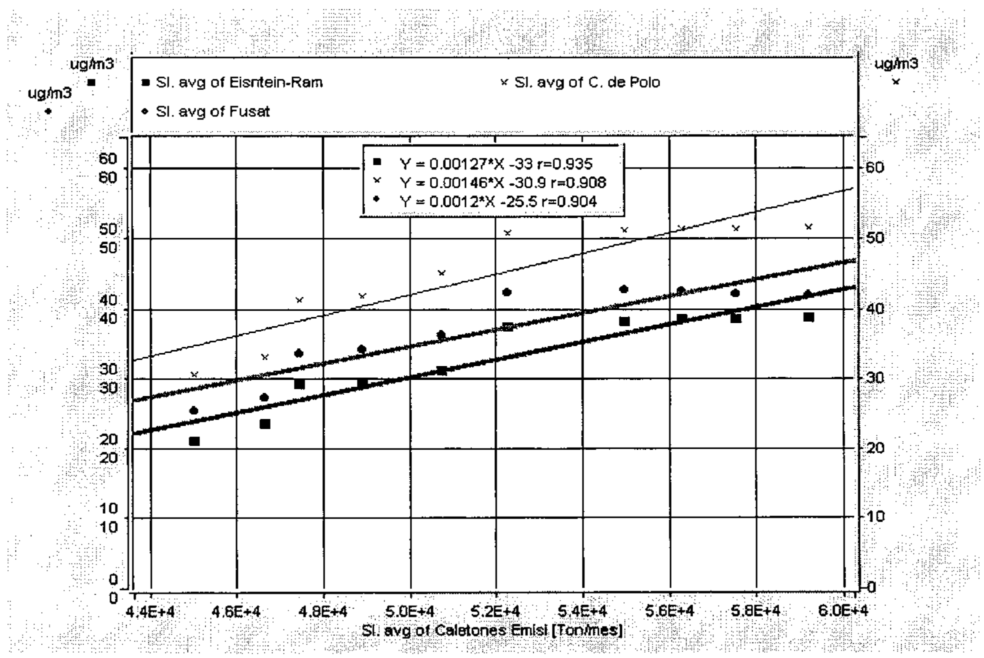

Figura 5: Ajuste lineal entre promedios móviles de 12 meses de concentraciones de SO2 en 3 zonas de Rancagua respecto de las emisiones medias anuales de la Fundición Caletones.

4.- Conclusiones

Los antecedentes aquí presentados evidencian una elevada correlación entre la calidad de aire por SO2 de zonas urbanas densamente pobladas, con megafuentes de emisión de SO2 ubicadas a decenas de kilómetros de distancia de dichas zonas urbanas. Los ajustes lineales obtenidos entre esos parámetros en una base anual, presentan factores de correlación superiores a 0.9 en todos los casos.

Lo anterior viene a confirmar resultados de estudios previos e independientes del presente, tanto de simulaciones numéricas como de análisis empíricos, que ya señalaban un impacto en calidad de aire de mediana a gran escala (al menos decenas de kilómetros) de las emisiones provenientes de fundiciones de cobre.

La magnitud de dicho impacto para el Gran Valparaíso y Rancagua, puede ser estimada a partir de los ajustes lineales obtenidos entre concentraciones y emisiones. Por el tipo de información disponible, dichos ajustes están hechos sólo en una base anual. Este hecho debería ponderarse adecuadamente si se pretende usar los ajustes para analizar impactos de escala temporal menor.

Lo anterior no descarta que otras fuentes locales o regionales también estén contribuyendo a disminuir la calidad del aire de las zonas urbanas analizadas. Sin perjuicio de ello, la evolución observada de la calidad, tanto en Rancagua como en el Gran Valparaíso, señala largamente a las emisiones provenientes de fundiciones de cobre como las principales responsables de las concentraciones atmosféricas de SO2 en dichas ciudades.

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ANEXO 1

Concentraciones mensuales de SO2 en 4 zonas del Gran Valparaíso y emisiones mensuales de SO2 de la Fundición Ventanas.

Mes	Ecuador [ug/m^3]	G. Carreño [ug/m^3]	N. Aurora [ug/m^3]	Miraflores [ug/m^3]	Emisiones Ventanas [Ton/mes]
Jun-97	37	36	36	37	3828
Jul-97	56	61	44	59	3715
Ago-97		35	32	39	3480
Sep-97	37	39	22	42	3733
Oct-97	24	25	16	22	3985
Nov-97	32	28	28	25	4469
Dic-97	68	57	64	78	3257
Ene-98	59	45	47	55	3282
Feb-98	43	26	22	30	1508
Mar-98	50	31	20	36	1906
Abr-98	37	29	18	27	1924
May-98	47	37	32	29	2752
Jun-98					2883
Jul-98					2627
Ago-98	17	22		18	1430
Sep-98	21	36			1404
Oct-98	30	39		35	1204
Nov-98	23	18		16	769
Dic-98	22	25		23	715
Ene-99	14	13	15	14	328
Feb-99	20	25	22	23	705
Mar-99	22	23	12	18	1045
Abr-99	26	23	13	22	1268
May-99	23	24	15	21	1055
Jun-99	21	18	13	22	1528
Jul-99	24		15	21	1353
Ago-99	14	21	9	11	1057
Sep-99	14	13	8	11	1602
Oct-99	15	14		12	2275
Nov-99	12	15	10	11	1731
Dic-99	17	11	18	28	1419

ANEXO 2

Concentraciones mensuales de SO2 en 3 zonas de Rancagua y emisiones mensuales de SO2 de la Fundición Caletones.

Mes	Fusat [ug/m^3]	Eisntein-Ramírez [ug/m^3]	C. de Polo [ug/m^3]	Emisiones Caletones [Ton/mes]
Jun-97	27	25	47	
Jul-97	35	31	52	
Ago-97	53	45	96	
Sep-97	27	22	34	
Oct-97	11	11	13	
Nov-97	10	12**	12	
Dic-97	11**	13	16	
Ene-98	12	14	14	60320
Feb-98	11	12	14	59182
Mar-98	17	19	21	54188
Abr-98	37	37	43	62730
May-98	107	103	113	57230
Jun-98	57	49	76	59552
Jul-98	63	61	103	59028
Ago-98	97	85	131	53794
Sep-98	52	52	63	61544
Oct-98	24	15	19	56262
Nov-98	11	8	11	62120
Dic-98	17	12	11.5**	64400
Ene-99	15	12	12	40607
Feb-99	14	10	14.5**	43992
Mar-99	20	15	17	38508
Abr-99	32	28	40	30236
May-99	34	27	43	38726
Jun-99	32	29	38	37502
Jul-99	57	58	97	41644
Ago-99	21	18	32	43998
Sep-99	30	22	33	42036
Oct-99				40547
Nov-99				41424
Dic-99				39616

** Datos sin información medida: se obtuvieron de interpolación entre concentraciones medias del mes previo y del mes siguiente.

1101

COMISION NACIONAL DEL MEDIO AMBIENTE
OFICINA DE PARTES Y ARCHIVO
Nº INGRESO: 14048 / 12487
FECHA: 27 NOV 2000
DESPACHADO:
OBS.: A HOFFMAN 2 8 + 26

GOBIERNO DE CHILE
Comisión Nacional del Medio Ambiente
Región de Atacama

ORD.: 00882 /

ANT.: No hay.

MAT.: Lo que indica.

COPIAPO, 23 NOV 2000

DE : DIRECTOR REGIONAL COMISION NACIONAL DEL MEDIO AMBIENTE REGION DE ATACAMA

A : SRA. ADRIANA HOFFMANN JACOBY
DIRECTORA EJECUTIVA COMISION NACIONAL DEL MEDIO AMBIENTE

1.- A traves de la presente, remito adjunto a Ud. comentarios del Consejo Consultivo de la COREMA Atacama, al Anteproyecto de Revisión de Norma Primaria de Calidad del Aire para Anhídrido Sulfuroso SO2.

Sin otro particular, saluda atentamente a Ud.,

Comisión Nacional del Medio Ambiente
ATACAMA

DANIEL ALVAREZ PARDO
DIRECTOR REGIONAL
COMISION NACIONAL DEL MEDIO AMBIENTE

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COMENTARIOS AL ANTEPROYECTO DE REVISION DE NORMA PRIMARIA DE CALIDAD DEL AIRE PARA ANHIDRIDO SULFUROSO SO2

Acuerdo Nº 9.3 del Consejo Consultivo COREMA Atacama
Sesion Ordinaria Nº 9
Realizada en Chanaral, el 15 de Noviembre del 2000

Respecto de este tema, luego de una especial deliberación, se concuerda que:

1. La Norma Horaria de carácter primario, tiene un profundo impacto negativo en áreas cercanas a importantes industrias de la III Región, en las que no se cumpliría este parámetro de la Calidad Primaria del Aire, no obstante haberse realizado importantes mejoras y cuantiosas inversiones recientemente.

2. De acuerdo a los especialistas, el cumplimiento de la Norma Horaria al nivel requerido, depende especialmente del comportamiento meteorológico en esas áreas y no de las actividades que puedan realizarse para mejorar esta componente de la Calidad del Aire.

3. Se considera apresurada la propuesta de definición de tipo de Calidad Ambiental (Es decir, la asociada al cumplimiento de una norma primaria horaria de SO2). No existen suficientes estudios epidemiológicos en el país que avalen su implantación.

4. Para el parámetro horario referido, se considera suficiente incremento de exigencia respecto de la Norma Primaria existente, el que resulta del incremento de las exigencias en el Parámetro Diario de la Norma, lo que implica técnicamente una mayor exigencia de calidad a nivel horario.

Por lo tanto se acuerda:

Acuerdo 9.3.

Eliminar la exigencia de Calidad Horaria del Aire para anhídrido Sulfuroso del Anteproyecto de Norma. (400 ppbv en 1 hora)

MINISTERIO DE MINERIA

TRANSMISION DE FAX 001103

A : Rodrigo Lucero

DE : María Luz Vasquez

FAX : 2441262

REF. :

FECHA : 23 11 00

N° PAG. : (Incl.ésta) 3

MENSAJE :

COMISION NACIONAL DEL MEDIO AMBIENTE
OFICINA DE PARTES Y ARCHIVO
FAX
N° INGRESO 2977.
FECHA 23 NOV 2000
DESPACHADO
OBS.
R. Lucero.

Quality: it's in our nature, it's what we are.

Administrative Services

Communications

Environmental Programs
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- Air Quality
- Readings
- Assessment
- Compliance
- Permits
- Planning
- Vehicle Emissions
- Compliance Assist
- Regional Offices
- Waste Programs
- Water Quality

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Last Revision:
03 July, 2000

001104

Arizona Department of Environmental Quality

Air Quality Division: Planning: Air Quality Standards

The Environmental Protection Agency has promulgated primary and secondary National Ambie[illegible] (NAAQS) for six criteria pollutants (carbon monoxide, nitrogen dioxide, particulate matter, oz[illegible] Primary standards are adopted to protect public health. Secondary standards are adopted to p[illegible] required to adopt ambient air quality standards which are at least as stringent as the federal [illegible] standards may be more stringent. Arizona has adopted the federal NAAQS as indicated in the [illegible]

State and Federal Ambient Air Quality Standards		
Pollutant	Averaging Time	Primary Sta[illegible]
Carbon Monoxide (CO) in parts per million (ppm)	1-hr 8-hr	35 9
Nitrogen Dioxide (NO_2) in ppm	Annual	0.05
Particulate Matter (PM_{10}) in micrograms per cubic meter	24-hr Annual	150 [illegible]
Ozone in ppm	1-hr	0.12
Sulfur Dioxide (SO_2) in ppm	[illegible] 24-hr Annual	[illegible] 365 (0.1[illegible] 80 (0.0[illegible]
Lead in micrograms per cubic [illegible]	[illegible]	[illegible]

As of July 18, 1997, EPA [illegible] protection of public health and the environment. These revised standards are an 8-hour ozone [illegible] four $PM_{2.5}$ (particulate matter with a [illegible] annual $PM_{2.5}$ standard of 15 micrograms per [illegible] annual and 24-hour PM10 standard. Under the revised form of the PM10 standard, Arizona rec[illegible] current Phoenix PM10 nonattainment area be designated nonattainment. Arizona will be recor[illegible] the revised ozone and new PM2.5 standards by July 1999.

Index || Areas That Do Not Meet Standards || Health and Welfare Effects

<<Prev Rule

T[illegible]s A[illegible]ni[illegible]tive Code 001105

N[illegible]

TITLE 30	[illegible]VI[illegible]MEN[illegible]QU[illegible]TY
PART 1	[illegible]XA[illegible]TUR[illegible]E[illegible]RCE CONSERVATION COMMISSION
CHAPTER 101	[illegible]NE[illegible]AIR[illegible]L[illegible]RULES
SUBCHAPTER A	[illegible]NE[illegible]RUL[illegible]
RULE §101.21	[illegible]Na[illegible] Prin[illegible]Secondary Ambient Air Quality Standards

The National Primary and Second[illegible] Air Q[illegible]dards as promulgated pursuant to section 109 of [illegible] Clean Air Act, as amended, will b[illegible]rced [illegible]ough[illegible]parts of Texas.

Source Note: The provisions of th[illegible]opted [illegible] effective January 1, 1976, amended to be effective M[illegible] 1979, 4 TexReg 1358

[illegible] Page [illegible] Previous Page

COMISION NACIONAL DEL MEDIO AMBIENTE
OFICINA DE PARTES Y ARCHIVO
Nº INGRESO: 14116/12534
FECHA:
DESPACHADO: 29 NOV 2000
OBS.:
P. MATUS
28798

ORD: 002730

MAT.: Lo que indica

Santiago, 28 de noviembre de 2000

CONAMA
COMISION NACIONAL DEL MEDIO AMBIENTE

Señora
Patricia Matus
Departamento Planes y Normas
CONAMA

De mi consideración:

Adjunto a usted observaciones al anteproyecto de "Normas Primarias de Calidad del Aire", que hiciera llegar a esta Dirección Regional el señor Luis Mariano Rendón y la señora Larisa de Orbe, ambos pertenecen a la Coordinadora Ecologista.

Sin otro particular, se despide atentamente,

Loreto Madrid Flores
Jefa Área Descontaminación del Aire
Comisión Nacional del Medio Ambiente
Región Metropolitana

LMF/blm

Recibido 17/11/2000 1/2
DGL-1609 / Fuerto

CONAMA REGION METROPOLITANA
FECHA RECIBO 16-11-2000
ANOTADO EN 20.70.46
DESTINO G-LR
FECHA DE ENTREGA

01107

Coordinadora Ecologista.
coordinadoraecologista@starmedia.com

OBSERVACIONES AL ANTEPROYECTO DE NORMAS PRIMARIAS DE CALIDAD DEL AIRE.

Coordinadora Ecologista en su afán por hacer válida la participación ciudadana en temas tan importantes como lo son las normas de calidad del aire, exponemos las siguientes observaciones.

1.- Después de estudiado los antecedentes del Anteproyecto de Normas Primarias de Calidad del Aire, hemos constatado que éstas siguen sobrepasando las recomendaciones de la Organización Mundial de Salud (WHO). Según se indica en el cuadro que acompaña el presenta escrito.

2.- Es preocupante el nivel de la norma permitida para el Anhídrido Sulfuroso ($SO2$), ya que sobrepasa la norma recomendada de 125ug/m3 a 243ug/m3 para 24 horas y de 50 ug/m3 a 76 ug/m3 para un periodo de 24 meses.
Tomando en cuenta que los sulfatos constituyen un peligro serio para la salud, habiéndose demostrado que concentraciones muy bajas de sulfatos (de 8 a 10 microgramos por metro cúbico) ejercen efectos adversos sobre los asmáticos, los ancianos y otras personas susceptibles con problemas respiratorios crónicos.
Creemos que esta norma es insuficiente para proteger la salud pública.

3.- La acumulación de Dióxido de nitrógeno en el cuerpo humano constituye un riesgo para las vías respiratorias ya que se ha comprobado que puede alterar la capacidad de respuesta de las células en el proceso inflamatorio, siendo más frecuente en casos de bronquitis crónica. La norma establecida en el anteproyecto rebasa significativamente las recomendaciones de la Organización Mundial de la Salud, de 40 ug/m3 a 65 ug/m3 para periodos de 24 meses y de 200 ug/m3 a 260 ug/m3 para 1 hora.

4.- Lamentamos que en el cuerpo del Anteproyecto no se establezcan valores comparables para una mejor comprensión de las normas, esto significa un obstáculo a la Participación Ciudadana, por cuanto otras organizaciones que no cuentan con los medios necesarios se ven imposibilitadas para presentar sus observaciones. Incluso lo consideramos una violación al derecho a la información ambiental.

Atentamente.

Luis Mariano Rendón.
Director
Coordinadora Ecologista.

Larisa de Orbe.
Salud Ambiental.
Coordinadora Ecologista.

CONAMA REGION METROPOLITANA
FECHA RECIBO...21.11.00............
ANOTADO EN......219....................
DESTINO.........LMF...................
FECHA DE ENTREGA.........................

2/2

01108

Observaciones al Anteproyecto de Normas de Calidad del Aire.

COORDINADORA ECOLOGISTA
14 DE NOVIEMBRE 2000

CONTAMINANTE	TIEMPO	RECOMENDACIONES WHO-0MS	ANTEPROYECTO
OZONO (O3)	8 HRS.	120 µg/m3	128µg/m3 (60ppbv)
DIOXODO DE NITROGENO (NO2)	24 MESES	40 µg/m3	65 µg/m3 (53ppbv)
	1 HORA	200 µg/m3	260 µg/m3 (212 ppbv)
ANHIDRIDO SULFOROSO (SO2)	24 HORAS	125 µg/m3	243µg/m3 (95ppbv)
	24 MESES	50 µg/m3	76 µg/m3 (30ppbv)
MONOXIDO DE CARBONO (CO)	1 HORA	30,000 µg/m3	31,000 µg/m3 (25ppmv)

ENAMI

VICEPRESIDENCIA EJECUTIVA Nº 161/278

2169

OF. ORD. Nº 145

ANT. : No hay.

MAT. : Observaciones a la evaluación costo beneficio correspondiente a la modificación Resolución 1215.

SANTIAGO, Diciembre 04 del 2000.

A : SRA. ADRIANA HOFFMAN J.
DIRECTORA EJECUTIVA
COMISIÓN NACIONAL DE MEDIO AMBIENTE

DE : VICEPRESIDENTE EJECUTIVO
EMPRESA NACIONAL DE MINERIA

En atención al proceso de revisión de las normas primarias de calidad de aire para Material Particulado Sedimentable (PTS), Ozono (O_3), Dióxido de Azufre (SO_2), Dióxido de Nitrógeno (NO_2) y Monóxido de Carbono (CO), con fecha 13 de Noviembre se realizó una presentación de la evaluación técnico-económica, en la cual se indicaron, en forma general, los costos y beneficios asociados a la modificación de la norma; en cuanto a lo expuesto, tengo a bien indicar las siguientes observaciones a dicha evaluación :

I. Los mayores costos asociados a la aplicación de una nueva norma horaria, adicionales a las restricciones que actualmente se aplican para cumplir la normativa vigente y prevenir episodios críticos, se indican explícitamente en el Anexo A adjunto, tanto para la Fundición Hernán Videla Lira de Paipote, como para la Fundición y Refinería de Ventanas.

En el anexo indicado se consigna la pérdida directa de ENAMI, asociada a la disminución de fusión y refino a fuego, es decir la transformación de concentrados de cobre a ánodos, alcanzando una disminución de ingresos por cargos de tratamiento de US$ 13.354.000. En el valor indicado no se consideran las pérdidas por menor producción de Acido Sulfúrico y por diferenciales de fletes para desviar concentrados.

Es necesario indicar que a nivel País, existe un potencial de pérdida asociado a una menor producción de concentrados que puede derivar directamente en menores exportaciones y menores ingresos, bastante superiores a la pérdida ENAMI indicada, según se puede observar en el anexo aludido.

Considerando la situación financiera en que se encuentra ENAMI, la alternativa de disminuir fusión no es viable derivado de las pérdidas indicadas, como tampoco es viable obtener recursos para invertir, razón por la cual, en caso de aplicarse la normativa, determina mantener la situación actual con un plan de cierre de las fundiciones para minimizar los problemas sociales

II. La normativa federal de Estados Unidos, junto con las normativas de los estados de Arizona y Texas, donde existen fundiciones de cobre, que se incluyen en el Anexo B, indican que no se aplica una norma primaria horaria, sólo contemplan como norma primaria, un valor promedio anual de 80 ugr/Nm^3 y un valor promedio diario de 365 ugr/Nm^3, similares a los actualmente vigentes en Chile. Según fue informado por la CONAMA, el valor propuesto como norma primaria horaria promedio de 1050 ugr/Nm^3, corresponde a la norma vigente en el estado de Washinton, donde no existen emisores de SO_2.

La incorporación de una norma horaria deriva de una recomendación de la OMS, que establece una condición deseada, que puede ser interpretada de largo plazo, especialmente en países en desarrollo.

III. Se reitera lo indicado en la carta enviada el pasado 03 de noviembre del 2000, en la cual se indica:

A.- Se solicitó modificar las áreas de evaluación para la aplicación de la nueva norma, dejando sólo las áreas mínimas (de impacto directo) que corresponden, para lo cual se indicó que el criterio a utilizar considera sólo aquellas áreas que se encuentran en categoría de zona latente y/o saturada.

Para la Fundición Ventanas se consideró dentro de la zona mínima la localidad de Puchuncaví, y para la Fundición Paipote, se consideraron las estaciones de Copiapó y Los Volcanes, las estadísticas de 1999 indican que en ninguna de ellas se ha sobrepasado el 80 % de los valores diarios y horarios propuestos.

De acuerdo a lo indicado, las zonas mínimas afectadas debieran circunscribirse a las localidades de Los Maitenes y La Greda en Fundición y Refinería Ventanas y a Estación Paipote y Tierra Amarilla para Fundición Paipote.

B.- Se indicó que en el mercado del Cobre se considera en forma creciente el aspecto ambiental de los procesos de obtención de este metal, y teniéndose en cuenta que las fundiciones chilenas se encuentran implementando Sistemas de Gestión Ambiental bajo el estándar de ISO 14000, se dificulta el cumplimiento de una de las exigencias básicas en este estándar, correspondiente al cumplimiento de la legislación ambiental.

La aplicación de la norma propuesta retrasará la certificación de la Norma ISO 14.000, lo cual debe ser evaluado como una pérdida de mercado del principal producto de exportación del país.

C.- Se informó que en la Fundición Paipote se implementó por imposición del Decreto N°180 del Ministerio Secretaria General de la Presidencia del año 1995 un modelo climático predictivo con alto costo (Inversión aproximada de US$ 1.000.000 y costo anual de US$ 70.000), con una certeza de sólo un 50% en sus resultados.

Las decisiones operativas asociadas para prevenir un evento, pueden iniciarse hasta 12 horas de anticipación de un posible evento, sin asegurar un resultados positivo de la gestión.

D.- En el informe de la Consultora SGA Soluziona, contratado por la CONAMA para la preparación del Proyecto de Ley, se recomienda claramente no incorporar una norma horaria para SO_2.

ENAMI

01111

En consideración a lo indicado, se reitera lo solicitado con anterioridad, en el sentido de no incorporar una Norma de Calidad Horaria, en la revisión que se realiza, como también, aplicar en forma gradual, la mayor exigencia de Norma Diaria para SO_2.

Le saluda atentamente,

Empresa Nacional de Minería
Vice Presidente Ejecutivo

Pérez de Arce

JAIME PÉREZ DE ARCE ARAYA
Vicepresidente Ejecutivo

ENAMI-SANTIAGO
DESPACHADO
- 4. DIC. 2000
OFICINA DE PARTES

01112

EMPRESA NACIONAL DE MINERIA
GESTION DE CALIDAD Y MEDIO AMBIENTE

ANEXO A

DETERMINACION DE MENORES INGRESOS DERIVADOS DE LA APLICACIÓN DE LA NORMA QUE REGULA CALIDAD DEL AIRE POR SO_2

SANTIAGO - NOVIEMBRE DEL 2000

MENORES INGRESOS POR APLICACIÓN NORMA SO2

DIFERENCIAL DE PERDIDAS ECONOMICAS

A nivel de ENAMI, las pérdidas económicas corresponden a los menores cargos de fusión y de refinación a fuego de blister líquido que ingresa la Empresa, como una menor venta de ácido sulfúrico, pero es imperativo considerar que la pérdida total corresponde a una menor venta de cobre refinado, a nivel país, ya que la gran mayoría de los productores trabaja muy cerca del límite de equilibrio económico, no es posible considerar la alternativa de trasladar y fundir los concentrados en fundiciones externas.

Se dispone de los antecedentes de los años 1999 y 2000, y con el propósito de realizar la evaluación, para ambos casos, Paipote y Ventanas, se considerará el año más negativo, que corresponde al año 2000.

FUNDICION HERNAN VIDELA LIRA - PAIPOTE

Menor Fusión Situación Proyectada (Ppto. Año 2001)	72.224 ton
Menor Fusión Situación Actual (Real Año 2000)	7.294 ton
Diferencial de Menor Fusión	64.930 ton
Cargo Tratamiento Fusión	90 US$/ton
Pérdida ENAMI por menor Fusión	**US$ 5.843.700**
Ley de cobre en Carga Nueva Util	27,5%
Recuperación Total Fusión-Refinación	95,8%
Finos Correspondientes a Cátodos	17.106 tmf
Cargo de Refinación a Fuego	2,5 cUS$/lb
Pérdida ENAMI por menor Refinación a Fuego	**US$ 942.807**
Ley de azufre en Carga Nueva Util	30,0%
Captación de azufre	88,0%
Eficiencia Plantas de Acido	93,5%
Peso Molecular Acido Sulfúrico	98,00
Peso Atómico del Azufre	32,00
Concentración Acido Sulfúrico	98,0%
Acido Sulfúrico Producido	50.085 ton
Precio Acido Sulfúrico año 2001	27 US$/ton
Pérdida por menor producción y venta de Acido Sulfúrico	**US$ 1.352.300**
Finos Correspondientes a Cátodos	17.106 tmf
Precio del Cobre 80c/lb	1763,7 US$/tmf
Potencial Pérdida PAIS por menores ventas	**US$ 30.169.500**

FUNDICION Y REFINERIA VENTANAS

Menor Fusión Situación Proyectada (Ppto. Año 2001)	63.281 ton
Menor Fusión Situación Actual (Real Año 2000)	1.314 ton
Diferencial de Menor Fusión	61.967 ton
Cargo Tratamiento Fusión	90 US$/ton
Pérdida ENAMI por menor Fusión	**US$ 5.577.030**
Ley de Carga Nueva Util	29,8%
Recuperación Total Fusión-Refinación	97,3%
Finos Correspondientes a Cátodos	17.968 tmf
Cargo de Refinación a Fuego	0,025 US$/lb
Pérdida ENAMI por menor Refinación a Fuego	**US$ 990.316**
Ley de azufre en Carga Nueva Util	31,5%
Captación de azufre	89,0%
Eficiencia Plantas de Acido	94,0%
Peso Molecular Acido Sulfúrico	98,00
Peso Atómico del Azufre	32,00
Concentración Acido Sulfúrico	98,0%
Acido Sulfúrico Producido	53.472 ton
Precio Acido Sulfúrico año 2001	27 US$/ton
Pérdida por menor producción y venta de Acido Sulfúrico	**US$ 1.443.744**
Finos Correspondientes a Cátodos	17.968 tmf
Precio del Cobre 80c/lb	1763,7 US$/tmf
Potencial Pérdida PAIS por menores ventas	**US$ 31.689.420**

PERDIDAS OPERACIONALES POR NORMA SO2
FUNDICION HERNAN VIDELA LIRA - PAIPOTE

SITUACION ACTUAL

Pérdida de fusión año 1999	**5.824 ton**
Pérdida por restricción en enriquecimiento de O2	
Horas/día por Prevención	2,72 hrs/día
Horas/día por Restricción	1,63 hrs/día
Perdida de fusión por Prevención	2.240 ton/año
Perdida de fusión por Restricción	3.584 ton/año
Perdida total de fusión	**5.824 ton/año**
Pérdida por paralización total de fusión	
Capacidad anual de fusión	297.480 ton/mes
Días operación al año	335 días/año
Capacidad horaria de fusión	37 ton/hr
Horas/día sin fusión por condición Extrema	0 hrs/día
Perdida de fusión asociada	**0 ton/año**

Pérdida proyectada de fusión año 2000	**7.294 ton**
Pérdida por restricción en enriquecimiento de O2	
Horas/día por Prevención	2,92 hrs/día
Horas/día por Restricción	2,32 hrs/día
Perdida de fusión por Prevención	2.052 ton/año
Perdida de fusión por Restricción	4.250 ton/año
Perdida total de fusión	**6.302 ton/año**
Pérdida por paralización total de fusión	
Capacidad anual de fusión	297.480 ton/mes
Días operación al año	335 días/año
Capacidad horaria de fusión	37 ton/hr
Horas/día sin fusión por condición Extrema	0,09 hrs/día
Perdida de fusión asociada	**992 ton/año**

SITUACION CON NUEVAS RESTRICCIONES

Përdidas estimadas de fusión	**72.224 ton**
Pérdida por paralización total de fusión	
Capacidad anual de fusión	297.480 ton/mes
Días operación al año	335 días/año
Capacidad horaria de fusión	37 ton/hr
Periodo May-Ago	123 días
Horas/día sin fusión	8 hrs/día
Hrs/año sin fusión	984 hrs/año
Perdida de fusión asociada	36.408 ton/año
Periodo Ene-Abr y Sep-Dic	242 días
Horas/día sin fusión	4 hrs/día
Hrs/año sin fusión	968 hrs/año
Perdida de fusión asociada	35.816 ton/año
Pérdida total de fusión	72.224 ton/año

PLAN OPERACIONAL PREVENTIVO
FUNDICION HERNAN VIDELA LIRA - PAIPOTE

01116

1999	Horas Promedio Diario				Pérdidas de Fusión			
MES	Prevención	Restricción	Extrema	Total	Prevención	Restricción	Extrema	Total
Ene	1,08	0,13	0,00	1,21	75,38	24,00	0,00	99,38
Feb	0,70	0,21	0,00	0,91	44,10	35,30	0,00	79,40
Mar	3,60	1,86	0,00	5,46	251,10	346,00	0,00	597,10
Abr	5,06	2,06	0,00	7,12	341,55	370,80	0,00	712,35
May	3,99	4,53	0,00	8,52	278,30	842,60	0,00	1.120,90
Jun	3,57	3,46	0,00	7,03	240,98	622,80	0,00	863,78
Jul	3,53	2,14	0,00	5,67	246,22	398,00	0,00	644,22
Ago	2,03	1,23	0,00	3,26	141,59	228,80	0,00	370,39
Sep	4,07	1,45	0,00	5,52	274,73	261,00	0,00	535,73
Oct	2,04	1,35	0,00	3,39	142,29	251,10	0,00	393,39
Nov	2,03	0,72	0,00	2,75	137,03	129,60	0,00	266,63
Dic	0,96	0,40	0,00	1,36	66,96	74,40	0,00	141,36
Promedio	2,72	1,63	0,00	4,35				
Total					2.240,23	3.584,40	0,00	5.824,63

En las condiciones de Prevención y Restricción se considera disminuir el enriquecimiento de Oxígeno
En Prevención 2,3 ton/hr
En Restricción 6,0 ton/hr

En la condición Extrema se considera paralización total de fusión
En Extrema 37,0 ton/hr

PLAN OPERACIONAL PREVENTIVO

FUNDICION HERNAN VIDELA LIRA - PAIPOTE

2000	Horas Promedio Diario				Pérdidas de Fusión			
MES	Prevención	Restricción	Extrema	Total	Prevención	Restricción	Extrema	Total
Ene	0,84	0,37	0,00	1,21	59,89	68,82	0,00	128,71
Feb	1,53	0,78	0,00	2,31	102,05	135,72	0,00	237,77
Mar	1,64	0,32	0,00	1,96	116,93	59,52	0,00	176,45
Abr	2,17	0,56	0,00	2,73	149,73	100,80	0,00	250,53
May	2,76	3,35	0,00	6,11	196,79	623,10	0,00	819,89
Jun	3,70	4,25	0,00	7,95	255,30	765,00	0,00	1.020,30
Jul	3,88	4,92	0,00	8,80	276,64	915,12	0,00	1.191,76
Ago	4,53	3,55	0,53	8,61	322,99	660,30	607,91	1.591,20
Sep	4,28	3,47	0,15	7,90	295,32	624,60	166,50	1.086,42
Oct	3,87	1,60	0,19	5,66	275,93	297,60	217,93	791,46
Nov								
Dic								
Promedio	2,92	2,32	0,09	5,32				
Total					2.051,58	4.250,58	992,34	7.294,50

En las condiciones de Prevención y Restricción se considera disminuir el enriquecimiento de Oxígeno

En Prevención	2,3	ton/hr
En Restricción	6,0	ton/hr

En la condición Extrema se considera paralización total de fusión

En Extrema	37,0	ton/hr

PERDIDAS OPERACIONALES POR NORMA SO2
FUNDICION Y REFINERIA VENTANAS

SITUACION ACTUAL

Pérdida de fusión año 1999	**745 ton**
Pérdida por paralización total de fusión	
Capacidad anual de fusión	416.000 ton/mes
Días operación al año	335 días/año
Capacidad horaria de fusión	51,7 ton/hr
Hrs/año de restricción	20,71 hrs/año
Perdida de fusión asociada	745 ton/año

Pérdida proyectada de fusión año 2000	**1.314 ton**
Pérdida por paralización total de fusión	
Capacidad anual de fusión	416.000 ton/mes
Días operación al año	335 días/año
Capacidad horaria de fusión	51,7 ton/hr
Hrs/año de restricción	41,24 hrs/año
Perdida de fusión asociada	1.314 ton/año

SITUACION CON NUEVAS RESTRICCIONES

Përdidas estimadas de fusión	**63.281 ton**
Pérdida por paralización total de fusión	
Capacidad anual de fusión	416.000 ton/mes
Días operación al año	335 días/año
Capacidad horaria de fusión	51,7 ton/hr
Periodo Jun-Jul-Ago	92 días
Horas/día sin fusión	8 hrs/día
Hrs/año sin fusión	736 hrs/año
Perdida de fusión asociada	38.051 ton/año
Periodo Abr-May y Sep-Oct	122
Horas/día sin fusión	4 hrs/día
Hrs/año sin fusión	488 hrs/año
Perdida de fusión asociada	25.230 ton/año
Pérdida total de fusión	63.281 ton/año

PLAN OPERACIONAL PREVENTIVO
FUNDICION Y REFINERIA VENTANAS

1999	Horas Promedio Diario			Pérdidas de Fusión		
MES	Conv. Tte.	Conv. P.S.	Total	Conv. Tte.	Conv. P.S.	Total
Ene	0,00	0,00	0,00	0,00	0,00	0,00
Feb	0,00	0,00	0,00	0,00	0,00	0,00
Mar	2,06	0,53	2,59	137,00	16,00	153,00
Abr	0,47	0,54	1,01	23,00	16,00	39,00
May	0,00	0,37	0,37	0,00	11,00	11,00
Jun	0,62	1,28	1,90	32,00	38,00	70,00
Jul	0,00	1,85	1,85	0,00	56,00	56,00
Ago	0,00	0,72	0,72	0,00	22,00	22,00
Sep	0,00	1,34	1,34	0,00	40,00	40,00
Oct	0,00	0,28	0,28	0,00	8,00	8,00
Nov	0,00	1,30	1,30	0,00	66,00	66,00
Dic	0,00	9,35	9,35	0,00	280,00	280,00
Promedio	3,15	17,56	20,71			
Total				192,00	553,00	745,00

En las condiciones de Prevención y Restricción se considera disminuir el enriquecimiento de Oxígeno

En Convertidor Teniente	61,0	ton/hr
En Convertidor Pierce Smith	31,5	ton/hr

PLAN OPERACIONAL PREVENTIVO
FUNDICION Y REFINERIA VENTANAS

2000	**Horas Promedio Diario**			**Pérdidas de Fusión**		
MES	Conv. Tte.	Conv. P.S.	Total	Conv. Tte.	Conv. P.S.	Total
Ene	0,00	2,10	2,10	0,00	63,00	63,00
Feb	0,00	1,57	1,57	0,00	47,00	47,00
Mar	1,77	7,11	8,88	84,00	214,00	298,00
Abr	0,00	4,76	4,76	0,00	143,00	143,00
May	1,50	6,40	7,90	72,00	192,00	264,00
Jun	0,00	3,00	3,00	0,00	90,00	90,00
Jul	0,75	2,68	3,43	38,00	80,00	118,00
Ago	0,00	3,76	3,76	0,00	113,00	113,00
Sep	0,17	2,61	2,78	8,00	78,00	86,00
Oct	0,00	3,06	3,06	0,00	92,00	92,00
Nov						
Dic						
Promedio	4,19	37,05	41,24			
Total				202,00	1.112,00	1.314,00

En las condiciones de Prevención y Restricción se considera disminuir el enriquecimiento de Oxígeno

En Convertidor Teniente	48,2	ton/hr
En Convertidor Pierce Smith	30,0	ton/hr

EMPRESA NACIONAL DE MINERIA
GESTION DE CALIDAD Y MEDIO AMBIENTE

01121

ANEXO B

ANTECEDENTES DE NORMATIVAS INTERNACIONALES

SANTIAGO - NOVIEMBRE DEL 2000

Title 40 - Code of Federal Regulations

been cancelled in accordance with § 53.11 or § 53.16 of this chapter.

(h) *Traceable* means that a local standard has been compared and certified either directly or via not more than one intermediate standard, to a primary standard such as a National Bureau of Standards Standard Reference Material (NBS SRM), or a USEPA/NBS-approved Certified Reference Material (CRM).

(i) *Indian country* is as defined in 18 U.S.C. 1151.

[36 FR 22384, Nov. 25, 1971, as amended at 41 FR 11253, Mar. 17, 1976; 48 FR 2529, Jan. 20, 1983; 63 FR 7274, Feb. 12, 1998]

§ 50.2 Scope.

(a) National primary and secondary ambient air quality standards under section 109 of the Act are set forth in this part.

(b) National primary ambient air quality standards define levels of air quality which the Administrator judges are necessary, with an adequate margin of safety, to protect the public health. National secondary ambient air quality standards define levels of air quality which the Administrator judges necessary to protect the public welfare from any known or anticipated adverse effects of a pollutant. Such standards are subject to revision, and additional primary and secondary standards may be promulgated as the Administrator deems necessary to protect the public health and welfare.

(c) The promulgation of national primary and secondary ambient air quality standards shall not be considered in any manner to allow significant deterioration of existing air quality in any portion of any State or Indian country.

(d) The proposal, promulgation, or revision of national primary and secondary ambient air quality standards shall not prohibit any State or Indian country from establishing ambient air quality standards for that State or area under a tribal CAA program or any portion thereof which are more stringent than the national standards.

[36 FR 22384, Nov. 25, 1971, as amended at 63 FR 7274, Feb. 12, 1998]

§ 50.3 Reference conditions.

All measurements of air quality that are expressed as mass per unit volume (e.g., micrograms per cubic meter) other than for the particulate matter (PM_{10} and $PM_{2.5}$) standards contained in § 50.7 shall be corrected to a reference temperature of 25 °C and a reference pressure of 760 millimeters of mercury (1,013.2 millibars). Measurements of PM_{10} and $PM_{2.5}$ for purposes of comparison to the standards contained in § 50.7 shall be reported based on actual ambient air volume measured at the actual ambient temperature and pressure at the monitoring site during the measurement period.

[62 FR 38711, July 18, 1997]

§ 50.4 National primary ambient air quality standards for sulfur oxides (sulfur dioxide).

(a) The level of the annual standard is 0.030 parts per million (ppm), not to be exceeded in a calendar year. The annual arithmetic mean shall be rounded to three decimal places (fractional parts equal to or greater than 0.0005 ppm shall be rounded up). (~ 80 µg/Nm³)

(b) The level of the 24-hour standard is 0.14 parts per million (ppm), not to be exceeded more than once per calendar year. The 24-hour averages shall be determined from successive nonoverlapping 24-hour blocks starting at midnight each calendar day and shall be rounded to two decimal places (fractional parts equal to or greater than 0.005 ppm shall be rounded up). (~ 365 µg/Nm³)

(c) Sulfur oxides shall be measured in the ambient air as sulfur dioxide by the reference method described in appendix A to this part or by an equivalent method designated in accordance with part 53 of this chapter.

(d) To demonstrate attainment, the annual arithmetic mean and the second-highest 24-hour averages must be based upon hourly data that are at least 75 percent complete in each calendar quarter. A 24-hour block average shall be considered valid if at least 75 percent of the hourly averages for the 24-hour period are available. In the event that only 18, 19, 20, 21, 22, or 23 hourly averages are available, the 24-hour block average shall be computed as the sum of the available hourly averages using 18, 19, etc. as the divisor. If fewer than 18 hourly averages are available, but the 24-hour average would exceed the level of the standard when zeros are substituted for the missing values, subject to the rounding rule of paragraph (b) of this section, then this shall be considered a valid 24-hour average. In this case, the 24-hour block average shall be computed as the sum of the available hourly averages divided by 24.

[61 FR 25579, May 22, 1996]

§50.5 National secondary ambient air quality standard for sulfur oxides (sulfur dioxide).

~1300 μg/Nm³

(a) The level of the 3-hour standard is 0.5 parts per million (ppm), not to be exceeded more than once per calendar year. The 3-hour averages shall be determined from successive nonoverlapping 3-hour blocks starting at midnight each calendar day and shall be rounded to 1 decimal place (fractional parts equal to or greater than 0.05 ppm shall be rounded up).

(b) Sulfur oxides shall be measured in the ambient air as sulfur dioxide by the reference method described in appendix A of this part or by an equivalent method designated in accordance with part 53 of this chapter.

(c) To demonstrate attainment, the second-highest 3-hour average must be based upon hourly data that are at least 75 percent complete in each calendar quarter. A 3-hour block average shall be considered valid only if all three hourly averages for the 3-hour period are available. If only one or two hourly averages are available, but the 3-hour average would exceed the level of the standard when zeros are substituted for the missing values, subject to the rounding rule of paragraph (a) of this section, then this shall be considered a valid 3-hour average. In all cases, the 3-hour block average shall be computed as the sum of the hourly averages divided by 3.

[61 FR 25580, May 22, 1996]

§50.6 National primary and secondary ambient air quality standards for PM_{10}.

(a) The level of the national primary and secondary 24-hour ambient air quality standards for particulate matter is 150 micrograms per cubic meter (μg/m³), 24-hour average concentration. The standards are attained when the expected number of days per calendar year with a 24-hour average concentration above 150 μg/m³, as determined in accordance with appendix K to this part, is equal to or less than one.

(b) The level of the national primary and secondary annual standards for particulate matter is 50 micrograms per cubic meter (μg/m³), annual arithmetic mean. The standards are attained when the expected annual arithmetic mean concentration, as determined in accordance with appendix K to this part, is less than or equal to 50 μg/m³.

(c) For the purpose of determining attainment of the primary and secondary standards, particulate matter shall be measured in the ambient air as PM_{10} (particles with an aerodynamic diameter less than or equal to a nominal 10 micrometers) by:

(1) A reference method based on appendix J and designated in accordance with part 53 of this chapter, or

(2) An equivalent method designated in accordance with part 53 of this chapter.

(d) The PM_{10} standards set forth in this section will no longer apply to an area not attaining these standards as of September 16, 1997, once EPA takes final action to promulgate a rule pursuant to section 172(e) of the Clean Air Act, as amended (42 U.S.C. 7472(e)) applicable to the area. The PM_{10} standards set forth in this section will no longer apply to an area attaining these standards as of September 16, 1997, once EPA approves a State Implementation Plan (SIP) applicable to the area containing all PM_{10} control measures adopted and implemented by the State prior to September 16, 1997, and a section 110 SIP implementing the PM standards published on July 18, 1997.

Title 49 - Arizona Revised Statutes

001124

CHAPTER 3 - AIR QUALITY

Article 1 - General Provisions

49-401 - Declaration of policy

49-401.01 - Definitions

49-402 - State and county control

49-404 - State implementation plan

49-405 - Attainment area designations

49-406 - Nonattainment area plan

49-407 - Private right of action; citizen suits

49-408 - Air quality conformity; definition

49-409 - Chlorofluorocarbons; permitted use; retaliation prohibited

49-410 - Arizona emissions bank; program termination

49-405. Attainment area designations

A. The governor may designate the status and classification of areas of this state with respect to attainment of national ambient air quality standards.

B. The director shall adopt rules that both:

1. Describe the geographic extent of attainment, nonattainment or unclassifiable areas of this state for all pollutants for which a national ambient air quality standard exists.

2. Establish procedures and criteria for changing the designations of areas that include all of the following:

(a) Technical bases for proposed changes, including ambient air quality data, types and distributions of sources of air pollution, population density and projected population growth, transportation system characteristics, traffic congestion, projected industrial and commercial development, meteorology, pollution transport and political boundaries.

(b) Provisions for review of and public comment on proposed changes to area designations.

(c) All area designations adopted by the administrator as of May 30, 1992.

49-408. Air quality conformity; definition

A. Any revision to the state implementation plan adopted pursuant to 40 Code of Federal Regulations, part 51, subpart T shall be no more stringent than required under those regulations. No state agency, metropolitan planning organization or local transportation agency shall take action that is more stringent than required under federal law in performing any of the following functions:

1. Determining which projects require conformity determinations pursuant to 40 Code of Federal Regulations, part 93, any state implementation plan revisions adopted pursuant to 40 Code of Federal Regulations, part 51, subpart T, or the conformity requirements set forth in the federal implementation plan at 40 Code of Federal Regulations, part 52, subpart D.

2. Determining which projects constitute regionally significant projects within the meaning of any of the regulations identified in paragraph 1.

3. Making conformity determinations pursuant to any of the regulations identified in paragraph 1.

B. Notwithstanding any other provisions of this section, the director may adopt consultation procedures for the public or affected agencies which supplement the requirements of 40 Code of Federal Regulations, part 51, subpart T.

C. For purposes of this section "local transportation agency" means any city, town, county or other local or regional government or agency that receives federal funds designated under Title 23 United States Code or the federal transit act.

Texas Administrative Code

001126

TITLE 30	ENVIRONMENTAL QUALITY
PART 1	TEXAS NATURAL RESOURCE CONSERVATION COMMISSION
CHAPTER 101	GENERAL AIR QUALITY RULES
SUBCHAPTER A	GENERAL RULES
RULE §101.21	**The National Primary and Secondary Ambient Air Quality Standards**

The National Primary and Secondary Ambient Air Quality Standards as promulgated pursuant to section 109 of the Fe Clean Air Act, as amended, will be enforced throughout all parts of Texas.

Source Note: The provisions of this §101.21 adopted to be effective January 1, 1976; amended to be effective May 7, 1979, 4 TexReg 1358

GOBIERNO DE CHILE
MINISTERIO DEL INTERIOR
INTENDENCIA REGION DE ATACAMA

COMISION NACIONAL DEL MEDIO AMBIENTE
OFICINA DE PARTES Y ARCHIVO
Nº INGRESO: 14601 / 12788
FECHA:
DESPACHADO: 7 DIC 2000
OBS.:
A. Hoffmann

001127

29152

896

ORD.: Nº___________________/

ANT.: No hay.

MAT: Envía documento.

COPIAPO, 05 DIC 2000

DE : INTENDENTE DE LA REGION DE ATACAMA

A : SRA. ADRIANA HOFFMANN JACOBY
DIRECTORA EJECUTIVA
COMISION NACIONAL DEL MEDIO AMBIENTE

En atención al acuerdo de fecha 04 de diciembre de 2000, de la Comisión Regional del Medio Ambiente de la Región de Atacama, adjunto envío a Ud. el documento **"Acuerdo Observaciones al Anteproyecto de Norma Primaria de Calidad del Aire para Anhídrido Sulfuroso (SO_2)"**, que corresponde a la revisión de la norma contenida en la Resolución Nº 1215, de 1978 del Ministerio de Salud.

Sin otro particular, saluda atentamente a Ud.,

ARMANDO ARANCIBIA CALDERON
INTENDENTE REGION DE ATACAMA

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ACUERDO
OBSERVACIONES AL ANTEPROYECTO DE NORMA PRIMARIA DE CALIDAD DE AIRE PARA ANHÍDRIDO SULFUROSO (S02)

1. ANTECEDENTES

Las observaciones que a continuación se presentan al anteproyecto de norma primaria de calidad del aire por anhídrido sulfuroso, se basan en un análisis del texto del anteproyecto y tienen presente los antecedentes que existen en la Región de Atacama respecto de la aplicación de los Planes de Descontaminación de las Fundiciones de Paipote y Potrerillos, información contenida en documentos presentados a las Autoridades Nacionales por el Sr. Intendente de la Región de Atacama y el Sr. Secretario Regional Ministerial de Minería, en el pronunciamiento del Consejo Consultivo de la Comisión Regional del Medio Ambiente, en una propuesta alternativa de norma presentada al Sr. Intendente Regional por la Empresa Nacional de Minería, y otros antecedentes relacionados con la normativa internacional sobre la misma materia.

2. LA PROPUESTA Y SUS FUNDAMENTOS

El anteproyecto propone que se mantenga para el anhídrido sulfuroso, el nivel de 80 Ug/Nm3 como norma primaria anual, tal como se encuentra en la Resolución N° 1215 de 1978 del Ministerio de Salud, objeto de la revisión en proceso.

Respecto de la norma primaria de 24 horas, se propone reducir el valor de la norma desde el valor vigente de **365 Ug/Nm3** que no se puede sobrepasar en más de una vez al año a un valor de **250 Ug/Nm3** en el percentil 99, es decir que se podría sobrepasar en no más de 4 oportunidades en el año.

Además, el anteproyecto propone introducir una norma primaria horaria, que actualmente no existe. El valor de la norma horaria propuesto es de **1050 Ug/Nm3** como concentración máxima permisible para el máximo valor horario de cada día, no pudiéndose sobrepasar este valor más de 4 veces en el año, es decir percentil 99 de los máximos valores horarios de cada día.

La propuesta se basa en el hecho que las guías de la OMS señalan para la población más sensible efectos agudos a partir de los 5-10 minutos de exposición, por lo que se recomienda que para proteger a los individuos más sensibles la concentración no debiera superar los **500 Ug/Nm3** en 10 minutos. De allí que, considerando que en el país existen localidades donde la población está expuesta a valores que superan el nivel señalado, se recomienda establecer una norma horaria que cumpla el objetivo de proteger a la población más sensible en localidades específicas. Además, en algunas presentaciones de la norma propuesta se indica que una norma horaria permitiría prevenir la instalación en el país de fuentes emisoras que pudieran provocar episodios de contaminación por encima del valor propuesto.

Respecto del valor de 250 Ug/Nm3 para la norma diaria., se lo justifica en consideración a que es el valor a partir del cual se detectan efectos adversos en salud en personas sensibles, teniendo en cuenta los efectos del material particulado en suspensión y otros contaminantes.
Por otro lado, se indica que estudios realizados en Chile, muestran que la mortalidad en relación con la presencia de anhídrido sulfuroso en el aire no es significativa y no se relaciona este efecto con el contaminante.

3. OBSERVACIONES AL ANTEPROYECTO.

3.1 **Desde el punto de vista de las consideraciones relativas a efectos en salud**, tal como lo señala el pronunciamiento del Consejo Consultivo de la COREMA Atacama, no existen suficientes estudios epidemiológicos que justifiquen la incorporación de una norma horaria en el país. De hecho, la información de respaldo se refiere a estudios realizados con individuos asmáticos expuestos voluntariamente a concentraciones controladas en períodos que van de unos pocos minutos hasta 1 hora, produciéndose los efectos a partir de los primeros minutos, sin que estos se incrementen con el aumento de los períodos de exposición. No existe evidencia de la validación de estos experimentos en un medio real, distinto a las condiciones de confinamiento en cámaras de concentración controlada. Por otro lado, la EPA en Estados Unidos, sin perjuicio de concordar con los resultados de la OMS, en relación con los niveles a partir de los cuales se producen los efectos, realiza una discriminación cuantitativa respecto del porcentaje de los asmáticos que presentarían tales efectos, el que no sería mayor al 10- 20 %, mientras que los mismos efectos en individuos sanos podrían presentarse sólo a partir de los 5000 Ug/Nm3.

3.2 **Desde el punto de vista de la cantidad de población expuesta** a concentraciones de anhídrido sulfuroso por sobre los 1000 Ug/Nm3 en períodos de exposición horarios, esta se reduce casi exclusivamente a las localidades cercanas a las fundiciones, las que en la mayoría de los casos, por la imposibilidad de controlar episodios críticos con la tecnología al alcance de las fundiciones chilenas, la población ha sido o está en proceso de ser erradicada, a fin de asegurar su protección. Tal es el caso de Potrerillos, Sewell y Chuquicamata; con lo que una norma horaria estaría orientada a la protección de un pequeño porcentaje de la población más sensible, cercana al área de influencia de aquellas fundiciones del país en los que no es posible la erradicación de la población. Por otro lado, los habitantes de esas localidades tienen en la actualidad los mecanismos de protección asociados a los Planes Operacionales de Control de Episodios Críticos en el contexto de sus Planes de Descontaminación. En el caso de Talcahuano, que podría ser la excepción desde el punto de vista del número de habitantes expuestos, los niveles diarios de la concentración que se presentan en la actualidad permiten concluir que se hace necesario un Plan de Descontaminación, con lo que la población más sensible debiera quedar protegida con el Plan Operación de Control de Episodios Críticos asociado a aquel, con lo que la existencia de una norma horaria no se justificaría, desde el punto de vista de la cantidad de población que se desea proteger.

3.3 **Desde el punto de vista de la factibilidad técnica de cumplimiento de una norma horaria con la tecnología actual**, ésta es muy difícil de cumplir, dado que, si bien es cierto el cumplimiento de una norma anual está en directa relación con el nivel de emisiones, no ocurre lo mismo con los niveles de concentración de carácter horario, ya que para aquellas localidades ubicadas en las áreas más cercanas a la fuente emisora, las concentraciones horarias son independientes del nivel de emisiones y dependen más bien de la distancia del punto de medición a la fuente y de factores meteorológicos y topográficos que determinan los mecanismos de dispersión del contaminante. Tal es el caso de las localidades cercanas a la Fundición Hernán Videla Lira, donde la paulatina baja en el nivel de emisiones (Ver cuadro 1 anexo) desde el año 1995 hasta 1999, año en que concluyó el Plan de Descontaminación, determinó que la norma anual de 80 Ug/Nm3 se empezó a cumplir en todas las localidades, incluso Estación Paipote, ubicada sólo a 1 Kilómetro de la Fundición, a partir del año 1997 (Ver cuadro 2 anexo), mientras que en esta misma localidad el número de superaciones de la norma diaria de 365 Ug/Nm3 se mantuvo en 2 oportunidades en tres años consecutivos (Ver cuadro 3 anexo) aún cuando las emisiones difirieron en forma importante en el mismo período. Así mismo, el número de episodios críticos varió muy poco en la localidad de Estación Paipote en los últimos tres años (Ver cuadro 4) si se considera la señalada diferencia en las emisiones de esos años.

3.4 **Desde el punto de vista de la pertinencia de la introducción de una norma horaria en presencia de una norma diaria exigente.**
Se ha señalado que son las condiciones meteorológicas en mayor medida que las emisiones las que determinan la existencia de episodios críticos en los sectores poblados más cercanos a las fuentes emisoras, pero, además, en la gran mayoría de los casos, es la existencia de episodios horarios de contaminación lo que determina el número de superaciones de la norma diaria. Por lo anteriormente expuesto si se introduce una norma diaria más exigente que la actual, tal como se propondrá más adelante, indirectamente se estará obligando a las fuentes emisoras a controlar los episodios críticos horarios para lograr por esta vía el cumplimiento de la norma diaria, lo que hace innecesaria la introducción de una norma horaria.

3.5 Desde el punto de vista del escenario de incumplimiento de la norma horaria propuesta y los costos de su cumplimiento. Si se proyecta el nivel de incumplimiento esperado con la existencia de una norma horaria de 1050 Ug/Nm3 considerando como ejemplo la Fundición Hernán Videla Lira (Ver cuadro 5) se prevé, a partir de los datos de 1999, que la norma horaria se superaría en unas 36 oportunidades alrededor de la Fundición, lo que obligaría en el corto plazo a la implementación de un nuevo Plan de Descontaminación, en circunstancias que este establecimiento fue obligado por la normativa vigente a restringir sus emisiones en un Plan de Descontaminación que terminó en 1999 con una inversión de unos 90 millones de dólares. La introducción de una norma horaria implicaría para las fundiciones chilenas un cambio demasiado drástico en el escenario normativo que no se condice con la política de reglas claras que se ha anunciado para el país en materia ambiental.

3.6. **Desde el punto de vista de la comparación con la realidad internacional.** De acuerdo con la información técnica de respaldo contenida en anexos del Expediente Público de la Norma Primaria de Calidad del Aire por anhídrido sulfuroso, la norma horaria del anteproyecto en estudio es bastante exigente si se considera que en Estados Unidos, la EPA resolvió en 1996 mantener como valor federal un nivel de **80 Ug/Nm3** como norma anual y **365 Ug/Nm3** como norma diaria y **no consideró necesario** introducir una norma horaria. Por otro lado, si bien es cierto que en algunos Estados como Washington y California existen normas horarias igual o más exigentes que la propuesta en el anteproyecto(**1050 y 655 Ug/Nm3, respectivamente),** también existen otros Estados con normas horarias más holgadas, como el caso de Georgia que tiene una norma para 3 horas equivalente a **1310 Ug/Nm3**.

Por otro lado, según información del Arizona Administrative Code, de la Secretaría de Estado de Arizona, Título 18 (Ver anexo), en Arizona, el Estado norteamericano donde se concentra la mayoría de las fundiciones de los Estados Unidos existe una norma anual de **80 Ug/Nm3**, una norma diaria de **365 Ug/Nm3** que no se puede sobrepasar en más de una vez en el año y no existe una norma primaria horaria. Es decir, Arizona en relación a normas primarias de calidad del aire por anhídrido sulfuroso tiene valores equivalentes a los de Chile. Mientras que en relación con la norma horaria secundaria Chile tiene una norma de 1000 Ug/Nm3 establecida en el D.S Nº 185/1991 del Ministerio de Minería, mientras que Arizona tiene una norma secundaria horaria de **1300 Ug/Nm3** en 3 horas sin que se pueda sobrepasar este valor más de una vez por año.

4. PROPUESTA DE NORMA

Por lo anteriormente expuesto se propone lo siguiente:

1. No establecer una norma primaria horaria para anhídrido sulfuroso.
2. Establecer como norma diaria el nivel de **330 Ug/Nm3** en el percentil 99.

ANEXOS

CUADRO 1.EMISIONES RESULTANTES DEL PLAN DE DESCONTAMINACION

	AÑO				
MESES	1995	1996	1997	1998	1999
ENERO	3252	2860	3252	1893	1111
FEBRERO	3551	2732	2347	1893	1114
MARZO	3344	2279	1597	2196	775
ABRIL	3554	2497	1074	1973	206
MAYO	3384	2297	1043	612	808
JUNIO	1992	1726	1258	1973	812
JULIO	1780	1863	877	1747	864
AGOSTO	1456	2188	1548	1029	975
SEPTIEMBRE	2019	2893	1252	1599	938
OCTUBRE	2350	3337	1206	1190	1069
NOVIEMBRE	2415	2623	1288	838	1092
DICIEMBRE	2816	2711	1799	810	892
TOTAL	28.662	24.672	15.454	17.753	10656

CUADRO.2. CONCENTRACIÓN DE ANHÍDRIDO SULFUROSO Y LA NORMA ANUAL

AÑO	PROMEDIO ANUAL (SO_2) SEGÚN LOCALIDAD			
	E. PAIPOTE	COPIAPO	T. AMARILLA	S. FERNANDO
1993	275,5	79,1	156,5	125,5
1994	234,5	62,3	148,3	95,8
1995	132,7	55,9	128,3	56,4
1996	104,8	43,2	84,4	38,5
1997	69,4	18,6	44,3	23,4
1998	57	14	36,2	17,4
1999	52,8	12,0	26,3	18,8
OCASIONES SOBRE NORMA ANUAL (80 μ/Nm^3)	4	0	4	2

CUADRO 3. COMPORTAMIENTO RESPECTO DE LA NORMA DIARIA

AÑO	N° DE SUPERACIONES DE LA NORMA PRIMARIA DIARIA SEGÚN LOCALIDAD			
	E. PAIPOTE	COPIAPO	T. AMARILLA	SAN FERNANDO
1993	98	4	23	30
1994	81	5	24	8
1995	17	2	17	0
1996	11	0	2	0
1997	2	0	0	0
1998	2	0	0	0
1999	2	0	0	0

CUADRO 4. RESULTADOS REDUCCION EPISODIOS CRITICOS SEGÚN AÑO

AÑO	Nº TOTAL DE EPISODIOS CRITICOS SEGÚN LOCALIDAD			
	E. PAIPOTE	COPIAPO	T. AMARILLA	SAN FERNANDO
1993	283	15	88	58
1994	216	7	67	31
1995	57	7	67	7
1996	26	0	16	0
1997	10	1	7	2
1998	11	0	2	1
1999	7	0	0	0

CUADRO 5. PROYECCIÓN SUPERACIONES DE NORMA HORARIA DE 1050 Ug/Nm3 EN FUNDICIÓN HERNÁN VIDELA LIRA , EN BASE A INFORMACIÓN AÑO 2000.

MES	COPIAPO	SAN FERNANDO	E. PAIPOTE	T. AMARILLA	TOTAL
Enero	0	0	0	0	0
Febrero	0	0	2	1	3
Marzo	0	0	1	0	0
Abril	0	0	1	0	0
Mayo	0	0	1	0	0
Junio	0	0	5	1	0
Julio	0	0	10	3	0
Agosto	0	0	7	1	0
Septiembre	0	0	2	0	0
Octubre					
Noviembre					
Diciembre					
Total	0	0	29	6	36

CUADRO 6. EPISODIOS CRITICOS DE CONTAMINACION ATMOSFERICA SEGÚN INTENSIDAD CENTROS POBLADOS DEL VALLE DE COPIAPO 1993 – 1999

	E. PAIPOTE			COPIAPO			T. AMARILLA			SAN FERNANDO		
AÑO	AL	AD	EM	AL	AD	EM	AL	AD	EM	AL	AD	EM
1993	118	103	62	9	6	0	40	38	10	31	24	3
1994	87	77	47	4	3	0	27	27	16	18	11	2
1995	32	17	8	6	2	0	29	27	13	7	0	1
1996	13	13	1	0	0	0	13	3	0	0	0	0
1997	5	4	1	1	0	0	3	3	1	1	1	0
1998	4	4	2	0	0	0	2	0	0	1	0	0
1999	5	1	1	0	0	0	0	0	0	0	0	0

TITLE 18. ENVIRONMENTAL QUALITY

CHAPTER 2. DEPARTMENT OF ENVIRONMENTAL QUALITY AIR POLLUTION CONTROL

ARTICLE 2. AMBIENT AIR QUALITY STANDARDS; AREA DESIGNATIONS; CLASSIFICATIONS

R18-2-201. Particulate matter

A. The primary ambient air quality standards for particulate matter are:
   1. 50 micrograms per cubic meter of PM10 -- annual arithmetic mean concentration.
   2. 150 micrograms per cubic meter of PM10 -- 24-hour average concentration.

B. The secondary ambient air quality standards for particulate matter are:
   1. 50 micrograms per cubic meter of PM10 -- annual arithmetic mean concentration.
   2. 150 micrograms per cubic meter of PM10 -- 24-hour average concentration.

C. The primary and secondary annual ambient air quality standards for PM10 shall be considered attained when the expected annual arithmetic mean concentration, as determined in accordance with 40 CFR 50, Appendix K, is less than or equal to 50 micrograms per cubic meter.

D. The primary and secondary 24-hour ambient air quality standards for PM10 shall be considered attained when the expected number of days per calendar year with a 24-hour average concentration above 150 micrograms per cubic meter, as determined in accordance with 40 CFR 50, Appendix K, is less than or equal to 1.

R18-2-202. Sulfur oxides (sulfur dioxide)

A. The primary ambient air quality standards for sulfur oxides, measured as sulfur dioxide, are:
   1. 80 micrograms per cubic meter (0.03 ppm) -- annual arithmetic mean.
   2. 365 micrograms per cubic meter (0.14 ppm) -- maximum 24-hour concentration not to be exceeded more than once per year.

B. The secondary ambient air quality standard for sulfur oxides, measured as sulfur dioxide, is 1300 micrograms per cubic meter (0.5 ppm) -- maximum 3-hour concentration not to be exceeded more than once per year.

R18-2-203. Ozone

A. The primary ambient air quality standard for ozone is 0.12 ppm (235 micrograms per cubic meter).

B. The secondary ambient air quality standard for ozone is 0.12 ppm (235 micrograms per cubic meter).

C. The standards are attained when the expected number of days per calendar year with maximum hourly average concentrations above 0.12 ppm (235 micrograms per cubic meter) is less than or equal to 1, as determined by 40 CFR 50, Appendix H.

R18-2-204. Carbon monoxide

A. The primary ambient air quality standards for carbon monoxide are:
   1. 9 parts per million (10 milligrams per cubic meter) -- maximum 8-hour concentration not to be exceeded more than once per year.
   2. 35 parts per million (40 milligrams per cubic meter) -- maximum 1-hour concentration not to be exceeded more than once per year.

B. An 8-hour average shall be considered valid if at least 75% of the hourly averages for the 8-hour period are available. In the event that only 6 or 7 hourly averages are available, the 8-hour average shall be computed on the basis of the hours available using 6 or 7 as the divisor.

C. When summarizing data for comparison with the standards, averages shall be stated to 1 decimal place. Comparison of the data with the levels of the standards in parts per million shall be made in terms of integers with fractional parts of 0.5 or greater rounding up.

R18-2-205. Nitrogen dioxide 001136

A. The primary ambient air quality standard for nitrogen dioxide is 0.053 parts per million (100 micrograms per cubic meter) -- annual arithmetic mean.

B. The secondary ambient air quality standard for nitrogen dioxide is 0.053 (parts per million (100 micrograms per cubic meter) -- annual arithmetic mean.

C. The standards are attained when the annual arithmetic mean concentration in a calendar year is less than or equal to 0.053 ppm, rounded to 3 decimal places, with fractional parts equal to or greater than 0.0005 ppm rounded up. To demonstrate attainment, an annual mean shall be based upon hourly data that is at last 75% complete or upon data derived from the manual methods, that is at least 75% complete for the scheduled sampling days in each calendar quarter.

GOBIERNO DE CHILE
Ministerio del Interior
Intendencia Región de Atacama

COMISION NACIONAL DEL MEDIO AMBIENTE
OFICINA DE PARTES Y ARCHIVO
Nº INGRESO: 4523 / 12766
FECHA:
DESPACHADO: 7 DIC 2000
OBS.: A. Hoffmann

001137

897

ORD.: Nº________/ 2971.

ANT. : No hay.

MAT.: Solicita pronunciamiento.

COPIAPO, 05 DIC 2000

DE : INTENDENTE DE LA REGION DE ATACAMA

A : DIRECTORA EJECUTIVA COMISION NACIONAL DEL MEDIO AMBIENTE
SRA. ADRIANA HOFFMAN JACOBY

En el mes de enero del presente año la Gerencia General de CODELCO Chile División Salvador, solicitó a la Comisión Regional del Medio Ambiente (COREMA) de la Región de Atacama, las gestiones pertinentes para derogar o dejar sin efecto la aplicación de los Decretos Supremos números 18/1997 y 179/1998, ambos del Ministerio Secretaría General de la Presidencia, que se refieren respectivamente, a la Declaración de Zona Saturada de la localidad de Potrerillos y a la aprobación del Plan de Descontaminación para esa zona saturada. Lo anterior basado en que por haber perdido esta localidad la calidad de asentamiento humano, a causa del traslado de la población a otros lugares de la Región, se considera por parte de CODELCO, que no se justifican las exigencias del Plan, dado que estas tendrían justificación sólo mientras existiera población residiendo en Potrerillos.

En consulta con la Comisión Nacional del Medio Ambiente, mediante Ord. Nº 54 del 10 de marzo del 2000, cuya copia se adjunta, se informó a CODELCO que se estaba solicitando un pronunciamiento a la Contraloría General de la República, por parte de CONAMA, a fin de resolver sobre el particular.

No habiéndose recibido respuesta a la fecha, CODELCO Chile División Salvador, mediante carta del 22 de Noviembre del presente, cuya copia se adjunta al presente oficio, ha reiterado la solicitud de un pronunciamiento respecto de la referida solicitud.

Por lo anteriormente expuesto, me permito solicitar a Ud., informe a esta Intendencia Regional sobre los resultados de las gestiones a la fecha, a fin de responder lo antes posible al solicitante.

Sin otro particular, saluda atentamente a Ud.

ARMANDO ARANCIBIA CALDERON
INTENDENTE DE LA REGION DE ATACAMA

AAC/DAP/RRD/rrd.
DISTRIBUCIÓN:
- Destinataria.
- CONAMA Región de Atacama (c.i.)
- Archivos.

001138

COMISION NACIONAL DEL MEDIO AMBIENTE CONSEJO CONSULTIVO NACIONAL

Opinión sobre Anteproyecto revisión de norma de emisión de ruidos de buses de locomoción colectiva urbana y rural; Revisión de normas de calidad primaria para SO2, CO, NO2, O3 y PTS; y borrador de Informe Nacional de Río + 10.

En sesión ordinaria del Consejo Consultivo Nacional de la CONAMA del 14 de diciembre del 2000, con la asistencia de los Consejeros Sra, Abogabir, Sr, Conteras, Sr. Del Favero, Sr. Dinamarca, Sr. Durán, Sr. Guerra, Sr. Varela, y Sr. Yáñez y Sr. Tomic, presida en forma sucesiva por el señor Eduardo Dokendorff V. , Subsecretario Secretaría General de la Presidencia, y por la Directora Nacional de la CONAMA señora Adriana Hoffmann J.

Teniendo presente:

1. Proceso de Consulta pública del anteproyecto revisión de norma de emisión de ruidos de buses de locomoción colectiva urbana y rural.
2. Análisis general del impacto económico y social del anteproyecto revisión de norma de emisión de ruidos de buses de locomoción colectiva urbana y rural.
3. Anteproyecto revisión de norma de emisión de ruidos de buses de locomoción colectiva urbana y rural
4. Análisis de observaciones formuladas a la revisión de normas de calidad primaria para SO2, CO, NO2, O3 y PTS.
5. Informe Nacional Río + 10

Acuerda:

Respecto del Anteproyecto revisión de norma de emisión de ruidos de buses de locomoción colectiva urbana y rural

a. No hacer distinción por tipo de buses, sino que hacerlo extensivo a todo tipo de vehículo que entre en la categoría de buses de locomoción colectiva particulares y públicos.

b. Crear ciertas condiciones de convergencia en el proceso de cumplimiento de la norma, ya que por ejemplo en el caso de los buses rurales, estos no tienen una edad de retiro máxima, y por tanto podrían demorarse un tiempo excesivo en cumplir la norma. Esta convergencia también incluiría a los buses a gas natural.

c. Se plantea la duda del sistema de tramos por edad y procedencia de los buses, para los períodos de entrada en vigencia de la norma, a lo que se sugiere, usar el criterio general de que para casos de buses nuevos , estos deben cumplir la norma vigente al momento de ingresar al parque, y se plantea una gradualidad para los buses viejos. Además se propone establecer una cifra realista, en cuanto a posibilidades efectivas de cumplimiento de la nueva norma.

d. Se destaca, como ha ocurrido en numerosas oportunidades en el proceso de dictación de normas, lo complejo que significa proceder a crear normas de emisión sin tener normas de calidad, ya que ello significa normar, sin tener alguna certeza de si el resultado final de la acción, logre el cometido de obtener que el nivel de ruido sea efectivamente no dañino ni molesto a la salud de las personas. A pesar de que el Plan regulador, define niveles máximo de ruido por zonas en la ciudad, ello no está sujeto a monitoreo, ni da lugar a un plan para enfrentar el tema en un caso de episodio crítico.

e. En relación a lo anterior se sugirió, explorar la posibilidad de crear una norma primaria de ruidos, o bien si es posible, utilizar la reglamentación urbana existente al respecto, en el sentido de que opere como norma primaria, esto es si se supera la norma, que dé lugar a un proceso automático de abatimiento.

f. Respecto de la tolerancia al incremento de los deciveles emitidos entre la medición inicial y posteriores, sin entrar en el fondo, se estima que bajo ninguna circunstancia se puede sobre pasar la norma vigente.

<u>Respecto del Anteproyecto de Revisión de normas de calidad primaria para SO_2, CO, NO_2, O_3 y PTS</u>

Se resolvió esperar a tener la información completa del estudio de impacto económico, conocido como de costo/beneficio. No obstante, esto se estimó:

1. Generar las condiciones de "fiabilidad" de cumplimiento y condiciones de operación, para que no haya espacio a la discrecionalidad, por ejemplo, una posibilidad es seguir el esquema del decreto 59.

2. En aquellos casos que resulte pertinente, y en las condiciones técnicas adecuadas, se sugiere efectuar un proceso de seguimiento, al estado de la salud de la población más expuesta, a objeto de constatar fehacientemente, que el marco normativo es el adecuado, en particular en el caso del SO_2

donde los niveles propuestos para la norma se alejan bastante de los sugeridos por la OMS.

3. En el marco de este debate, se han planteado tres puntos que se detallan a continuación:

   a. El Artículo 11 de la ley 19.300, indica que para evaluar los riesgos y efectos adversos indicados en las letras a y b, del respectivo artículo, se considerará lo establecido en las normas de calidad y de emisión vigentes, sin embargo, la norma no establece el porcentaje, respecto del nivel de saturación, para dar lugar a un estudio de impacto ambiental, a lo que se sugiere establecer un nivel de contenido del contaminante del 80% del valor de la norma, para condicionar la elaboración del EIA.

   b. Los períodos de medición de un determinado agente contaminante, para determinar si su nivel es tal que gatilla la implementación de un plan de descontaminación, debería guardar cierta proporcionalidad, con los tiempos que demora la elaboración del plan de descontaminación es decir del orden de tres años.

   c. Se propone que los estudios de impacto económico o de costo/beneficio, se realicen bajo las condiciones metodológicas de la mayor rigurosidad, a sabiendas, que hay muchas estimaciones con márgenes de error importante, debido precisamente a problemas metodológicos no resueltos, y que ellos se utilicen en el sentido de que, sin cuestionar el fin último de la norma, privilegien una estrategia de implementación que signifiquen a nivel privado y social, la de menor costo relativo posible.

Fuera de tabla, el Consejo Consultivo solicita al Comité de Ministros de la CONAMA, por intermedio de su Presidente, Señor Álvaro García A., Ministro secretario General de la presidencia, hacer ver a la señora Ministra de Salud, la profunda y creciente preocupación por el lento proceso de aprobación de la Norma de Residuos Peligrosos, que afecta negativamente el trabajo de CONAMA al respecto, ya que de su promulgación dependen un conjunto procesos en relación al marco normativo ambiental.

Tonci Tomic
Secretario

GOBIERNO DE CHILE
COMISION NACIONAL
DEL MEDIO AMBIENTE

COMISION NACIONAL DEL MEDIO AMBIENTE 001141
Dirección Ejecutiva
Participación Ciudadana y Educación Ambiental

MEMORANDUM PAC N° 015 /2000

DE : MARISA WEINSTEIN
JEFA DPTO. PARTICIPACION CIUDADANA Y EDUCACION AMBIENTAL

A : SEGUN DISTRIBUCION

MAT.: CIERRE DEL PROCESO DE CONSULTA PUBLICA DE LOS ANTEPROYECTOS DE NORMAS DE CALIDAD PRIMARIA DE CALIDAD DE AIRE PARA ANHIDRIDO SULFUROSO (SO2), MONOXIDO DE CARBONO (CO), DIOXIDO DE NITROGENO (NO2), OZONO (O3), Y PARTICULAS TOTALES EN SUSPENSION (PTS)

FECHA: SANTIAGO, 08 de enero del 2001.

A través de la presente deseo informar a usted sobre el proceso de cierre de la consulta pública de los anteproyectos de normas de calidad primaria de calidad de aire para anhídrido sulfuroso (SO2), monóxido de carbono (CO), dióxido de nitrógeno (NO2), ozono (O3), y partículas totales en suspensión (PTS).

Como es de su conocimiento, el proceso de consulta concluyó el 14 de Noviembre generando más de 200 observaciones que enriquecieron notablemente los anteproyectos. Las actividades realizadas incluyeron la elaboración y distribución de materiales didácticos y copias del texto de los anteproyectos a un total de 1993 personas y organizaciones de distintos sectores a lo largo del país, la realización de talleres de consulta ciudadana en Antofagasta, Copiapó, Viña del Mar, Rancagua, Concepción y Santiago reuniendo un total de 328 participantes. En todos estos casos, CONAMA asumió el compromiso de comunicar a los asistentes la sistematización y resumen general de las observaciones recibidas.

Según lo acordado, los últimos días de Diciembre se distribuyó a todos los participantes a los talleres el resumen de observaciones y una carta de la Directora Ejecutiva agradeciendo la participación.

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Con el objeto de informarle, adjunto el resumen de la sistematización de las observaciones recibidas. Para aquellas ciudades donde se realizó talleres, se adjunta también la carta de cierre del proceso de participación ciudadana y el listado de distribución correspondiente.

Sin otro particular le saluda cordialmente

Marisa Weinstein Cayuela
Jefa Dpto. Participación Ciudadana y Educación Ambiental
Comisión Nacional del Medio Ambiente

OSH

Distribución:
Director Regional I Región, Sr José González
Directora Regional II Región, Sra. Loreto Rubio
Director Regional III Región, Sr. Daniel Alvarez
Director Regional IV Región, Sr. Elier Tabilo
Director Regional V Región , Sr. Gerardo Guzmán
Director Regional VI Región, Sr. Mario Meneses
Director Regional, VII Región, Sr. Alen Gerson
Director Regional, VIII Región, Sr. Bolívar Ruiz
Directora Regional, IX Región, Sra. Jeanette Matte
Director Regional, X Región, Sr. Raúl Arteaga
Directora Regional XI Región, Sra. Millaray Hernández
Directora Regional XII Región, Sra. María Ojeda
Director Regional RM, Sr Gianni López

Cc: Patricia Matus, Jefa Departamento de Descontaminación, Planes y Normas
Rodrigo Lucero, profesional del Depto de Descontaminación, Planes y Normas

PERSONAS QUE ENVIARON OBSERVACIONES POR ESCRITO A CONAMA

NOMBRE	APELLIDO	CARGO	INSTITUCIÓN	DIRECCIÓN	COMUNA	TELÉFONO	Nº
Jaime	Pérez de Arce Araya	Vicepresidente Ejecutivo	Empresa Nacional de Minería – ENAMI	Mac-Iver 459, piso 2	Santiago	6375000	1
Jacqueline	Saintard Vera	Ministra de Minería (S)	Ministerio de Minería	Teatinos 120	Santiago	6967804	2
Juan Domingo	Galleguillos Herrera	Secretario Regional Ministerial de Educación	Secretaría Regional Ministerial de Educación Región de Los Lagos	Avda. Décima Región 480 Edificio anexo a Intendencia 4º piso	Puerto Montt	65-254026 65-268244	3
Santiago	Torres E.	Gerente de Medio Ambiente	Corporación Nacional del Cobre – CODELCO Chile	Huérfanos 1270 Casilla 150-D	Santiago	6903059	4
Gerardo	Guzmán Grimaldi	Director Regional	Comisión Nacional del Medio Ambiente – CONAMA V	Blanco 1663 Depto. 1501	Valparaíso	(32) 233493	5
Antonino	Prado Castro	Secretario Regional Ministerial de Minería	Secretaría Regional Ministerial de Minería Región de Atacama	Edificio Copayapu, depto. 31 3º piso.	Copiapó	52-218537	6
Armando	Arancibia Calderón	Intendente	Intendencia de la Región de Atacama	Edificio Gobierno Regional Calle Los Carreras	Copiapó	52-212727	7
José	Sanhueza Reyes	Gerente	Fundición Hernán Videla Lira	Casilla 483	Copiapó	52-213210	8
Lorenzo	Sotomayor Torreblanca	Relacionador Público	Fundición Hernán Videla Lira	Casilla 483	Copiapó	52-213210	9
Rubén	Bastías Orellana	Encargado de Medio Ambiente	Fundición Hernán Videla Lira	Casilla 483	Copiapó	52-213210	10
Daniel	Alvarez Pardo	Director Regional	Comisión Nacional del Medio Ambiente – CONAMA III Región	Ayacucho 275	Copiapó	52-214511 52-214309	11
Loreto	Madrid Flores	Jefa Area Descontaminación del Aire	Comisión Nacional del Medio Ambiente – CONAMA Región Metropolitana	Obispo Donoso 6	Providencia	2405600	12
Luis Mariano	Rendón	Director	Coordinador Ecologista	Colo Colo 1019	Nuñoa	3759454	13
Larisa	de Orbe	Salud Ambiental	Coordinadora Ecologista	Colo Colo 1019	Nuñoa	3759454	14
Ricardo	Troncoso San Martín	Director Nacional	Servicio Nacional de Geología y Minería – SERNAGEOMIN	Avda. Santa María 0104	Santiago	7375050	15
Pedro	Valenzuela Diez de Medina	Director Regional (S)	Comisión Nacional del Medio Ambiente – CONAMA IV Región	Las Rojas Oriente 322	La Serena	51-210830 51-219534	16
Víctor	Correa Romero	Jefe Departamento de Programas sobre el Ambiente	Servicio de Salud Coquimbo	Av. Francisco de Aguirre 795	La Serena	51-226019	17

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LISTADO DE ASISTENTES
TALLER SANTIAGO

NOMBRE	APELLIDO	CARGO	INSTITUCIÓN	DIRECCIÓN	COMUNA	TELÉFONO	Nº
Jeannette	Albanés	Tesorera	Junta de Vecinos Villa La Merced	Missouri 3921	Macul	2937293	1
Paulina	Aldunce	Académico	Universidad de Chile	La Capitania 171, depto. 102	Las Condes	2079537 09-7480951	2
Carla	Aliaga	Ingeniero de Proyectos	Gestón Ambiental Consultores	Padre Mariano 103, of. 307	Providencia	2360886 2351100	3
Gladys	Anziani	Estudiante	Instituto del Medio Ambiente, Gylania	Vergara 702	Santiago	6985861	4
Paola	Arat	Ingeniero de Proyectos	EMOS S.A:	Av. Pte. Balmaceda 1398, piso 7	Santiago	6942913 6942754	5
María Alicia	Arratia	Presidenta	Junta de Vecinos Nº 7 Gabriela Mistral	Av. Larraín 7048	La Reina	2278441	6
Nicolas	Binfa	Director	Red Ecológica de Acción Ecológica	Seminario 774	Ñuñoa	2234483 2258909	7
Heroica	Cadiz	Estudiante Gestión y Control Ambiental	Instituo Gylania	Vergara 702	Santiago	6985861	8
Carla	Calderón	Estudiante	Universidad de Chile	Antonio Varas 1362, depto. 106	Providencia	2043980	9
Alfredo	Cánepa	Ing Jefe de Procesos Y Medio Ambiente	Cristalerias de Chile S.A.	Camino a Valparaíso 501	Padre Hurtado	2468619 2468657	10
Sergio	Carstens	Encargado Ambiental Ventanas	ENAMI	Carretera F-30-E Nº 58270	Puchuncavi	933411	11
Ramón	Casas-Cordero	Supervisor Programa de Reciclaje	Municipalidad de La Cisterna	Av. El Parrón 0749 A	La Costerna	5482981 5485167	12
Yenim	Cavieres	Encargada Area Jurídica	Operatorio de Conflictos Ambientales	Av. Matta 318, depto. 2	Ñuñoa	2745713 3430696	13
Marelino	Collio	Presidente	Corporación CECOEMA	Astaburuaga 9360 – C	Lo Espejo	8543714	14
Clorinda	Cueva	Directora	Unión Comunal de Adulto Mayor Pudahuel	Lago Notario 8472	Pudahuel	6439456	15
Matías	Del Campo	Divisón Industrial	AMBAR S.A.	José Pedro Alessandri 1498	Ñuñoa	8101304 2710419	16
Catalina	Delpiano	Asistente de Proyectos	Corporación Participa	Almirante Simpson 014	Santiago	2225384 2221374	17
Alejandro	Diez	Jefe Corporativo de Medio Ambiente	ENAMI	Mac Iver 459	Santiago	6375357 / 6375452	18
Rosa	Escobar	Gerente de Proyectos	CH2MHILL Chile Ltda.	Isidora Goyanechea 3162 / 303	Las Condes	3788044	19

NOMBRE	APELLIDO	CARGO	INSTITUCIÓN	DIRECCIÓN	COMUNA	TELÉFONO	Nº
Juan	Escudero	Director	CENMA	Larraín 9975	La Reina	2751455 2751688	20
Angélica	France	Profesional	CEDEM	Purísima 305	Recoleta	7357755 7772297	21
Andrea	Gana	Depto. Higiene Ambiental	Municipalidad de Providencia	Caupolicán 1151	Providencia	4105247 4105207	22
Juan Antonio	Garcés	Jefe Area Medio Ambiente	EMOS S.A:	Av. Pte. Balmaceda 1398, piso 7	Santiago	6942910 6942754	23
Nora	Garcés	Socia	Junta de Vecinos Villa La Merced	Missouri 3859	Macul	2832231	24
Macarena	García	Estudiante	Universidad Católica	Malaga 279, depto. 112	Las Condes	2288319	25
Carmen	Godoy	Director	Universidad Tecnoñógica Metropolitana	Jose Pedro Alessandri 1242	Ñuñoa	7877164 2710166	26
Carlos	González	Director Gerente	CONTAC Ingenieros Ltda..	Av. Américo Vespucio sur 315	Ñuñoa	2700901 2770164	27
Manuel	Hevia	Jefe Gabinete Rector	UTEM	Dieciocho 161	Santiago	7877542 6881421	28
Raul	Imuna	Reportero gráfico	Las últimas Noticias	Bellavista 0111	Providencia	7303000	29
Ruby	Irribarra	División Industrial	AMBAR S.A.	José Pedro Alessandri 1498	Ñuñoa	8101304 2710419	30
Ricardo	Jerez	Asesor consultor	2ª comuna Santa Ana Democracia Cristiana	General Gana 376	Santiago	5565621	31
María Amalia	Jeria	Asesora Medio Ambiente	Municipalidad de Las Condes	Apoquindo 3401, Depto. 33	Las Condes	3353640 3359445	32
Gaspar	Kusar	Gerente de Desarrollo	Química OSKU S.A.	Camino El Guanaco 5212	Huechuraba	7400251 7400446	33
Antonio	Lamas	Jefe de Carrera – Ing. Ambiental	INACAP	Av. Vitacura 10151	Vitacura	3651020	34
Alejandra	López	Directora de Obras	Municipalidad de María Pinto	Av. 18 de Septiembre 78	María Pinto	8351932 8351995	35
Jaime	López	Gerente	Fundación Patrimonio Natural y Biodiversidad	Av. Bulnes 259, of. 205	Santiago	6984164	36
Loreto	Matthens	Voluntaria Programa Biodiversidad	CODEFF	Av. Bilbao 691	Providencia	2510262 2518433	37
Manuel	Molina	Depto. Estudios y Control Ambiental	Municipalidad de San Miguel	Alcalde Pedro Alarcón 831	San Miguel	5519197 5516055	38
Ximena	Molina	Académico	Universidad de Chile	Las Palmeras 3425	Ñuñoa	6787320 2727363	39
Gerardo	Muñoz	Subgerente Medio Ambiente	Codelco Chile	Huérfanos 1270, piso 9	Santiago	6903900 6903917	40

NOMBRE	APELLIDO	CARGO	INSTITUCIÓN	DIRECCIÓN	COMUNA	TELÉFONO	Nº
Ercilia	Narváez	Tesorera	Unión de Ancianos – URCA	Canalejas 1134, Pobl Florentina	Pudahuel	6438530	41
Bernardita	Navarro	Depto. Medio Ambiente y Zoonosis, médico veterinario	Municipalidad de Renca	Blanco Encalada 1335	Renca	3627869	42
Christián	Olguín	Encargado Prevención de Riesgos y Medio Ambiente	Cerámicas Cordillera S.A.	Av. Américo Vespucio 1001	Quilicura	3874200 7390557	43
Fernando	Ostornal	Gerente General	Química OSKU S.A.	Camino El Guanaco 5212	Huechuraba	7400251 7400446	44
Iván	Poflepovic	Abogado Unidad de Medio Ambiente	Consejo de Defensa del Estado	Agustinas 1687	Santiago	6751871 6751978	45
Mariló	Puente	Estudiante	Universidad de Chile	Paul harris 515	Las Condes	3711720	46
Luis Mariano	Rendón	Director	Coordinadora Ecologista	Colo Colo 1019	Ñuñoa	3759454	47
Eduardo	Riquelme	Director	Organización de Defensa del Medio Ambiente	Artemio Gutierrez 1935	Santiago	09-8250505	48
Claudia	Rivera	Químico Ambiental		Halimeda 325 Depto. 802, jardín del Mar	Viña del Mar	32-835494	49
Cepolania	Riveros	Presidenta	J. de V. Nº 2 Villa Portales	Plazuela Ls Higueras 14, Villa Portales	Estación Central	6812597	50
Rodrigo	Romero	Jefe de Laboratorio de Calidad del Aire	Centro Nacional del Medio Ambiente	Av. Larraín 9975	La Reina	2750764 2751688	51
Omar	Rosales	Director	Comité Econlógico Pudahuel "Aguas Claras"	Federico Errázuriz 1422	Pudahuel	6499470	52
Pablo	San Martín	Asesor Ambiental	SERPLAC R.M.	Teatinos 370, piso 3	Santiago	2509300 2509310	53
Katia	Schneider	Periodista	Las últimas Noticias	Constitución 01172	Santiago	7303000	54
Edward	Thraves	Gerente General	Fundación Britania S.A.	Bernal del Mercado 1387	Estación Central	6834498 6835230	55
Patricia	Vargas	Directora	ENICAL	Concordia 2237, depto. 43	Providencia	2349060 3343830	56
Sebastián	Vicuña	Ingeniero de Proyectos	Gestón Ambiental Consultores	Padre Mariano 103, of. 307	Providencia	2360886 2351100	57
Carlos	Zúñiga	Alumno	Instituo Gylania	Vergara 702	Santiago	6985861	58

LISTADO DE ASISTENTES
TALLER CONCEPCION

NOMBRE	APELLIDO	CARGO	INSTITUCIÓN	DIRECCIÓN	COMUNA	TELÉFONO	Nº
Patricio	Alarcón	Jefe Depto. Medio Ambiente	Municipalidad de Coronel		Coronel	711335	1
Miguel Angel	Amética	Jefe Unidad Química	Endesa Central Bioquímica	Pedro Aguirre Cerda 1013	Coronel	711072 711560	2
Andrea	Aste Von Bennewitz	Subdirectora del Ambiente	Servicio de Salud de Talcahuano, Subdirección del Ambiente	Thompson 32	Talcahuano	409177 409183	3
Jovino	Avaria Caro	Jefe de Seguridad y Medio Ambiente	Petroquim S.A.	Camino Ramuncho S/N	Talcahuano	41-440416 Fax 440412	4
Claudio	Barrera V.	Ingeniero Ambiental	CIDEM Consultores	Enrique Soro 1266	San Pedro de la Paz	285520 Fax 285480	5
Francisco	Bermascor G.	Jefe Unidad de Medio Ambiente	Pietrox S.A.	Casilla 29-c	Concepción	506402 Fax 410563	6
José Miguel	Bravo	Asistente Jurídico	CODEFF	Portales 508, Depto. C, piso 3	Concepción	239163 239163	7
Juan	Bruna Albani	Ingeniero	Huachipato	Gran Bretaña 2910	Talcahuano	502831 Fax 502931	8
Alex	Caniulao Castro	Ingeniero Asesor	Servicio de Salud Talcahuano	Thompson nº 32	Talcahuano	409180 Fax 409183	9
Claudia	Carbacho Hidalgo	Presidenta	Junta de vecinos Nº4 Rivera del Bio Bio	Avda. Candelaria 1965	San Pedro de la Paz	378066	10
Andrés Marcelo	Carrasco Cisternas	Ingeniero de Servicios	Proterm Ltda.	Av. Sanhueza 1825-B	Concepción	331412 Fax 332098	11
Héctor	Carrasco Concha	Miembro Activo	Grupo Ecológico Altue	Freire 960 Depto. 502-B	Concepción	230425 Fax 611009	12
Juan Isaac	Carreño Escobar	Encargado Oficina Higene Ambiental	Hospital de Lota –Higene Ambiental	Carrrera esq. Caupolicán	Lota	302348	13
José Miguel	Chandía F.	Depto. Infraestructura (profesional)	Consejo Provincial de Deportes	O'Higgins 740 of. 23	Concepción	226797	14
Carolina Alejandra	Chávez Herrera	Docente del Depto. de Ing. en maderas	Universidad del Bio Bio	Callao 1202	Concepción	261667 Fax 323333	15
Irma	Contreras Merino	Delegada	Junta de Vecino Trechuaco nº 56	Trehuaco 722 parque Residencial Bio Bio	Talcahuano	788107	16
Maria Ximena	Cortès de la Maza	Biologa Unidad de Medio Ambiente SECPLAC	Municipalidad de Concepciòn	O'Higgins 325, 6º piso	Concepción	266721 Fax 266711	17
Sergio	Cuevas	Jefe Depto. Higiene Ambiental	Asociación Chilena de Seguridad	Maipú 1920	Concepción	315981	18

NOMBRE	APELLIDO	CARGO	INSTITUCIÓN	DIRECCIÓN	COMUNA	TELÉFONO	Nº
Eugenio	De la Fuente	Subcomisario de los servicios	Carabineros de Chile	Salas 329	Concepción	235011	19
Roberto Alejandro	Delgado Candia	Presidente	Junta de Vecinos "Trehuanco Nº 56	Trehuaco 713 P.R. Bio Bio	Talcahuano	478081	20
Lilian	Disel Molina	Presidenta	Unión Comunal de Juntas de Vecinos	Los Choferes nº 210, Villa Riviera del Bio Bio	Concepción	371465	21
Ricardo	Espinoza	Salu ocupacional y Medio Ambiente	Servicio de Salud de Ñuble, subdirección de Salud del Ambiente	Purén 601	Chillán	42-235633 42-235649	22
Guillermo	Fernández Correa	Inspecto de Obras	I. Municipalidad de Lota	Pedro Aguirre Cerda 302	Lota	876234	23
Claudina Matilde	Flores Sáez	Secretaria Regional	Colegio de Enfermeras	Diagonal Pedro Aguirre Cerda 1180, 3º piso of 302	Concepción	Fono-fax 224332	24
Braulio	Fuentealba Merino	Director	Acción Ciudadanay un Talcahuano sustentable	Calle Lautaro s/u Talcahuano	Talcahuano	543143	25
Lisa	Godoy Aburto	Secretaria	Unión Comunal de Junta de Vecinos de Penco	Freire 520	Penco	452105	26
Patricia	Gonzàlez Sánchez	Ingeniero Asesor	SEREMI de Salud VIII	Caupolicán 518, of 510	Concepciòn	227044 Fax 226066	27
Gladis	González Vera	Directora	Junta Vecinal Nº6 Los Acacios, Villa San Pedro	Ambrosio O'Higgins 1623, Villa San Pedro	San Pedro de la Paz	372527	28
Juan Pablo	Granzow	Encargado Unidad de Evaluación de Impacto Ambiental	Servicio de Salud de Concepción	O'Higgins 297	Concepción	201571 201595	29
Evelyn	Habit	Docente	Universidad del Bío Bío	Av. Collao s/n	Concepción	261302	30
Manfred	Hellwig Franckenhoff	Profesor asistente Fac. De Ingenieria	Universidad de Concepción	Casilla 53- C	Concepción	203449 Fax 332098	31
Nery	Hernández Fernàndez	Encargado depot Medio Ambiente	Municipalidad de Los Angeles	Caupolicán 399	Los Angeles	409473 Fax 311497	32
Eduardo	Hillerns	Jefe de energía y medio Ambiente	Huachipato	Gran Bretaña 2910	Talcahuano	502831 Fax 502931	33
María Cecilia	Jones	Ingeniero Estudios Ambientales	Celulosa Arauco y Constitución S.A.	Los Horcones s/n	Arauco	509604	34
José	Lagos Vásquez	Presidente	Unión Comunal de J.J. Uus THNO.	Anibal Pinto nº40	Talcahuano	545735 Fax 543570	35
Enrique	Lòpez Parra	Director Postgrado DIE Fac. de Ingenieria Electrica	Universidad de Concepción	Fac. Ing. Depto de Elèctrica	Concepción	41-204747	36
Abelardo	Mardones Rebolledo	Coordinador Capacitación y Desarrollo	Instituto de Educación Rural	Rupanco s/n	Chillán	Fono-Fax 271257-58	37

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Luis	Martìnez Betanzo	Tesorero	Accion ciudadna por un Talcahuano sustantable	Malaquias Concha 911 Talcahuano	Talcahuano	543400	38
Daniela	Merino	Investigador	Centro Enla-Chile	Casilla 160-C	Concepción	41-242465 Fax 292546	39
Alejandro	Muñoz	Presidente	Grupo de iniciativas culturales urbanismo rural	Argentina 1022	Concepción	09-8751878	40
Pedro	Navarrete Ugarte	Presidente	Consejo Consultivo	O'Higgins 537, of. 3	Concepciòn	41-259572 Fax 259237	41
Virginia	Norambuena Cheseaux	Socióloga, Educadora en Salud	EPES (Educación Popular en Salud) ONG	Freire 247 of. 201	Concepciòn	226607 Fax 210966	42
Genoveva Ivette	Orellana Cifuentes	Monitora Ambiental	Comision Tripactit Sector 4 Hualpendillo	Rumania nº2906 Arturo Prat Hualpencillo	Talcahuano	424933	43
Gerardo	Osben Ledermann	Jefe de Producción	Cemento Bio Bio SACI	Avda. Gran Bretaña 1725	Talcahuano	41-267000 Fax 267010	44
Nora Hortensia	Parra	Presidenta	Junta de Vecinos Nº 45 Blanco Encalada	Colon 8411	Talcahuano	431855	45
Pedro Patricio	Pedrero Pérez	Academico	Centro	Casilla 110-C	Concepción	204053	46
Eduardo	Pimentel M.	Subgerente de Operaciones	Cemento Bio Bio SACI	Avda. Gran Bretaña 1725	Talcahuano	41-267000 Fax 267010	47
Reinaldo	Pincheira Leiva	Presidente	Junta de Vecinos 12 Nueva Candelaria	Avda. EL Estero 210	San Pedro de la Paz	377973	48
José Antonio	Poblete V.	Jefe de Depto. Programación del Ambiente	Servicio de Salud Concepción	O'Higgins 398	Concepción		49
Héctor	Pulgar	Estudiante, depto. Ingeniería Eléctrica	Universidad de Concepción	Chacabuco s/n	Concepción		50
Luis Maximiliano	Quezada Oróstica	Ing. Civil Mecánico	Proterm Ltda.	Pasaje 2, nº 114, Lorenzo Arenas 2	Concepción	474777	51
Raùl Angel	Ramírez Vergara	Presidente	Junta de vecinos Renè Schneider UV52 Hualpencillo	Los àneles 104 Pob. René Schneider, Hualpencillo	Talcahuano	470515	52
Hernan	Rivas Ferreira	Encargado Area Medio Ambiente	Depto. Pastoral Obrera	Cochrane 440	Concepción	226726 Fax 236989	53
Luis	Rivera	Presidente	Junta de Vecinos Camelias 31	Olivar 5616	Talcahuano	943313	54
Leonidas	Rodríguez	Tesorero	Unión Comunal de JJ.VV. Tome	O'Higgins 1380	Tomé	656643	55
Hugo	Rojas	Jefe Depto. Unidades Técnicas	Servicio de Salud Talcahuano, Subdirección del Ambiente	Thompson 32	Talcahuano	409177 409183	56
Vicente Germán	Saclientto Santibáñez	Ingeniero U.S.O	Servicio Salud Bio Bio	Lautaro 602	Los Angeles	40986-65	57
Fabricio	Salgado	Estudiante	Universidad de Concepción	Chancabuco s/n	Concepción		58

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Javier	Sánchez	Secretario	Oficina Parlamentaria Diputado A. Navarro	Freire 799	Penco	450310 450334	59
Juan	Sandoval González	Secretaria Organización	CUT Concepción	Maipú 70	Concepción	230395 Fax 216879	60
Enrique Ulises	Silva Rodríguez	Coordinador Programa bibliotecas comunitarias	Función CEPAS	Democracia 923	Coronel	711589	61
Teresita Paola	Soto Mora	Explo. Prevención de Riesgos	Servicio Salud Ñuble Subdirección salud de Ambiente	Purén 601, 2 piso	Chillan	237515 Fax 235649	62
Ricardo Alex	Soto Neira	Investigador	Centro EULA-Chile Universidad de Concepción	Barrio Universitario	Concepción	204061	63
Rodrigo	Toledo	Voluntario	Cuerpo de Bomberos de Concepción	General Novoa 592, Puchacay	Concepción	313541 216024	64
Adolfo	Torres	Químico, línea de estudios aplicados	PROMAS	Sotomayor 890	Coronel	711907	65
Hugo	Troncoso	Presidente	Coordinación Acción Ciudadana por un Futuro Sustentable	Av. España 663	San Vicente	542086 541051	66
Carmen M.	Tuche Ojeda	Socia (en representación de la directora)	Junta de Vecinal Nº 7 San Pedro de la Paz	Los acacios 1700 Villa san Pedro de la paz	San Pedro de la Paz	Fono-Fax 374891	67
Héctor	**Velanwo**	**Presidente**	Junta de Vecinos 44	Colón 8437,	Talcahuano	424770	68
Fresia	Vera Freire	Secretaria	Centro Causa Comùn (Discapacitados)	Las Garzas 44	San pedro de la Paz	373385	69
Roberto	Villegas	Químico Analista		Pasaje 3, casa 2809, Villa Antuco	Hualqui	780150	70
Javier Enrique	Zambrano Vergara	Presidente de la Junta de Vec. Nº44	Red Social de Salud Integral de Hualpencillo	Local Organizaciones Comunitarias Suecia 2871	Talcahuano	416689	71
Emelina	Zamorano	Coordinadora Unidad Ambeintal y Salud Ocupaciónal	Servicio de Salud de Arauco	Latorre 308	Lebu	597777	72

LISTADO DE ASISTENTES
TALLER RANCAGUA

NOMBRE	APELLIDO	CARGO	INSTITUCIÓN	DIRECCIÓN	COMUNA	TELÉFONO	Nº
Cristián	Acevedo	Presidente	Avanzada Ambiental	Laguna del Inca 0500, Villa San Rafael	Rancagua	641851	1
Crista	Acevedo		CONAMA	Hermano Claudio 364	Rancagua	224549 239106	2
Jacqueline	Alea	Jefe de Carrera, Ing. Prevención de Riesgos	INACAP	Av. Nelson Pereira 2519, Paque Industrial	Rancagua	256163	3
Larry	Alzamora	Estudiante	INACAP	Av. Nelson Pereira 2519	Rancagua	256163	4
Ramón	Araneda	Presidente	Comisión de salud y ambiente, Unión Comunal de Juntas de Vecinos	Pasaje 6 Nº 357, Villa de Blanco	Rancagua	221918	5
Sonia	Arias	Estudiante	INACAP	Av. Nelson Pereira 2519	Rancagua	256163	6
Víctor	Atenas	Medio Ambiente	I. Municipalidad de Rancagua	Plaza Los Héroes 449	Rancagua	221319	7
Marcial	Atenas	Estudiante	INACAP	Av. Nelson Pereira 2519	Rancagua	256163	8
Liliana	Avilés	Monitor	Monitores Ambientales San Vicente	Romeral de Zúñiga 280	San Vicente de Tagua Tagua	668200	9
Miguel	Braun	Estudiante	PROPAM	San Martín 750	Rancagua	230121 222993	10
Jorge	Bravo	Estudiante	INACAP	Av. Nelson Pereira 2519, Paque Industrial	Rancagua	256163	11
Catherine	Cabello	Estudiante	INACAP	Av. Nelson Pereira 2519	Rancagua	256163	12
Sonia	Campos	Secretaria	Unidad Vecinal 16	Villa Brasilia B, Nº 1073	Rancagua	210402	13
Felipe	Carreño	Estudiante	INACAP	Av. Nelson Pereira 2519	Rancagua	256163	14
Germán	Cofré	Asesor Ambiental	I. Municipalidad de Rancagua	Alameda / Viña del Mar s/n	Rancagua	226631	15
Luis	Concha	Asesor Medio Ambiente, Subgerencia Proyecto Desarrollo Teniente	Codelco Chile – División El Teniente	Millán 1020	Rancagua	292786	16
Pamela	Contreras	Estudiante	PROPAM	San Martín 750	Rancagua	230121 222993	17
María	Cruz	Presidenta	Junta de Vecinos Villa Costa del sol	Pje. El Abra, Block 16, Depto. 216	Rancagua	276099	18
Marcela	Díaz	Estudiante	INACAP	Av. Nelson Pereira 2519, Paque Industrial	Rancagua	256163	19
Angle	Figueroa	Vice- Presidente	Paz Silvestre	Héctor Zamorano 1436	Rancaga	212032	20

NOMBRE	APELLIDO	CARGO	INSTITUCIÓN	DIRECCIÓN	COMUNA	TELÉFONO	Nº
Patricio	Flores	Vice-superintendente	Cuerpo de Bomberos de Olivar	Rafael Estrada 197, Olivar Alto	Olivar	391178 391966	21
Alejandra	Gaete	Jefe de Carrera, Control de calidad	PROPAM	San Martín 750	Rancagua	230121 222993	22
Patricio	Galaz	Presidente	Central Unitaria de Trabajadores Cachapoal	Cuevas 174	Rancagua	09-6383318 233769	23
Carmen Gloria	Gallardo	Estudiante	INACAP	Av. Nelson Pereira 2519, Paque Industrial	Rancagua	256163	24
Alejandro	Galvez	Estudiante	PROPAM	San Martín 750	Rancagua	230121 222993	25
Regina	Godoy	Asesor Ejecutivo	SEREMI de Economía	Plaza Los Héroes 433	Rancagua	224492	26
Ximena	Gonzalez	Estudiante	PROPAM	San Martín 750	Rancagua	230121 222993	27
Lilian	González	Vice Presidenta	Diigente Pobl. Santa Filomena	Av. La Compañía 0274	Rancagua	266090	28
Clotilde	Herrera	Monitor	Monitor Medio Ambiente	Pje. El Manzano 95-A	San Vicente de Tagua Tagua	668165	29
Luis	Jara	Jefe de Unidad Técnica	MOP. Dirección de Obras Hidráulicas	Embalse Convenio Viejo	Chimbarongo	781177 924053	30
Iván	Jerez	Estudiante	INACAP	Av. Nelson Pereira 2519	Rancagua	256163	31
Isolina	Jerez	Presidente	Unión Comunal de Juntas de Vecinos	Viña del Mar 305	Rancagua	243943	32
Juan	Jibaja	Estudiante	PROPAM	San Martín 750	Rancagua	230121 222993	33
Eliana	Lantadilla	Presidenta	Junta de Vecinos Patricio Metris	Ignacio Carrera Pinto 1020	Rancagua	241307	34
Rodrigo	Latorre	Estudiante	INACAP	Av. Nelson Pereira 2519	Rancagua	256163	35
Hugo	Leal	Presidente	Consejo Consultivo CONAMA VI Región	Isaac Anich 547	Rancagua	255452	36
Paula	Lepe	Docente	PROPAM	San Martín 750	Rancagua	230121 222993	37
Sebastián	Maldonado	Representa Legal	Huña-Pukio Ltda.		Rengo	512499	38
Guillermo	Maulen	Estudiante	PROPAM	San Martín 750	Rancagua	230121 222993	39
Nubia	Medina	Coordinadora Regional	U. Metropolitana de Ciencias de la Educación	Av. España 373	Rancagua	236399	40
René	Miranda	Docente	PROPAM	Cuevas 105	Rancagua	241471	41
Francisca	Molina	Presidenta	Junta de Vecinos Nº 40, Comunidad La Cruz	Malleco 57, Comunidad La Cruz	Rancagua	276587	42

NOMBRE	APELLIDO	CARGO	INSTITUCIÓN	DIRECCIÓN	COMUNA	TELÉFONO	Nº
Francisco	Montané Vives	Encargado Ambiental Fundición Caletones	CODELCO Chile División El Teniente	Millán 1020	Rancagua	295257	43
Laura	Morán	Estudiante	INACAP	Av. Nelson Pereira 2519	Rancagua	256163	44
Juan	Muñoz	Presidente	Paz Silvestre	Pasaje 5 Nº 16, pobl. Rancagua Sur	Rancagua	233858	45
Alejandra	Muñoz	Estudiante	PROPAM	Las Brisas, pje. 6 oriente 62, Santa Teresa	Machali		46
Rodolfo	Muñoz	Periodista – Profesor	Radio Bonita - Corporación Municipal Educación	Casilla 143	Rancagua	09-7444579 235755	47
Nadia	Ogaz	Estudiante	PROPAM	San Martín 750	Rancagua	230121 222993	48
Luis	Olguín	Docente	PROPAM	Av. San Juan 2156	Machalí	676538	49
Sergio	Ortiz	Estudiante	INACAP	Av. Nelson Pereira 2519	Rancagua	256163	50
Hector	Paez	Estudiante	INACAP	Av. Nelson Pereira 2519, Paque Industrial	Rancagua	256163	51
Lincoln	Perez	SEREMI	Ministerio de Transportes	Paula Jara Quemada 0295	Rancagua	233059 241645	52
Nancy	Pizarro	Presidenta	Junta Vecinal Teniente 2	Beta 01249, Villa teniente 2	Rancagua	261557	53
Ivan	Riquelme	Director Regional	Superintendencia de Electricidad y Combustibles	Astorgan 360 oficina 22, piso 3	Rancagua	230610	54
Ricardo	Rivera	Estudiante	INACAP	Av. Nelson Pereira 2519	Rancagua	256163	55
Williams	Rodríguez	Estudiante	INACAP	Av. Nelson Pereira 2519, Paque Industrial	Rancagua	256163	56
Gonzalo	Rojas	Estudiante	PROPAM	San Martín 750	Rancagua	230121 222993	57
Lilian	Rojas	Estudiante	PROPAM	San Martín 750	Rancagua	230121 222993	58
Leandro	Silva	Estuadiante	PROPAM	San Martín 750	Rancagua	230121 222993	59
María	Valdés	Estudiante	PROPAM	San Martín 750	Rancagua	230121 222993	60
Rodrigo	Valdés	Estudiante	PROPAM	San Martín 750	Rancagua	230121 222993	61
Marcela	Valdivia	Estudiante	PROPAM	San Martín 750	Rancagua	230121 222993	62
Agustina	Verdoso	Ingeniero Industrial		Av. Pedro Aguirre Cerda 125, Lo Miranda	Rancagua	09-7486743	63
Marco	Vergara	Director	Paz Silvestre	Buera 0598, Pobl. Esperanza	Rancagua	220417	64

NOMBRE	APELLIDO	CARGO	INSTITUCIÓN	DIRECCIÓN	COMUNA	TELÉFONO	Nº
Pamela	Villalobos	Estudiante	PROPAM	San Martín 750	Rancagua	230121 222993	65
Mónica	Villarroel	Estudiante	PROPAM	San Martín 750	Rancagua	230121 222993	66
Bernardo	Zapata	Abogado		Democracia 91	Rengo	511343	67

LISTADO DE ASISTENTES
TALLER VIÑA DEL MAR

NOMBRE	APELLIDOS	CARGO	INSTITUCIÓN	DIRECCIÓN	COMUNA	TELÉFONO	Nº
Claudio	Alvarado Solarí	Jefe Sección Medio Ambiente	Municipalidad de Viña del Mar	Arlegui 615	Viña del Mar	269804 Fax 978360	1.
Sergio	Aparicio Caro		Comunidad Bahía de Viña del Mar	Dr. Gregorio Marañon 1235 Viña del Mar	Viña del Mar	Fono Fax 612150	2.
Edita Luz	Araneda Cajas	Encargada Of. De Medio Ambiente	Ilustre Municipalidad de Concón	Santa Laura 567	Concón	09-4717482	3.
Hernán Bravo	Aravena	Presidente	Federación Nacional de Trabajadores Portuarios	Prat 827 of. 401	Valparaíso	253376 234323	4.
Sandro	Buzzone Figueroa	Adm. Parque Nacional La Campana	Corporación Nacional Forestal	Av. Granizo Pd. 43	Olmue	(33) 441342 442922	5.
Andrea	Calvo Alvarez	Alumna en Práctica Sección Medio Amb.	Ilustre Municipalidad de Viña del Mar	5 Oriente 890	Viña del Mar	269804	6.
Juan Carlos	Cárdenas Alvarez	Asesor	Grupo Juvenil "Don Bosco"	Adriatico 4680 1ª Sector G. Carreño	Viña del Mar	Fono Fax 867825	7.
Pilar	Carrillo F.	Asesor Ambiental		Santa Laura 567	Concón	09- 8324847	8.
Mariangela	Cassinelli Gorigoitia	Coordinadora	Aldea Ambiental Puchuncaví	Los Alerces S/N La Greda	Puchuncavi	09-5421791 796759 Fax 796759	9.
Christian Andrés	Chodin Pozo	Estudiante Ing. Ambiental	Universidad de Viña del Mar	Quinta 137	Villa Alemana	09-3496239	10.
Carlos Alberto	Cifuentes Morgues	Vicepresidente de Com. De planificación y proyecto	Universidad de Playa Ancha	Avda. Pedro Montt 2053 Depto. 70	Valparaíso	09- 8913130 fax 286713	11.
Maria José	Cisternas Castro	Ing. En Medio Ambiente y RR.NN.		Melvin Jones 10 Recreo Alto	Viña del Mar	610300	12.
José Raúl	Cisternas Montero	Secretario	Unidad Vecinal 125	Cooperativa "Meluin Jones" Volcán Aconcagua 10 Recreo Alto	Viña del Mar	610300	13.
Norberto Enrique	Collao Seguel	Secretario	Unión Comunal de Juntas de Vecinos Quintero	5 de Abril 2435	Quintero	932928	14.
Daniel Andrés	Cortés	Estudiante Egresado	Universidad Viña del Mar	Rio Elqui 2872	Villa Alemana	928064	15.

NOMBRE	APELLIDOS	CARGO	INSTITUCIÓN	DIRECCIÓN	COMUNA	TELÉFONO	Nº
	Jimeñez			Villa Caviale			
Nicolás Patricio	Escobar Arellano	Inspector Técnico de Sanamiento y Salud	Servicio Salud Viña del Mar – Quillota	Paso Gran Hotel 451 Viña del Mar	Viña del Mar	09-8406862 680429 Fax 680428	16.
Karina Francis	Gajardo	Jefe de Depto. Ambiental S.S. Viña	Subdirección Ambiental S.S. Viña-Quillota	Paseo Gran Hotel – 451	Viña del Mar	680429 Fax 680428	17.
Rodrigo Antonio	García Caballero	Consultor Ambiental		Recinto Estación Nº 4	La Cruz	(33) -319569	18.
Melquisedel Manuel	González Barra	Ing. Inspector de Seguridad Minera	Servicio Nacional de Geología y Minería	Manuel Rodríguez Nª 853	Quilpué	32) 920118 Fax 913248	19.
Mauricio	González Peñailillo	Jefe de Unidad Asesora M. Ambiente	Unidad Asesora Medio Ambiente. Municipalidad Valpo.	Serrano 546, 2ª piso	Valparaíso	Fono fax 939467	20.
Rodrigo Alfonso	Guzmán Fuentes	Subcomisario Administrativo	Carabineros de Chile Prefectura V. Del Mar	4 Norte y 4 poniente	Viña del Mar	640270	21.
Mario Arturo	Herrera Araya	Asesor Científico	Gobernación Marítima de Valparaíso – DIRECTEMAR	Prat 681	Valparaíso	(32) 208902 Fax 208909	22.
Lucía	Ibarra Ayala	Jefe Medio Ambiente	Ilustre Municipalidad Quilpue	Vicuña Mackenna 684	Quilpue	(32) 910710 Fax 927453	23.
Pedro	Irarrázabal I.	Director	Unión Comunal de Juntas de Vecinos de Viña del Mar	8 Norte 855	Viña del Mar	Fono-Fax 689245	24.
Jorge Emerson	Jímenes Baeza	Presidente de Consorcio de Planif. y Desarrollo de proyectos	Universidad de Playa Ancha Ing. Civil Ambiental	Paseo 21 de Mayo 344-B Playa Ancha	Playa Ancha	09-4293970 286713	25.
Federico	Jonow	Director Regional	CODEFF	Pasaje San Luis 1088	Viña del Mar	692461	26.
Mauricio Javier	Lara Pérez	Alumno en práctica Depto. Aseo y Ornato	Ilustre Municipalidad de Algarrobo	San Jorge Pje. 3 Nª 104 Villa Nagasaky.	Villa Alemana	955677	27.
Ernesto Eduardo	Liendo Montaner	Jefe Depto. Programas sobre el Ambiente	Servicio de Salud Viña del Mar-Quillota . Subdirección de Salud Ambiental.	Chacabuco 357. Quillota.	Quillota	(33) 315898 Fax 317852	28.
Ana Silvia	Loayza	Jefe Depto. Administración	Gobernación Provincial de Valparaíso.	Melgarejo 669 Piso 15	Valparaíso	257894	29.
Juan Roberto	Lobos Cabrera	Consejero	Fenats H.G.F.	Alvarez 1532	Viña del Mar	Fono- fax 631880	30.
Rolando	Maturana Ossa	Secretario	Junta de Vecinos Amp. Canal Beagle.	Amp. Canal Beagle B/23 Depto. 32	Viña del Mar	852108	31.
Rodrigo	Miranda Arévalo	Estudiante Ing. Medio Ambiente y RR.NN.	Universidad de Viña del Mar	Bruselas 339 Retiro	Quilpue	912006	32.
Cristian	Morales	Encargado Area de	Universidad de Playa Ancha	Necochea 347	Valparaíso	09-5267302	33.

NOMBRE	APELLIDOS	CARGO	INSTITUCIÓN	DIRECCIÓN	COMUNA	TELÉFONO	Nº
Andrés	Vidal	Proyectos de la Comisión	Ing. Civil Ambiental	Playa Ancha		fax 286713	
Eduardo	Olivares Vargas	Presidente	Junta de Vecinos Amp. Canal Beagle.	Isla Melipika B / 17 Depto. 24 Amp. Canal Beagle.	Viña del Mar	852800	34.
Julieta	Oltra Quintana	Presidenta	Unión Comunal Adultos Mayores Viña	2 Norte 843 (Pasaje Kramer)	Viña del Mar	978551 Fax 691723	35.
Claudia Verónica	Osorio Leroy	Estudiante Ing. Medio Ambiente y Recursos Naturales	Universidad de Viña del Mar	Calle Limache 2047 Casa 8	Viña del Mar	672552	36.
Dario Braulio	Pareja Plaza	Ing. Procesos Calidad	ESVAL S.A.	Limache 3431, Sec. El Salto.	Viña del Mar	671749 Fax 631625	37.
Ema Rosa	Pizarro Díaz	Jefe Of. Estudios Planificación y Medio Ambiente.	Corporación Nacional Forestal V región	3 Norte 541	Viña del Mar	245238 Fax 699689	38.
Américo A	Pozo Muñoz	Dirigente	Unidad Vecinal 0125 Recreo Alto	Av. Prolongación 21 de Mayo. Recreo Alto	Viña del Mar	610347	39.
Gerardo	Riquelme D.	Profesor Titular Depto. Procesos Químicos y Ambientales.	Universidad Técnica Federico Santa María	Avda. España 1680, Casilla 110-V	Valparaíso	(32) 654258 Fax 654478	40.
Jaime Javier	Riquelme Gaete	Ing. Civil Qimico Depto. Desarrollo Regional.	Gobierno Regional V Región Valpo.	Melgarejo 669 Piso 7 Ed. Esmeralda	Valparaíso	655200 224315	41.
Cristian A.	Román R.	Tesorero	Sindicato Nº 2 de Plásticos Warda S.A.	Calle Limache 3061	Viña del Mar	672305	42.
Nora Iris	Sandoval Fernández	Presidenta	Unión Comunal de Junta de Vecinos.	Piloto Moraga 2240	Quintero	930906	43.
Waldo	Soto Novoa	Vicepresidente	Unión Comunal J. Vecinos CESCO Viña del Mar	8 Norte 855 (U. Comu.) Chironta 97 El Olivar (dom)	Viña del Mar	Fono-Fax 689215	44.
David	Toro Herrera	Experto Prevención de Riesgos.	Clínica Reñaca	Anabaena 336 Jardín del Mar	Viña del Mar	658783	45.
Bernardita Paz	Uribe Venegas	Arquitecto Jefe Depto. de Planificación	Gobernación Provincial de Petorca	Portales 367	La Ligua	711181 711055 711014	46.
Enrique	Zambrano	Presidente	Comunitaria	Israel 88	Valparaíso	210809	47.

LISTADO DE ASISTENTES
TALLER COPIAPO

NOMBRE	APELLIDO	CARGO	INSTITUCIÓN	DIRECCIÓN	COMUNA	TELÉFONO	Nº
Darío	Aguirre	Analista Espacial	Secplac	Los Carrera s/n, Edif. Gobierno Regional	Copiapó	212772	1
Aliro	Alfaro	Asesor particular	Prevención de Riesgos y Medio Ambiente	Los Carrera 755, depto. 403	Copiapó	219886	2
Mónica	Alvarez	Asesor finanzas USMT (educación)	Municipalidad de Vallenar	Serrano 913	Vallenar	611887 616020	3
Hugo	Balocchi	Jefe Gestión de Calidad y Medio Ambiente	Empresa Nacional de Minería	Mac Iver 459	Santiago	6375364 6375452	4
Rubén	Bastias	Encargado Medio Ambiente	Fundición Hernán Videla Lira	Camino Público s/n, Paipote	Copiapó	201523 201529	5
Mirta	Bordones	Delegada	Junta vecinal 6 Rosario	Canto del Agua 730	Copiapó	621762	6
Jorge	Braun	Asesor Ambiental	Codelco Chile, División Salvador	Atacama 116	El Salvador	472271 472907	7
Patricia	Cáceres	Depto. Recursos Naturales	Servicio Agrícola y Ganadera	Yumbel 470	Copiapó	211064 219424	8
Jorge	**Cáceres**	**Profesional asesor Unidad** Planes y Normas	**CONAMA Atacama**	**Ayacucho 275**	Copiapó	214511 214309	9
Luis	Carmona	Evaluación de Proyectos	Servicio de Salud Atacama	Los Carrera 691, piso 3	Copiapó	219824 230008	10
Santiago	Carrasco	Presidente	Junta Vecinal 6 Rosario Central	Dulcinea 802	Copiapó	09-6630822	11
Víctor	Castelleto	Jefe Gestión y Control Ambiental	CMP S.A.	Brasil 1050	Vallenar	208416	12
Marcela	Del Solar	Profesional de Apoyo	SEREMI de Agricultura	Chacabuco 546, of. 32	Copiapó	212865 219002	13
Eduardo	Fernández	Jefe Centro de Estudios del Medio Ambiente	Universidad de Atacama	Avenida Copayapu 485	Copiapó	206794	14
Jorge	Fritis	Jefe Seguridad Hospitalaria	Hospital Regional Copiapó	O'Higgins s/n	Copiapó	213474 213204	15
Claudia	Goic	Arquitecto Depto. Desarrollo Urbano	Ministerio de Vivienda y Urbanismo	Los Carrera s/n, Edif. Gobierno Regional	Copiapó	213337 217722	16
Gregorio	González	Concejal	Municipalidad de Huasco	Sargento Aldea 600	Huasco	531674	17
Roberto	González	Jefe Participación Ciudadana	CONAMA Atacama	Ayacucho 275	Copiapó	214511	18
Vicente	Guerra	Jefe Depto. Coordinación Territorial	Gobierno Regional de Atacama	Los Carrera, Edificio Gobierno Regional	Copiapó	218930 216552	19

NOMBRE	APELLIDO	CARGO	INSTITUCIÓN	DIRECCIÓN	COMUNA	TELÉFONO	Nº
Aliro	Hernández	Jefe Mina	INACESA	Casilla 194	Copiapó	202300 202315	20
Agustín	Holgado	Gerente de Ingeniería	Soc. Contractual Minera Atacama Kozan	Parcela Los Olivos s/n, Punta del Cobre,	Tierra Amarilla	329222 329223	21
Nidia	Knuckey	Jefe Control de Calidad	INACESA	Casilla 194	Copiapó	202300 202315	22
Herminda	Leiva	Delegada	Junta vecinal 6 Rosario	Los Lirios 1046	Copiapó		23
Pedro	Montero	Jefe Unidad de Prevención de Riesgos	MOP, Secretaría Regional Ministerial	Edificio MOP, piso 4	Copiapó	200214 200208	24
Hélice	Morales	Presidenta	AMPARES	O'Higgins 850	Copiapó	218684	25
Fabiola	Olivares	Docente Area Química	INACAP	Yumbel 811	Copiapó	213182	26
Marcos	Ortiz de Zarate	Estudiante	INACAP	Vicente Alvarez 207, Villa Hoschild	Copiapó	09-8384445	27
Silvia	Pizarro	Vice Presidenta	AMPARES	O'Higgins 850	Copiapó	218684	28
Karina	Pizarro	Estudiante	INACAP	Jesuitas 2596, Villa San Luis	Copiapó	09-8526471	29
Rolando	Porras	Asesor Prevención de Riesgos y Coordinador Ambiental	Cía. Minera Huasco, Mina Los Colorados	Serrano 1755	Vallenar	208641 208836	30
Antonio	Prado	SEREMI	Ministerio de Minería	Chacabuco 576, depto. 21	Copiapó	212537 217057	31
Juan Carlos	Quiñónez	Asesor particular	Prevención de Riesgos y Medio Ambiente	Río Copiapó 1487, Pobl. El Tambo	Copiapó	216485	32
Crasnia	Rivera	Estudiante	INACAP	Pedro león Gallo 1055	Copiapó	226957	33
Bernardo	Rojas	Estudiante	INACAP	Rancagua 436	Copiapó	7410735	34
Rebeca	Rosales	Presidenta	Junta de Vecinos Juan Martínez	Juan Martínez 196	Copiapó		35
Julio	Saavedra	Académico	INACAP	Yumbel 811	Copiapó	217104 213182	36
Gabriel	Silva	Asesor Técnico	SEREMI de Salud	Colipi 660	Copiapó	212016 214408	37
Dino	Silva	Jefe de Carrera Ing. en Prevención de Riesgos	INACAP	Yumbel 811	Copiapó	217104 213182	38
Marco	Ulloa	Estudiante	INACAP	Circunvalación 243	Copiapó		39
Andrés	Ullrich	Jefe Depto. Proyectos	EMSSAT S.A.	El Tránsito 96	Copiapó	212142 210031	40

LISTADO DE ASISTENTES
TALLER ANTOFAGASTA

NOMBRE	APELLIDO	CARGO	INSTITUCIÓN	DIRECCIÓN	COMUNA	TELÉFONO	Nº
Yerko	Aenis Lanslims	Memorista	CONAMA	Prat 0461	Antofagasta	268200	1
Marcela	Aguilera	Asistente Prevención de Riesgos y Medio Ambiente	Minera Rayrock Ltda.	Leonardo da Vinci 936	Antofagasta	274354	2
Orlamer	Alcayaga	Director	Parque AGPIA (Asoc. Gremial Peq. y Med. Emp.)	Juan Glasinovic 480, piso 2	Antofagasta	230008 233192	3
Rubén	Alfaro	Analista Gestión Ambiental	Codelco Chile – Div. Chuquicamata	Av. Tocopilla s/n	Chuquicamata	322858 322207	4
Jasna	Andrade	Delegada	Población Prat B, Unidad Vecinal 46	Rengo 5792	Antofagasta	296045	5
Fanny	Araya	Estudiante Periodismo	Universidad José Santo Ossa	Félix Contreras 854, Villa Gabriela Mistral	Antofagasta	372483	6
María	Avalos	Docente	Escuela F 96	Av. Argentina	Antofagasta	245847	7
Cristian	Bruna	Estudiante Periodismo	Universidad José Santos Ossa	Los Inmigrantes 733	Antofagasta	247798	8
Fresia	Cabrera	Directora	Población Prat B, Unidad Vecinal 46	Av. España 6167	Antofagasta	221460	9
Giorgo	Calfa	Ejecutivo de proyectos	Asociación Industriales Antofagasta	Sucre 220, of. 410	Antofagasta	223827 285626	10
Niza	Camacho	Secretaria	Junta de Vecinos Villa Bulnes	Pje. Eloisa Sade de Zurita 7536	Antofagasta	237577	11
Francisco	Camaño	Presidente	Junta de vecinos	Villa Bulnes	Antofagasta	370541	12
Patricio	Campuzano	Consejero	Consejo Regional	Prat 462	Antofagasta	260721	13
Andrea	Cantellany	Supervisor	CIMM T y S S.A.	Pedro Aguirre Cerda 5611	Antofagasta	269923 223323	14
Marco	Cepeda	Sargento 2º	Carabinero de Chile	Rendic 6000	Antofagasta	231209	15
Sergio	Cerda	Subgerencia Ingeniería y Proyectos	Asistencia Técnica S.A:	Angamos 601	Antofagasta	244012 243911	16
Joyce	Chow	Gerente General	Laboratorio ASL Chile Ltda.	Juan Gutemberg 438, galpón 9	Antofagasta	232697 232690	17
Elliot	Cohen	Superintendente Calidad y Medio Ambiente	Noranda Chile S.A.	Av. Rendic 5032	Antofagasta	630128 630143	18
Uranía	Coros	Presidente	Unión Comunal Junta de Vecinos	Iván Merino 08	Tocopilla	812087	19
Jenny	Ehremerg		Unidad Vecinal Prat B	Pto. Montt 6249, Pobl O'Higgins	Antofagasta	299884	20

NOMBRE	APELLIDO	CARGO	INSTITUCIÓN	DIRECCIÓN	COMUNA	TELÉFONO	Nº
Roberto	Espejo	Académico	Universidad Católica del Norte	Av. Angamos 0610	Antofagasta	355515 355512	21
María	González	Ingeniero Ambiental	SQM	Aníbal Pinto 3228	Antofagasta	412685 412686	22
Dina	Gutiérrez	Estudiante Química Ambiental	Universidad Católica del Norte	Santa Cruz 02255, Coviefi	Antofagasta	240516 375772	23
Sandra	guzmán	Asistente Ambiental	SMC El Alba	San José de El Alba, Casilla 79	Calama	348691 348690	24
Luis	Hernández	Coordinador ambiental	Laboratorio Químico Central, Dirección Gestión Ambiental Codelco División Chuquicamata	Av. Tocopilla S/N	Chuquicamata	323145 325344	25
Juan	Mellate	Jefe Control Químico	Edelnor S.A.	Av. Angamos 745	Antofagasta	621470 621471	26
Yeimy	Miranda	Estudiante	Universidad José Santo Ossa	Edificio Huanchaca 67, depto. 32	Antofagasta	242768	27
Macarena	Monsalva	Analista de Proyectos	ESSAN S.A.	Av. José Miguel Carrera 1701	Antofagasta	356606 224547	28
Augusto	Montenegro	Gobernador	Gobernación Provincial	Prat 482	Antofagasta	223582 224221	29
Eliana	Montenegro	Tesorera	Unidad Vecinal 65, Villa Alemania	Huamachuco 8284	Antofagasta	294623	30
Angélica	Moya	Asesora Ambiental	Ministerio de Bienes Nacionales	Cornelio Vernaza 0558, Playa Blanca	Antofagasta	242866	31
Ruth	Muñoz	Presidenta	Unidad Vecinal 65, Villa Alemania	Leonardo da Vinci 936	Antofagasta	234210	32
Ingrid	Navea	Delegada	Población Prat B, Unidad Vecinal 46	Montegrande 1195	Antofagasta	271782	33
Carlos	Núñez	Teniente, oficial SIAT	Carabineros de Chile	Pje. Bilbao s/n	Antofagasta	268912 269069	34
Iván	Pavlov Peric	Abogado	SEREMI de Educación	Arturo Prat 384, piso 4	Antofagasta	223175 226013	35
Sandra	Riquelme	Encargado Ambiental Divisional	Codelco – Div. Radomiro Tomic	Av. Nueva Oriente 2696	Calama	366209 366203	36
Alejandra	Rodríguez	Estudiante	Universidad José Santos Ossa	Inmigrantes 733	Antofagasta	247798	37
Pedro	Rojas	Encargado Programas y Proyectos	Gobernación Provincial de Antofagasta	Prat 384, piso 6	Antofagasta	264300 224221	38
Myriam	Tapia	Estudiante Química Ambiental	U. católica del Norte	Av. Oscar Bonilla 7683, Villa Bulnes	Antofagasta	238534	39
Luis	Toledo	Director de Investigación	Universidad José Santos Ossa	Los Inmigrantes 733, Casilla 1344	Antofagasta	247798 241496	40

NOMBRE	APELLIDO	CARGO	INSTITUCIÓN	DIRECCIÓN	COMUNA	TELÉFONO	Nº
María	Torres	Presidenta	Unidad Vecinal 46	Panhuane 1203	Antofagasta	232214	41
Juan	Ugarte	Presidente	Junta de Vecinos Nº 2, Coviefi	Santa María 02334	Antofagasta	243832	42
Julia	Valladares	Secretaria	Población Prat B, Unidad Vecinal 46	Av. España 5896	Antofagasta	377313	43
Osman	Veas	Secretario	Junta de Vecinos	Villa Bulnes	Antofagasta		44

GOBIERNO DE CHILE
COMISION NACIONAL
DEL MEDIO AMBIENTE

Con fecha 08 de Enero del 2001 se archiva bajo el número que a continuación se indica, el siguiente antecedente para la Revisión de las Normas Primarias de Calidad de Aire para CO, 03, NO2, SO2 y PTS:

10. NORM-1/01 "Programa de Participación Ciudadana del Anteproyecto Revisión de Normas Primarias de Calidad de Aire para Anhídrido Sulfuroso (SO2), Monóxido de Carbono (CO), Dióxido de Nitrógeno (NO2), Ozono (O3) y Partículas Totales en Suspensión (PTS).

RODRIGO LUCERO CH.
Depto. Descontaminación , Planes y Normas
Comisión Nacional del Medio Ambiente

ENAMI 001164

GESTIÓN DE CALIDAD Y MEDIO AMBIENTE Nº 04

305Ue.

COMISION NACIONAL DEL MEDIO AMBIENTE
OFICINA DE PARTES Y ARCHIVO
Nº INGRESO: 00376/0224.
FECHA: 10 ENE 2001
DESPACHADO:
OBS.:
Patricia Mattus

Santiago, 8 enero del 2001

Señora
Patricia Mattus
Jefa Departamento de Planes y Normas
Comisión Nacional del Medio Ambiente
Presente

Ref.: Solicitud información para Evaluación Económica Norma SO2 .
At.: Sr. Juan Ladrón de Guevara.

Según lo conversado telefónicamente con el señor Juan Ladrón de Guevara, sírvase encontrar adjunto la información solicitada de desglose de costos fijos y variables de las fundiciones de Ventanas y Paipote, tanto para Fundición (1) como para Refinería a Fuego (2).

En caso de requerir algún tipo de información adicional, agradeceré contactar directamente al suscrito al fono: 637 53 46.

Le saluda atentamente,

Gestión Calidad-Medio Ambiente JEFE ENAMI

HUGO BALOCCHI VELASTIN
JEFE DE GESTIÓN DE CALIDAD

EMPRESA NACIONAL DE MINERIA
MAC-IVER Nº 459
TELEFONO : 6375000
CASILLA : 100-D
SANTIAGO
CHILE

COSTOS FIJOS Y VARIABLES POR PROCESOS - FUNDICION HERNAN VIDELA LIRA 001165

(CIFRAS EN US$)

AÑO : 1999

	CHANCADO	P.MEZCLA	HORNO ELECTRICO	CONVERSION	CONVERS. MODIFIC.	REFINO	PTA. DE ACIDO	TOTAL
COSTOS FIJOS	**495.566**	**455.988**	**3.847.847**	**3.297.685**	**7.473.576**	**2.115.726**	**5.203.118**	**22.889.506**
10.000 Sueldos (Excluye item 10.152)	79.566	211.498	626.075	605.864	719.555	387.440	489.322	**3.119.320**
40.300 Movilización		0	726	0	0	0	0	**726**
40.400 Honorarios	0	0	0	0	0	0	158	**158**
40.900 Mat. y Serv. Comp.	267	555	308	1.364	1.595	1.345	973	**6.407**
41.200 Seguros	963	877	10.474	18.093	22.947	8.701	57.138	**119.193**
30.600 Mat. para producc.	432	252	30.260	10.166	72.039	6.151	9.607	**128.907**
30.900 Materiales de Bodega	6.470	3.232	10.770	7.334	15.659	4.619	20.944	**69.028**
40.100. Pasajes	30	0	269	342	330	54	544	**1.569**
40.200 Gtos de viaje	4	0	28	139	103	7	74	**355**
40.500 Compras Menores	1.379	117	10.870	3.792	3.141	3.023	3.169	**25.491**
40.600 Servicios de Terceros	75.261	18.768	232.533	245.993	203.489	81.845	177.213	**1.035.102**
40.800 Pagos varios a Personal ENAM	863	2.808	9.971	2.348	3.494	7.843	9.725	**37.052**
41.000 Atenciones a Terceros	0	102	0	0	0	0	676	**778**
41.900 General	0	0	53.273	0	23.267	192	380	**77.112**
50.000 Depreciación	35.214	22.823	1.278.848	610.364	1.241.718	269.757	2.781.857	**6.240.581**
Gastos Administracion	114.041	94.954	888.826	738.026	1.454.926	585.394	865.191	**4.741.358**
Depreciacion Adm.	13.346	11.113	104.020	86.372	170.271	68.509	101.254	**554.885**
90.210 Agua sueldo	140	285	0	792	666	884	5.872	**8.639**
90.210 Agua depre	1.147	2.326	0	6.474	5.447	7.225	47.995	**70.614**
90.230 Aire sueldo	560	2.038	0	13.995	14.366	11.869	541	**43.369**
90.230 Aire depre	1.547	5.624	0	38.616	39.641	32.753	1.493	**119.674**
90.240 Oxigeno sueldo	0	0	0	17.779	161.431	0	0	**179.210**
90.240 Oxigeno depre	0	0	0	79.374	720.705	0	0	**800.079**
90.240 Oxigeno fijo				162.384	1.437.464			**1.599.848**
90.300 Mantención Mecánica sueldo	66.633	44.261	190.185	217.606	395.486	231.371	198.374	**1.343.916**
90.300 Mantención Mecánica depre	2.632	1.748	7.513	8.596	15.622	9.139	7.836	**53.086**
90.400 Mantención Eléctrica sueldo	39.887	21.187	112.733	157.619	160.704	118.313	134.831	**745.274**
90.400 Mantención Eléctrica depre	649	345	1.833	2.563	2.613	1.924	2.192	**12.119**
90.600 Refractarios sueldo	783	8.728	56.132	78.308	50.375	117.308	10.112	**321.746**
90.600 Refractarios depre	44	488	3.142	4.383	2.819	6.565	566	**18.007**
90.100 Electricidad sueldo	2.183	769	90.193	40.355	58.200	7.815	138.699	**338.214**
90.100 Electricidad depre	1.549	546	63.983	28.628	41.287	5.544	98.393	**239.930**
90.500 Control calidad sueldo	40	0	35.936	6.962	382.609	56.031	25.209	**506.787**
90.500 Control calidad depre	4	0	3.728	722	39.697	5.813	2.615	**52.579**
90.550 Informatica sueldo	2.785	318	413	270	777	656	1.182	**6.401**
90.550 Informatica depre	491	56	73	48	137	116	209	**1.130**
90.700 Equipos de Servicio sueldo	32.006	117	16.966	69.982	7.543	53.179	6.019	**185.812**
90.700 Equipos de Servicio depre	14.650	53	7.766	32.032	3.453	24.341	2.755	**85.050**
% COSTO SEMIVAR. A FIJO	**55.367**	**9.845**	**567.084**	**178.614**	**597.577**	**589.042**	**143.681**	**2.141.210**
30.100 Combustibles	0	857	11	28.290	430.000	493.360	12.364	**964.882**
30.700 Artículos de Seguridad	1.287	2.231	24.034	7.642	13.706	5.794	7.352	**62.046**
40.700 Mant. y Reparac. Externas	27.276	6.339	83.413	83.428	77.765	34.413	98.281	**410.915**
80.101 Informática	664	3	25	6	10	10	0	**718**
80.102. Operac. computador alpha	646	273	62	36	126	110	0	**1.253**
80.104. Soporte de microcomputac.	1.136	0	275	198	546	456	1.038	**3.649**
90.500 Control calidad	7	0	5.924	1.148	63.072	9.236	4.155	**83.542**
90.550 Informatica	807	92	120	79	225	190	343	**1.856**
90.700 Equipos de Servicio	13.701	50	7.263	29.956	3.238	22.764	2.576	**79.548**
90.900Varios	9.843	0	40.577	27.831	8.889	22.709	17.572	**127.421**
90.100 electricidad fijo			405.380					**405.380**
A) TOTAL COSTO FIJO	**550.933**	**465.833**	**4.414.931**	**3.476.299**	**8.071.153**	**2.704.768**	**5.346.799**	**25.030.716**
	(1)	(1)	(1)	(1)	(1)	(2)	(1)	

COSTOS VARIABLES	68.882	85.946	580.768	881.084	1.186.996	853.263	1.078.158	4.735.097
10.152 Sobretiempo	8.347	11.204	38.398	14.437	28.981	20.456	70.378	192.201
30.200 Refractarios	0	0	57.200	323.340	73.054	185.815	15.283	654.692
30.300 Reactivos y Fundentes	67	0	274.999	1.349	343.832	88.572	357.549	1.066.368
30.800 Mat. y Reptos. de Mant.	28.485	35.524	99.726	314.911	478.300	332.298	406.208	1.695.452
90.210 Agua	3.478	7.058	19.977	19.646	16.528	21.924	145.639	234.250
90.230 Aire	3.745	13.620	0	93.530	96.013	79.329	3.616	289.853
90.240 Oxigeno	0	0	0	0	0	0	0	0
90.300 Mantención Mecánica	17.316	11.502	49.425	56.550	102.777	60.128	51.553	349.251
90.400 Mantención Eléctrica	7.153	3.800	20.217	28.268	28.821	21.218	24.180	133.657
90.600 Refractarios	291	3.238	20.826	29.053	18.690	43.523	3.752	119.373
% COSTO SEMIVAR. A VARIAB.	75.496	16.749	2.526.206	512.485	689.881	165.818	1.388.413	5.375.048
30.100 Combustibles	539	857	1.555.088	0	0	0	12.364	1.568.848
30.700 Artículos de Seguridad	1.287	2.231	24.034	7.642	13.706	5.794	7.352	62.046
40.700 Mant. y Reparac. Externas	27.276	6.339	83.413	83.428	77.765	34.413	98.281	410.915
80.101 Informática	664	3	25	6	10	10	0	718
80.102. Operac. computador alpha	646	273	62	36	126	110	0	1.253
80.104. Soporte de microcomputac.	1.136	0	275	198	546	456	1.038	3.649
90.100 Electricidad	19.590	6.904	809.425	362.161	522.308	70.136	1.244.732	3.035.256
9[illegible]0 Control calidad	7	0	5.924	1.148	63.072	9.236	4.155	83.542
90.550 Informatica	807	92	120	79	225	190	343	1.856
90.700 Equipos de Servicio	13.701	50	7.263	29.956	3.220	22.764	2.576	79.530
90.900 Varios	9.843	0	40.577	27.831	8.903	22.709	17.572	127.435
B) TOTAL COSTO VARIABLE	144.378	102.695	3.106.974	1.393.569	1.876.877	1.019.081	2.466.571	10.110.145
COSTO TOTAL (A+B)	695.311	568.528	7.521.905	4.869.868	9.948.030	3.723.849	7.813.370	35.140.861
% Costo Variable	20,76	18,06	41,31	28,62	18,87	27,37	31,57	
% Costo Fijo	79,24	81,94	58,69	71,38	81,13	72,63	68,43	

BENEFICIO CNU t.	285.721
PROD. ANODOS t.	73.478
PROD. ACIDO t.	238.073

	CHANCADO	P.MEZCLA	TRATAM. ESCORIAS	CONVERSION	CONVERS. MODIFIC.	REFINO	PTA. DE ACIDO	TOTAL
	US$	US$	US$	US$	US$	US$	US$	US$
DEPRECIACION	71.273	45.122	1.470.906	898.172	2.283.410	431.686	3.047.165	8.247.734
ADMINISTRACION	114.041	94.954	888.826	738.026	1.454.926	585.394	865.191	4.741.358
COSTO VARIABLE	144.378	102.695	3.106.974	1.393.569	1.876.877	1.019.081	2.466.571	10.110.145
COSTO FIJO	365.619	325.757	2.055.199	1.840.101	4.332.817	1.687.688	1.434.443	12.041.624
COSTO TOTAL	695.311	568.528	7.521.905	4.869.868	9.948.030	3.723.849	7.813.370	35.140.861

	CHANCADO	P.MEZCLA	TRATAM. ESCORIAS	CONVERSION	CONVERS. MODIFIC.	REFINO	PTA. DE ACIDO	FUSION
	US$/ t.	US$/ t.	US$/ t.	US$/ t.	US$/ t.	US$/ t.	US$/ t.	US$/ t.
DEPRECIACION	0,25	0,16	5,15	3,14	7,99	5,88	12,80	16,69
ADMINISTRACION	0,40	0,33	3,11	2,58	5,09	7,97	3,63	11,51
COSTO VARIABLE	0,51	0,36	10,87	4,88	6,57	13,87	10,36	23,19
COSTO FIJO	1,28	1,14	7,19	6,44	15,16	22,97	6,03	31,21
COSTO TOTAL	2,44	1,99	26,32	17,04	34,81	50,69	32,82	82,60
	(1)	(1)	(1)	(1)	(1)	(2)	(1)	

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F.R. VENTANAS

[redacted]

(US$)

NOVIEMBRE/2.000

	COSTOS FIJOS	COMPRAS	CHANCADO	FUNDICION	ANODOS	COBRE ELECTROL.	PLATA	ORO	ACIDO SULFURICO	TOTAL
10.100	Gastos en Personal	148.792	24.431	2.039.017	1.318.647	2.635.474	481.079	102.283	285.473	7.035.196
30.900	Materiales de Bodega	3.065	150	45.945	38.994	207.227	18.247	3.905	2.931	320.464
40.100	Pasajes	0	0	63	454	1.708	39	1	8	2.273
40.200	Gastos de Viajes	0	0	92	12	39	55	1	96	295
40.300	Movilización	0	0	0	94	0	137	8	97	336
40.400	Honorarios	0	0	0	0	0	391	0	0	391
40.500	Compras Menores de Materiales	22	0	2.602	532	1.878	656	63	283	6.036
40.600	Servicios a Terceros	2.719	40.181	616.194	232.383	1.539.131	13.936	906	77.102	2.524.552
40.800	Pagos Vrs. Personal ENM	549	136	12.514	11.186	13.072	9.289	2.190	1.412	50.348
40.900	Mater. Y Serv. Computacionales	4.486	0	2.874	2.006	4.286	723	43	1.250	15.668
41.000	Atención a terceros	0	0	226	324	37	581	26	13	1.207
41.200	Seguros	0	0	136	0	0	101	4	0	241
41.900	General	-14.834	0	465	0	0	0	0	0	-14.369
50.000	Depreciaciones	365	189.259	3.961.171	201.256	4.030.198	259.961	14.171	4.551.223	13.207.604
	ADM. GENERAL FAENA	21.969	35.931	2.277.924	1.087.808	2.034.949	228.500	30.621	573.366	6.289.068
	ADM. DE LA PRODUCCION	0	14.409	918.773	437.072	822.439	91.083	12.301	231.098	2.527.176
% C. SEMIVARIABLES A C. FIJO										
30.100	Combustibles	0	0	657.973	1.516.276	0	15.587	733	10.594	2.201.163
30.700	Articulos de Seguridad	357	378	59.899	35.195	40.295	6.388	658	4.738	147.908
40.700	Mant.y Rep. Externas	0	23.273	556.743	107.271	207.023	26.423	4.539	160.021	1.085.293
90.100	Electricidad	0	0	1.437.663	38.396	0	0	0	0	1.476.059
90.220	Vapor	0	0	87.307	44.558	1.464.296	0	0	0	1.596.161
COSTOS FIJOS TOTAL :		167.490	328.148	12.670.581	5.070.464	13.002.052	1.151.138	172.433	5.879.705	38.451.009
COSTOS VARIABLES										
10.152	Sobre Tiempo Funcionarios	1.471	3.795	225.977	162.868	335.255	50.048	9.353	22.355	811.122
30.200	Refractarios	0	0	586.615	855.842	6.452	47.899	2.606	31.382	1.530.796
30.300	Reactivos y Fundentes	0	0	1.872.685	191.580	506.880	91.489	6.141	805.905	3.474.680
30.400	Acido Sulfurico	0	0	0	0	0	12.829	0	0	12.829
30.600	Materiales para la Producción	0	7	268.935	211.951	179.431	88.952	11.077	56.777	817.130
30.800	Mat. y Rep para Mantención	744	80.228	1.697.092	698.742	774.774	272.324	30.527	692.020	4.246.451
41.100	Medio Ambiente	0	0	0	0	0	0	0	13	13
41.600	Fletes de Productos Mineros	0	0	18.841	0	49.148	0	0	0	67.989
41.700	Fletes Acido Sulfúrico	0	0	0	0	16.419	0	0	0	16.419
42.000	Servicios de Operación	0	0	11	0	20	0	0	0	31
43.000	Adm. Deleg. Ley 16.744	0	0	0	0	0	0	0	0	0
90.210	Agua	4.111	27.271	116.612	120.928	60.675	7.132	2.193	629.145	968.067
90.230	Aire Comprimido	0	0	197.552	68.043	81.176	3.757	196	229	350.953
90.240	Oxigeno	0	0	2.399.582	0	0	26.800	1.304	0	2.427.686
90.300	Mantenc. Mecánica	0	31.946	950.533	526.472	722.420	225.797	24.163	235.631	2.716.962
90.400	Mantenc. Eléctrica	0	13.197	269.022	154.945	244.272	98.333	10.963	89.098	879.830
90.501	Ensayes Quimicos	348	0	299.462	49.241	300.654	33.900	2.857	44.394	730.856
90.502	Muestreo y Experimentación	0	0	412.311	59.027	219.313	24.133	1.335	14.369	730.488
90.503	Inspección Fisica	0	0	0	52.950	216.915	0	0	0	269.865
90.550	Informática Ventanas	9.304	0	10.953	3.273	49.186	3.012	166	2.468	78.362
90.600	Refractarios	0	546	187.289	276.359	0	31.498	1.628	1.041	498.361
90.700	Obras	0	0	0	0	158.658	32.698	1.876	71.274	264.506
90.800	Acido Sulfurico	0	0	0	0	141.667	18.334	1.063	0	161.064
90.920	Equipos y Servicios	0	792	642.928	283.492	508.945	7.937	427	23.262	1.467.783
% C. SEMIVARIAB. A C. VARIAB.										
30.100	Combustibles	16	72	657.973	1.516.275	-43.760	15.588	734	0	2.146.898
30.700	Articulos de Seguridad	357	378	59.899	35.195	40.295	6.389	659	4.738	147.910
40.700	Mantenc. y Rep. Externas	0	23.273	556.743	107.270	207.023	26.424	4.539	160.022	1.085.294
90.100	Electricidad	15.203	24.636	1.437.663	38.395	5.581.282	81.189	14.952	1.267.403	8.460.723
90.220	Vapor	0	0	87.307	44.557	0	44.529	2.676	0	179.069
COSTOS. VARIABLES TOTAL		31.548	206.141	12.955.965	5.457.406	10.357.100	1.250.971	131.437	4.151.526	34.542.119
COSTOS TOTAL US$		199.038	534.282	25.635.542	10.527.864	23.359.143	2.402.092	303.862	10.031.209	72.993.128
			(1)	(1)	(2)				(1)	

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ANÁLISIS Y EVALUACIÓN DE DATOS DE EMISIÓN Y CALIDAD DE AIRE DE LA FUNDICIÓN ALTONORTE – NORANDA

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Santiago, Enero de 2001

1. INTRODUCCIÓN

A continuación se presenta un análisis de la información disponible para el estudio solicitado por CONAMA como apoyo para la evaluación los datos de emisión y calidad del aire de la Fundición Altonorte – Noranda.

En primer lugar se discutirán las características meteorológicas de la zona para poder establecer fenómenos y características que afectan a la dispersión de contaminantes en la zona. Luego la información de emisiones disponible para el período Enero – Diciembre de 1999, en términos de la consistencia de diferentes fuentes de información y de las situaciones excepcionales encontradas para algunos conjuntos de datos. Después se discutirá la información de calidad de aire disponible para este estudio, considerando como factores la calidad de los valores reportados y su representatividad. Finalmente se presenta una comparación entre la información reportada de calidad de aire y la de emisiones con el fin de mostrar las eventuales relaciones que existen entre la emisión de dióxido de azufre por parte de la fundición Altonorte y la calidad de aire observada en las cercanías.

2. METEOROLOGÍA

La meteorología del norte grande se caracteriza por la poca o nula precipitación observada en el año, así como por la persistencia de la alta presión del pacífico sur. La influencia de la alta presión del pacífico se refleja en una casi permanente inversión térmica de subsidencia alrededor de los 1000 metros de altura (Miller, 1976). Dado que los valles cercanos a la costa en la zona del norte grande tienen normalmente altitudes del orden de 800 m, esta inversión de subsidencia se encuentra siempre cerca del nivel del suelo en estas zonas. La Figura 1 muestra dos perfiles de temperatura observados en Antofagasta para un día de invierno (14 de Junio de 1999) y un día de verano (24 de Noviembre de 1999). En esta figura se puede observar la diferencia en altura e intensidad de la inversión de subsidencia para dos estaciones del año 1999. Estos valores son consistentes con los reportados en la literatura (Miller, 1976) que muestran una inversión más baja (ca. 800 m) e intensa en los meses de invierno que en los de verano (ca. 1200 m).

Otra característica de las zonas cercanas a la costa en el área de Antofagasta, es la presencia de camanchacas durante casi todo el año de manera de que en las madrugadas y primeras horas del día se observa nubosidad baja (ca. 800 m) penetrando por los valles hacia el interior, estabilizando la capa de mezcla en los valles. Esto se ilustra en la Figura 2 donde se muestra que el aire alcanza en la saturación durante las horas de la noche hasta alrededor de las 9 a 10 de la mañana para bajar hasta cerca del 70% al medio día y en horas de la tarde. Esto se observa durante todo el año. Cabe señalar el diferente comportamiento observado en el mes de Junio que hace pensar en una falla en el equipo de monitoreo puesto que es el único mes en que se observa humedad relativa en torno al 60% durante la noche.

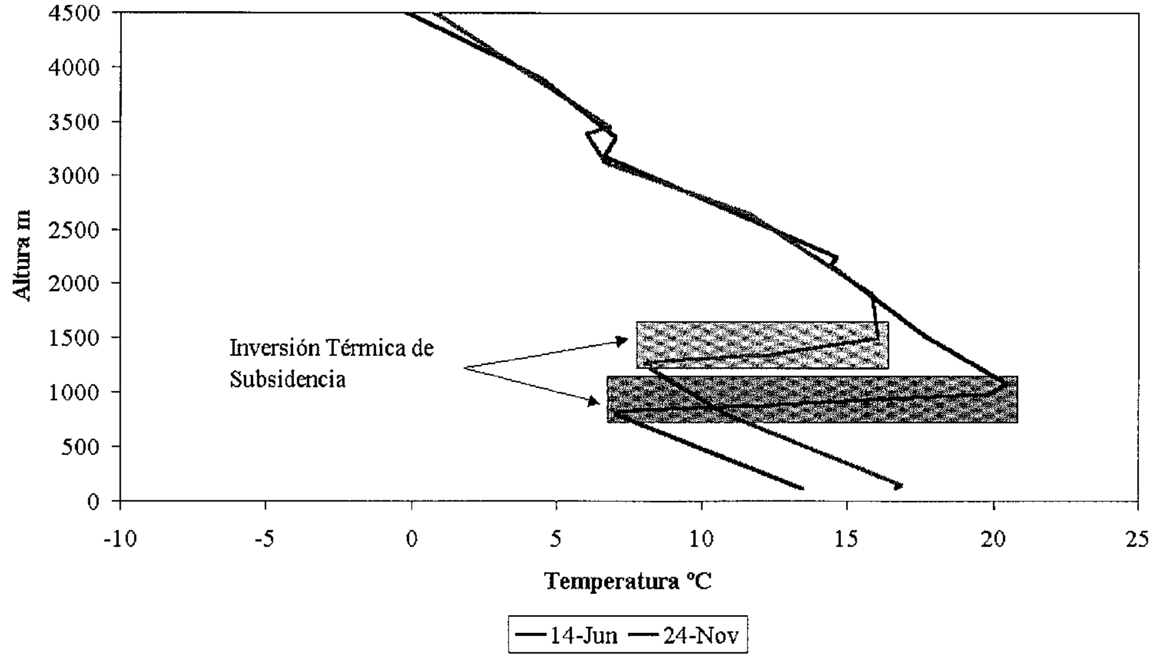

Figura 1. Perfil vertical de temperaturas para dos fechas seleccionadas del año 1999. Se destaca la posición e intensidad de la inversión de subsidencia para ambas fechas. Sondeo de Antofagasta (23° 39'S; 70° 24°O)

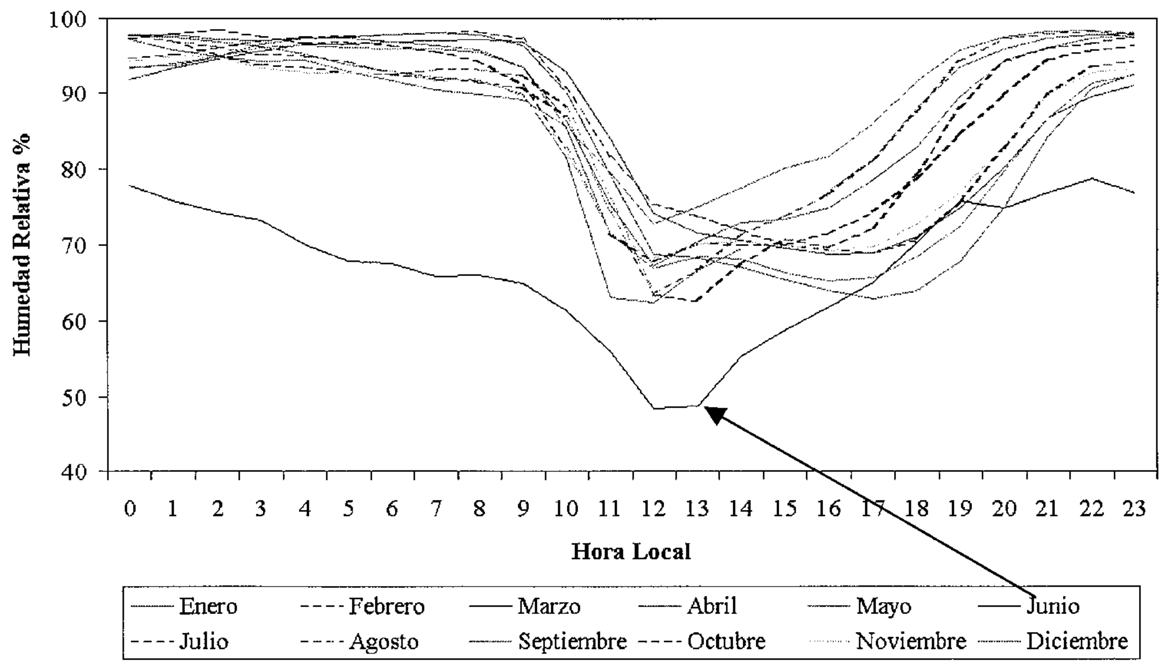

Figura 2. Ciclos diarios mensuales de la humedad relativa para el año 1999. Nótese la diferencia entre el mes de Junio y los restantes. Estación Central (23° 50°S; 70° 18°O).

La circulación típica en la zona de la fundición (23° 50°S; 70° 18°O) viene del Oeste como se muestra en la Figura 3. La dirección del viento no tiene un ciclo diario evidente, a diferencia de la velocidad la cual si presenta una variación diaria importante, tal como se muestra en la Figura 4. Así, la circulación en las cercanías de la fundición es del poniente, con velocidades mayores a mediados de la tarde, lo que coincide con las horas de mayor insolación. Esto se discutirá en conjunto con los datos de calidad de aire más adelante en este reporte.

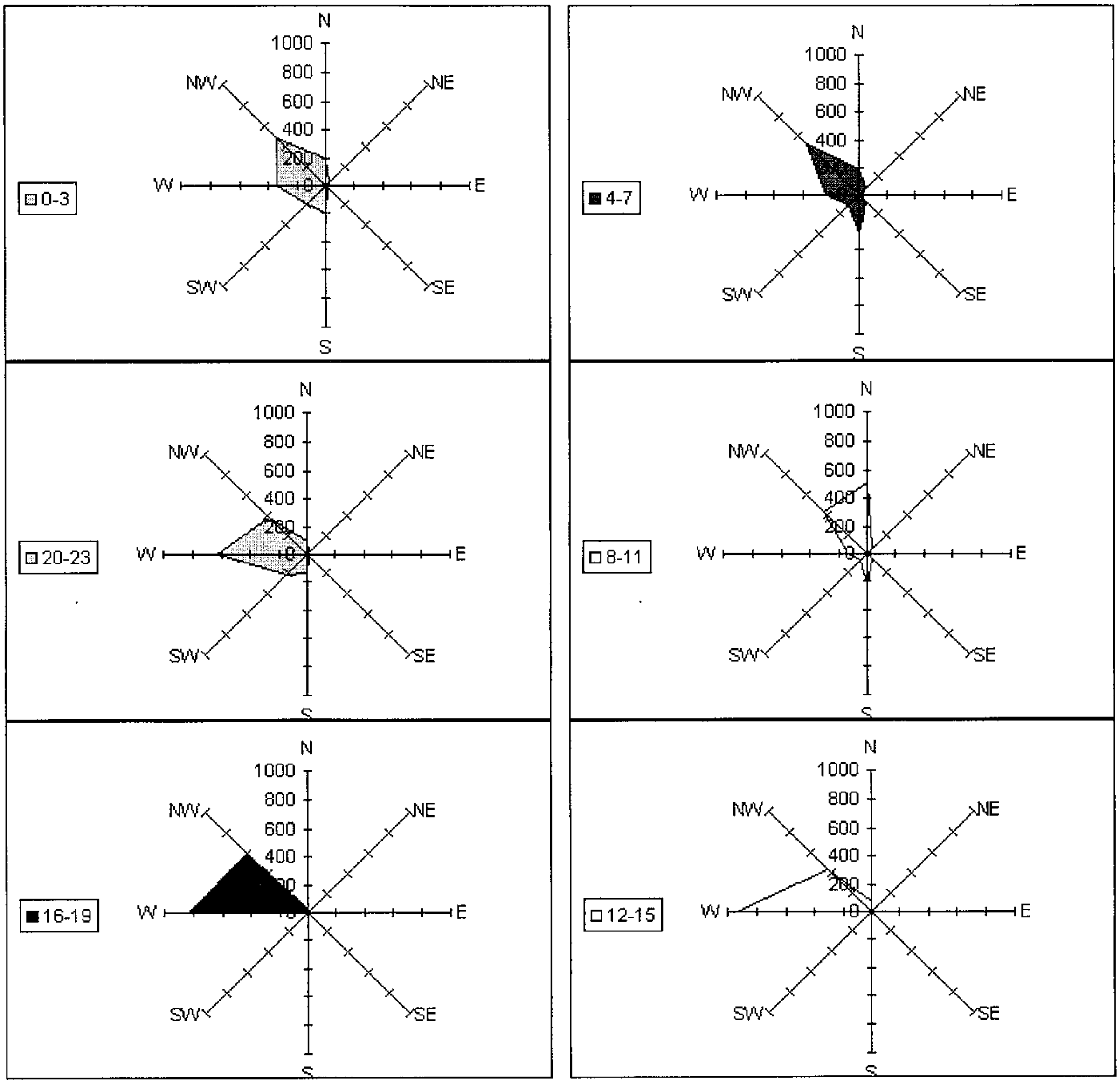

Figura 3. Rosas de vientos para diferentes horas del día. Desde la esquina superior izquierda y en el sentido de las manecillas del reloj, las horas corresponden a: 0 – 3 hr; 4 – 7 hr; 8 – 11 hr; 12 – 15 hr; 16 – 19 hr y 20 – 23 hr. El eje corresponde al número de ocurrencias. Estación Central (23° 50°S; 70° 18°O).

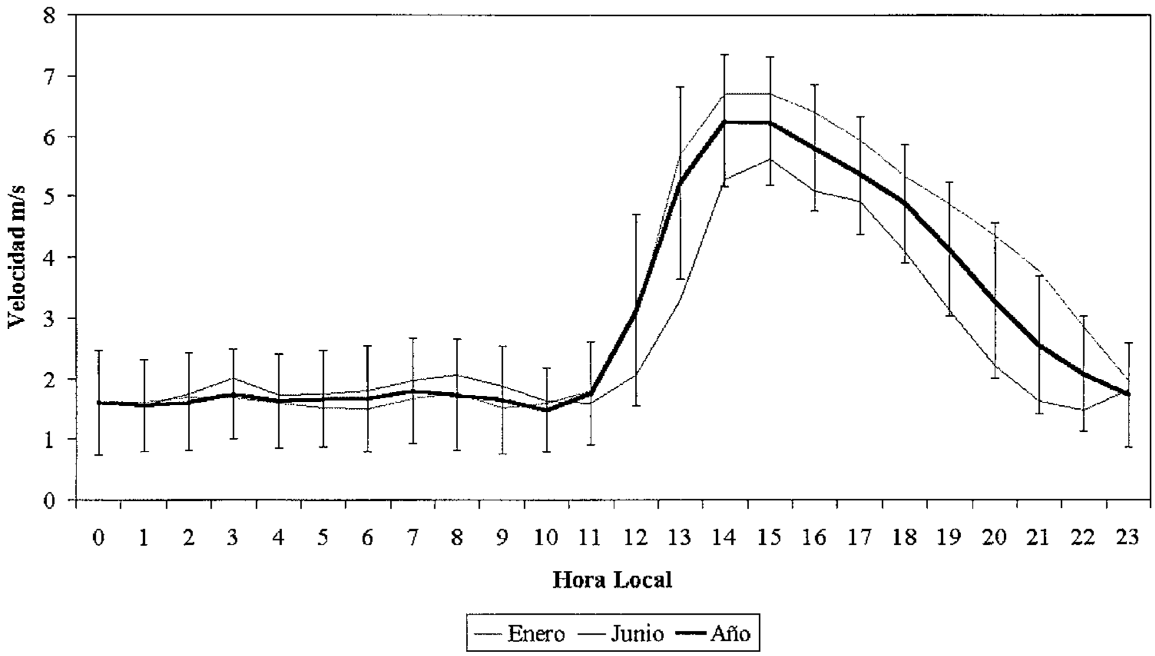

Figura 4. Ciclo diario promedio anual de velocidad del viento en la Fundición. Las barras de error corresponden a una desviación estándar del promedio, calculada con los valores horarios disponibles. También se indican dos meses extremos, Enero y Junio. Estación Central (23° 50ºS; 70° 18ºO).

3. EMISIONES

La información de emisiones disponible corresponde a balances de masa en base diaria para todo el año 1999. Además se cuenta con la emisión mensual y anual reportada por la fundición para el año 1999 en base, al parecer, a los mismos balances de masa.

La Tabla 1 muestra las emisiones mensuales y anual reportadas para 1999, junto con los mismos valores calculados con los balances de masa diarios provistos por la fundición.

Tabla 1. Emisiones de azufre reportadas por Altonorte para el año 1999 de forma mensual y calculadas a partir de las emisiones diarias. Unidades ***ton S***

Período	Emisión Reportada	Emisión Calculada
Enero	2093	2187
Febrero	1801	1788
Marzo	2260	2386
Abril	1061	1089
Mayo	861	1028
Junio	1002	1054
Julio	1507	1771
Agosto	1395	1504
Septiembre	1610	1853
Octubre	2143	2164
Noviembre	1902	1824
Diciembre	2389	2330
Total Año 1999	**20023**	**20978**

Como se aprecia en la Tabla 1, las emisiones reportadas presentan diferencias de hasta 260 toneladas de azufre al mes (Julio) acarreando una diferencia de 955 toneladas de azufre para el año.

El procedimiento de cálculo de las emisiones mensuales no está reportado con el mismo detalle que el de las emisiones diarias. Este último es realizado mediante un balance de masa automático considerando la ley de azufre en la alimentación y los contenidos de azufre de cada corriente de acuerdo al siguiente esquema.

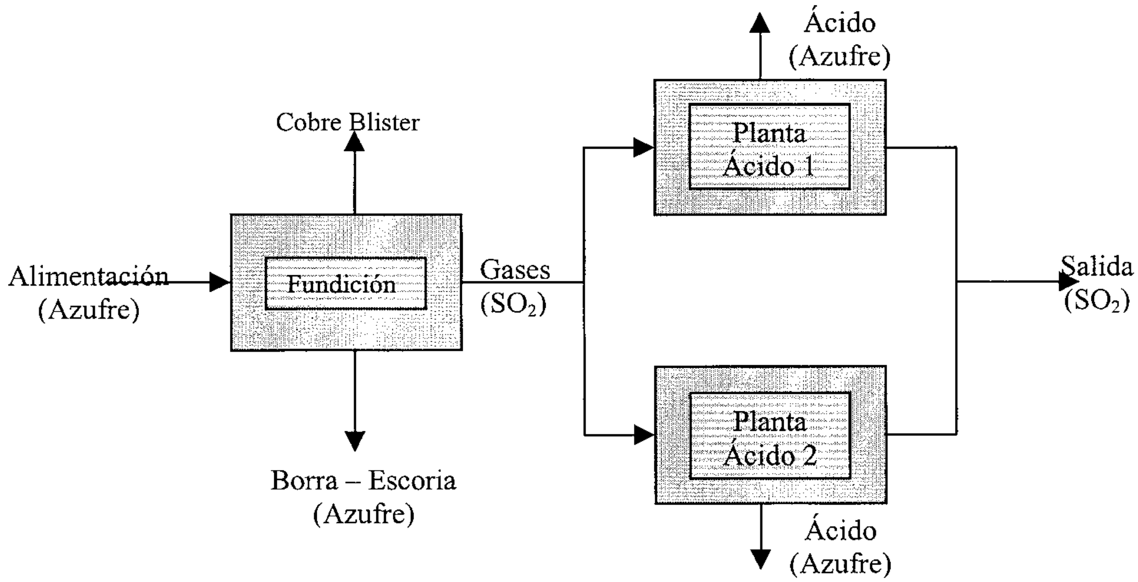

Figura 5. Esquema Balance de masas.

Este método de estimación de las emisiones totales muestra claros problemas en su interpretación debido a la respuesta automática de los instrumentos, observándose reportados valores de captura de azufre iguales e incluso superiores a 100%, lo que significa **cero emisiones** o **emisiones negativas** en los reportes de emisiones (ver destacados en Figura 3). Estas situaciones correspondieron a 8 días durante 1999, lo que significa una *des-emisión* de más de 60 toneladas de azufre al año. Aunque esta diferencia represente menos de un 1% del total de las emisiones anuales de azufre no se pueden dejar de considerar los problemas que la utilización de estos valores conlleva al momento de analizar la relación de estas emisiones negativas con la calidad de aire observada en los alrededores. Otro punto a considerar es la eficiencia de remoción de azufre reportada de las plantas de ácido. Como se muestra en la figura 3, esta recuperación de azufre reportada alcanza en reiteradas ocasiones niveles superiores al 95% lo cual es excesivo dado que la recuperación normal de estos equipos se encuentra en el rango del 80 a 90%. Esto hace sospechar una pobre calibración de los instrumentos que reportan para el balance de masa diario pudiendo explicar así la diferencia entre los reportes mensuales y diarios.

Las Figuras 6 y 7 muestran la variación de las emisiones de azufre durante el año 1999 en una base mensual y diaria respectivamente. La característica más sobresaliente es el mínimo de emisiones reportado en Abril. Este mínimo tiene relación con más de 10 días en que la fundición no funcionó normalmente puesto que esos días se reportaron valores nulos para la alimentación al proceso. Otro punto a destacar es que las emisiones durante el primer trimestre de año fueron superiores (hasta en un 30%) a las de los meses siguientes sin considerar Abril. No se observa una estacionalidad relevante en la información de emisiones. La Figura 7 muestra la alta variabilidad que tienen las emisiones de la fundición día a día, observándose variaciones de hasta tres veces en las emisiones de días consecutivos. Esto debe tenerse en cuenta al relacionar esta información con la de calidad de aire disponible.

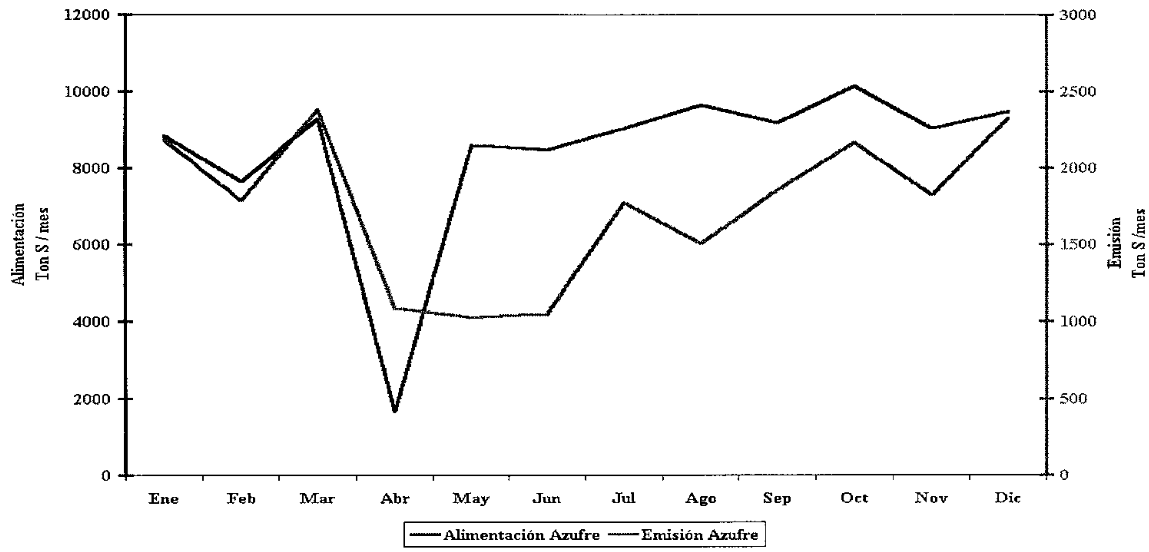

Figura 6. Cantidades mensuales de azufre alimentado y emitido, reportadas por Altonorte – Noranda para el año 1999.

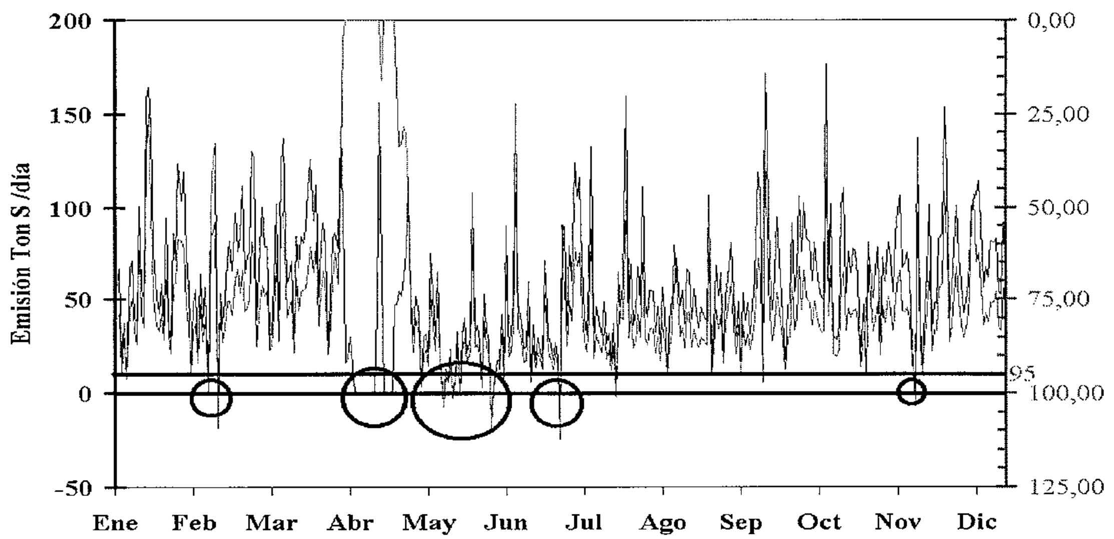

Figura 7. Emisiones diarias de azufre y porcentaje de captura de azufre de las plantas de ácido, reportadas por Altonorte – Noranda para el año 1999.

4. Calidad de Aire

La información de calidad de aire disponible para esta zona corresponde a tres estaciones en el entorno de la fundición (ver Figura 4): La Negra (23°46'S; 70°19'O), Sur (23°50'S; 70°17'O) y Coviefi (23°42'S; 70°23'O). Estas tres estaciones cuentan con información horaria de concentración de dióxido de azufre en el aire. Estas estaciones, como se muestra en la Figura 8, están localizadas en las cercanías de la fundición Altonorte – Noranda y por esto debieran reflejar el impacto de esta fuente en los alrededores. Sin embargo, en las cercanías también se encuentra una planta de cemento cuyas emisiones afectarán también las observaciones de la red de monitoreo.

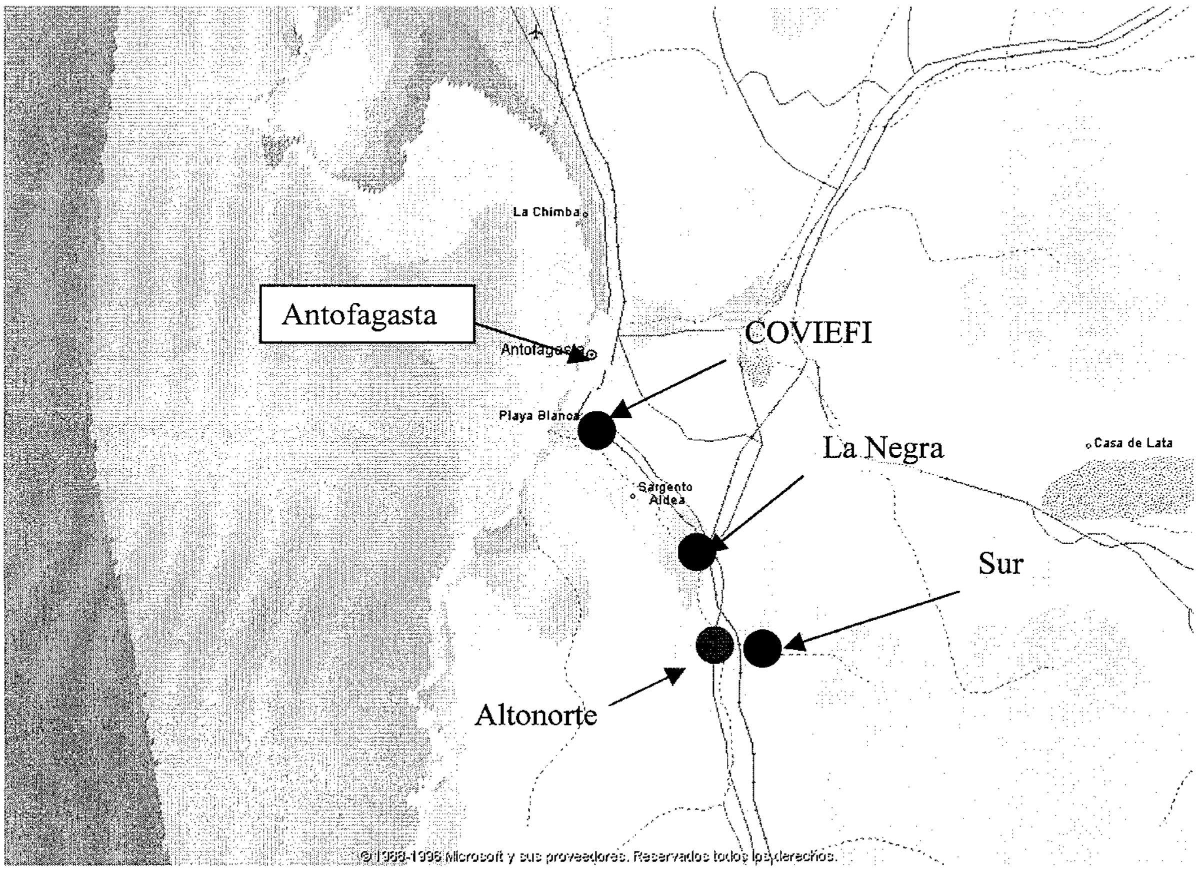

Figura 8. Mapa con la localización aproximada de las tres estaciones monitoras y la fundición Altonorte.

La estación Coviefi se descartó como representativa del impacto de la fundición debido a su localización y a que sus mediciones están siempre cerca del límite de detección del instrumento mientras que las otras dos estaciones reportan valores más de 10 veces superiores, como se aprecia en la Tabla 2.

Tabla 2. Promedio anual de concentración de SO_2 en las estaciones La Negra, Sur y Coviefi, para el año 1999. Basado en los promedios diarios reportados.

Estación	Promedio	Desviación Estándar	N° de Observaciones
La Negra	**23**	**30**	**355**
Sur	**162**	**124**	**306**
Coviefi	**2**	**5**	**334**

Respecto de la calidad de la información disponible, las series de tiempo reportadas incluyen numerosos valores de concentración **cero** lo cual hace pensar en una deficiencia en el proceso de validación de los datos reportados por las estaciones y resta representatividad a todos los datos reportados. Esto porque es posible que estos mismos valores cero de las concentraciones se encuentren en las mediciones de mayor resolución temporal (p.ej. mediciones cada 5, 15 o 30 minutos) resultando en valores poco representativos. En el análisis aquí presentado se reemplazaron estos valores cero por 0,1 $\mu g/m^3$ (valor típico de límite de detección de los instrumentos utilizados). No obstante, dado que la información disponible está presentada en forma de promedios horarios los cuales probablemente incluyeron valores cero en sus reportes de mayor resolución temporal, no es posible descartar ningún valor salvo los promedios horarios cero.

Los promedios mensuales de concentración de SO_2 observados en la estación Sur no muestran una variación estacional relevante siendo el rasgo más evidente el mínimo relativo observado en Abril, el cual es coincidente con el mínimo de emisiones reportado para el año 1999 (ver Figura 5).

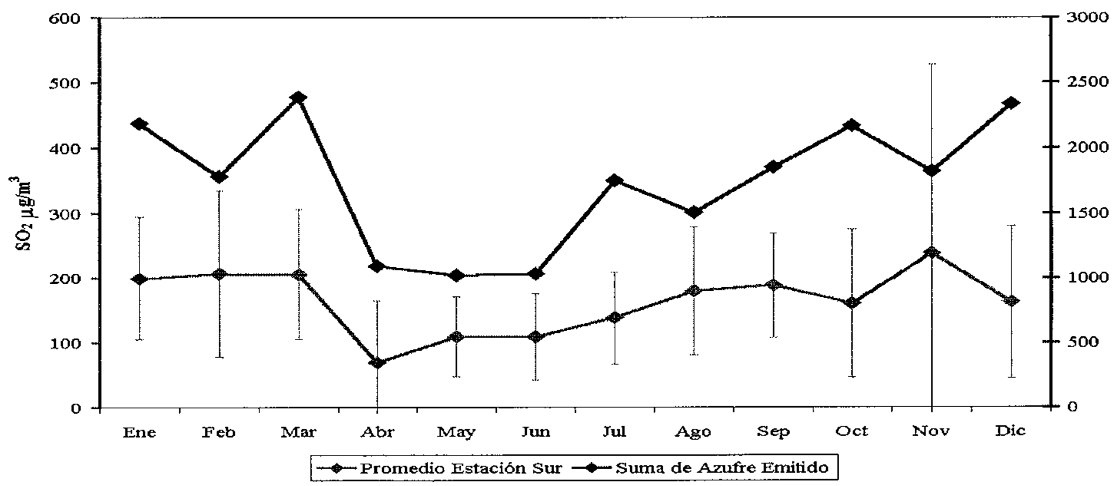

Figura 9. Promedios mensuales de concentración de SO_2 en la Estación Sur y emisiones mensuales de Altonorte para 1999. Las barras de error indican la desviación estándar del promedio mensual calculado sobre los promedios diarios.

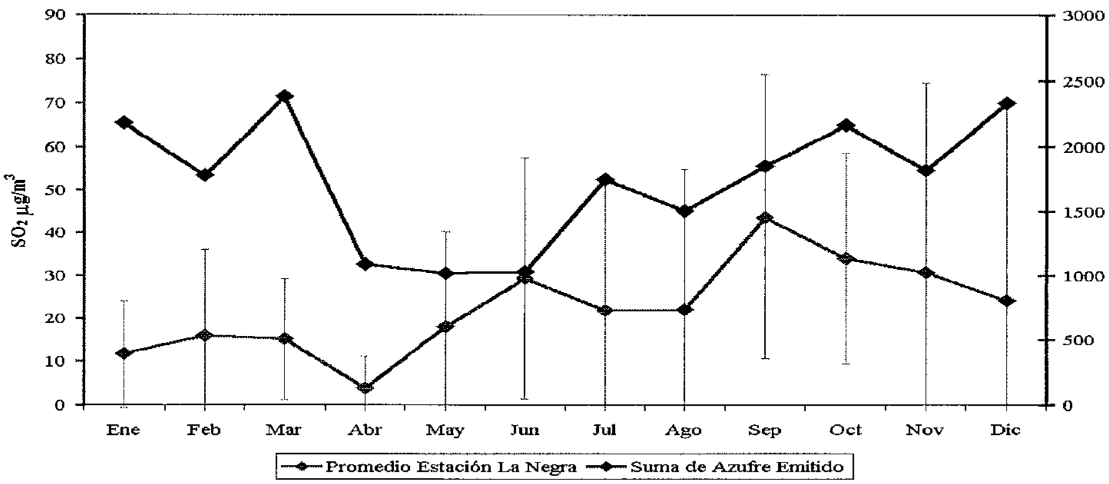

Figura 10. Promedios mensuales de concentración de SO_2 en La Negra y emisiones mensuales de Altonorte para 1999. Las barras de error indican la desviación estándar del promedio mensual calculado sobre los promedios diarios.

En la estación La Negra se observa un aumento en las concentraciones promedio mensual de SO_2 en los meses de Junio a Septiembre el cual se relaciona en parte con el aumento en las emisiones de Altonorte pero que puede reflejar además la influencia de las condiciones meteorológicas de la zona o de otrasfuentes (ver Figura 10).

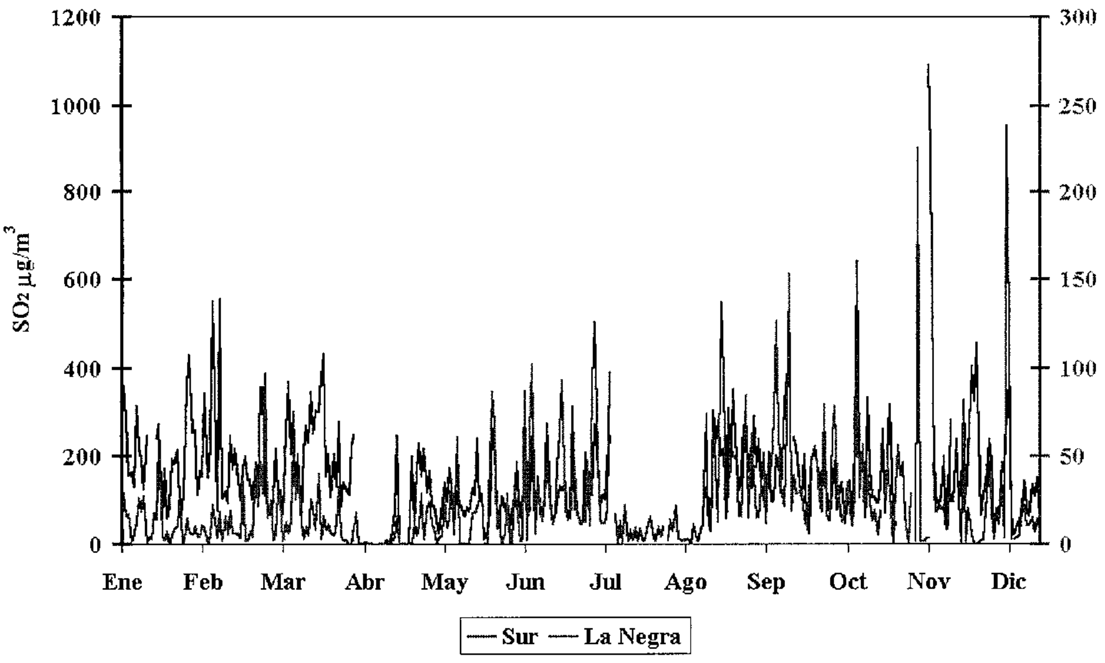

Figura 11. Promedios diarios de concentración de SO_2 en La Negra y en la estación Sur para 1999.

La Figura 11 muestra las concentraciones diarias observadas en las estaciones Sur y La Negra para 1999. En este gráfico se puede ver que ambas estaciones tienen un comportamiento similar durante los períodos de altas concentraciones (sobre 25 $\mu g/m^3$ en La Negra y sobre 150 $\mu g/m^3$ en la estación Sur) aunque con niveles hasta seis veces mayores en la estación Sur que en La Negra. La alta variabilidad mostrada con las desviaciones estándar en las Figuras 9 y 10 se hace más clara en la figura 11 donde se observan variaciones de hasta más de 300 $\mu g/m^3$ entre días consecutivos. Esto puede estar relacionado con las grandes variaciones reportadas para las emisiones de Altonorte. Sin embargo no se puede descartar la influencia de otra fuente en estas observaciones.

La variación diurna de las concentraciones observadas en La Negra y en Sur muestra un persistente máximo en las primeras horas de la mañana (ver figuras 12 y 13). La evolución de este máximo sugiere una mezcla vertical en las primeras horas de la mañana en conexión con un aumento en la altura de la capa de mezcla lo cual podría mezclar aire rico en azufre que se encuentra en las capas superiores. Esta hipótesis se sostiene considerando que en los meses de invierno el aumento de las concentraciones comienza alrededor de las 10 de la mañana mientras que en los meses de verano alrededor de las 7 de la mañana, lo cual se relaciona con las horas del amanecer. Además, como se mostró anteriormente, la meteorología de la zona indica una alta estabilidad atmosférica durante las horas de la noche y eventos de camanchaca recurrentes durante casi todo el año lo que sumado a la situación geográfica de la zona, con una altitud alrededor de los 1000 metros sobre el nivel del mar, redunda en una capa de mezcla muy cercana al suelo. De hecho, el ciclo diario de humedad relativa se anticorrelaciona con el de concentración y se observa que el mximo de concentración de SO_2 coincide con el comienzo de la disminución en la humedad relativa debido probablemente a la inestabilización provocada por la radiación solar.

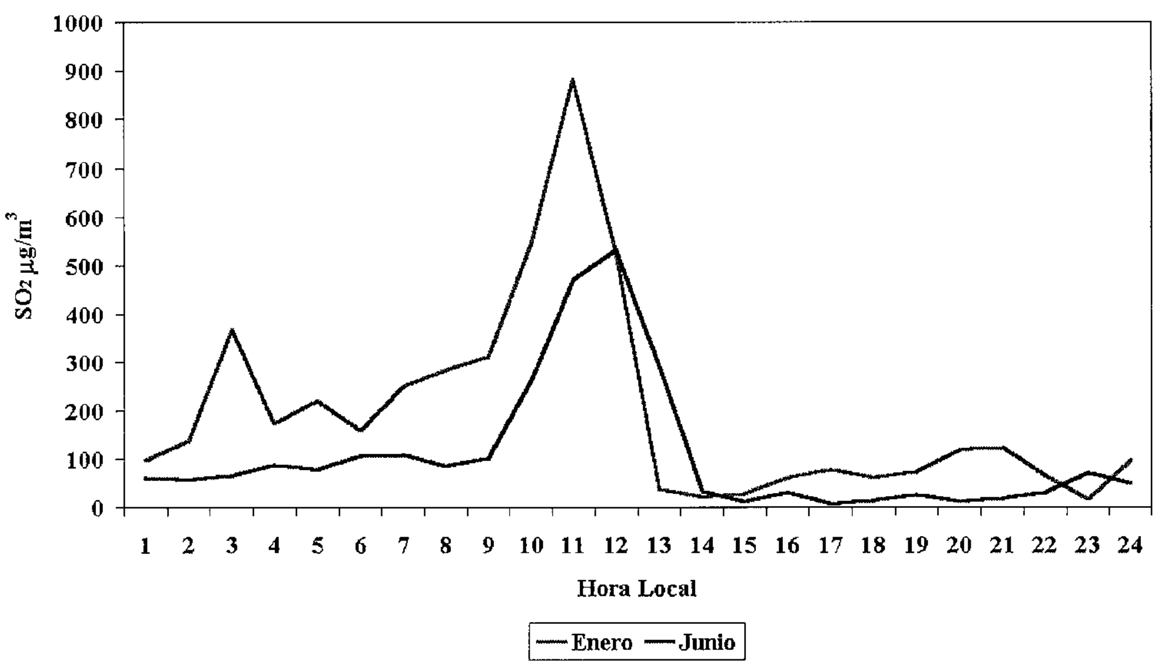

Figura 12. Ciclo diario promedio de SO_2 para Enero y Junio de 1999 en la estación Sur.

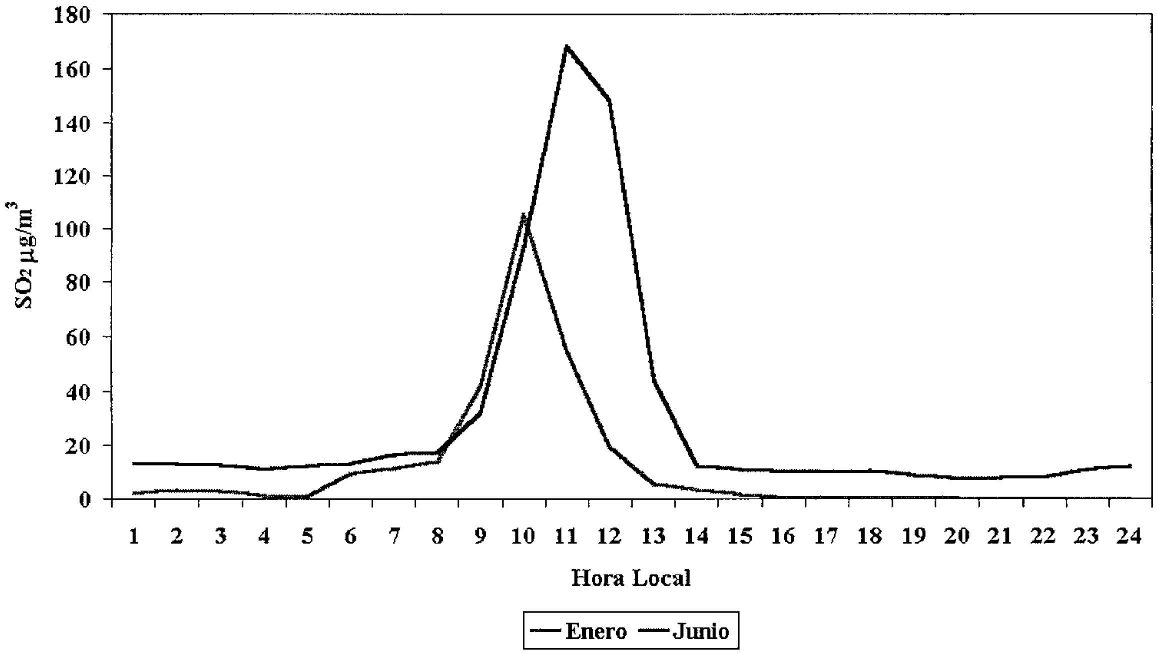

Figura 13. Ciclo diario promedio de SO_2 para Enero y Junio de 1999 en la estación La Negra.

5. EMISIÓN – CALIDAD DE AIRE

Dada la cercanía de los puntos de monitoreo con la fuente emisora, es de esperar una relación entre las emisiones de Altonorte y las concentraciones de SO_2 observadas en las estaciones en las cercanías. Esta relación aparece evidente en los promedios anuales reportados para los años 1997 y 1998, como se muestra en la Tabla 3, sin embargo, la disminución en las concentraciones observadas en 1999 no se relaciona con la pequeña reducción en las emisiones respecto del año anterior. El año 2000 no cuenta con información suficiente como para hacer un análisis de emisión – calidad de aire.

Tabla 3. Emisiones anuales históricas de azufre y concentraciones de SO_2 observadas en La Negra para los mismos períodos.

Año	Emisión Kton S	La Negra µg SO_2 /m^3
1997	41	95
1998	22	50
1999	20	20
2000	20[1]	26[2]

[1] Las emisiones del año 2000 están reportadas hasta el 30 de Noviembre.
[2] El promedio de concentración en La Negra para el año 2000 se tomó sólo con los meses de Enero, Febrero, Marzo, Abril Mayo.

Anteriormente se mostró la relación entre la emisión mensual de Altonorte y la calidad de aire observada en La Negra y en la estación Sur. Esta relación aparece menos evidente que en los promedios anuales pero aún es significativa. Por ejemplo, el mínimo de emisiones de Abril coincide con el mínimo de las series de tiempo de SO_2 observado. La relación es más directa y evidente para la estación Sur, la que está más cerca de la fuente a sólo dos kilómetros hacia el oriente.

Esta relación sin embargo, se hace más evidente en ambas estaciones si se consideran los promedios de los máximos diarios comparados con las emisiones mensuales reportadas (ver Figuras 14 y 15). Esto refleja la influencia de las emisiones de Altonorte en los máximos de SO_2 observado tanto en la estación Sur como en La Negra.

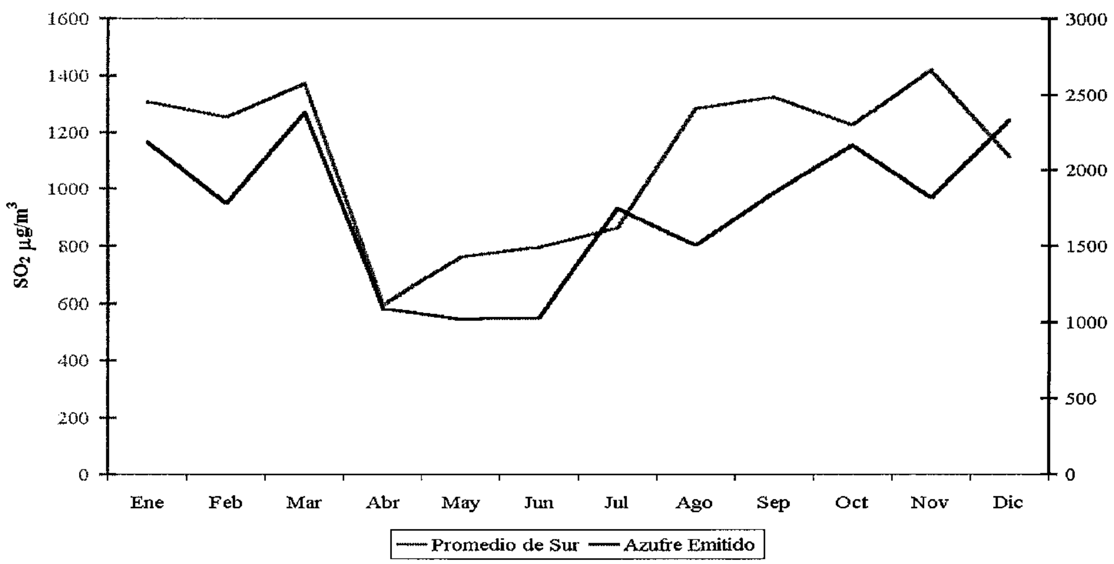

Figura 14. Promedios de los máximos de concentración de SO_2 en la estación Sur y emisiones mensuales de Altonorte para 1999.

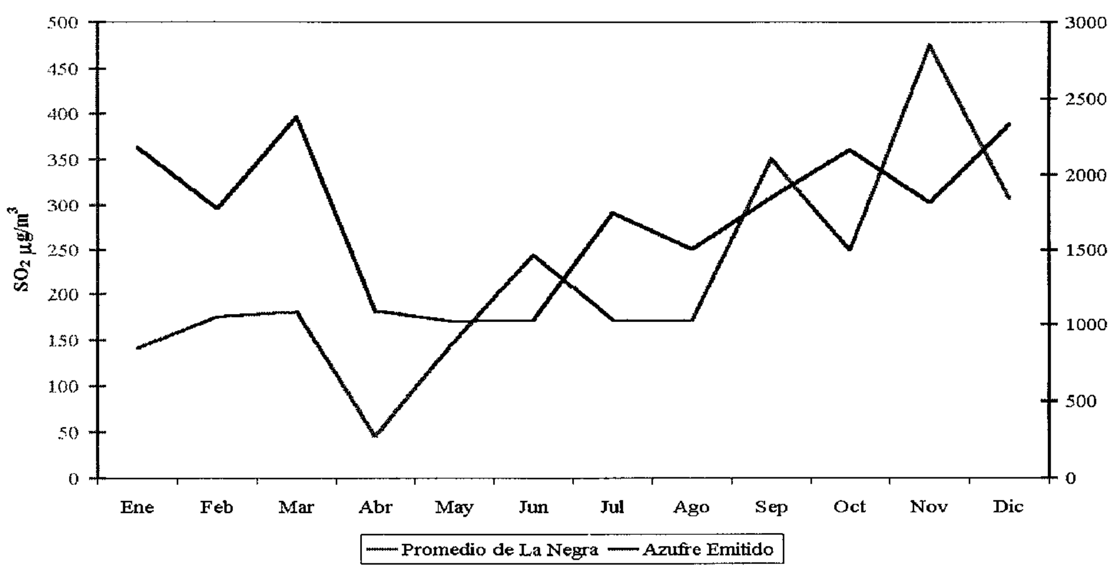

Figura 15. Promedios de los máximos de concentración de SO_2 en La Negra y emisiones mensuales de Altonorte para 1999.

Tanto los promedios diarios como los máximos diarios muestran una correlación más pobre al compararlos con las emisiones diarias reportadas por la fundición. Esta correlación es variable en el año puesto que depende de las condiciones meteorológicas en la zona. Durante el período de Julio a Septiembre, la correlación entre las emisiones y la calidad de aire aparece más evidente que en el resto de los períodos, tanto en la estación Sur como en La Negra. Como se espera una relación entre la emisión y la calidad de aire, se realizó una regresión múltiple entre la calidad de aire, la emisión diaria y una variable reflejando las condiciones meteorológicas, proponiendo la siguiente relación:

$$C_{SUR} = \alpha_{SUR} * Q + \beta_{SUR} * E + \gamma_{SUR}$$
$$C_{NEGRA} = \alpha_{NEGRA} * Q + \beta_{NEGRA} * E + \gamma_{NEGRA}$$

Donde **Q** corresponde a las emisiones y **E** al parámetro de estabilidad que se discutirá más adelante. Dado que las condiciones meteorológicas que afectan las concentraciones en La Negra y en la estación Sur deben ser las mismas, se impuso que $\beta_{SUR} = \beta_{NEGRA}$, quedando la regresión a resolver de la siguiente manera:

$$C_{SUR} = \alpha_{SUR} * Q + \beta * E + \gamma_{SUR}$$
$$C_{NEGRA} = \alpha_{NEGRA} * Q + \beta * E + \gamma_{NEGRA}$$

El parámetro de estabilidad consiste en una mezcla de la radiación solar insidente y la velocidad promedio del viento de manera de reflejar las clases de estabilidad de Pasquill (Seinfeld, 1998) asignando un valor a cada una de acuerdo a las tablas 4 y 5.

Tabla 4. Estimación de las clases de estabilidad de Pasquill (Seinfeld, 1998)

Velocidad del viento a 10m (m/s)	Radiación Solar			Estabilidad Nocturna
	$I > 700$ (W/m^2)	$350 \leq I \leq 700$ (W/m^2)	$I < 350$ (W/m^2)	
<2	A	A – B	B	E
2 – 3	A – B	B	C	D – E
3 – 5	B	B – C	C	D
5 – 6	C	C – D	D	D
>6	C	D	D	D

Tabla 5. Valores asignados al parámetro de estabilidad utilizado en la regresión múltiple.

Clase	Longitud de Monin – Obukhov[3] (m)	Valor (·)
A	-7,5	0,33
B	-13,4	0,41
C	-39,3	0,57
D	∞	0,92
E	36,5	2,33
F	12,2	10,00

La regresión se realizó con la herramienta SOLVER del software MS-EXCEL con una estimación cuadrática, derivadas progresivas, mediante el método de Newton con una tolerancia del 1%, por separado para cada estación. Los resultados obtenidos se presentan en la Tabla 6 donde también se muestra un estimador del error promedio de la estimación respecto de las observaciones.

Tabla 6. Resultados de la regresión múltiple sobre los datos de calidad del aire, emisiones y estabilidad.

Estación	α	β	γ	RMS[4]
SUR	2,03	0,85	38,16	**58 %**
La Negra	0,30	0,85	4,76	**132 %**

Las Figuras 16 y 17 muestran las concentraciones diarias observadas y estimadas mediante la regresión. En estas figuras se observa que existe una relación entre las concentraciones observadas tanto en La Negra como en Sur con las emisiones y las condiciones meteorológicas observadas en el lugar. El Ajuste es mucho mejor en la estación SUR que en La Negra. Esto puede deberse a la cercanía de la estación SUR con la fuente, y por lo tanto las emisiones de Altonorte definen en gran medida las concentraciones en la estación.

Para la estación en La Negra sin embargo, se observa un ajuste no tan bueno en general pero con episodios de ajuste muy bueno. Las diferencias observadas pueden deberse a la presencia de otra fuente en las cercanías, dada la dirección predominante del viento que se discutió anteriormente.

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[3] La Longitud de Monn – Obukhov entrega una medida de la estabilidad atmosférica de la capa de superficie (Seinfeld, 1998):
L > 0 : Estable
L < 0 : Inestable
L = 0 : Neutral

[4] Error promedio simple: $RMS = \sqrt{\frac{\sum_{i=1}^{n}(obs_i - estim_i)^2}{n}}$

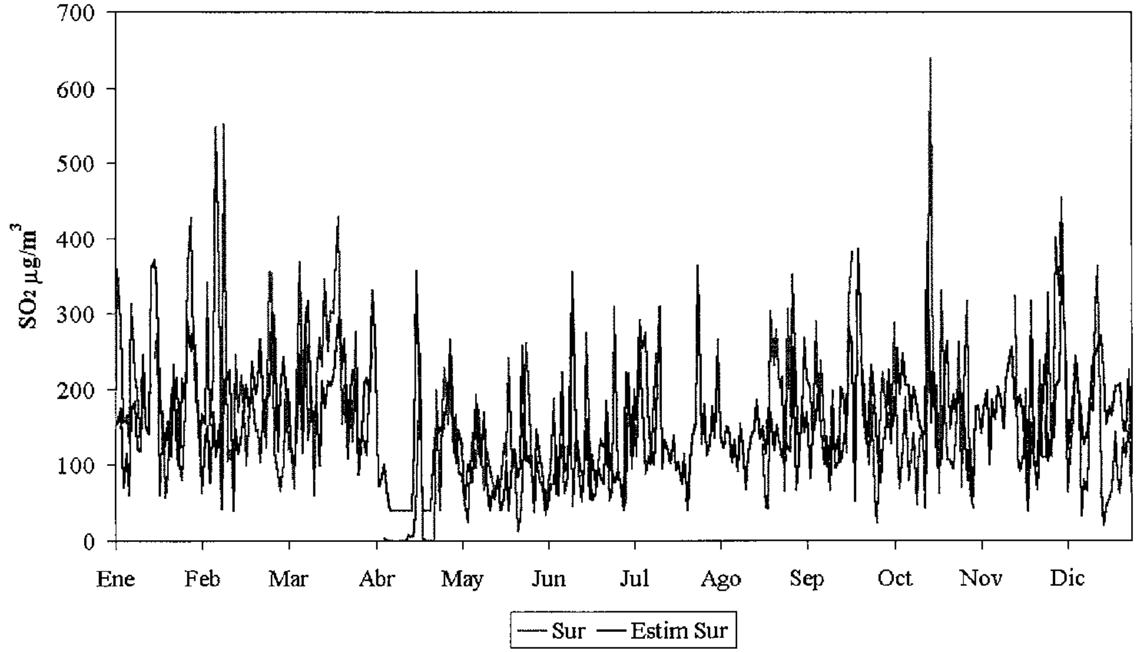

Figura 16. Comparación entre la observación y la regresión de las concentraciones de SO_2 para la estación Sur.

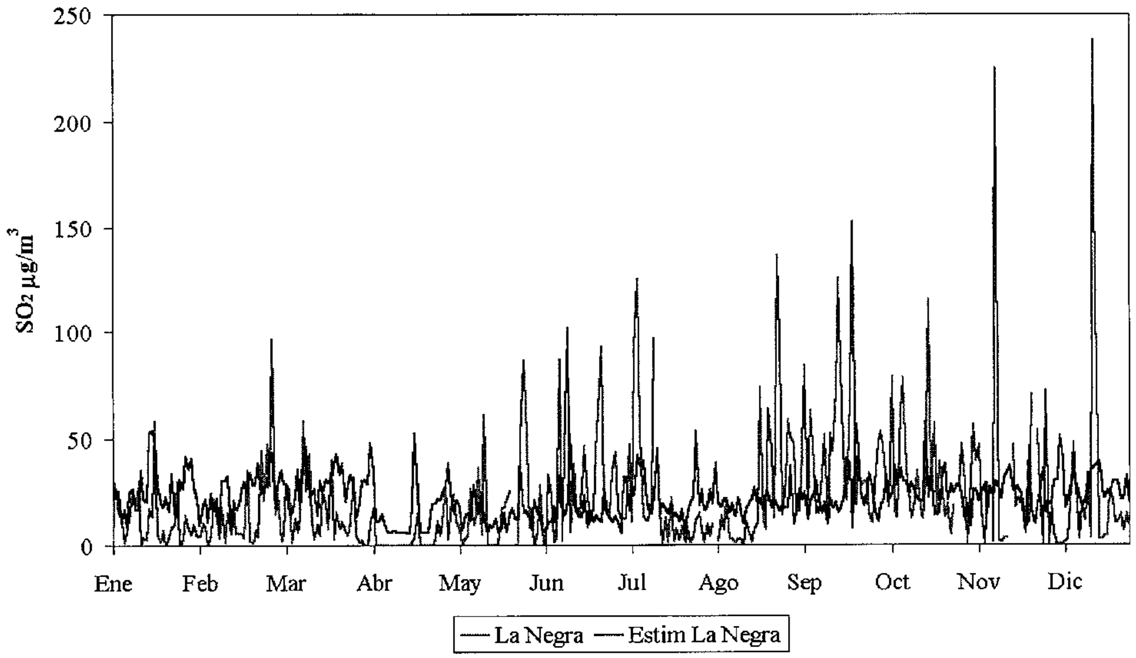

Figura 17. Comparación entre la observación y la regresión de las concentraciones de SO_2 para la estación La Negra.

Por solicitud de CONAMA se confeccionaron los gráficos de emisión – calidad de aire para la estación La Negra de manera de reproducir la Figura 18 que fue presentada por Altonorte en un reporte anterior. Como se observa en la Figura 19, las emisiones corresponden a las reportadas en 1999 sin embargo los datos de calidad de aire aparecen de diferente forma no siendo posible la reproducción del gráfico presentado por la empresa con anterioridad.

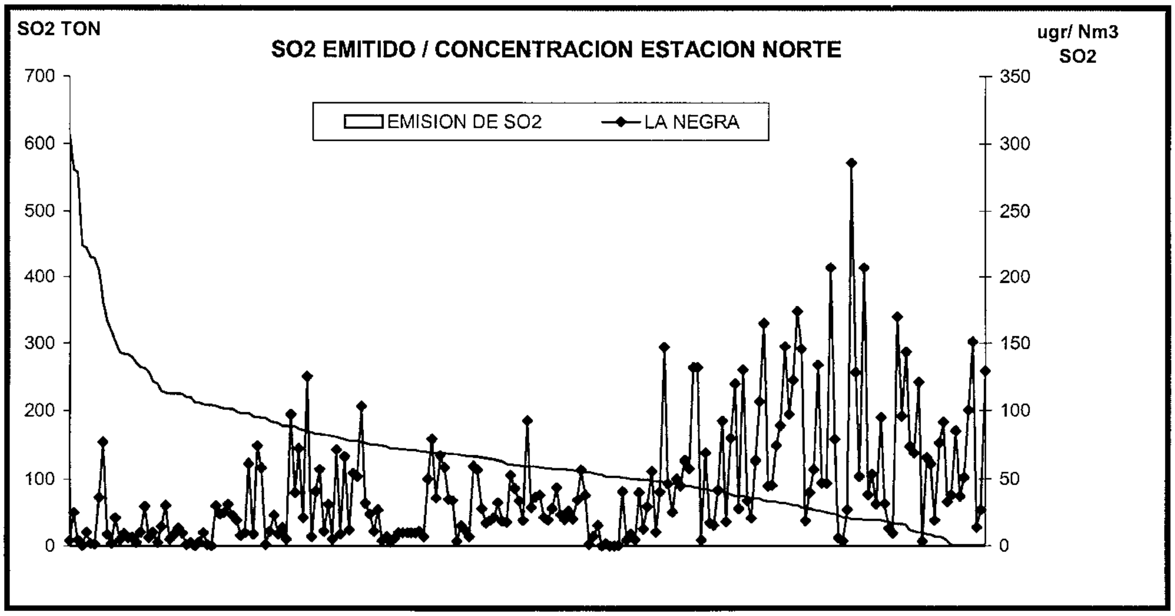

Figura 18. Figura presentada por Altonorte para relacionar la emisión con la concentración de SO_2 en La Negra.

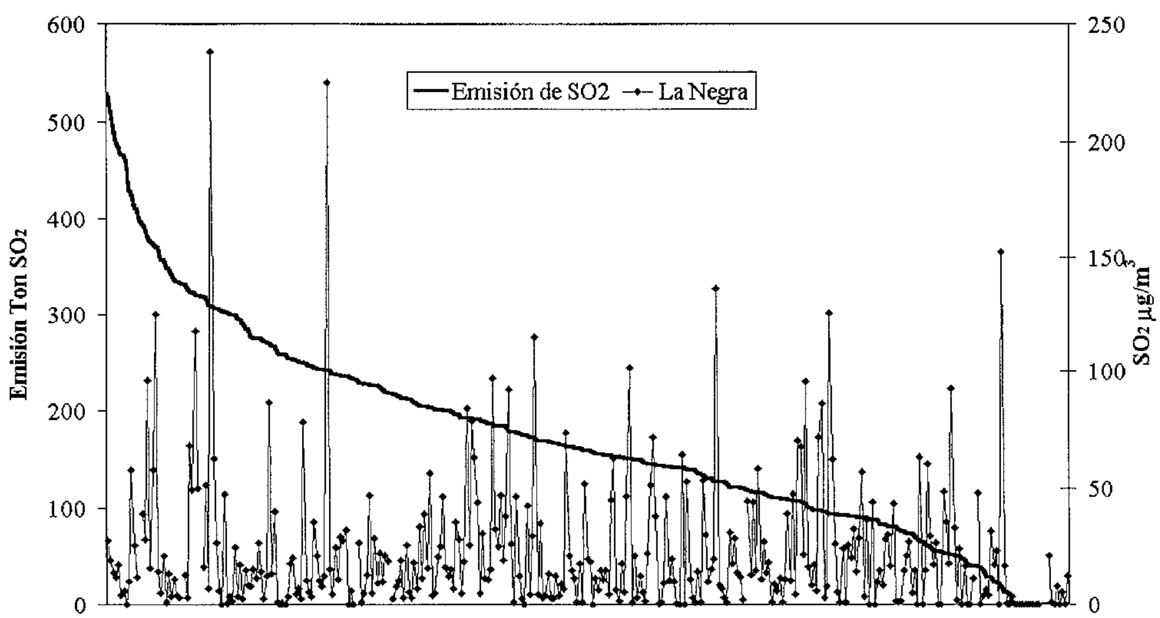

Figura 19. Comparación entre la emisión diaria y el promedio diario de concentración de SO_2 para la estación La Negra, con los datos provistos por CONAMA.

6. Resumen y Conclusiones

Una vez analizada la información disponible se puede concluir lo siguiente:

- La información tanto de emisiones como de calidad de aire presenta problemas de consistencia y confiabilidad derivados probablemente de deficiencias en los procedimientos de validación y verificación de reportes.
- La circulación de aire en la zona de la fundición es desde el poniente de la fundición con velocidades mayores durante la tarde, coincidentes con una mayor radiación solar.
- La presencia de camanchaca durante prácticamente todo el año estabiliza la atmósfera en las horas de la madrugada. Esta estabilidad se rompe en conexión con el comienzo del día y de la radiación solar.
- Las emisiones reportadas en base mensual difieren en más de 900 toneladas de azufre (1800 toneladas de SO_2) anuales con las calculadas a partir de las emisiones diarias reportadas.
- El procedimiento de estimación de emisiones diarias provoca que se obtengan valores negativos de las emisiones de hasta –27 ton/día acumulando un total de –60 toneladas al año.
- Las emisiones diarias de la fundición tienen una alta variabilidad (hasta un 300% entre días consecutivos)
- Las estaciones de calidad de aire se encuentran en las cercanías de la fundición y de una planta de cemento por lo que se espera que reflejen el impacto conjunto de estas fuentes en los sitios de monitoreo.
- Se descartó del análisis a la estación COVIEFI dada la gran cantidad de valores cero reportados (límite de detección del instrumento) y a su ubicación geográfica.
- El máximo de SO_2 se observa en la estación Sur que es la más cercana a la fundición.
- Ambas estaciones muestran un comportamiento similar, en términos de promedios diarios, durante los períodos de mayores concentraciones.
- Se observa una alta variabilidad de los promedios diarios lo cual puede estar relacionado con la alta variabilidad de las emisiones señalada anteriormente.
- El máximo se produce casi siempre en las primeras horas de la mañana luego del amanecer y podría estar relacionado con una estabilización nocturna que impide la mezcla vertical de las emisiones de las chimeneas altas hasta las primeras horas del día en que la capa de mezcla comienza a crecer. Esto se ve soportado por la evolución de los máximos durante el año así como de las horas en que comienza el aumento de concentraciones y la variación de la humedad del aire en las horas de la mañana.
- Existe una relación entre las emisiones de Altonorte y la calidad del aire observada tanto en la estación Sur como en La Negra. Esta relación es más clara en la estación Sur que es la más cercana a la fundición.
- Parámetros meteorológicos de estabilidad también aparecen relacionados con la calidad del aire en la zona.
- Es posible que la estación La Negra esté siendo afectada por otra fuente debido a las diferencias observadas en su comportamiento con la estación Sur.
- Es necesario realizar un análisis integrado de la zona considerando las fuentes emisoras presentes y condiciones meteorológicas definidas.
- Se propone la utilización de un modelo de dispersión de escala local para relacionar las emisiones con la calidad de aire observada en la zona.

7. Referencias

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G. Olivares, Enero de 2001

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OFICINA DE PARTES Y ARCHIVO
Nº INGRESO: 1383 / 1227
FECHA: 15 FEB 2001
DESPACHADO:
P. Matus

ENAMI

VICEPRESIDENCIA EJECUTIVA Nº 15

OF. ORD. Nº 013

31812

ANT. : No hay.

MAT. : Modificación Resolución Nº 1215, Norma de Calidad de Aire por SO_2.

SANTIAGO, Febrero 12 del 2001.

A : SRA. PATRICIA MATUS
JEFE DE DEPARTAMENTO DE PLANES Y NORMAS
CONAMA

DE : VICEPRESIDENTE EJECUTIVO
EMPRESA NACIONAL DE MINERIA

En atención a la reunión sostenida entre representantes de la CONAMA, del Ministerio de Minería y de ENAMI, adjunto remito a Ud. informe correspondiente a la materia indicada, en el cual se presentan los antecedentes generales incluyendo los principales argumentos que determinan la posición de la Empresa Nacional de Minería.

De acuerdo a dichos antecedentes, se presenta además, una propuesta de modificación de la norma, que en un tiempo adecuado puede acercarse a los valores que se indican en la proposición presentada por la CONAMA.

Le saluda atentamente,

EMPRESA NACIONAL DE MINERIA
Vice Presidencia Ejecutivo

Pérez de Arce

JAIME PÉREZ DE ARCE ARAYA
VICEPRESIDENTE EJECUTIVO

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INFORME

REVISION NORMATIVA DE CALIDAD DE AIRE POR SO2 RESOLUCION Nº 1215 DEL AÑO 1978

1.- ANTECEDENTES GENERALES

La CONAMA se encuentra actualmente modificando la Resolución Nº 1215 de 1978, referente a la normativa de calidad del aire por los contaminantes de CO, NO_2, O_3, SO_2 y PTS (Particulas Totales en Suspensión), encontrándose el anteproyecto de norma en su revisión final, y considerando que la principal empresa afectada es la Empresa Nacional de Minería, ya que una restricción de emisiones de SO_2, como se plantea en dicho anteproyecto, trae consigo una serie de problemas para lograr el cumplimiento de la normativa ambiental por parte de sus fundiciones, se entregan las siguientes consideraciones que no hacen recomendable la aprobación del anteproyecto en la forma publicada:

a.- La normativa de SO2, si bien data del año 1978, tuvo su real aplicación a contar del año 1992, año en el cual se promulgó el Decreto Supremo Nº185 del Ministerio de Minería que reguló las fuentes de emisión de dicho contaminante. A partir de este Decreto Supremo se determinaron las zonas saturadas afectadas por Anhídrido Sulfuroso, y en consecuencia, el diseño e implementación de Planes de Descontaminación en las fundiciones de Cobre de Chile.

Los costos involucrados en descontaminar las fundiciones de Cobre de ENAMI ascendieron a un valor superior a los US$ 170 millones. El hecho que el anteproyecto elaborado por la CONAMA este considerando rebajar los actuales valores de la Normativa Diaria de 365 a 250 ugr/Nm^3 e imponiendo una nueva normativa horaria de 1050 ugr/Nm^3 conlleva un alto costo al país y constituye a nuestro entender una desviación del principio de gradualidad establecido en la ley 19.300, Ley de Bases Generales del Medio Ambiente.

b.- La Empresa en consideración a su delicada situación financiera se ve impedida en el mediano plazo de hacer inversiones en nuevos planes de descontaminación del aire para lograr cumplir los nuevos valores normativos propuestos por CONAMA, debiéndose estipular, en dicho caso, la alternativa real de detener en forma permanente las actividades de la Fundición en Paipote, alternativa que involucra, además de los costos económicos para el país, un altísimo costo social.

En cuanto a la Fundición y Refinería Ventanas, esta se vería afectada por la necesidad de disminuir su nivel de producción en un valor estimado en un 15%, con un costo de varios millones de dólares.

c.- La preocupación por el medio ambiente de las fundiciones de cobre del país no solo se ha manifestado en realizar esfuerzos por cumplir la normativa actual, sino que se ha hecho cargo de otros temas más allá de la legalidad, ello se manifiesta en que al menos 5 de las 7 fundiciones existente en el país se encuentran actualmente implementado las Normas ISO 14.000. Al respecto es sabido que uno de los requisitos fundamentales para obtener la certificación ISO14.000 es el cumplimiento de la legislación. El hecho que valores más restrictivos de Norma diaria y horaria de SO2 sean impuestos, conlleva posibles atrasos o perdida de las certificaciones esperadas teniendo como consecuencia un menoscabo de la imagen exterior y pérdida de competividad del cobre chileno

d.- Es necesario mencionar que en un país desarrollado como E.E.U.U se mantiene una normativa ambiental para el SO2 en el aire, de menor exigencia que la normativa propuesta por la CONAMA en Chile, en efecto, en los Estados Unidos de América, en los estados donde existen fundiciones de Cobre (Arizona y Texas), se mantienen normativas iguales a las que actualmente rigen en Chile, y más aún, se considera como secundaria, una normativa promedio de tres Horas en 1300 ugr/Nm3 para calidad de aire.

e.- Los resultados del monitoreo de calidad del aire de los últimos meses indica que los niveles de calidad del aire han sido desfavorables respecto de las estadísticas de años anteriores, habiendo un fuerte incremento de los niveles diarios y horarios de SO_2 (anexo 1). Lo anterior reafirma la dependencia de cumplimiento de la norma de factores no controlables al 100 % por las fundiciones, motivo por el cual el cumplimiento de las normativas diarias y horarias propuestas se dificultan fuertemente.

2.- PROPOSICION ENAMI

En atención a lo anteriormente expuesto, se propone el siguiente esquema para la aplicación de las normas, para consideración de la CONAMA:

a.- Norma diaria de SO2

Valor Ugr/Nm3	Vigencia años
365	2001
330	2002 - 2005
290	2006 - 2009
250	A partir del 2010

Se considera un percentil de cumplimiento de 99%, con una excedencia máxima del 1%, para cada periodo anual calendario.

b.- Norma horaria de SO2

Valor Ugr/Nm3	Vigencia años
1965	2001
1800	2002 - 2005
1650	2006 - 2009
1500	A partir del 2010

Se considera un percentil de cumplimiento de 99%, con una excedencia máxima del 1%, para cada periodo anual calendario.

En cuanto a la fecha de entrada en vigencia de las normativas, debido a que los criterios de superación se calculan en base anual, se sugiere que el decreto de promulgación de la nueva normativa de Anhídrido Sulfuroso entre en vigencia el día 1º de Enero del año siguiente a la publicación de este en el diario oficial, razón por la cual se podrían modificar los años indicados en las tablas precedentes.

HBV / ADV.

RESUMEN CUMPLIMIENTO NORMATIVA DIARIA FUNDICION Y REFINERIA VENTANAS

Cumplimiento año 1999

MES	250-275	275-300	300-325	325-350	350-365	> 365
Enero						
Febrero						
Marzo						1
Abril						
Mayo		2				
Junio						
Julio						
Agosto						
Septiembre		1				
Octubre						
Noviembre						
Diciembre						
Sub-Total	0	3	0	0	0	1
Total	4	4	1	1	1	1

Cumplimiento año 2000

MES	250-275	275-300	300-325	325-350	350-365	> 365
Enero						
Febrero						
Marzo						
Abril				1		
Mayo						
Junio	1					
Julio			1			
Agosto						
Septiembre						
Octubre						
Noviembre	2		1			
Diciembre	2	1				1
Sub-Total	5	1	2	1	0	1
Total	10	5	4	2	1	1

Cumplimiento año 2001

MES	250-275	275-300	300-325	325-350	350-365	> 365
Enero	3	2	2	3		
Febrero						
Marzo						
Abril						
Mayo						
Junio						
Julio						
Agosto						
Septiembre						
Octubre						
Noviembre						
Diciembre						
Sub-Total	3	2	2	3	0	0
Total	10	7	5	3	0	0

RESUMEN CUMPLIMIENTO NORMATIVA HORARIA FUNDICION Y REFINERIA VENTANAS

Cumplimiento año 1999

MES	1000-1200	1200-1400	1400-1600	1600-1800	1800-1963	> 1963
Enero			1			
Febrero						
Marzo	2		1			2
Abril	3		1			
Mayo	2		2		1	
Junio	3					1
Julio	1	1	3			
Agosto	1					1
Septiembre						2
Octubre	1					
Noviembre	2	1				
Diciembre	7	2	1			1
Sub-Total	**22**	**4**	**9**	**0**	**1**	**7**
Total	**43**	**21**	**17**	**8**	**8**	**7**

Cumplimiento año 2000

MES	1000-1200	1200-1400	1400-1600	1600-1800	1800-1963	> 1963
Enero	1					2
Febrero	5	1				2
Marzo	2		1	1		2
Abril	2	2				1
Mayo	1	1	3			1
Junio	2					
Julio	4	1				
Agosto	3	1				
Septiembre		1	2		1	
Octubre	1	1		1		
Noviembre	4	3	6	1		3
Diciembre	15	7	8	3		2
Sub-Total	**40**	**18**	**20**	**6**	**1**	**13**
Total	**98**	**58**	**40**	**20**	**14**	**13**

Cumplimiento año 2001

MES	1000-1200	1200-1400	1400-1600	1600-1800	1800-1963	> 1963
Enero	16	3	6	9	4	4
Febrero						
Marzo						
Abril						
Mayo						
Junio						
Julio						
Agosto						
Septiembre						
Octubre						
Noviembre						
Diciembre						
Sub-Total	16	3	6	9	4	4
Total	42	26	23	17	8	4

GOBIERNO DE CHILE
COMISION NACIONAL
DEL MEDIO AMBIENTE

Con fecha 30 de Enero del 2001 se archiva bajo el número que a continuación se indica, el siguiente antecedente para la Revisión de las Normas Primarias de Calidad de Aire para CO, 03, NO2, SO2 y PTS:

11. NORM-1/01 "Análisis General del Impacto Económico y Social de las Normas de calidad de Aire de Partículas Totales en Suspensión (PTS), Ozono (03), Anhídrido Sulfuroso (SO2), Monóxido de Carbono (CO) y Dióxido de Nitrógeno (NO2).

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Depto. Descontaminación , Planes y Normas
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RESUMEN EJECUTIVO[1]

Análisis general del impacto económico y social de las normas de calidad primaria de aire de partículas totales en suspensión (PTS), Ozono (O_3), anhídrido sulfuroso (SO_2), monóxido de carbono (CO) y dióxido de nitrógeno (NO_2)

Introducción

El establecimiento de una nueva norma de calidad significa la fijación de una meta para la gestión ambiental. En algunas áreas desencadenará mejoramientos de la calidad ambiental (por ejemplo como resultado del establecimiento de un plan). Desde otro punto de vista, las normas también significan la aceptación de niveles de riesgo, ya que fija el límite bajo el cual no se realizarían esfuerzos de control de emisiones.

Las normas de calidad no implican exigencias inmediatas a las fuentes generadoras de la contaminación, sino que mediante el establecimiento de medidas dentro de planes o directamente a través de normas de emisión. Este hecho significa que para evaluar los impactos se deben estimar estas medidas (en cuanto a niveles de reducción y plazos). Es más, según lo establece la Ley 19.300, la excedencia de una norma de calidad no basta para suponer que el Estado establecerá exigencias a las fuentes emisoras; será necesario nuevos estudios y decisiones posteriores.

Estos antecedentes permiten entender por qué la presente evaluación de los impactos de las normas de calidad de aire contenidas en la Resolución N° 1215/78 del MINSAL se referirá a costos de cumplimiento para emisores, impactos evitados y riesgos aceptados en salud asociados a los valores propuestos. En los costos e impactos evitados la evaluación considera un escenario de reducción y el cumplimiento de la calidad en un plazo breve, cuyo objetivo es evaluar el escenario más estricto en cuanto a cumplir con las normas que se están fijando. Estos plazos no reflejan, y no buscan hacerlo, un juicio sobre la pertinencia de un futuro plan de descontaminación en un área determinada.

La evaluación se realizó sobre la base de la información de monitoreo de calidad de aire disponible en el país, las metodologías normalmente en uso para este tipo de evaluaciones y la información recopilada en el proceso de elaboración de los anteproyectos.

El presente informe se concentra en los impactos en los emisores y en las poblaciones afectadas del anhídrido sulfuroso (SO_2) y el contaminante ozono (O_3). Las restantes modificaciones (PTS, CO y NO_2) no generan impactos cuantificables en el país para los emisores y las poblaciones humanas, según las metodologías y la información disponibles en CONAMA.

Este informe se realiza para dar cumplimiento con los requisitos de la Ley y el Reglamento para la dictación de normas de calidad ambiental e informar el proceso de toma de decisiones con antecedentes de los impactos técnicos y económicos asociados a las propuestas incluidas en los anteproyectos.

Mas detalles de los cálculos de costos y beneficios aquí señalados están disponibles en el informe final y anexo.

[1] El presente informe fue preparado en la Unidad de Economía Ambiental (UEA) de CONAMA. El desarrollo de los cálculos estuvo a cargo de la Srta. Sandra Moreira (beneficios) y del Sr. Nicolás Chacón (emisiones y costos). La coordinación general y responsable del informe es el profesional de la UEA Sr. Juan Ladrón de Guevara. Cualquier consulta dirigirla al responsable del informe al correo electrónico jladron@conama.cl o al fono (56-2) 2405690.

SO_2

1. Antecedentes

La mayor atención respecto del efecto del SO_2 se concentra en analizar los efectos agudos en exposiciones inferiores a 10 minutos. La literatura se concentra en demostrar y describir los efectos en el rango de 600 a 1.000 ppb para este tiempo de exposición. No obstante, se señala que hay evidencia de efectos en humanos a niveles inferiores.

Niveles de 10 minutos sobre 600 ppb ocurren en nuestro país sólo en el entorno de algunas fundiciones de cobre (Altonorte, Paipote, Ventanas y Caletones).

En términos epidemiológicos, se han establecido relaciones confiables entre promedio diarios y anuales y mortalidad y morbilidad aguda. Estos antecedentes fundamentan la fijación de valores de norma para estos promedios. Si bien la OMS recomienda un valor igual al 50% del valor diario propuesto, reconoce que nuevas investigaciones señalan la existencia de efectos aún bajo su recomendación, pero bajo ciertas condiciones (presencia de otros contaminantes).

En Talcahuano y en el entorno de las fundiciones antes señaladas se verifican niveles diarios sobre los valores guía de OMS y sobre la norma propuesta.

2. Descripción de los efectos o riesgos aceptados asociados a los valores de norma horaria propuesta

Según nuestra legislación, concentraciones inferiores a la norma de calidad no permiten al Estado el establecimiento de medidas para controlar emisiones de fuentes existentes, excepto medidas voluntarias y/o preventivas en el rango de la latencia.

Esto permite identificar un primer efecto de la incorporación de una norma horaria, que es la aceptación de niveles de contaminación bajo el límite propuesto (y bajo los límites establecidos en las normas vigentes o en otras normas propuestas), y por lo tanto, la aceptación de riesgos a la salud.

En teoría todas las áreas pobladas del país podrían llegar a concentraciones iguales a la norma sin mediar el establecimiento de medidas de control de emisiones.

Esta situación hipotética es posible de descomponer con el objeto de observar mejor las magnitudes de los riesgos que se aceptan.

- Lugares donde positivamente ocurrirá este efecto: áreas que hoy superan la norma horaria propuesta y que fruto de la norma redujeran hasta dicho valor. Este es el caso de las fundiciones de cobre mencionadas anteriormente;

- Lugares donde se tiene información y probablemente ocurrirá el efecto: caso de Talcahuano ante, por ejemplo, repunte de la actividad de la harina de pescado o desarrollo de nuevas fuentes;

- Resto de áreas urbanas, donde no es posible prever en el mediano plazo la aparición de áreas que eleven su contaminación a valores de norma. Para ponderar este escenario debe considerarse la existencia de un sistema de evaluación de impacto ambiental de nuevos proyectos, la existencia de normativa de SO_2 secundaria, de otras normas o medidas que pueden obligar de manera indirecta la reducción de emisiones de este contaminante (reducción de azufre en diesel) y la disponibilidad del gas natural en varias zonas industriales del país.

Como se verá a continuación, en las áreas donde positivamente la concentración horaria estará cercana a la propuesta de norma y basándose en la literatura médica, debieran seguir existiendo efectos adversos a la salud, principalmente en poblaciones asmáticas o con enfermedades crónicas al pulmón.

a) Relación norma horaria/máximos 10 minutos en mediciones de calidad de aire en fundiciones

La norma se expresa como promedio horario de 400 ppb. Como los efectos de corto plazo ocurren en los primeros 10 minutos (o antes), para identificar los efectos que perduran con la norma propuesta es necesario conocer el nivel máximo (para esta fracción de tiempo) que implícitamente la norma está fijando. Esta relación es particular para cada área donde la norma horaria tendrá efectos.

Tomando preliminarmente datos del entorno de Puchuncaví del año 1999 se obtiene que un promedio horario de 400 ppb lleva asociado generalmente un peak de 10 minutos 2,5 veces mayor (1.000 ppb). Por lo tanto, se puede asumir que la norma no evitará la ocurrencia de los efectos en salud que se pueden producir bajo el nivel de 1.000 ppb en 10 minutos.

b) Descripción de los efectos remanentes ocasionados bajo 1.000 ppb en 10 minutos

A partir de la literatura internacional (OMS, EPA, entre otros) se puede construir el siguiente cuadro (cuadro i.) que describe los efectos que podrían ocurrir ante la presencia de concentraciones de 10 minutos de 1.000 ppb. Se asume que estas concentraciones ocurrirán con los valores propuestos de norma horaria de 400 ppb en el entorno de las fundiciones de Altonorte, Paipote y Ventanas.

Cuadro i: Descripción de efectos agudos remanentes por exposiciones inferiores a 10 minutos

Grupo de Riesgo y nivel de exposición	**Tipo de Efecto**	**Factores agravantes**	**Factores atenuantes**
Asmáticos leves y moderados (niños, adolescentes y adultos) a nivel de 600 a 1000 ppb	Ante esfuerzos moderados un **porcentaje mayor a 20-25%** de este grupo presentará "cambios en la función respiratoria" y "síntomas respiratorios graves" que claramente son superiores a aquellos que experimentan en la variación diaria normal de la función pulmonar (producto del asma) o en respuesta a otros estímulos. **Estos síntomas son percibidos como una "dificultad respiratoria" pero no lo suficientemente grave como para ir a atención médica de urgencia**	• Tasa de cumplimiento del uso de inhaladores baja • Mayor riesgo en caso de respiración por la boca (en USA representa el 15% de asmáticos)	• Efecto inhibido por inhaladores (beta agonistas) • Efecto de broncoconstricción es más leve en zonas cálidas y húmedas que frías y secas. • Respuesta se acaba con el tiempo (1 hora después de acabada la exposición), y es más rápida si se usa inhalador • No hay evidencia de aumento de sensibilidad posterior ("respuesta tardía") • Después de este tipo de crisis pueden seguir desarrollando actividades con normalidad • Probabilidad de existencia de "periodo refractario" (menor sensibilidad después de una exposición aguda)
Asmáticos graves y asmáticos "intrínsecos" (tercera edad) a nivel de 600 a 1.000 ppb	Las reducciones en las funciones tienen mayores impactos cuando línea base pulmonar es inferior. Los efectos serán mayores que en asmáticos leves.		• No son suficientemente activos por la baja tolerancia al esfuerzo y por lo tanto no expuestos al SO_2 ambiental. • Se medican regularmente antes de involucrarse en actividades físicas
Sanos a nivel de 600 a 1.000 ppb	No se ha demostrado efecto en reposo o con esfuerzo en la mecánica respiratoria bajo 1.000ppb		
Sanos a nivel de 1.000 ppb	Pequeños cambios en función pulmonar (incrementos en resistencia especifica en vías respiratorias (sRAW))		

c) *Lugares y número de veces que debiera ocurrir el efecto remanente (número de veces bajo 1.000 ppb y sobre 600 ppb 10 minutos)*

Los episodios de alta concentración horaria ocurren una vez al día en las áreas analizadas. El número de veces que estos episodios están en el rango 240 y 400 ppb promedio horario (o 600 y 1.000 ppb en 10 minutos respectivamente), tomando datos de 1999 son los señalados en el cuadro ii.

Cuadro ii: Frecuencia que ocurrirían los efectos agudos remanentes descritos (600 y 1000 ppb en 10') en las áreas de impacto de las fundiciones afectadas.

Lugar	N° veces que concentración horaria está entre 240 y 400 ppb[1]
Fundición Hernán Videla Lira	
Paipote	24 veces/año
Tierra Amarilla	17 veces/año
Copiapó	4 veces/año
Fundición Ventanas	
Los Maitenes	40 veces/año
La Greda	11 veces/año
Valle Alegre	3 veces/año
Puchuncaví	5 veces/año
Fundición Altonorte	
La Negra	15 veces/año
Fundición Caletones	
Coya Población	0 veces/año

Nota 1: Se asume que el 100% de las veces que se observa este rango de concentración horaria se daría un *peak* de 10 minutos 2,5 veces más grande.

d) Incertidumbres sobre el daño remanente por la norma horaria de 400 ppb: Situación de asmáticos

La principal fuente de incertidumbre es la información sobre prevalencia de asmáticos en Chile y en particular en las áreas analizadas. Los porcentajes y la gravedad de los síntomas señalados en el cuadro i) puede variar en las condiciones locales donde se excederían los valores de 10'. No se dispuso de antecedentes que pudieran confirmar o modificar (reducir o aumentar) las cifras y descripciones de dicho cuadro.

3. Descripción y cuantificación de los efectos remanentes asociados a la propuesta de norma diaria de 95 ppb.

El origen de esta norma es la relación epidemiológica entre variaciones diarias de mortalidad y morbilidad aguda y promedios de 24 horas de SO_2, en presencia de MP y otros contaminantes. Por lo tanto los beneficios atribuibles a la norma diaria es la reducción en los casos de mortalidad y morbilidad descritos para cambios en el promedio de 24 horas.

El valor propuesto corresponde al LOAEL (lowest-observed-adverse-effect-level) de la OMS, por lo tanto es esperable que bajo norma los efectos remanentes sean mínimos. Estudios recientes (citados en OMS, 2000[2]) encuentran de manera consistente efectos bajo 125 ug/m^3 (la mitad del nivel LOAEL, que es el valor guía de la OMS) y no obtienen un valor umbral para esta media. Por lo tanto, se puede esperar la ocurrencia de los efectos descritos (mortalidad prematura y admisiones hospitalarias respiratorias por neumonía, pulmonar obstructiva, por asma y cardioisquémica).

Cuantificación de efectos remanentes de norma diaria

Considerando las funciones concentración respuesta utilizadas más adelante para cuantificar los efectos evitados, es posible estimar los efectos que seguirán existiendo una vez alcanzada la norma diaria propuesta en algunas de las áreas de concentración de SO_2 conocidas.

En este ejercicio se considera tanto la inexistencia de umbral, que es lo normal al emplear estas funciones (por ejemplo las evaluaciones de EPA, 1997 y de los planes de Caletones y Potrerillos realizados en CONAMA), como la existencia de uno fijado al valor de norma propuesto por OMS (50% del LOAEL, 47,7 ppb). El riesgo asociado al valor de norma propuesto en Chile se señala como "porcentaje de los casos totales que se atribuyen al SO_2". Estos valores son los siguientes.

Cuadro iii. Porcentaje de efectos atribuibles al SO_2 una vez alcanzada la norma horaria en el área de impacto de Paipote, expresado como porcentaje del total de efectos observados con y sin umbral.

Efectos	% atribuible al contaminante sobre los efectos totales	
	(sin umbral)	(con umbral)
Mortalidad prematura	11,55%	6,21%
Admisión Hospitalaria (ICD 460-519)	11,45%	6,11%
Admisión Hospitalaria Neumonía	12,7%	6,91%
Admisión Hospitalaria Pulmonar Obstructiva	4,09%	2,24%
Admisión Hospitalaria Asma	30,23%	16,26%
Admisión Hospitalaria Cardio Isquémica	15,48%	8,41%

Nota: Para este cálculo se tomaron las funciones concentración respuesta empleadas para el cálculo de los beneficios de la reducción de emisiones.

Como se observa, los porcentajes de casos atribuibles al SO_2 a niveles de la norma son relativamente altos para el caso de Paipote. Estas cifras tienen sesgos importantes dado que se está extrapolando una función estimada para rangos superiores de concentración.

4. Cuantificación de los efectos asociados a las eventuales reducciones de emisión por la norma horaria y diaria de SO_2 propuesta (análisis costo beneficio tradicional)

Las zonas donde las modificaciones de la norma para SO_2 puede gatillar nuevas reducciones de emisión y de concentraciones de contaminantes, en relación a las normas vigentes, son las áreas de impacto de la

[2] WHO (2000) Guidelines for air quality. Geneve.

Fundición Altonorte de Noranda, Fundición Hernán Videla Lira (Paipote) y Ventanas de ENAMI y Fundición Caletones de la División Teniente de CODELCO Chile. En estos casos la norma horaria domina la reducción (cumpliendo la horaria se cumple la diaria). A esto se agrega la ciudad de Talcahuano que probablemente deberá reducir la concentración de contaminantes para lograr con la norma diaria propuesta.

Para cuantificar los efectos agudos que se evitarán al alcanzar las metas de calidad propuestas se emplean las funciones concentración respuesta determinadas a través de estudios epidemiológicos. Estas funciones estiman cambios en mortalidad aguda y admisiones hospitalarias por causas respiratorias a partir de cambios en el promedio de 24 horas. Se considera la población total, según rangos de edad.

Para determinar el cambio en el promedio diario (valor que ingresa a la función) para el caso de las fundiciones consideradas, se estimó el cambió en este valor que ocurre después de controlar las excedencias horarias.

Para determinar los costos que deberán incurrirse para lograr la meta propuesta en cada caso, se identificó la reducción de emisión asociada a cada meta de calidad, se identificó la opción tecnológica de menor costo que permite reducir dicha emisión y se valoró económicamente. Se asume además que dichos esfuerzos de reducción empezarían en un plazo de 2 años. (2003).

a) SO_2 En Copiapó y Tierra Amarilla

La zona de impacto de las emisiones de la Fundición Paipote son las comunas de Copiapó y Tierra Amarilla. El cálculo de los costos se hizo en base a estimaciones de los costos de reducción de fusión para el control de las excedencias de la norma horaria y diaria. Además se consideró como costo el perfeccionamiento de un modelo de pronóstico que permitiría minimizar las reducciones de fusión. No se consideró el desarrollo de inversiones porque los costos estimados por esta vía cumplen el objetivo a un menor valor presente. Las estimaciones de costos y beneficios son las siguientes.

Cuadro iv. Costos y Beneficios cuantificados para SO_2 en Copiapó y Tierra Amarilla 2000-25 (en US$ 2000)

	VP de los beneficios netos	**VP de los costos**
	Mediana (Percentil 5% y 95%)	Valor central de estimación
Propuesta	**$ 1,820,949** ($539,240 y $4,734,788)	**$ 6.952.310**

b) SO_2 en área de impacto de Fundición Ventanas (comuna de Puchuncaví)

Al igual que en Paipote, los costos de la Fundición Ventanas de ENAMI se estimaron suponiendo bajas de fusión para control de excedencias horarias y el desarrollo de modelos de pronóstico. Los resultados son los siguientes.

Cuadro v. Costos y Beneficios cuantificados para SO_2 en área de impacto de Fundición Ventanas 2000-25 (en US$ 2000)

	VP de los beneficios netos	**VP de los costos**
	Mediana (Percentil 5% y 95%)	Valor central de estimación
Propuesta	**$ 82.779** ($25.219 y $215.474)	**$ 3.042.220**

Existen antecedentes que señalan que hay efectos de la emisión de Ventanas en la ciudad de Viña del Mar y Valparaíso, pero no fue posible construir una relación emisión calidad que permitiera dar cuenta de la ganancia ambiental en estas ciudades asociada a la reducción de emisiones. Los valores de concentración ambiental con que impactan las emisiones de la Fundición son inferiores a los valores de norma horaria y diaria y muy probablemente inferiores a los niveles propuestos por OMS como promedio diario.

c) SO_2 en área de impacto de Caletones con estación Coya Club como EMRPG

El monitor de máximo impacto de las emisiones de Caletones es el monitor de Coya Club. La implementación de la norma horaria en este monitor significa impedir o modificar el proyecto de expansión de la Fundición del año 2003 y aumentar el porcentaje de captación de azufre. Por lo tanto, el impacto económico de la presente norma se puede estimar como una reducción en el VPN del proyecto original al tener que optar por otra alternativa de menor VPN pero que cumpla con las normas propuestas.

La norma horaria significará una reducción permanente respecto del escenario base (con proyecto de expansión el 2003) que beneficia a toda el área de impacto de las emisiones.

Por otro lado, es importante mencionar que el monitor de Coya Club posee mediciones más altas que las concentraciones que estarían percibiendo la población de la localidad de Coya. En la eventualidad que la estación Coya Club dejara de ser válida para efectos de declarar zonas saturadas o latentes, la norma horaria no tendría costos.

Los costos y beneficios estimados del escenario con la estación Coya Club vigente es el siguiente:

Cuadro vi: Costos y Beneficios cuantificados para SO_2 en área de impacto de Caletones 2000-25 (comuna de Machalí; en US$ 2000)

	VP de los beneficios netos	**VP de los costos**
	Mediana (Percentil 5% y 95%)	Valor central de estimación
Propuesta	**$ 1.106.308** ($317.991 y $2.850.343)	**$ 214.000.000** [1]

Nota: El valor del impacto real debiera ser menor, dado que no se dispuso de un análisis exhaustivo de las opciones tecnológicas ante una norma horaria. Esto obligó a tomar un escenario de aborto del plan de expansión, dejando de lado otras opciones presumiblemente de menor costo como cambio de tecnología.

d) SO_2 en Noranda

Esta fuente se lleva el menor costo asociado al control de excedencias de la norma horaria con bajas de fusión. Por su parte los beneficios son prácticamente cero dado la poca población del área de impacto.

Cuadro vii: Costos y Beneficios SO_2 en Noranda/La Negra 2000-25 (en US$ 2000)

	VP de los beneficios netos	**VP de los costos**
	Mediana (Percentil 5% y 95%)	Valor central (+- 32,1% error)
Propuesta	**$ 109** ($40 y $306)	**$ 2.101.391** ($1.195.401 y $1.803.313)

e) SO_2 Total Fundiciones

Considerando los antecedentes anteriores, la cuantificación de costos y beneficios totales se presenta en el cuadro viii. El costo se atribuye casi en su totalidad (>98%) a la propuesta de norma horaria.

Cuadro viii: Costos y Beneficios propuestas de normas de SO_2 para fundiciones 2000-25 (US$2000)

Propuesta	**VP de los beneficios netos**	**VP de los costos**
	Mediana (Percentil 5% y 95%)	Valor central de estimación
Anteproyecto	**$ 3.010.145** ($882.490 y $7.803.911)	**$ 226.095.921**
Anteproyecto s/E Coya Club	**$1.903.837** ($564.499 y $4.953.568)	**$ 12.095.921**

f) SO_2 en Talcahuano

En el caso de Talcahuano la norma diaria es la que domina la reducción, y por lo tanto, la que explica el 100% de los costos y beneficios. Considerando los datos de calidad del año 1999, las reducciones en la calidad y en la emisión total para lograr el valor propuesto en la estación "bomberos", son del orden de un 18% respecto de los valores de ese año.

Según antecedentes proporcionados por las propias fuentes afectadas, dichas reducciones se podrían lograr holgadamente con cambio de combustible a gas natural o petróleo diesel en Huachipato, Petrox, en las empresas pesqueras y las otras fuentes del área. En los casos de Huachipato y Petrox dicho cambio ya existe, y en el caso de las pesqueras se espera que algunas se modifiquen en el mediano plazo. De este modo, la excedencia a la propuesta de norma podría no ser tal en el futuro, y por lo tanto, los costos y beneficios de la norma ser cero.

Argumentos a favor de la independencia del cambio de combustibles respecto de la norma diaria propuesta son que constituye también una medida para reducir emisiones de MP10 y de un costo relativamente bajo en el mediano y largo plazo en comparación con combustibles limpios derivados del petróleo.

En la eventualidad de persistir la excedencia a la norma propuesta, un eventual plan por SO_2 podría cumplirse exigiendo un cambio de combustibles en un 42% de las calderas de las fábricas de harina de pescado que no lo hayan hecho, lo cual es tecnológicamente factible y significa costos del orden de los US$ 12,8 millones (expresados como VPN a 25 años y US$ del 2000).

Estas conclusiones son válidas incluso ante una recuperación de la industria de harina de pescado a los niveles máximos históricos.

En la eventualidad de un plan para cumplir norma diaria, los beneficios asociados a la reducción de emisiones son del orden US$15 millones (expresados como VPN a 25 años y dólares del 2000).

Impactos totales de los cambios propuestos a la norma de SO_2

Finalmente, se resumen los efectos que tendrá las modificaciones propuestas en el anteproyecto de norma de calidad de SO_2. El siguiente cuadro muestra el resumen con los impactos no cuantificados y cuantificados asociado a la norma diaria y horaria propuesta.

Cuadro ix: Resumen de impactos de las modificaciones de la norma de SO_2

Area de impacto	Beneficios		Costos	
	Cuantificados (VPN en US$ 2000)	**No cuantificados**	**Cuantificados** (VPN en US$ 2000)	**No cuantificados**
Norma horaria de 400 ppb				
Impacto por las eventuales reducciones de emisión en Fundiciones y entorno	US$ 2.972.068[1] (1.106.308+1.865.760)[3] en efectos en salud evitados (cuantificados y no cuantificados) en áreas de impacto de fundiciones afectadas (mortalidad y morbilidad)	Reducción significativa en cantidad de "ataques de asma" en personas con la enfermedad (de leve a grave) que redundan en costos por medicamentos, reducciones en las actividades y que no significan hospitalizaciones	US$ 225.854.002[2] (214.000.000 + 11.854.002)[3] en reducciones en la producción de cobre fino e inversiones para cumplir norma horaria	Eventuales reducciones en la vida útil de algunos equipos.
Efecto de prevención en entorno de fundiciones y eventuales futuras áreas con concentraciones al nivel de norma		Se evita la ocurrencia de efectos agudos importantes de corta duración (10') por sobre el valor 1000 ppb, que no los cubre la norma diaria actual o propuesta, y que puedan ocurrir en el futuro. El grupo beneficiado es principalmente la población asmática.		Ocurrencia de "ataques de asma" en asmáticos leves y moderados que no revisten hospitalizaciones, pero si gastos en medicamentos y restricciones menores de actividad con una frecuencia de hasta 40 veces en el año en algunas zonas.
Norma diaria de 95 ppb				
Impacto por las eventuales reducciones de emisión en Fundiciones y entorno	US$ 60.203 en efectos en salud evitados en las áreas de impacto de las fundiciones afectadas (mortalidad y morbilidad)		US$ 241.918 Reducciones en la producción de cobre fino para cumplir norma diaria	
Impacto por las eventuales reducciones de emisión en Talcahuano	Rango[4] entre US$ 0 y US$ 15.206.234 en efectos en salud evitados y cuantificados (mortalidad y morbilidad)		Rango[4] entre US$0 y US$12.830.432 de costos por cambio de combustibles atribuibles a la propuesta de norma diaria	
Efecto de prevención en entorno de fundiciones, Talcahuano y eventuales áreas con concentraciones en la norma		Se evita la ocurrencia de efectos agudos que pueden redundar en hospitalizaciones y muerte, y que ocurren en el rango de concentraciones entre el valor propuesto y el vigente.		Casos de mortalidad y morbilidad atribuibles al SO_2 en los niveles de norma. Estos efectos pueden ser significativos, por ejemplo "admisiones hospitalarias por asma"

Notas:
1) Valor corresponde al 98% del total de beneficios en salud en las fundiciones de cobre afectadas. El cálculo es (1.106.308 + 1.903.837*0,98)
2) Valor corresponde al 98% del costo total para las fundiciones de cobre afectadas. El cálculo es (12.095.921*98% + 214.000.000)
3) La primera cifra del paréntesis representa el caso de Caletones (si Coya club siguiera vigente como EMRP) y la segunda cifra el resto de las fundiciones
4) El rango depende de si es posible atribuible la reducción de emisiones de SO_2 entre los valores de 1999 (situación base) y la norma propuesta a esta norma, o será fruto de otras normas (por ejemplo MP10) u otras causas (rentabilidad del cambio de combustible).

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Conclusiones respecto de las propuestas de modificación de la norma para SO_2

Norma horaria

La norma horaria protegería de efectos que no son cubiertos por la norma diaria (actual o proyectada), en particular problemas ocasionados en exposiciones de muy breve periodo (inferior a 10 minutos). En los niveles actuales de concentración de las áreas más contaminadas del país, podrían darse estas situaciones no de manera permanente y afectar a la población de asmáticos o con problemas respiratorios crónicos (que corresponde a la población más sensible). Los efectos que se evitarán por la norma horaria, en presencia de una norma diaria más estricta, probablemente no se relacionan con admisiones hospitalarias o mortalidad, sino más bien cuadros controlables con medicamentos o reducciones en la exposición o la actividad.

Los efectos que seguirían existiendo una vez normado se relacionan principalmente con los mismos efectos controlables ambulatoriamente. Esto puede ser muy significativo si la población sensible es importante en las áreas afectadas.

Por otro lado, el cumplimiento de la norma horaria significa reducir los promedios diarios de exposición y por lo tanto, reducir daños que se relacionan estadísticamente con estos promedios, y que tienen que ver con mortalidad prematura y admisiones hospitalarias por causa cardio respiratoria.

Esto permite concluir que no sería un medio orientado a controlar los efectos de mayores consecuencias producidos por el SO_2, sino que problemas agudos en las poblaciones sensibles.

No es posible dar una mejor cuantificación del daño que se evita por la ausencia de información sobre la cantidad de personas sensibles.

Por el lado de los costos, las medidas significan costos no despreciables y que tienen que ver principalmente con manejo de episodios críticos a través de bajas de fusión y predicción. Estos costos no debieran modificarse con el transcurso del tiempo, excepto si hubieran cambios profundos en los procesos afectados. En definitiva, si la norma entra en vigencia, generará en el corto o mediano plazo costos relativamente importantes.

Por lo tanto, se recomienda antes de implementarla generar mejor información sobre los grupos sensibles y establecer una norma o medidas en el mérito de la gravedad del problema.

Caso de Caletones

La situación de la Fundición Caletones apunta más bien a redefinir el concepto de estación representativa de población para gases, mas que cuestionar o no la propuesta de norma horaria. El acento debiera estar en esta definición porque la norma horaria (o cualquiera otra) le exigiría reducciones a una fuente con un objetivo (cumplir norma en Coya club) que no necesariamente tiene relación con proteger la salud de la población.

Norma diaria

Limitar las concentraciones promedio diario se justifica principalmente por que se apunta a reducir emisiones de manera más permanente, y por lo tanto, reducir efectos estadísticamente comprobados en mortalidad y admisiones hospitalarias.

Esta norma en el país no tendría efectos económicos importantes en las áreas de impacto de las fundiciones de cobre. En el caso de Talcahuano el efecto puede ser de cero costos y beneficios (si sigue la tendencia a cambiar combustibles observada en la actualidad), o en su defecto significa costos menores que los beneficios, suponiendo un eventual plan de descontaminación entre el año 2003 y 2011.

En definitiva, por razones de prevención (evitar la existencia de niveles donde se sabe fehacientemente que ocurren efectos en salud) y dado que el impacto puede ser cercano a cero o un valor neto positivo se recomienda fijar el valor propuesto.

O_3

El cambio propuesto es la reducción del valor de norma (80 a 60 ppb) y el aumento del lapso de tiempo para la obtención del promedio máximo diario (de 1 a 8 horas).

Descripción del efecto del O_3

Los efectos del O_3 son mayores mientras mayor sean las concentraciones, más larga la exposición y más alto el nivel de ejercicio del individuo. Las respuestas agudas al contaminante incluyen cambios en las función pulmonar, inflamación de las vías respiratorias y otros síntomas. Estas respuestas son estadísticamente significativas en personas adultas saludables a partir de concentraciones de 80 ppb en 6,6 horas.

Por otro lado, concentraciones más altas, grupos más sensibles, niveles de esfuerzo mayor generan respuestas en menores tiempos de exposición.

Fundamentos del cambio

La OMS señala que establecer un valor guía es "complicado por el hecho que respuestas detectables ocurren al, o muy cerca del, nivel del valor más alto de los límites de concentraciones background" (p. 38, OMS, 2000). Este hecho impide establecer una guía sobre la base de los criterios de NOAEL o LOAEL. Esto obliga a establecer un juicio o premisa que cierto nivel de efectos pueden ser asumidos como de poca preocupación desde un punto de vista de salud pública. Sobre esta base se establece el valor guía de 60 ppb en 8 horas (que equivale a un cambio en FEV1 de un 5%), en el cual "los efectos agudos en la salud pública probablemente son pequeños". (op. cit.; p. 38).

Descripción del impacto

Tomando las funciones dosis respuestas empleadas en determinar el riesgo asociado al valor guía propuesto, es posible detectar el riesgo asociado al valor vigente (80 ppb como promedio de una hora). Comparando ambas normas se obtiene que los riesgos asociados en "cambios en FEV_1", "cambios inflamatorios", y "cambios en la exacerbación de síntomas entre adultos y asmáticos" son siempre levemente menores en la norma vigente respecto de la norma propuesta. En cambio, el incremento en las admisiones hospitalarias es levemente menor con la norma propuesta.

Según la OMS, la norma de ocho horas "protegería contra las exposiciones agudas de una hora en los rangos propuestos, entonces se concluye que el valor guía de una hora no sería necesario". (op. cit.; p.41). Esto fundamentalmente por las características del contaminante y la mejor correlación de los efectos a mayores tiempos de exposición.

Esta afirmación de la OMS se corrobora parcialmente en la estadística de la Región Metropolitana basándose en que de un total de 730 días (100%), el número de veces que se superan ambas normas simultáneamente es de 36,3%, el número de veces que no se superan ambas es de 56,4% y que se supera sólo la de ocho y la de una es de 6,7% y 0,5%. Esto demuestra que efectivamente los episodios de ocho horas incluyen gran parte de los episodios horarios (265 días), quedando 49 días en que los episodios horarios ocurren aisladamente.

Por lo tanto, el impacto de la norma es desregular estos 6,7% (49 sobre 730) de días de ocurrencia de episodios horarios que no ocurren simultáneamente con episodios de ocho horas. Esto aparece como una relajación si se observa que los promedios anuales de los máximos diarios en uno y otro caso son mayores en la norma propuesta que en la vigente. Esto quiere decir que el valor de ocho horas genera una exposición en promedio mayor en el lapso de un año.

No obstante lo anterior, estos días que se desregulan, según el criterio de la OMS, serían periodos en que los impactos no representan problemas a la salud pública (no necesariamente se producirán efectos relevantes en términos de salud pública).

Según lo anterior, la modificación propuesta no debiera generar efectos en la salud que revistan un carácter de problema de salud pública, incrementales a los problemas que se verifican en situación actual, y permitiría focalizar los esfuerzos en aquellos episodios.

COMISION NACIONAL DEL MEDIO AMBIENTE
CONSEJO CONSULTIVO NACIONAL

Opinión sobre Proceso de Revisión Normas Primarias de Calidad de Aire para CO, PTS, N02, 03 y S02, y Opinión sobre Propuesta del 6° Programa Priorizado de Normas.

El Consejo Consultivo Nacional de la CONAMA reunido en sesión extraordinaria el 22 de marzo de 2001, con la asistencia de los Consejeros Sra. X. Abogabir, Sr. G. Del Favero, Sr. J. Dinamarca, Sr. H. Durán, Sr. Carlos Guerra, Sr. A. Varela y Sr. J. Yañez y Sr. C. Zaror presidida por la Directora Nacional de la CONAMA señora Adriana Hoffmann J., acordó emitir la siguiente opinión sobre el Proceso de Revisión Normas Primarias de Calidad de Aire para CO, PTS, N02, 03 y S02, y sobre la Propuesta del 6° Programa Priorizado de Normas.

1. Proceso de Revisión Normas Primarias de Calidad de Aire para CO, PTS, NO2,O3 y SO2.

Teniendo presente:

La exposición general acerca del impacto socio económico de las normas en revisión, la metodología utilizada para calcular los costos y beneficios de los estándares sugeridos, los resultados de la metodología utilizada y la necesidad de mayores estudios sobre tales efectos socioeconómicos,

Acuerda:

Emitir una opinión final cuando haya una propuesta definitiva sobre la norma.

Sin perjuicio de lo anterior, los Consejeros reiteraron la conveniencia de que la norma señale a partir de qué nivel, un titular de proyecto de inversión, que emita algunos de los elementos mencionados en la norma, deberá efectuar un Estudio de Impacto Ambiental, a fin de dar cabal cumplimiento al inciso final del art. 11 de la ley N°19.300.

Asimismo, hubo consenso entre los Consejeros sobre la necesidad de discutir en profundidad el tema del "nivel de riesgo", que deberían representar los estándares específicos que contienen las normas de calidad ambiental, de manera que tengan coherencia entre sí. Se destaca la conveniencia de una definición política acerca de dicho nivel de riesgo, de manera que informe al proceso normativo que a está realizando en esta materia.

Además los Consejeros convinieron en que si bien el análisis costo / beneficio es un dato más que ayuda a la toma de decisión respecto del estándar de una norma de calidad ambiental o de emisión, cuando los resultados de tales análisis arrojan valores muy negativos (costos muy altos y beneficios muy bajos), resulta conveniente buscar soluciones alternativas que representen en un menor costo social, sin descuidar la debida protección de la salud de la población potencialmente afectada, lo cual constituye un deber ético ineludible.

2. Propuesta del 6° Programa Priorizado de Normas.

Teniendo presente:

La exposición general acerca de la nueva propuesta de programa priorizado de Normas, el grado de avance que presenta el proceso normativo en curso y las peticiones que los diversos entes públicos han hecho presente en relación a los aspectos que les preocupan en forma prioritaria,

Acuerda:

a) Aprobar la propuesta del 6° Programa Priorizado de Normas.

b) Sin perjuicio de lo anterior, reitera la necesidad de que se priorice la dictación de Normas de Calidad Ambiental por sobre las de Emisión, sobre todo considerando que éstas últimas pueden tener que ser objeto de modificaciones si son dictadas con anterioridad a la Norma de Calidad Ambiental correspondiente. Si ello ocurre, resultaría contraproducente en relación con las señales de inversión en abatimiento que haya derivado de la Norma de Emisión original, y podría afectar negativamente la credibilidad del proceso normativo.

c) Asimismo, manifiesta su preocupación por la tendencia a dictar Normas de Emisión para una industria, sector específico o para regular una situación muy particular, en circunstancias que una adecuada "gestión ambiental", en lo posible debe tender a regular de un modo general los elementos que constituyan motivo de preocupación para la salud de las personas o para los demás componentes del medio ambiente.

d) Reitera la necesidad de explicitar "los criterios" que se utilizan para otorgar prioridades al proceso normativo, y la necesidad de focalizar los recursos humanos y financieros en acelerar la dictación de normas de calidad ambiental.

En relación a lo anterior, el Consejo deja explícita su voluntad de que se privilegie la dictación y revisión de Normas de Calidad Ambiental, como por ejemplo para:

i Sedimentos
ii Aguas marinas
iii Suelos
iv Ruidos
v. Olores, y
vi. Elementos radioactivos, dioxinas, furanos y Aox

Gabriel Del Favero Valdés
Secretario Subrogante

COMISION NACIONAL DEL MEDIO AMBIENTE
CONSEJO CONSULTIVO

Opinión sobre Norma de Calidad de Primaria del Aire y del Recurso de Reclamación del Proyecto "Relleno Sanitario de San Carlos" ; Presentación sobre revisión del Decreto 4/94 de Transporte, Norma de Emisión de Contaminantes Aplicables a vehículos Motorizados; Presentación Revisión Plan de Descontaminación María Elena.

En sesión ordinaria del Consejo Consultivo Nacional de la CONAMA del día 12 de abril del 2001, con la asistencia de los Consejeros, X. Abogabir, C. Guerra, J. Dinamarca, J. Yañez, O. Contreras, S. Troncoso, H. Durán, C. Zaror y T. Tomic. Presidida por la señora Adriana Hoffmann, Directora Ejecutiva de la CONAMA.

Teniendo Presente:

a. Proceso de Revisión Normas Primarias de Calidad de Aire para CO, PTS, NO2, O3 y SO2.

b. Anteproyecto de revisión de la Norma de Contaminantes aplicables a los vehículos motorizados establecida por el DS N°4 de 1994 por el MTT.

c. Anteproyecto de reformulación del plan de descontaminación para la localidad de Pedro de Valdivia.

d. Resumen ejecutivo del Estudio de Impacto Ambiental proyecto "Relleno Sanitario San Carlos".

e. Informe Técnico del Estudio de Impacto Ambiental proyecto "Relleno Sanitario San Carlos".

f. Resolución Exente N° 030/2001 que califica Ambientalmente el Estudio de Impacto Ambiental proyecto "Relleno Sanitario San Carlos".

g. Recurso de reclamación presentado por el señor Julio Arnaboldi Cáceres en relación a la Resolución Exente N° 030/2001 que califica

Ambientalmente el Estudio de Impacto Ambiental proyecto "Relleno Sanitario San Carlos

Se acuerda:

En relación al Proceso de Revisión Normas Primarias de Calidad de Aire para CO, PTS, NO2, O3 y SO2.

a. Corregir la aseveración respecto del plazo de entrada en vigencia de la norma para PTS, lo que tendría una demora de 30 días en virtud de la vigencia de la norma anterior, a lo que se sugiere eliminar derechamente la norma anterior y así establecer la vigencia automática de la nueva disposición.

b. Respecto de las estaciones de monitoreo, que deben ser certificadas por el Servicio de Salud pertinente, se propone que la información de dichas estaciones de monitoreo, sean considerada válida o fidedigna, aquellas registrada con posterioridad a la certificación correspondiente.

c. Que el manual que se va a elaborara para la implementación de esta normas, defina una estrategia efectiva para informar a la ciudadanía.

En relación al Recurso de reclamación presentado por el señor Julio Arnaboldi Cáceres en relación a la Resolución Exente N° 030/2001 que califica Ambientalmente el Estudio de Impacto Ambiental proyecto "Relleno Sanitario San Carlos

Acoger el recurso de reclamación sujeto al compromiso del proponente de colocar una membrana protectora de geotextil de polietileno para evitar cualquier filtración de líquidos percolados a las napas del acuífero.

En relación a los temas: Presentación sobre revisión del Decreto 4/94 de Transporte, Norma de Emisión de Contaminantes Aplicables a vehículos Motorizados; Presentación Revisión Plan de Descontaminación María Elena, en ambos casos se analizaron los casos y no hubo observaciones de parte del Consejo Consultivo Nacional, por lo tanto se entiende que estamos de acuerdo con su contenido total.

Tonci Tomic
Secretario
TTJ

ANALISIS DE LAS OBSERVACIONES FORMULADAS AL ANTEPROYECTO DE REVISION DE NORMAS PRIMARIAS DE CALIDAD DEL AIRE PARA ANHIDRIDO SULFUROSO (SO_2), MONOXIDO DE CARBONO (CO), DIOXIDO DE NITROGENO (NO_2), OZONO (O_3) Y PARTICULAS TOTALES EN SUSPENSION (PTS)

1. OBSERVACIONES RECOGIDAS EN TALLERES DE CONSULTA

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Taller V Región (Viña del Mar)	19/10/00	1. Aclarar los pasos a seguir en el proceso normativo	1. El procedimiento y etapas del proceso se encuentran claramente establecidas en el reglamento para la dictación de normas de calidad ambiental y de emisión, D.S N°93 de 1995 del ministerio Secretaría General de la Presidencia
		2. Aclarar cómo la OMS y otros organismos internacionales (citados en los fundamentos de los anteproyectos) llegan a determinar los niveles de normas que recomiendan	2. Ello se encuentra establecido en los documentos y estudios que constan en el expediente público de la norma.
		3. Se requiere información respecto a dónde existen estaciones de monitoreo instaladas y operando en el país	3. La información puede ser solicitada a CONAMA.
		4. ¿Quién fiscaliza el monitoreo?	4. Dado que se trata de normas primarias de calidad de aire. La fiscalización del monitoreo de calidad del aire corresponde a los Servicios de Salud respectivos.
		5. Se recomienda facilitar los datos sobre mediciones en las estaciones de monitoreo a la comunidad a fin de hacer transparente su funcionamiento	5. Este requerimiento fue incorporado en los proyectos definitivos de normas. En ellos se establece que los Servicios de Salud respectivos deberán tener a disposición de la comunidad la información de calidad de aire.
		6. Aclarar los criterios que se consideran para la localización de las redes de monitoreo y la definición del número de estaciones de medición de la calidad del aire	6. Dada la importancia de estos temas en cuanto a la representatividad que deben tener las redes de monitoreo, como también lo relacionado por ejemplo a la validación de información operación, mantención y calibración de equipos, En los proyectos definitivos de normas se incorporo en lo relativo a la implementación de la norma, la elaboración de un manual, el cual deberá dar cuenta de estos temas.
		7. Para la aplicación de las normas se debe correlacionar la situación particular de contaminación de cada ciudad o región con el impacto económico que la norma significa	7. El reglamento para la dictación de normas de calidad ambiental establece que debe realizarse una evaluación del impacto económico y social de los anteproyectos de normas. Este estudio fue realizado y consta en el expediente público del proceso.
		8. Se solicita argumentar con mayor detalle por qué se decide no normar PTS	8. Los fundamentos de porque no normar PTS se pueden encontrar en el expediente público del proceso (foja N° 818)
		9. Se solicita aclarar si se considera la variabilidad ambiental de las regiones o zonas del país para la definición de los valores de las normas	9. Uno de los antecedentes analizados en el proceso es el cumplimiento de la normativa ambiental en el País. Sin embargo es importante tener claro que

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			de acuerdo a lo establecido en la legislación vigente, una norma primaria de calidad de aire no puede hacer diferencias entre distintas regiones, es decir la norma debe ser una sola a nivel nacional.
		10. Aclarar cuáles son las razones por las cuales se definen los valores de norma más altos recomendados a nivel internacional (por ejemplo, SO_2)	10. Para el caso del SO2 como concentración horaria se consideró el valor mas alto a nivel internacional en base al criterio de tener en cuenta la realidad del país en cuanto a la existencia de grandes fuentes emisoras a lado de centros poblados. Sin embargo finalmente basado en los nuevos antecedentes disponibles en cuanto a la valoración económica y los beneficios sobre la población se decidió no establecer una norma de concentración horaria para SO2, pero estableciendo en la normativa la exigencia al los Servicios de Salud respectivos de recopilar información sobre la incidencia y prevalencia de población asmática en el país, en especial en áreas circundantes a grandes fuentes emisoras de SO2.
		11. Se debería considerar una normativa adaptada a los métodos de medición alternativos para el monitoreo	11. Los proyectos definitivos de normas incorporan la posibilidad de medir con métodos alternativos a fin de realizar un diagnóstico de calidad de aire.
		12. Existen limitaciones importantes en algunas regiones o ciudades para implementar las normas (fundamentalmente escasez de recursos para la fiscalización y monitoreo)	12. En los proyectos definitivos de normas se incorporo un programa de implementación de las normas el cual establece la exigencia a los Servicios de Salud de realizar un diagnóstico de calidad de aire según sus áreas territoriales y posteriormente un programa priorizado de monitoreo para el seguimiento del cumplimiento de la normativa.
		13. Se solicita utilizar términos simples y sencillos en la normativa para facilitar que la comunidad comprenda sus alcances e implicancias concretas sobre la calidad de vida de las personas	13. Si bien esto no es parte de los contenidos de una norma. Se tendrá en consideración para el mejoramiento del proceso de participación ciudadana en futuros procesos.
		14. Aclarar la metodologías que se estipulan para las mediciones en las estaciones de monitoreo y enfatizar si se considera la rigurosidad necesaria para normas de 1 hora, 8 horas, 24 horas y anuales	14. Se incorpora en los proyectos definitivos de normas la realización por parte de CONAMA de un manual de aplicación de la normativa el cual dará cuenta de lo observado.
		15. Aclarar si el proceso normativo considera la expectativas o visiones particulares del sector privado en relación a la contaminación del aire y el desarrollo productivo	15. El procedimiento para la dictación de normas, D.S N°93 de 1995 del ministerio Secretaría General de la Presidencia se4ñala que para la dictación de una norma se deben tener en consideración todos los antecedentes disponibles.
		16. ¿Cómo se coordina el proceso normativo con los planes de descontaminación?	16. Las normas de calidad ambiental son la base a partir a partir de la cual, según corresponda, se puede declarar una zona saturada y posteriormente elaborar el respectivo Plan de Descontaminación.

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		17. ¿Cómo se regulan o interpretan los valores "peack" de contaminantes en las mediciones?	17. Es parte del proceso de validación de la información de monitoreo de calidad de aire.
		18. Se solicitan mayores antecedentes respecto de los fundamentos para la definición de norma para O_3	18. En el expediente público del proceso, disponible en CONAMA, se encuentran los antecedentes que fundan la norma de calidad de aire para ozono propuesta.
		19. Se recomienda el uso del sistema internacional de unidades de medida para obtener base estandarizada	19. En los proyectos definitivos de normas los niveles se expresan en unidades de ppvb y ug/m3N.
		20. Se debe aclarar cuáles serán las unidades de concentración que se utilizarán en las normas (ug/m^3N / mg/m^3N o ppbv / ppmv)	20. Ver punto anterior.
		21. Se deben profundizar líneas de investigación sobre la relación que existe entre NO_2 y SO_2 como precursores de O_3	21. Este tema esta siendo estudiado en la actualidad, especialmente en el contexto del Plan de Descontaminación de la Región metropolitana.
		22. Se solicita considerar mayores recursos para la implementación de las normas y su fiscalización revisando los roles institucionales de los servicios públicos (¿por qué sólo se considera a los Servicios de Salud? Se señala que otras instancias pueden apoyar, tales como los municipios y otros)	22. En los proyectos definitivos de norma se ha incorporado lo relacionado a la implementación de las normas, que servirá a los fiscalizadores (Servicios de Salud) para fundamentar mayores recursos.
		23. Se debe incorporar en la norma mecanismos para facilitar la fiscalización (coordinación de servicios públicos, participación de la comunidad, etc.)	23. La fiscalización de las normas es responsabilidad de quién fiscaliza y en este caso la potestad la tienen los Servicios de Salud del País.
		24. Se solicita poner mayor énfasis en la incorporación de profesionales en los procesos de participación ciudadana para la consulta pública de las normas	24. El proceso de participación ciudadana es para toda la comunidad, no solo para profesionales.
		25. Se señala como elemento clave el fomento de los estudios nacionales sobre los efectos de los contaminantes normados en la salud de las personas	25. Para la formulación de los niveles de normas se tuvieron en consideración junto a los demás antecedentes disponibles los estudios específicos realizados a nivel nacional. Sin embargo se reconoce que en algunos casos estos son escasos y se requiere como por ejemplo para luna norma de SO2 como concentración de 1 hora la generación de información específica a nivel nacional.
		26. Se sugiere incorporar la metodología de los tubos pasivos como método oficial y no como alternativo	26. No es posible utilizar los tubos pasivos para fiscalzar las normas, debido a la incertidumbre asociada en los resultados así como también que su aplicación es limitada (solo para periodos largos de exposición). Esta metodología se utiliza como disgnóstico de la calidad de aire.
		27. Se sugiere normar otros contaminantes tales como CO_2, Hidrocarburos y vapor de agua (responsables del efecto invernadero)	27. No es materia de esta norma. Este proceso se limita a la revisión de los contaminantes contenidos en la Resoulción N°1215 de 1978, del Delegado del Gobierno en el Servicio de Salud. La forma de proponer la dictación de normas para otros contaminantes es a través del programa priorizado de normas, proceso que se lleva a cabo cada año.
		28. Incluir en las normas la exigencia de monitoreo continuo de los contaminantes	28. Esto esta considerado en las normas.
		29. Implementar un teléfono de denuncia para situaciones de emergencia	29. Esto es materia de un Plan de Descontaminación,

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		ambiental por niveles peligrosos de los contaminantes normados	pero no de una norma. La norma solo fija los niveles que definen situaciones de emergencia ambiental, las medidas a adoptar son materia de un Plan de descontaminación a través del Plan Operacional para el control de episodios críticos de contaminación.
		30. Se recomienda incentivar el uso de sistemas de control que operen en horarios nocturnos para fiscalizar la contaminación de ciertas fuentes fijas (industrias, etc.)	30. No es materia de esta normativa.
		31. Se debe incluir en las normas criterios para la determinación del número de estaciones de monitoreo que se deberán implementar en las regiones, siendo necesario que al menos el 50% de las redes de monitoreo de todo el país estén fuera de la Región Metropolitana	31. Este tema se abordará a través del manual de aplicación de las normas. Esto fue incorporado en los proyectos definitivos de normas mediante un programa de implementación de las normas.
		32. Se sugiere que la aplicación de las normas y su cumplimiento se haga de acuerdo al tipo de proceso productivo y nivel tecnológico disponible en el país	32. Las normas propuestas corresponden a normas de calidad ambiental y no a normas de emisión.
		33. Para facilitar la comprensión sobre cuáles niveles se modifican se sugiere señalar para cada contaminantes los valores en ppbv/ppmv y en ug/m^3N	33. Esto fue incorporado en los proyectos definitivos de normas.
		34. Se debe incorporar con mayor claridad las medidas que se deberán tomar por el incumplimiento de las normas (información a la comunidad, difusión, optimización de velocidad de respuesta ante eventos de superación de las normas, etc.)	34. La fiscalización de las normas corresponde al los Servicios de Salud del País. respecto a la información de niveles de concentración a la comunidad en general, esto se incorporará en los proyectos definitivos de normas.
		35. ¿Cuál es el efecto combinado que produce dos o más de los contaminantes normados sobre la salud de la población? Considerar efectos sinérgicos	35. Es posible que existan efectos sinérgicos entre dos o más contaminantes. sin embargo, al normar estos contaminantes se estaría disminuyendo este efecto, si este existiera.
		36. Incorporar factores meteorológicos y topográficos para la priorización de la localización de redes de monitoreo de calidad del aire	36. Esto se incorporará en los proyectos definitivos de normas mediante la elaboración de un manual de aplicación de las normas al interior de un programa de implementación de las mismas.
		37. Se deben incorporar aclarar especificaciones respecto de las obstrucciones espaciales para las mediciones de los contaminantes	37. Mirar respuesta anterior.
		38. Se debe incorporar norma diaria para NO_2 con el fin de tener adecuada correlación entre precursores de O_3	38. No existen fundamentos en efectos sobre la salud de la población, que indiquen la necesidad de incorporar una norma de NO2 para un periodo diario.
		39. Se considera excesivo el plazo máximo de 3 años para que el Servicio de Salud establezca un monitoreo formal si los resultados de concentración de contaminantes medida por métodos exploratorios (tubos pasivos) son superiores al nivel de las normas	39. El plazo propuesto trata de ajustarse a la realidad de los Servicios en lo que respecta a la solicitud y obtención de recursos e implementación.
		40. Se recomienda definir valores de norma exigentes hoy y no esperar años para revisarlos y modificarlos (en este caso, no es recomendable la gradualidad de los valores de norma)	40. Los valores propuestos se fundamentan en la mejor información disponible a nivel nacional e internacional, sobre los efectos que producen los contaminantes en la salud de las personas.
		41. Revisar la posibilidad de no monitorear las concentraciones de O_3 por cuanto es suficiente con las mediciones de los contaminantes precursores (NO_2, CO, SO_2)	41. La normativa ambiental vigente obliga a verificar el cumplimiento de la normativa si existe norma. No tiene ningún sentido no fiscalizar si se dispone de norma. No0 es suficiente con monitorear los

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			precursores. Por ejemplo si se quisiera declarar una zona saturada por ozono, las mediciones que cuentan son las de ozono.
		42. Considerar la definición de los niveles de contaminantes en relación a la vulnerabilidad de las personas y los efectos sobre la salud (aplicar estudios nacionales)	42. Esto fue considerado para la elaboración de los anteproyectos de normas.
		43. Modificar norma horaria para SO_2 adoptando la sugerida por la OMS que incluye factor de seguridad o utilizando el valor más bajo a nivel internacional	43. Si se refiere a la norma de SO2 como concentración horaria. El nivel propuesto no solo considera la recomendación de la OMS sino que también la realidad del país en cuanto a donde y porque se producen altos niveles de concentración en este periodo de evaluación.
		44. Se debe definir concentración máxima admisible de PTS por cuanto sí representa molestias a las personas	44. Los antecedentes en salud disponibles y que constan en el expediente público del proceso fundamentan de manera sufuiciente el derogar esta normativa.
Taller II Región (Antofagasta)	24/10/00	45. Aclarar por qué se consideran valores de normas iguales para todo el país y no se consideran las diferencias regionales	45. La legislación vigente establece que una norma primaria de calidad de aire debe ser la misma para todo el país. Lo anterior se fundamenta en que los efectos que puede causar sobre la salud de las personas la exposición a un determinado nivel de concentración de un contaminantes es similar para todas las personas.
		46. Incluir en las normas menciones respecto a los tipos de contaminantes más relevantes en las regiones del país y las condiciones ambientales de cada caso (contexto geográfico y de salud pública)	46. Esto se incorporará en los proyectos definitivos de normas a través de la exigencia a los Servicios de Salud del País de elaborar un diagnóstico de calidad de aire e establecer un programa priorizado de monitoreo de calidad de aire en un plazo determinado. Lo anterior en el contexto de un programa de implementación de la norma.
		47. Deberían incorporase en las normas las recomendaciones y medidas de protección de la población ante eventos de emergencia ambiental	47. Esto es materia de un Plan de Descontaminación y no de una Norma.
		48. En el título sobre Fiscalización de la Norma se debe agregar: "El Servicio de Salud tendrá la obligación de informar a la ciudadanía sobre el estado de contaminación" (Art. 12º Norma NO_2; Art. 13º Norma SO_2; Art. 9º Norma O_3; y Art. 10º Norma CO)	48. Se incorporara este tema en los proyectos definitivos de normas.
		49. Utilizar en las normas unidades de concentración comunes a los utilizados en la Resolución 1215 a fin de facilitar la comprensión de los cambios	49. Se incorporará esto en los proyectos definitivos de normas.
		50. ¿Quién valida o certifica las metodologías de monitoreo y medición establecidos en las normas?	50. El fiscalizador. En este caso los Servicio de Salud respectivos.
		51. ¿Quién define dónde y cómo se instalarán las redes de monitoreo en el país?	51. El fiscalizador es quien tiene la facultad de aprobar las redes de monitoreo de calidad de aire.
		52. Aclarar cómo se definen y manejan los niveles de emergencia para NO_2. Considerar mayor número de días con mediciones de máximo diario de concentración de una hora igual o sobre el valor de la norma para definir que la norma ha sido sobrepasada (Art. 4º) y aclarar que pasa con la norma anual en esta caso	52. La norma define los niveles que originan situaciones de emergencia ambiental. Sin embargo las medidas a aplicar ante la superación de estos niveles es materia de los Planes de Descontaminación o de Prevención pero no de la norma.

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			En relación al segundo tema, se avaluará.
		53. Aclarar cómo se determinan los valores de las normas	53. El proceso de dictación o revisión de una norma esta contenido en el D.S N°93 de 1995, del Ministerio secretaría General de la Presidencia.
		54. ¿Qué es ppb?	54. Corresponde a una unidad de concentración. Su definición se encuentra contenida en los anteproyectos de normas.
		55. Se requiere dotar de mayores recursos humanos, materiales y financieros a los fiscalizadores (fortalecer las instituciones que tienen este rol) y solucionar las limitaciones de los Servicios de Salud sobre todo en lo que respecta a la falta de equipos de monitoreo	55. No es posible mandatar esto a través de la norma. Sin embargo, en los proyectos definitivos de norma se incorporará un programa de implementación de las normas, en el cual se establecen exigencias a los Servicios de Salud respectivos, responsables de la fiscalización de estas. Esto, creemos, permitirá al fiscalizador fundamentar de manera mas concreta la solicitud de los recursos necesarios para realizar su labor.
		56. ¿Quién regula a las industrias que dañan la salud de la población? ¿Dónde se realizan las denuncias?	56. No es materia de una norma de calidad.
		57. Incorporar en las normas a Carabineros de Chile como fiscalizadores	57. La responsabilidad de la fiscalización de normas primarias de calidad de aire es potestad, según lo establece la normativa vigente, de los Servicios de Salud.
		58. Con la eliminación de la norma para PTS, ¿se elimina también la normativa definida para los lugares de trabajo (D.S. N°745 del Ministerio de Salud)?	58. No, El D.S N°745 del ministerio de Salud es un normativa independiente de esta.
		59. Considerar que las características diferenciales de las regiones del país hace necesaria una revisión de normar o no PTS. Al respecto, se señala que en el norte del país las mineras son fuentes significativas de polvo y que en las ciudades se genera polvo por falta de áreas verdes y calles sin pavimentar.	59. Los antecedentes sobre efectos en la salud de las personas disponibles y que constan en el expediente público indican sustentan la derogación de esta norma. Los principales efectos en la salud de las personas se encuentran asociados al particulado respirable PM10 y PM2,5. Es importante hacer notar también que a la fecha se encuentra vigente una norma de calidad para plomo en aire y una norma de emisión de Arsénico.
		60. Aclarar cómo se maneja el tema de la composición química de las partículas totales en suspensión	60. La norma en revisión corresponde a PM10 y esto implica todo lo que contiene el PM10, no es específica por tipo de compuesto específico, por muy tóxico que este pueda ser.
		61. Revisar la manera en que se realiza la consulta ciudadana para los procesos normativos. Debe existir en forma previa un programa de educación ambiental a fin de que los diversos participantes comprendan los términos y los alcances de las normas y se fortalezcan los hábitos ambientales positivos de la población para enfrentar la contaminación	61. La experiencia recogida durante este proceso de consulta pública será evaluada a fin de optimizar el tema de participación ciudadana mas real y efectiva en futuros procesos de dictación o revisión de normas de calidad ambiental o de emisión.
		62. Se requiere mayor difusión de los talleres de consulta y la utilización de lenguaje más simple para la entrega de la información	62. Se considerará al igual que lo señalado en el punto anterior, en el diseño de futuros procesos de participación ciudadana asociados a la di9ctación o revisión de normas de calidad ambiental y de emisión.
		63. Se solicita aclarar qué es CONAMA y qué es COREMA	63. No es materia de la norma. La ley de Bases del

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			Medio Ambiente se refiere en forma específica a cada una de ellas.
		64. ¿Qué son las afecciones cardiovasculares respiratorias?	64. En el proyecto definitivo de norma se definirá el concepto de manera que quede claro.
		65. Se requiere información médica sobre los contaminantes y sus efectos en la salud (especialmente en relación al plomo)	65. En el expediente público del proceso se adjuntan documentos e informes relativo a lo observado. Respecto al caso particular del Plomo, no es materia de esta revisión. Recientemente entró en vigencia una norma para el contaminante plomo en aire.
		66. Se señala que la presencia del Servicio de Salud es clave en este proceso ya que tiene un rol relevante en la materia	66. Los responsables de la fiscalización de estas normas son los Servicios de Salid del país.
		67. Se solicita información sobre otros temas generales: a) posible contaminación por antenas celulares; b) tráfico de camiones; c) localización de estanques de combustibles.	67. No es materia de este proceso de revisión de normas.
Taller III Región (Copiapo)	26/10/00	68. Aclarar diferencia de norma horaria para SO_2 de la norma respecto de la normativa ambiental de Estados Unidos	68. Estados Unidos posee dos tipos de normativas, una a nivel Federal que debe ser cumplida a nivel de todo el país, y normas a nivel de cada Estado, las cuales pueden ser diferentes entre sí, pero no menos estrictas que las Federales. Las normas primarias de calidad de aire vigentes en Chile, se comparan con las norma Federales en Estados Unidos. En el caso específico de la norma horaria para SO2 propuesta en el Anteproyecto, esta corresponde a la norma vigente en el estado de Washington. A nivel Federal Estados Unidos no posee una norma horaria para SO2.
		69. Aclarar por qué se considera para el CO una norma horaria de 25 ppm siendo que para lugares de trabajo (interiores) se considera un nivel máximo de 45 ppm	69. Las normas primarias de calidad de aire son independientes de las normas vigentes para lugares de trabajo. (La norma específica vigente para ambientes laborales en Chile es el 745).
		70. ¿Por qué no se utiliza el percentil 98 para la superación de normas tal como se utiliza para la norma de PM10?	70. Se decidió como criterio común establecer percentil 99, a fin de tratar de resguardar que siendo que se este cumpliendo con una norma se registren situaciones de emergencia ambiental. La probabilidad de esta ocurrencia podría aumentar mientras mas bajo es el percentil adoptado. Lo anterior porque el percentil lo que hace es dejar fuera los valores de concentración mas altos.
		71. Se debe incorporar mecanismos de control proactivo del cumplimiento de la normativa (poner esfuerzos en la prevención antes que en las medidas de emergencia)	71. No es materia de una norma primaria de calidad de aire.
		72. Se deben considerar situaciones puntuales o zonas geográficas con mayores problemas por contaminación para la definición de las normas	72. Una norma primaria de calidad de aire, según lo establece la Ley de Bases del Medio Ambiente

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		(especialmente para SO_2)	debe ser la misma en todo el País.
		73. Poner mayor énfasis en las normas que su objetivo es la protección de la salud de la población	73. Esto se encuentra señalado en los Anteproyectos de Normas propuestos.
		74. Se deben considerar los efectos sinérgicos sobre la salud de las personas por la suma de contaminantes en zonas de alta fragilidad ambiental (por ejemplo, Valle del Huasco)	74. Las normas propuestas tienen en principalmente en consideración los efectos que produce el contaminante sobre la salud de las personas, objetivo de protección de estas normas que se están revisando.
		75. Aclarar qué se entiende por "población expuesta" (una ciudad, un grupo humano, una persona, campamentos mineros, etc.). Ver Título sobre criterios de priorización para el establecimiento de Redes de Monitoreo de Calidad del Aire	75. Respecto de este tema no existe una definición clara en cuanto a que número de personas constituye una población (1-2-3..100-100.000, etc). Se tratará de establecer lo más claro posible el tema en los Proyectos Definitivos de Normas. Sin embargo, siempre va a quedar a criterio del fiscalizador.
		76. ¿Por qué no se definen criterios base para la definición de medidas ante situaciones incumplimiento de las normas?	76. No es materia de la norma. Si una norma no se esta cumpliendo lo que corresponde es la declaración de una zona como saturada y posteriromente la aplicación de un Plan de Descontaminación de dicha área. Es en el Plan en donde se debe identificar a los responsables y donde se establecen las medidas que correspondan a fin de descontaminar el área declarada como saturada.
		77. Se señala que las normas no contemplan bases científicas para su definición y no se han validado los criterios internacionales en Chile	77. Las normas propuestas consideran los resultados obtenidos de estudios científicos realizado tanto a nivel nacional como internacional. Esto constituyó una fuente de información importante la evaluar los efectos de un determinado contaminante sobre la salud de las personas y fijar las normas propuestas.
		78. Utilizar en las normas el concepto de "gradualidad" para su cumplimiento (con énfasis en el aumento progresivo del nivel de exigencia en ciertos plazos)	78. A nuestro juicio, el concepto de gradualidad se inserta en la aplicación de otro instrumento de gestión ambiental, el cual es los Planes de Descontaminación o de Prevención. Es aquí donde se tienen que identificar a los responsables de las emisiones, producto de las cuales las normas se están superando, para los cuales se establece un cronograma de reducción de emisiones, para cuya elaboración se tiene en consideración el principio de gradualidad establecido en la Ley 19.300.
		79. Fortalecer los estudios nacionales sobre efectos en la salud y no únicamente los criterios económicos para la definición de los valores de normas	79. En relación a lo mencionado sobre estudios nacionales se comparte la necesidad de ejecutar mayores estudios para ciertos contaminantes específicos. En relación a lo señalado sobre los criterios económicos, este constituye un antecedente mas para la evaluación de las normas y no el único.
		80. Se solicita que en los procesos normativos la CONAMA Regional lleve a	80. Este proceso se ha llevado a cabo, pero sin duda

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		cabo talleres con el objetivo de recabar todos los antecedentes disponibles (tanto en instancias públicas, privadas y comunidad en general) antes de elaborar los anteproyectos de normas	que requiere de ser reforzado en algunos lugares específicos. Se tendrá en consideración la experiencia adquirida en este proceso para poder optimizar en futuros procesos de dictación o revisión de normas de calidad ambiental.
		81. Considerar como base para la elaboración de las normas los parámetros biomédicos existentes en el país (Programa IRA del Ministerio de Salud)	81. Para la definición de las normas propuestas se tomo en consideración la mejor información disponible a la fecha de aprobación de los proyectos definitivos de normas.
		82. Se debe especificar cómo se validarán las mediciones y cómo se calibrarán los instrumentos de medición (ver Títulos sobre Metodología de Medición de las Normas y Validación de la Información de Monitoreo de Calidad del Aire)	82. Este tema será incorporado en los proyectos definitivos de normas a través de un programa de implementación de las normas, mediante la elaboración de un manual de aplicación de la normativa.
		83. Para la medición de contaminantes se deben considerar variables dinámicas tales como presión, velocidad del viento y temperatura, entre otras	83. Este tema deberá ser evaluado a fin de ser incorporado en el manual de aplicación de la norma según corresponda (ver punto anterior)
		84. En el análisis de las mediciones de contaminantes para evaluar la excedencia de las normas, se debe considerar el uso de los promedios móviles para normas horarias	84. En el caso de las normas para 8 horas se incorpora el uso de promedios móviles.
		85. En Art. 12º Norma SO_2 y en general para todas las normas (NO_2, O_3, CO) modificar por: "...deberá considerarse **al menos** uno de los puntos siguientes (...)". Debe incluirse como uno de los puntos "evaluaciones de riesgo del contaminante sobre la salud de la población".	85. Los criterios señalados en el artículo al cual se hace mención, serán incorporados en el manual de aplicación de la norma, al cual se hará mención en el programa de implementación de las normas en los proyectos definitivos de las mismas.
		86. Se solicita eliminar modificación de norma diaria para SO_2 y mantener la existente (365 ug/m^3)	86. No se acoge. Existen los fundamentos en salud suficientes que avalan el cambio normativo propuesto.
		87. Se solicita no derogar norma para PTS por cuanto sí representa molestias a la salud (irritaciones de nariz, ojos y garganta)	87. No se acoge. Existen los fundamentos suficientes en salud que avalan derogar la norma de PTS vigente. Existe consenso a nivel internacional que los principales efectos en la salud producto del material particulado se encuentran asociados a la fracción respirable que corresponde a PM10 y PM2,5, especialmente en lo que se refiere al PM2,5 el cual contiene los componentes mas tóxicos. En relación la fracción gruesa por sobre PM10 y que pudiera ocasionar un problema en salud, actualmente en el País se encuentra vigente una norma de calidad primaria de calidad de aire para Plomo y una norma de emisión de As al aire.
		88. Considerar las normativas como una protección a la vida y la salud de las personas, las cuales deben ser siempre la primera prioridad	88. De esta manera esta planteado en los objetivos de las normas propuestas.
		89. Se deben considerar los aspectos de la fragilidad del ecosistema del lugar, y debido a esto, las normas deben ser dinámicas. Los planes de descontaminación otorgan la gradualidad que las fuentes contaminantes requieren.	89. Las normas en revisión corresponden a normas primarias de calidad de aire, cuyo objetivo es proteger la salud de las personas. La fragilidad de ecosistemas es materia de otra normativa, normas secundarias de calidad ambiental.
		90. A lo largo del tiempo y en otros países con problemas ambientales similares	90. Para la elaboración de las normas propuestas se

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		ya hay estudios de causa – efecto sobre la población. ¿Tendremos que seguir esperando mientras los niños se enferman?	tuvo en consideración la mejor información disponible de efectos sobre la salud de la población (Nacional e Internacional).
		91. Para las normas primarias se debe considerar como población expuesta cualquier cantidad de personas: millones de personas o una persona que se vea afectada por la emisión de contaminantes	91. En la legislación vigente no se ha encontrado una definición en cuanto a que número de personas constituye una población. En los proyectos definitivos se tratará de definir de una manera más específica a su forma actual.
		92. Existe la percepción que las empresas contaminantes están presionando para se proteja el poder económico por sobre la vida y la salud de las personas	92. Las empresas que emiten contaminantes para los cuales se están revisando las normas tienen el derecho a formular observaciones a los anteproyectos de las normas de la misma manera que cualquier persona natural o jurídrica. Así lo establece el reglamento para la dictación de normas de calidad ambiental y de emisión, D.S N° 93 del Ministerio Secretaría General de la Presidencia.
		93. Las tecnologías para que las empresas sean eficientes y sustentables en sus actividades deben cumplir con las normativas internacionales vigentes	93. No es materia del proceso de revisión de normas.
		94. La exposición continua en un espacio de tiempo, ya sea elevada contaminación en poco tiempo, o bien poca contaminación por años, desencadena reiteradas bronconeumonías y asma crónico dejando a los niños limitados para su desarrollo posterior. ¿Debemos flexibilizar las normas? ¿Por qué no considerar los aspectos biomédicos?	94. Las normas propuestas en los anteproyectos se basan en los antecedentes nacionales e internacionales mas recientes respecto del efecto del contaminante sobre la salud de las personas. El objetivo de una norma primaria es proteger la salud de las personas.
		95. Conjuntamente con el estudio de las normativas debe estudiarse cómo se reforzará la fiscalización a las fuentes contaminantes. El fiscalizador debe ser un ente externo y ética y moralmente válido para que curse los partes o multas por los daños causados, o cierre la empresa contaminantes. La fiscalización es deficiente en Chile.	95. El tema de la fiscalización es un punto extremadamente importante el cual es necesario de potenciar en la legislación a<mbiental vigente. A través de un programa de implementación de las normas a incorporar en los proyectos definitivos de las mismas se tiene por objetivo entregar al fiscalizador, en este caso, los Servicios de Salud del País, mayores herramientas para la fiscalización.
Taller Región Metropolitana (Santiago)	02/11/00	96. Considerar los costos de inversión que habrá que abordar para cumplir con las normas. Se debe ser riguroso en el estudio de costos / beneficios de las normas	96. La evaluación del impacto económico y social de las normas contenidas en los anteproyectos es parte del procedimiento establecido en el reglamento para la dictación de normas de calidad ambiental y de emisión.
		97. Revisar el método del percentil 99 para la determinación de la excedencia de los niveles de norma	97. Se ha considerado el percentil para evaluar la excedencia de las normas, dado que con ello se da cuenta de mejor forma de la disponibilidad de información.
		98. Los criterios que se utilizan para la definición de las normas deben enfatizar la protección de la salud de la población garantizando la calidad de vida de las personas	98. Los valores de norma propuestos en los anteproyectos están basados principalmente en los efectos del contaminante sobre la salud de las personas.
		99. Se debe impulsar procesos productivos más limpios	99. Esto no es materia específica de una norma de

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			calidad de aire.
		100. Considerar mecanismos de control de episodios críticos (efectos agudos y crónicos)	100. Las medidas a adoptar producto de la superación de los niveles que definen situaciones de emergencia ambiental no son materia de esta norma. Esto se aborda en otro instrumento de gestión ambiental, denominado plan de descontaminación.
		101. ¿Cuál es la cobertura de la red de monitoreo existente en la Región Metropolitana? ¿Existen proyectos de monitoreo en otras ciudades del país?	101. Para la implementación de la norma se requiere de la necesidad de incrementar el número de redes de monitoreo actuales. En este sentido se deja abierta la posibilidad en las normas de utilizar metodologías alternativas para el monitoreo de la calidad del aire que pueden ser usadas como herramientas de diagnóstico, por ejemplo, tubos pasivos.
		102. Se debe tener en cuenta que la calidad de los datos de mediciones de la concentración de contaminantes depende además de la operación y mantención de los equipos	102. Esto será incorporado de una forma mas precisa en los proyectos definitivos de norma. Se incorporará un programa para la implementación de las normas el cual considerará la elaboración de un manual de aplicación de la norma y que contendrá lo relativo a la operación mantención y calibración de los monitores.
		103. ¿Quién tendrá a cargo el monitoreo de la calidad del aire?	103. La fiscalización de las normas es responsabilidad de los Servicios de Salud del país por tratarse de una norma primaria de calidad de aire.
		104. La ciudadanía debe exigir a las autoridades competentes programas de monitoreo eficientes y continuos	104. No se responde pues se considera una opinión
		105. Explicar con mayores fundamentos por qué se elimina la norma para PTS	105. En el expediente público de la norma se encuentran los antecedentes que fundan el no regular el PTS.
		106. Se considera que los sistemas predictivos para la definición de situaciones de emergencia ambiental (normas horarias) son de alto costo y baja eficiencia. ¿Qué se hará al respecto?	106. En los anteproyectos de normas se deja la alternativa de poder utilizar una metodología de pronóstico para establecer si se superarán los niveles que definen situaciones de emergencia ambiental. La eficiencia y el costo depende del tipo de pronóstico. En la región metropolitana la eficiencia lograda es del orden del 70% lo cual es bastante bueno.
		107. Se debe establecer las normas más estrictas ahora y no esperar a incrementar la exigencia de a poco en el tiempo. En este sentido, se debe aclarar bien cómo se incorporaría el principio de gradualismo en el proceso normativo.	107. Los valores de normas establecidos son los que se considera adecuados para la protección de la salud de las personas. La gradualidad no es tema de la norma de calidad, pues esta no establece responsables si esta se incumpliera. En los planes de descontaminación es en donde se debe establecer quienes son los responsables y en cuanto deben reducir sus emisiones a fin de que se cumpla con la normativa.
		108. ¿Qué ocurre con las innovaciones que se den en cuanto al uso de metodologías de medición de contaminantes? Al respecto, en el Título sobre	108. Dado que en el país no existe una institución que certifique este tipo de instrumentos, en los

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		Metodología de Medición de las Normas (para todos los contaminantes) se debe agregar que "el monitoreo deberá realizarse con instrumentos aprobados por un organismo internacional **o nacional** calificado para este fin (...)".	proyectos definitivos de normas se mantendrá que la aprobación este condicionada a la aprobación por parte de un organismo internacional.
		109. No puede obviarse la relación directa que existe entre algunas fuentes contaminantes (fundiciones mineras) y la factibilidad de cumplimiento de las normas de calidad (especialmente para norma horaria de SO_2)	109. El incumplimiento de las normas de calidad no implica una responsabilidad directa de las fuentes emisoras. En los planes de descontaminación es donde se se asigna la responsabilidad de cada una.
		110. Se debe establecer una correlación entre número de estaciones de monitoreo y número de personas expuestas	110. Esto es parte de los que deben abordar los Servicios respectivos encargados de la fiscalización de las normas, respecto de la aprobación de redes de monitoreo.
		111. Se considera que las empresas que no tengan certificación ambiental (ISO 14.000) estarán expuestas a la pérdida de competitividad. La norma horaria para SO_2 pondrá en serias dificultades a las empresas que buscan cumplir con tal certificación por cuanto tendrán problemas para mejorar sus emisiones en la perspectiva de las exigencias que se demanden por incumplimiento de la norma de calidad.	111. Sobre la base de los antecedentes proporcionados por la evaluación económica de la norma de SO2 y la falta de información en cuanto a la prevalencia e incidencia de asmáticos, se ha tomado la decisión de postergar la implementación de la norma horaria para SO2.
		112. Se solicita eliminar norma horaria para SO_2	112. Ver punto anterior.
		113. Establecer antecedentes biomédicos en poblaciones expuestas a los distintos contaminantes	113. Se planteará este tema al Ministerio de Salud.
		114. Las organizaciones sociales demandan mayor y mejor relación con CONAMA para opinar en estos procesos de consulta pública	114. La experiencia acumulada en este proceso normativo se tendrá en consideración para futuros procesos normativos de normas.
		115. Se solicita incorporar estudios epidemiológicos realizados por ENAMI en relación al SO_2	115. Se solicitará los estudios a ENAMI a fin de ser evaluados.
		116. Se recomienda revisar casos donde exista norma de emisión sin norma de calidad ambiental (por ejemplo, Arsénico) y evaluar esto a la luz de la eliminación de la norma para PTS	116. La derogación de la norma primaria de calidad de aire para PTS se fundamenta en los estudios en salud internacionales y los últimas revisiones de la normativa internacional. (USA, CE, OMS)
		117. Se solicita profundizar respecto a en qué medida CONAMA o los Servicios de Salud pueden definir la trazabilidad de los datos generados en las mediciones de concentración de contaminantes.	117. La responsabilidad de fiscalizar el cumplimiento de la normativa y todo lo relativo al monitoreo de la calidad del aire se asigna a los Servicios de Salud respectivos.
		118. Se recomienda la elaboración de guías metodológicas de referencia para la operación y mantención de los equipos de medición de concentraciones de contaminantes normados	118. Este tema será abordado en los proyectos definitivos de normas a través del un programa de aplicación de la norma que contempla la elaboración de un manual de aplicación.
		119. La norma de PTS es viable y necesaria ya que existe importante generación de polvo en suspensión en las poblaciones por falta de áreas verdes y presencia de sitios eriazos	119. Todos los antecedentes recopilados sobre el impacto en salud producto de la exposición a material particulado, asocian los efectos en la salud de las personas a la fracción respirable del material particulado.
		120. Reconsiderar la eliminación de la norma horaria para O_3	120. Existen antecedentes fundados y que constan en el expediente público de la norma de que los efectos en salud, para el caso del ozono, se asocian de mejor manera a una exposición de 8 horas que de 1 hora.

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		121. Mejorar los mecanismo de participación ciudadana incorporando nuevas instancias de información a través de ciclo de charlas en donde la comunidad vive (en terreno)	121. Se tendrá en consideración para futuros procesos normativos.
		122. Se recomienda contemplar mayores regulaciones para fuentes móviles	122. No es materia de esta norma.
Taller VIII Región (Concepción)	07/11/00	123. Respecto al Título sobre Metodología de Medición de las normas, se solicita aclarar que se considera "suelo" donde se señala la altura máxima y mínima a la que debe estar la toma de muestra	123. Se revisará y corregirá si corresponde.
		124. Se debe enfatizar el tema del gradualismo en la aplicación y cumplimiento de las normas	124. En los proyectos definitivos de norma se incorporara un programa de implementación de las normas. Respecto a la gradualidad para su cumplimiento, esto es materia de otro instrumento de gestión ambiental que corresponde a los Planes de Descontaminación. En este instrumento es donde se debe establecer gradualidad según corresponda para reducir las emisiones.
		125. Se debe aprovechar de mejor manera la instancia del Consejo Consultivo Regional para la presentación de las normas y la recepción de opiniones	125. Se abordará este tema con las Direcciones regionales de CONAMA a fin de poder optimizar la participación regional en futuros procesos normativos.
		126. Para entender mejor las normas se deben expresas los valores en unidades similares en todo el texto	126. Se revisará se expresarán de manera similar las unidades en los proyectos definitivos de normas.
		127. En las normas se señala que se considerarán sobrepasadas cuando las concentraciones sean mayor o igual al valor definido. Al respecto, se debe modificar por "sea **mayor** al valor indicado (...)".	127. De acuerdo a lo señalado en los antecedentes recopilados los efectos en la salud de la población se manifiestan a partir del nivel de concentración señalado en la norma respectiva.
		128. Se deben incorporar otras instancias de fiscalización y control de las normas primarias de calidad del aire (por ejemplo, universidades y otras)	128. La facultad de fiscalización corresponde, de acuerdo a la legislación vigente, corresponde a los servicios de Salud, en este caso, por tratarse de una norma primaria de calidad de aire.
		129. Incorporar en las definiciones para las normas de CO y O_3 a las fuentes contaminantes	129. No se considera necesario incluir esto para efectos de aplicar la norma. En el expediente público de las normas se da cuenta de las fuentes emisoras de los contaminantes regulados
		130. Disminuir el plazo de revisión de las normas (por ejemplo, a 2 años)	130. El reglamento para la dictación de normas de calidad ambiental y de emisión establece que toda norma será revisada a lo menos cada cinco años. Sin embargo, La CONAMA a solicitud de cualquiera de los Ministerios competentes, fundados en la necesidad de readecuación de la norma, podrá adelantar el proceso de revisión.
		131. Mantener norma para PTS a modo de proteger la calidad de vida de las personas	131. Los antecedentes disponibles y que constan en el expediente público de la norma indican que no existen fundamentos, desde el punto de vista de la salud de las personas, para mantener esta normativa.
		132. No se deben adoptar los valores de norma más altos para SO_2 existentes a nivel internacional, se deben considerar recomendaciones más estrictas	132. Los valores adoptados corresponden a aquellos a partir de los cuales se verifica un efecto en la salud de las personas. A excepción del valor propuesto como concentración de 1 hora, en que se tuvo en

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			consideración la realidad nacional.
Taller VI Región (Rancagua)	09/11/00	133. Aclarar qué ocurre, para efectos de estas normas, en áreas con fuentes contaminantes pero sin población expuesta	133. Por tratarse de normas primarias de calidad de aire, las normas tienen vigencia en todo el territorio de la república. Sin embargo y de acuerdo a lo establecido en el reglamento para la dictación de normas de calidad ambiental y de emisión, las normas se verifican solo donde existe población, que constituye el objetivo de protección de estas normas.
		134. Aclarar si el sistema de pronóstico para la definición de niveles de emergencia ambiental es conveniente, obligatorio o sólo recomendado	134. Se deja la alternativa de usar uno u otro. Claramente es mucho mas eficiente para el control del episodio poder utilizar una herramienta de pronóstico.
		135. ¿Se consideran los efectos sobre la salud de las personas de los contaminantes en su conjunto (2 o más)?	135. Los antecedentes disponibles y que constan en el expediente público de la normas hacen referencia a los efectos sinérgicos del contaminante con otros.
		136. ¿Se consideran sanciones por incumplimiento de las normas?	136. El incumplimiento de una norma de calidad no establece responsabilidades a las fuentes emisoras, por lo cual no corresponde la aplicación de una sanción. Si se establecen sanciones por el incumplimiento de un Plan de Descontaminación, en el cual se fijan metas específicas de emisión para los emisores.
		137. ¿Cómo se explica que el percentil 99 implique 4 superaciones del valor de la norma en un año si la actual normativa establece sólo una? ¿Se están flexibilizando las normas?	137. El considerar el percentil para efectos de evaluar la superación de una norma implica que se da cuanta de una mejor forma de la falta de información de monitoreo de calidad de aire, descartando los valores extremos. Esta forma de evaluar la normativa se esta adoptando de manera general a nivel internacional.
		138. Aclarar qué se entenderá por "población expuesta" (¿cuál es el límite o criterio?)	138. El termino población expuesta se refiere a aquella población que reside habitualmente en un lugar en el cual producto de las emisiones de fuentes emisoras se registran niveles de concentración de calidad de aire determinados.
		139. Los lugares donde se instalen las redes de monitoreo deben ser definidos según si existen o no personas expuestas, no dependiendo del número de personas.	139. El reglamento para la dictación de normas de calidad ambiental y de emisión establece que las normas de calidad ambiental se deben verificar donde existe población. No se establece en el reglamento ni en la Ley una definición de población.
		140. Entregar mayores fundamentos para los valores de norma horaria y diaria para SO_2 (se solicita reconsiderar los fundamentos utilizados)	140. En el expediente público de la norma se encuentra un documento resumen que contiene un resumen de los antecedentes recopilados respecto del anhídrido sulfuroso (SO2).
		141. ¿Cómo se implementan las medidas de prevención para la protección de la población (por ejemplo, en colegios)?	141. Esto no es materia de la norma. Las medidas específicas para la protección de la salud producto de la superación de los niveles de concentración

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			que definen situaciones de emergencia ambiental se establecen mediante un plan operacional inserto en un plan de descontaminación, instrumento de gestión ambiental diferente a una norma.
		142. Generar instancias de educación masiva sobre la contaminación del aire, tanto para la comunidad como para empresas y otros actores.	142. Este tema será considerado en la evaluación de alternativas de cómo potenciar la participación de la comunidad en los procesos de dictación o revisión de normas ambientales y otros instrumentos de gestión ambiental.
		143. Se debe incorporar a los municipios como entidades encargadas de fiscalizar el cumplimiento de las normas	143. De acuerdo a lo establecido en la legislación vigente corresponde a los Servicios de Salud la fiscalización del cumplimiento de las normas primarias de calidad ambiental.
		144. Incorporar medidas de mitigación de impactos derivados del material particulado (PTS)	144. No es materia de la norma.
		145. Incorporar mecanismos para identificar las causas del aumento de los niveles de contaminantes en el aire para facilitar la toma de medidas en situaciones de emergencia ambiental	145. No es materia de la norma.
		146. Se debe incentivar la reconversión tecnológica para reducir las emisiones en las fuentes	146. No es materia de la norma.
		147. Fortalecer y enfatizar programas de descontaminación de áreas y zonas frágiles	147. No es materia de la norma.
		148. Ampliar de 5 a 25 años el ciclo de revisión de las normas	148. El objetivo de establecer un plazo para que se revisen las normas es que se incorporen los nuevos antecedentes generados al respecto y que se evalúe la eficiencia y eficacia de la norma dictada. Teniendo en cuenta lo anterior, un plazo de 25 años se considera demasiado. El reglamento para la dictación de normas de calidad ambiental y de emisión establece que las normas se deben revisar a lo menos cada 5 años. Sin embargo, estas podrían ser revisadas anticipadamente si se requiere. También es importante señalar que si a los cinco años la norma mantiene su vigencia en cuanto a los objetivos, eficacia y eficiencia esta no tiene porque ser modificada.
		149. Se plantean otras observaciones generales: a) establecer exigencias para las fuentes emisoras; b) incorporar estudios sobre la presencia de virus en el aire que afectan la salud de la población; c) incluir el tema de la contaminación de los alimentos; y d) aclarar qué ocurre con los efectos sobre la calidad del aire derivados del adelgazamiento de la capa de ozono.	149. A) No es materia de la norma. B) No es materia de la norma. C) No es materia de la norma. D) No es materia de la norma.

2. OBSERVACIONES ENVIADAS POR ESCRITO A CONAMA

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Santiago Torres E. Gerente de Medio Ambiente CODELCO Huérfanos 1270, Casilla 150-D, Santiago Fax: 6903059	21/08/00	150. **PTS**: la propuesta elimina este parámetro, idea con la cual concordamos plenamente, al existir otras normas que controlan en mejor forma el material particulado.	150.
		151. **Norma Anual SO_2**: la propuesta mantiene el valor de este parámetro, posición con la que concordamos, pues no existen antecedentes que ameriten modificarlo.	151.
		152. **Norma 24 horas SO_2**: se ha propuesto disminuirla de 365 a 250 ug/Nm3, con un percentil de cumplimiento de 99%. El valor límite propuesto no es posible de ser cumplido bajo ninguna circunstancia en el campamento de Chuquicamata, ni ser cumplida a cabalidad en el Centro de Alojamiento de Potrerillos (División El Salvador) o en Coya Club de Campo y en lugares residenciales de Coya cercanos a él (División El Teniente). Ante un eventual traslado del campamento de Chuquicamata, estaríamos corporativamente en condiciones de cumplir una norma no inferior a 300 ug/Nm3, con un percentil de cumplimiento de 98%.	152.
		153. **Norma Primaria Horario de SO_2**: aquí se ha propuesto, contra la opinión del consultor de CONAMA sobre esta materia, establecer una Norma Horaria, fijándola en un valor de 1050 ug/Nm3, con un percentil de cumplimiento de 99%. AL margen de las consideraciones de beneficio-costo realizadas por el consultor, se debe tener en cuenta lo poco práctico de una norma de este tipo, pues las acciones de control operacional a adoptar de tipo reactivas no tendrían efectos dentro de este corto período. Para evitar su ocurrencia, las medidas necesariamente deberían ser de tipo preventivas, lo que obligaría a operar las fundiciones en base a complejos modelos meteorológicos predictivos (que han revelado ser de escasa exactitud), que las llevaría a significativas pérdidas productivas, muchas veces innecesarias. Nos parece que las situaciones de impactos agudos de corto tiempo pueden ser mucho mejor manejados a través de las medidas establecidas para el manejo de episodios críticos, los que se pueden establecer aún cuando no existan Planes de Descontaminación en vigencia (Ejemplo: restricciones de circulación de vehículos y paralización de fábricas en Santiago desde mucho tiempo antes que se estableciera un Plan de Descontaminación al respecto). Si se mantuviera la idea de manejar estas situaciones a través de una Norma de Calidad, nos parece más lógico establecer una que regule el promedio móvil de tres horas, período en el cual si se puede reaccionar con medidas de control operacional efectivas. El valor podría ser el mismo propuesto, pero con un percentil de cumplimiento de 98%.	153. La norma propuesta es posible cumplirla, de echo hoy en día existe una fundición de cobre que cumple con un nivel inferior al de la norma propuesta. Es decir existe la tecnología para cumplirla. El punto es un tema de costos y plazos. Sin embargo, teniendo en consideración los resultados de la evaluación económica de las normas propuestas en términos de los costos asociados y los beneficios de su aplicación, se ha decidido postergar la implementación de la norma, especialmente porque no es posible conocer hoy todos los beneficios de la misma.
		154. No entendemos la razón de aplicar para el SO_2 percentiles de cumplimiento de 99%, en circunstancias que para PM10 este percentil es de 98%. A nuestro juicio, este nivel de percentil debería igualarse para todas las normas y no definir este valor en forma arbitraria para cada una de ellas.	154. Se aplica un percentil 99 pues se quiere reducir la incertidumbre en cuanto a que a pesar de cumplirse con la norma, se verifiquen niveles de emergencia ambiental.
		155. En relación al proceso normativo ambiental, en general, la globalización del comercio internacional ha llevado a establecer modelos de comportamiento ambiental aceptables internacionalmente, para evitar discriminaciones arbitrarias al respecto. Las empresas chilenas que basan su gestión en el comercio internacional de sus productos, están siendo presionadas	155. El incumplimiento de una norma de calidad ambiental no es imputable en responsabilidad a una fuente determinada. La responsabilidad de cada fuente se establece en el marco de un plan de descontaminación.

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		progresivamente por el mercado a establecer estos modelos de gestión ambiental consensuados. CODELCO, así como otras empresas exportadoras, están implementando sistemas de gestión ambiental para ser certificados por la Norma ISO-14001. Esta Norma tiene como su principal exigencia, el cumplimiento del marco regulatorio aplicable. Un no cumplimiento de este marco es razón suficiente para no certificar o, peor aún, para perder una certificación alcanzada. Ello lleva a la necesidad de ser muy cuidadosos al definir la normativa a aplicar, teniendo en consideración sus posibilidades reales de cumplimiento, a fin de no dejar fuera del mercado internacional a volúmenes importantes de la producción nacional.	
		156. Adjunta antecedentes solicitados por CONAMA a CODELCO con relación al proceso de revisión de las normas primarias (carta UEA Nº 4568).	156.
Micehlle Bachelet Jeria Ministra de Salud	11/10/00	157. Respecto a la proposición para SO2 es opinión de esta Secretaría de Estado, que dicha proposición presenta tanto mejorías como retrocesos respecto al grado de protección que confiere la norma vigente. En efecto por un lado se propone incluir un valor máximo horario y por otro reducir el valor de 365 ug/Nm3 como norma para 24 horas, sin embargo, los criterios de excedencia de dicha norma disminuyen el grado de protección a la población expuesta. Lo anterior implica que la norma horaria se puede superar en 87 horas del año, equivalente a 4 días y en el caso de la norma diaria en 4 días. En base a lo expuesto anteriormente, esta Secretaría de Estado propone que se considere un factor protector para la población que sea a lo menos igual al contenido en la legislación vigente, así como asegurar que las excedencias horarias y diarias estén equiespaciadas durante el año o periodos del año. 158. En lo que a contaminantes gaseosos se refiere, en opinión de este Ministerio de Salud y habida cuenta que la proposición hecha por esa Comisión, solo se aplicaría a los gases normados por la Resolución 1215, los valores de normas propuestos deben ser expresados tanto en ug/Nm3, como unidades que correspondan a concentraciones expresadas en términos de volumen a volumen, es decir partes por millón (ppm). Lo anterior, debido a que los equipos que realizan las mediciones de concentraciones ambientales de gases entregan los valores de dichas concentraciones en base a una relación volumen-volumen.	157. El objetivo de las normas propuestas es proteger la salud de la población y por lo tanto para fijar la norma se ha tenido en consideración la información mas reciente a nivel internacional tanto en lo que respecta al nivel, periodo de evaluación y criterio de excedencia. Específicamente en lo que se refiere a la excedencia en los proyectos definitivos de norma se incorporara un criterio adicional, cual es, el considerar el promedio de tres años sucesivos para evaluar si la norma se esta superando. Esto tiene por objetivo tener en consideración la variación de la estabilidad inter-anual y tener certeza que la norma se supera y que no corresponde a un evento producto de una situación anual favorable o desfavorable. 158. En los proyectos definitivos de normas se expresarán los valores en las dos unidades. Sin embargo, para efecto de la fiscalización de las normas se deberá considerar las unidades de ppbv o ppmv según corresponda.
Armando Arancibia Calderón Intendente de la Región de Atacama Refiere a observaciones formuladas en reunión del 23 de octubre de 2000 donde participaron: **Antonino Prado Castro**, Secretario Regional Ministerial de Minería; **José Sanhueza Reyes**, Gerente Fundición Hernán Videla Lira; **Lorenzo Sotomayor Torreblanca**, Relacionador Público Fundición Hernán Videla	25/10/00	159. La carta adjunta documento elaborado por ENAMI donde se entregan los antecedentes y observaciones en detalle. La carta sólo refiere a un resumen de las observaciones.	159.

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		160. **<u>Norma diaria para SO_2</u>**. Se ha propuesto disminuirla de 365 a 250 ug/m^{3}N, con un percentil de cumplimiento de 99%. El valor límite propuesto no es posible de ser cumplido bajo ninguna circunstancia en el poblado de Estación Paipote, distante solo a 1 Km al NO de la Fundición Hernán Videla Lira. La proposición de ENAMI conlleva el criterio de gradualidad, proponiéndose para los próximos 5 años un valor de la norma diaria de calidad del aire de 330 ug/m^{3}N con un 99% de cumplimiento, o bien 300 ug/m^{3}N con percentil 98. Como dato ilustrativo, la norma federal de USA, que data de 1971, es de 365 ug/m^{3}N; en 1996 fue objeto de revisión, concluyéndose que no existían méritos suficientes para modificarla. **<u>Situación actual bajo esta nueva normativa</u>**. Al mes de septiembre del presente año se habría sobrepasado en 7 oportunidades, todas ellas en Estación Paipote. La actual normativa se ha sobrepasado sólo en una oportunidad el presente año.	160. De acuerdo a la información disponible para el año 99 la propuesta de norma de 250 ug/Nm3 como concentración de 24 horas en las condiciones de excedencia establecidas en el anteproyecto se cumplió. Se señala además, en en el proyecto definitivo de norma se incorporará una nueva condición para verificar si la norma se excede que establece que se deberá considerar el promedio de tres años del percentil 99. Esto a fin de hacerce cargo de la variación de la estabilidad anual, lo que permitirá disminuir la incertidumbre respecto a la superación de una norma. En relación a la norma de Estados Unidos, es importante señalar que no es posible comparar directamente con nuestro país, pues la normativa se aplica de manera diferente. En estados Unidos si bien es cierto existe una norma federal que rige para todo el país, también es cierto (a diferencia de nuestro país) que los estados pueden fijar normas mas estrictas que la federal si lo requieren. En este sentido si se compara respecto a la norma del estado de California y Washington se encontrará que son mucho mas estrictas que la norma federal.
		161. **<u>Norma primaria horaria para SO_2</u>**. Se ha propuesto establecer una norma horaria, con un valor de 1.050 ug/m^{3}N, con un percentil de cumplimiento de 99%. Se señala como justificación para esta nueva norma, la protección de la salud de la población en lo que respecta a aspectos agudos de corto plazo en personas sensibles, en especial asmáticos. Una norma de este tipo, que permite sólo 4 excedencias al año, es técnicamente imposible de cumplir en áreas habitadas tan cercanas a la Fundición, como lo es la localidad de Paipote, ello porque no depende del nivel de emisiones de la Fundición, sino de las variables meteorológicas de la zona, las que son difícilmente predecibles por el relieve del sector. En la mencionada revisión de la norma federal de USA (1996), se estimó innecesario establecer normas para periodos inferiores a 24 horas. **<u>Situación actual bajo esta nueva normativa</u>**. Al mes de septiembre del presente, se habría sobrepasado en 36 oportunidades.	161. Es importante mencionar que la norma propuesta es factible técnicamente de ser cumplida. De hecho existe actualmente una fundición en el país que cumple con una norma horaria mas estricta que la propuesta. El punto es un tema de costos y plazos. Al respecto es importante mencionar también que el área en la cual se encuentran localizadas la fundiciones de ENAMI están declaradas saturadas por norma secundaria de SO2 y esta a pesar de la aplicación del Plan de descontaminación aún no se cumple, sobretodo en el área de Ventanas, V Región. La norma secundaria es de 1000 ug/Nm3. Sin embargo, sobre la base del análisis de la evaluación económica de la implemnetación de la norma y los beneficios asociados se ha decidido postergar la implementación de esta norma.

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		162. El cobre es un "commodity" transado en los mercados internacionales, donde las exigencias de certificación están siendo un requisito indispensable si se quiere ser un actor relevante en el mercado, por lo que al momento de generar una normativa nacional hay que tener presente el impacto que puede tener ésta en la comercialización del producto. La certificación exige el cumplimiento de la normativa nacional y cambios demasiado seguidos dificultan su satisfacción. (Se adjuntan Anexos con antecedentes de Fundición Hernán Videla Lira).	162. El hecho que no se cumpla una norma de calidad ambiental en un área determinada no implica de manera directa una responsabilidad a una fuente específica. Lo que implica es que el Estado debe hacerse cargo a fin de revertir tal situación mediante la declaración de zona saturada y la elaboración de un Plan de Descontaminación en el cual se determina la responsabilidad de cada fuente, se establece el cronograma de reducción de emisiones que sea necesario otorgando los plazos que correspondan.
Santiago Torres E. Gerente de Medio Ambiente CODELCO Huérfanos 1270, Casilla 150-D, Santiago Fax: 6903059	30/10/00	163. La División, en su Plan de Desarrollo, considera un aumento de su capacidad de fusión desde 1.25 a 1.6 millones de toneladas de concentrado al año y ha incluido para ello proyectos adicionales de captación de sus gases, concordantes con los límites de emisión establecidos en su Plan de Descontaminación (Nuevo Módulo de Planta de Limpieza de Gases Nº1 y Tratamiento de Gases Secundarios de Convertidor Teniente y Convertidores Peirce-Smith).	163. Se reconoce el esfuerzo realizado por la empresa para llevar a cabo el cumplimiento del cronograma de reducción de emisiones. Sin embargo, en la actualidad y de manera específica en la localidad de Ventanas aún persiste el incumplimiento de la norma secundaria de calidad de aire, lo cual implica la necesidad de evaluar la reformulación del Plan de Descontaminación.
		164. La materialización del Plan de Descontaminación y el cumplimiento de las emisiones de SO2 consignadas en él permitirá dar cumplimiento con holgura a la norma anual vigente y en forma muy ajustada a la norma de 24 horas propuesta (250 ug SO2/Nm3). La incorporación de una norma horaria en los valores propuestos en el anteproyecto, no tiene posibilidad alguna de ser cumplida, proyectándose excedencias en un 10% de los días del año.	164. En relación a la norma horaria y sobre la base de los antecedentes proporcionados por la evaluación económica de su implementación y los beneficios asociados, se ha decidido postergar la implementación de esta norma.
		165. Las excedencias horarias son resultado exclusivamente de variaciones meteorológicas ante las cuales no es posible reaccionar oportunamente para evitarlas. Se haría necesario operar con modelos meteorológicos predictivos que obligarían a bajar de fusión con 8 horas de anticipación a la posible ocurrencia del fenómeno, muchas veces sin que ello sea necesario a causa del alto nivel de incerteza de estos modelos. Ello, en su oportunidad, fue bien entendido por CONAMA con ocasión de la dictación del Plan de Descontaminación. La única forma de asegurar el cumplimiento de la normativa horaria propuesta es no materializando la expansión proyectada, pero sí realizando los proyectos adicionales de captación de gases que se han diseñado para permitirla.	165. Ver punto anterior.
		166. CODELCO insiste en que la situación de impactos agudos debe ser abordada a través del manejo de episodios críticos incluidos en el mismo Anteproyecto de Revisión de la Norma.	166. Las medidas a adoptar producto de la superación de los niveles que definen emergencia ambiental son materia de un Plan de Descontaminación y no de una norma de ambiental.
Gerardo Guzmán Grimaldi Director Regional CONAMA V Región	30/10/00	**Observaciones referidas al anteproyecto de norma primaria para Ozono (O_3)**	

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		167. Punto II. Artículo 2, letra a. ¿Qué se entenderá por "períodos cortos de exposición"? ¿No importa la frecuencia con que el individuo se expondrá a estos períodos cortos? Se propone especificar los rangos de tiempo que se entenderán como exposición en períodos cortos. Lo anterior se consulta debido a lo que se entenderá como el límite permisible de exposición sobre el cual el contacto con este contaminante significa un riesgo.	167. Para efectos de esta norma se entiende por periodos de exposición igual o inferior a 24 horas. Se revisara la redacción para una mayor claridad.
		168. Punto II. Artículo 2, letra f. Se requiere definir si los criterios consignados en la letra i) e ii) se deben cumplir en forma simultánea, para lo cual se propone el siguiente texto: "EMRPG: Una estación monitora podrá clasificarse como EMRPG si se cumplen simultáneamente los siguientes criterios". Se sugiere especificar bajo qué criterio se estableció la representatividad de la estación en un radio de 2 KM., debido a que el radio de 2 Km. (el mismo usado en el decreto 59 de norma primaria de material particulado) está determinado para una estación de muestreo Urbano con un área de representatividad en torno a la estación que va desde los 100 metros a los 2 Km. Si en el área de 2 Km., hay una fuente de óxidos de nitrógeno en algún punto de esta área por ejemplo fuentes móviles ¿La muestra tomada en esta estación pierde su representatividad?. ¿Es posible la instalación de distintas estaciones de monitoreo (distinta representatividad) dentro del área de la estación EMRPG? (adjunta Figura). En general la condición de representatividad puede decir: "Una estación EMRPG tendrá un área d representatividad para la población expuesta equivalente a una estación de monitoreo tipo Urbana correspondiente a un radio de 2 KM, medido desde la ubicación de la estación, según las especificaciones entregadas por la ETC-AQ y la EUROAIRNET/AIPBASE". Se sugiere definir "Área Habitada", como propuesta se presenta lo siguiente: "Área del territorio donde permanece una o más personas durante un período igual o superior a 8 horas, ya sea para vivir o realizar su jornada de trabajo". Se requiere definir como se va a establecer la distancia mínima que asegure que no existan interferencias sistemáticas por sumideros de Ozono. Para esto se sugiere establecer en la Norma que será el Servicio de Salud respectivo quien lo definirá, para esto se propone utilizar parte del Art 6º de la Norma de PM-10 de tal forma de incluir el siguiente texto como otro artículo: "El Servicio de Salud respectivo mediante resolución fundada, deberá aprobar la clasificación de una EMRPG, de acuerdo a las condiciones establecidas en la definición que se indica en al artículo 2º de la presente Norma". ¿Qué se entenderá por sumidero de Ozono?. Se propone agradar lo siguiente (o algo similar): "Se entenderá como un sumidero de Ozono a todo elemento (orgánico o inorgánico, ...etc), que a través de algún proceso físico o químico genere el retiro de este contaminante desde la atmósfera.	168. Se revisara la redacción. En los proyectos definitivos de normas se buscará una definición mas concreta de área habitada. Se adoptó el criterio de 2 km. Como una condición mínima para la representatividad de una estación desde el punto de vista de la población. En los proyectos definitivos de norma se establece que los servicios de Salud deberán aprobar las estaciones de monitoreo con representatividad poblacional. Específicamente se incorpora en el programa de implementación de ñla norma en la cual se señalan además los plazos para ello.
		169. Punto II. Artículo 2, letra g. Se debe cambiar ug/Nm3 por ppbv. El texto debiera decir: "corresponde al valor "q" calculado a partir de los valores efectivamente medidos de la concentración de Ozono en ppbv. Todos los ....".	169. Se corregirá
		170. Punto II. Artículo 2. Se sugiere agregar a las definiciones el siguiente concepto: "Área de	170. Este punto deberá ser abordado en el manual de aplicación de la norma, al que se hará mención

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		representatividad: se entenderá por área de representatividad de una estación de monitoreo, al área en donde las concentraciones del contaminante, en cualquier punto, está representada por el valor promedio de concentración medido en la estación de muestreo.	en los proyectos definitivos. Se establece que el manual deberá ser elaborado por CONAMA en un plazo de un año a partir de la publicación del Decreto en el Diario Oficial.
		171. Punto II. Artículo 2, letra h. Se requiere que primero se defina lo que se entenderá por situación de emergencia y luego se describa cuales son los métodos a través de los cuales de determinará alcanzada esta situación. Ejemplo: "Situación de Emergencia Ambiental: se entenderá como situación de emergencia ambiental cuando se constate en alguna estación de monitoreo clasificada como EMRPG la superación de la norma primaria de calidad de aire para Ozono establecida en el Art 4º de esta resolución.	171. La norma establece los niveles críticos que definen una situación de emergencia ambiental y las herramientas mediante las cuales se puede establecer que estos niveles se superan. No se señalan las medidas a adoptar, porque no es materia de la norma.
		172. Título III. Artículo 3. Se sugiere cambiar el Art. 3º por el siguiente teto: "La norma primaria de calidad de aire para ozono como concentración de 8 horas será de 60 ppbv. Se considerará sobrepasada la norma primaria de calidad de aire para Ozono como concentración de 8 horas, cuando el percentil 99 de las concentraciones promedio de 8 horas registradas durante un año calendario, o en su defecto de 12 meses a partir de inicio de las mediciones, en cualquier estación monitora clasificada como EMRPG sea mayor o igual al valor indicado en el inciso precedente. Asimismo, se considerará sobrepasada la norma, si antes que concluya un año calendario, o en su defecto 12 meses a partir del inicio de las mediciones, se registrare en cualquier estación monitora clasificada como EMRPG, más de cuatro días con mediciones de concentración de 8 horas igual o sobre el valor de la Norma". Respecto del párrafo anterior se solicita aclarar: Dice:........ más de cuatro días con mediciones de concentración de 8 horas igual o sobre el valor de la Norma. Debe decir: ..... más ce cuatro valores promedio móviles de 8 horas con un valor de concentración igual o superior al valor de la Norma. Recordar que se están proponiendo el percentil 99, por lo tanto, el valor de la norma sólo podrá superarse en cuatro ocasiones, en un año calendario.	172. Se revisará la redacción y se modificará de ser necesario para mayor claridad.
		173. Título IV. Artículo 6, letra a. ¿Qué pasará si las estaciones que actualmente están en operación no pueden dar cumplimiento a esta especificación?. ¿Que pasa en el caso de que la estación este emplazada en una pendiente? Por ejemplo en Valparaíso (adjunta Figura). Sería interesante consignar la fuente usada de referencia para la determinación de estas especificaciones técnicas.	173. Este título será modificado en los proyectos definitivos de normas, incorporándose a un programa de implementación de la norma.
		174. Título IV. Artículo 6, letra b. iv. no queda suficientemente claro esta exigencia. Se propone "iv. La toma de muestra no deberá presentar obstrucciones que restrinjan la libre circulación del aire, a lo menos en un arco de 270º respecto a su eje de posición normal a la superficie.	174. Ver punto anterior.
		175. Título V. Artículo 7. ¿Cuál es el criterio estadístico para consignar el 75% de los valores medidos?. ¿Qué hay respecto a la calibración de los equipos y el control de calidad de	175. El criterio del 75% como requisito para la disponibilidad mínima de información se adopto de lo establecido en la EPA y que actualmente

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		los datos?. ¿Qué se entiende por disponible?. El controlador de la estación puede eliminar los datos promedios horarios que hacen que su promedio móvil de 8 horas alcance los límites de la norma, pudiendo dejar sólo el 75% de los datos disponibles. En otras palabras la definición no detallada de lo que significa un dato válido puede permitir la manipulación de los mismos.	se utiliza a nivel nacional. El tema relacionado a la calibración y el control de calidad de los datos es materia del Fiscalizador de la norma. Sin embargo, es importante señalar que este tema deberá ser abordado en el manual de aplicación de la norma, al que se hará mención el programa de implementación de la norma a incorporar en los proyectos definitivos de norma.
		176. Título VI. Se considera que este título no es exigible dentro de la norma, más se puede hacer referencia a que el diseño de las redes de monitoreo deberá ajustarse a los criterios y estándares internacionales adoptados en Chile y que son aprobados por el servicio competente. Respecto a los lugares prioritarios ¿Cómo se determinarán estos?, es preferible que se revisen los procedimientos que la ley establece para la determinación de zonas latentes y saturadas, y ahí se consigne la conveniencia de considerar los criterios expuestos en este capítulo. Por lo tanto no se considera necesaria su incorporación dentro de esta norma.	176. Se revisará el punto y se modificará de ser necesario.
Jaime Pérez de Arce Araya Vicepresidente Ejecutivo Empresa Nacional de Minería (ENAMI)	03/11/00	177. En referencia a la **metodología a utilizar en la evaluación técnico – económica** para el proceso de revisión de las normas de calidad primara para los contaminantes SO_2, O_3, NO_2, CO y PTS, se indican las observaciones que siguen a continuación.	177. Las respuestas a las observaciones se señalan en los puntos siguientes.
		178. Las áreas de estudio de las distintas normas fueron divididas en áreas mínimas (de impacto directo) y áreas complementarias. Para la selección de las áreas mínimas en cuestión se utilizó el criterio de incluir aquellas áreas que se encuentren en categoría de zona latente y/o saturada. Según estudio estadístico de los datos proporcionados de monitoreo de calidad de aire, dentro del estudio de normativa de SO_2 se seleccionaron algunas áreas que no se encuentran en esta categoría, estando muy por debajo de los niveles requeridos según el criterio utilizado. En efecto, para el área circundante a la Fundición Ventanas se consideró dentro de la zona mínima la localidad de Puchuncaví, siendo que las estadísticas de 1999 indican que no se ha sobrepasado ninguna vez el 80% de los valores diarios y horarios propuestos. Por su parte, para la Fundición Paipote, en las estaciones de Copiapó y Los Volcanes no se sobrepasa la norma y tan solo en una ocasión se sobrepasa el valor establecido de latencia horaria 320 ppb (se adjunta tabla con máximas concentraciones de SO_2 en Estaciones Copiapó, Los Volcanes y Puchuncaví en ug/m^3N para 1999). En igual condición se encuentra la estación Cal de Caletones. Es nuestro parecer que las zonas mínimas afectadas debieran circunscribirse a las localidades de Los Maitenes y La Greda en Fundición y Refinería Ventanas y a Estación Paipote y Tierra Amarilla para Fundición Paipote.	178. Se revisará la metodología propuesta.
		179. Cabe hacer notar que el mercado del Cobre considera en forma creciente los aspectos ambientales de los procesos de obtención de este metal, es por ello que la gran mayoría de las fundiciones chilenas se encuentran implementando	179. El incumplimiento de una norma ambiental no es vinculante directamente en responsabilidad a una fuente emisora. El Plan de

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		Sistemas de Gestión Ambiental bajo el estándar de ISO 14.000. Una de las exigencias básicas en este estándar, corresponde al cumplimiento de la legislación ambiental. En este contexto, la introducción de normas altamente restrictivas retrasaría en varios años las opciones de certificación de la Norma ISO 14.000, lo cual debe ser evaluado en términos económicos como una potencial pérdida de mercado del principal producto de exportación del país.	Descontaminación es el instrumento en el cual se establecen las responsabilidades de las fuentes.
		180. Dentro de las alternativas de reducción de emisiones de SO_2 en las fundiciones de Cobre en Chile se menciona la implementación de un modelo climático, que permita predecir períodos de alta estabilidad atmosférica sobre los cuales se deberá reducir fusión al nivel que evite la ocurrencia de episodios horarios. Al respecto, cabe señalar que las experiencias existentes no han tenido buenos resultados en Chile. La Fundición Paipote implementó por imposición del Decreto N°180 del Ministerio Secretaría General de la Presidencia del año 1995 un modelo climático predictivo con alto costo (inversión de US$ 1.000.000 aproximadamente y costo anual de US$ 70.000), con resultados que determinan un certeza de sólo un 50%. Los resultados de modelos climáticos predictivos han tenido resultados satisfactorios para el manejo de episodios de altas concentraciones de contaminantes como **promedio diario.** Sin embargo, el manejo de la situación horaria requiere bajar la fusión en forma preventiva, lo que depende de cada cuenca atmosférica. Las decisiones operativas asociadas para prevenir un evento, pueden iniciarse hasta 12 horas de anticipación de un posible evento, sin asegurar un resultado positivo de la gestión.	180. Sin duda que la implementación de un modelo es algo complejo. Sin embargo, es posible un mejoramiento continuo de los mismos en base a los objetivos y la experiencia y validación del mismo.
		181. La incorporación de una norma horaria para SO_2 deriva de la recomendación de la OMS, que establece una condición deseada, que puede ser interpretada de largo plazo, especialmente en países en desarrollo. Además, en las normas EPA de Estados Unidos, a nivel federal, sólo se establece una recomendación de norma diaria, equivalente a la vigente en Chile, dejando en libertad de acción a cada estado para la incorporación de normas horarias, para estos efectos, de acuerdo a los antecedentes disponibles, solo en algunos estados se ha legislado al respecto, específicamente, en los estados en que no existen fundiciones de Cobre, para otros estados que si poseen fundiciones de cobre y a nivel federal no se han establecido normas de calidad horaria para SO_2.	181. Este punto ha sido abordado ampliamente en respuesta a observaciones anteriores (ver punto 163, 159)
		181. En concordancia con lo anterior, en el informe de la Consultora SGA Soluziona, contratada por la CONAMA para la preparación del Proyecto de Ley, se recomienda claramente no incorporar una norma horaria para SO_2. En atención a estos antecedentes, se solicita formalmente no incorporar una Norma de Calidad Horaria para SO_2 en la revisión que actualmente se realiza, como también, aplicar en forma gradual la mayor exigencia de la Norma Diaria para SO_2.	182. Ver punto anterior.
Juan Domingo Galleguillos Herrera Secretaria Ministerial de Educación Región de Los Lagos	07/11/00	183. No envían observaciones por no contar con los recursos humanos calificados.	183.

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German Oyola Ing. Civil Químico Dirección Regional CONAMA BIO BIO	10/11/00	183. **En general a los 5 proyectos**: Una EMRPG tendrá representatividad para la población expuesta correspondiente a un radio de 2 km., medido desde la ubicación de la estación. Esto implica entonces que se podrá argumentar falta de representatividad de las redes actuales por una insuficiencia de estaciones monitoras de las redes urbanas y por lo tanto que la determinación de áreas o zonas saturadas no aplica o no es correcta, que existe discriminación o cualquier otro argumento. Por otro lado implica que para cumplir con una adecuada cobertura habrá que invertir en densificar las redes, costo que deberá ser asumido por el Estado.	183. Se considerará este punto en la elaboración de los proyectos definitivos de normas.
		184. **En general a los 5 proyectos**: Respecto del emplazamiento de las estaciones monitoras creemos que el punto que indica distanciamiento de 20 metros de cualquier edificación existente en el lugar y más de 10 metros de árboles, no lo cumplen las actuales estaciones monitoras urbanas y no es necesario si se considera el siguiente punto de la siguiente forma (adjunta Figura): En donde la distancia es 10 veces la diferencia de altura entre la toma de muestra y la obstrucción de flujo de aire más cercana.	184. Este tema será modificado, haciéndose referencia en el programa de implementación de la norma a incorporar en los proyectos definitivos de normas.
		185. **En general a los 5 proyectos**: Qué pasara con la data histórica existente en el país, puesto que no se especifica si se consideraran válidos o no, si podrán utilizarse como referencia en la determinación de zonas geográficas, en los planes, en las declaraciones de zonas, etc.	185. Las condiciones específicas a que se hace referencia son válidas desde la publicación del Decreto en el Diario Oficial. Lo anterior a ello rige en base a la normativa existente.
		186. **En general a los 5 proyectos**: Creemos que siempre se deben aplicar promedios móviles al igual que en Ozono puesto que se mejora la gestión de la calidad del aire, al tener constantemente nuevos promedios, además se asegura de estar cubriendo eventos que pudieran quedar fuera de los períodos fijos tal como se señala a continuación (adjunta Figura). Por lo tanto si el criterio de salud es que se producen efectos a las 24 horas, bajo x concentración, entonces debe aplicarse promedio móvil. Lo anterior es válido tanto para los promedio diarios como anuales puesto que por ejemplo, en el área de Talcahuano los mayores eventos críticos se producen en el período de noviembre a marzo. Además la utilización de promedios móviles anuales por ejemplo hace más dinámica la gestión y no inhabilita la información de promedio año calendario (adjunta Figura). Lo anterior representa promedios anuales móviles de SO_2 donde el año calendario cumple norma pero claramente la población está siendo afectada en períodos de largo plazo, puesto que está sometida a niveles sobre la norma en realidad.	186. Se adopto los criterios vigentes a nivel internacional y sobre las cuales están basado los estudios que establecen los efectos sobre la salud de las personas.
		187. **Ozono**: ¿No hay antecedentes respecto de los efectos crónicos a la exposición de Ozono?.	187. Los antecedentes en salud revisados y que constan en el expediente público de la norma establecen que estos son de carácter agudo. No se hace mención a efectos crónicos.
		188. **NO_2**: no hay observaciones	
		189. **SO_2**: No nos parece adecuado un criterio de protección de la salud de la población que se considere sólo el valor máximo del día para contabilizar el número de excedencia de la norma, puesto que días con 12 horas sobre norma horaria por ejemplo, con valores muy por sobre la norma, sólo sería contabilizado como una superación de norma horaria y de seguro una	189. De acuerdo a lo señalado en el punto 153 y 163, se postergará la implementación de una norma de concentración horaria para SO2.

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		superación de norma diaria, en circunstancias que se sabe que hay efectos significativos a valores de corto plazo mucho menores como lo reconoce la OMS.	
		190. <u>CO</u>: no hay observaciones.	190.
		191. <u>PTS</u>: no hay observaciones	191.
Antonio Prado Castro Secretario Regional Ministerial de Minería Región de Atacama	13/11/00	192. En la Región funciona al servicio de la Pequeña y Mediana Minería la Fundición Hernán Videla Lira, la cual a partir de 1995 y hasta fines de 1999, realizó inversiones por un monto superior a los 90 millones de dólares, para dar cumplimiento al Plan de Descontaminación de dicho plantel. Dicho Plan significó adecuarse técnica y productivamente a las normas primarias y secundarias de calidad anual de 80 ug/Nm3 de SO_2 y diaria de 365 ug/Nm3 de SO_2 y secundaria horaria de 1000 ug/Nm3 de SO_2, las que gradualmente se han cumplido. Las condiciones meteorológicas que inciden fuertemente en la localidad en que se encuentra ubicada la Fundición y la cercanía de un área habitada al Plantel, son factores que también inciden fuertemente en el cumplimiento de las normas en cuestión.	192. Se reconoce el esfuerzo realizado por la empresa en el cumplimiento de las medidas establecidas en el Plan de Descontaminación.
		193. Nos parece imprudente y una señal poco afortunada el fijar nuevos parámetros en la norma, a pocos meses de la implementación y cumplimiento de la anterior, considerando la inversión ejecutada y el gradual cumplimiento de un plan de descontaminación ampliamente consensuado y discutido en la comunidad regional.	193. El objetivo de las normas en revisión es la protección de la salud de las personas por lo cual los valores propuestos en los anteproyectos obedecen a los niveles a partir de los cuales se registran efecto sobre la salud de las personas. Lo anterior a la luz de los nuevos antecedentes científicos y revisión de la normativa ambiental vigente y revisada en el último tiempo a nivel internacional.
		194. Los antecedentes técnicos que motivan la preocupación de las Autoridades Regionales son compartidos en el Informe evaluado por la Unidad Ambiental del Ministerio de Minería mediante UAMM/88/2000 del 20 de julio del 2000 y la documentación adjunta a dicho oficio.	194. Ver puntos anteriores.
		195. Los antecedentes entregados al Sr. Intendente de la Región de Atacama el día 23 de octubre por el Sr. Gerente de la Fundición Hernán Videla LIra y lo informado a Ud., en reunión de la COREMA en día 25 de octubre por el suscrito y la información entregada en su visita a la Fundición el 25 de octubre, demuestran la importancia que para la región significa la existencia del plantel productivo y las enormes dificultades que acarrearía para Atacama y sus habitantes un eventual cierre del plantel.	195. No existen los antecedentes fundados que la aplicación de la normativa implique un eventual término de las operaciones. Lo anterior dado que en el marco de un Plan de Descontaminación (si no se cumpliera la normativa) se debe ponderar junto a la necesidad de reducción de emisiones los plazos que se requieren para ello según las modificaciones tecnológicas necesarias y los costos asociados.
		196. Es necesario que en la definición del anteproyecto se consideren todas las variables que puedan incidir en ella, tanto técnicas como productivas que ameriten una solución que sea compartida por la comunidad de Atacama.	196. Para la elaboración de los proyectos definitivos de norma se deben tener en consideración, según lo establece la reglamentación vigente, las observaciones formulaban a los anteproyectos, los resultados de la evaluación económica de los anteproyectos y demás antecedentes que consten en el expediente público del proceso.
Dr. Víctor Correa Romero Jefe Adepto. Programas sobre el Ambiente	14/11/00	197. En relación al anteproyecto de norma primaria de calidad de aire para Anhídrido Sulfuroso (SO_2), informo a Ud. que este Servicio de Salud considera importante aclarar si dentro de los procesos de generación de Anhídrido Sulfuroso, se encuentra el lixiviado de minerales de cobre donde se utiliza	197. No es materia de la norma

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"Por orden del Sr. Director del Servicio de Salud Coquimbo" Avenida Francisco de Aguirre Nº795 La Serena Fono: 226019 Fax: 226947 Enviada a CONAMA a través de ORD. Nº1114 de Director Regional (s) CONAMA Región de Coquimbo, Sr. Pedro Valenzuela Diez de Medina		ácido sulfúrico. De ser así, se sugiere incorporar este proceso industrial dentro de los mencionados en el Título I, párrafo 10º de la página 2, del citado anteproyecto.	
Ricardo Troncoso San Martín Director Nacional Servicio Nacional de Geología y Minería (SERNAGEOMIN) Remite observaciones de la Subdirección Nacional de Minería	14/11/00	198. **Oportunidad de la consulta**. Por razones que desconocemos la "Consulta Pública" de las normas no fue formulada a través de la Dirección Nacional del Servicio, único ente encargado por ley de emitir las opiniones oficiales del SERNAGEOMIN. Sólo se tomó conocimiento de dicha consulta a través de las direcciones regionales de Atacama y Coquimbo, las cuales fueron consultadas por las CONAMAs de dichas regiones. Por lo anterior, solamente llegó a nuestro poder la consulta en cuestión la segunda semana de noviembre, por lo cual no es posible entregar nuestras observaciones a todos los anteproyectos enviados. De todas maneras se entrega observación de dos de ellos, solicitando, si es posible, se amplíe el plazo para efectuar un estudio más profundo.	198. De acuerdo a lo establecido en el reglamento para la dictación de normas de calidad ambiental y de emisión, un extracto de los anteproyectos de norma se publicó en el Diario Oficial y en un Diario de circulación nacional. También se solicitó su opinión al Consejo Consultivo Nacional y se remitió copia de los Anteproyectos a las Direcciones Regionales de CONAMA así como a los miembros del Comité Operativo y Ampliado de la norma. Cabe señalar también que se realizó un programa de participación ciudadana en varias ciudades del País a fin de recopilar observaciones a los anteproyectos.
		199. **Anteproyecto de Norma Primaria de Calidad de Aire para PTS**. Dispone no establecer niveles de concentración, dejando sin efecto los valores de concentración para las partículas totales en suspensión que hayan estado vigentes hasta la fecha. Dicha conclusión se fundamenta en que estudios recientes han demostrado que las partículas que más afectan la salud de las personas son aquellas con un diámetro aerodinámico menos a 10 um (PM10) y más aún, aquellas con diámetro aerodinámico menor a 2,5 um (PM2,5). El fundamento presentado en el documento sujeto a consulta es decisivo, en particular porque existiría normativa aplicable para material particulado respirable, en donde actividades de la minería, tales como fundiciones, estarían reguladas. No obstante, se recomienda reflexionar respecto de la utilidad de mantener o dictar una norma equivalente de PTS, dado que existen áreas del territorio nacional que se encuentran más sensibles a este tipo de emisiones, y que generan otro tipo de fuentes, independientemente del tamaño de las partículas. Nuestra preocupación apunta a un segundo grupo de actividades mineras que son potencialmente contaminadoras de la atmósfera por emisiones de polvo: Se sabe que la minería emite partículas que tienen diámetros comprendidos entre 1 y 1.000 um, las cuales, en su mayor parte, se depositan por gravedad y tienen una composición muy variada según su procedencia. El polvo constituye la principal fuente de polución del aire en el sector minero, cuyo	199. El objetivo de la norma en revisión es la protección de la salud de la población, puesto que se trata de una norma primaria de calidad de aire. En este sentido, los antecedentes internacionales y nacionales fundamentan el no regular el PTS. Los principales efectos sobre la salud de la población se encuentran en el particulado respirable. Respecto del material particulado emitido por las empresas mineras y cuya composición puede ser diferente al de áreas urbanas, es importante tener en consideración que elementos tales como plomo y arsénico se encuentran normados.

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		origen proviene de actividades de explotación del mineral, acción del viento sobre las canteras o rajos abiertos, depósitos de estériles, tranques de relaves, actividades relacionadas con la trituración del mineral (incluyendo áridos), transporte, etc. Los efectos del polvo emitido por la actividades mineras son muy numerosos y variados, comenzando por molestias a la población que se encuentra cercana, incluyendo efectos sobre la salud debido a las partículas de tamaño respirable, problemas de oclusión de las estomas de las plantas, empeoramiento de la calidad del aire a nivel local, etc. Finalmente, en cuanto a esta norma, pensamos que, en lugar de eliminarla, sería aconsejable estudiarla de tal manera de hacerla de más fácil aplicación y control. Se deja abierta la inquietud y nuestra voluntad para participar en cualquier estudio que se decida realizar al respecto.	
		200. **<u>Anteproyecto de Norma Primaria de Calidad de Aire para SO_2</u>**. La mayoría de las Fundiciones de Cobre del país se encuentran implementando o terminando sus Planes de Descontaminación. Con esto han estado incorporando a los procesos consideraciones técnicas para cumplir con la Norma Primaria de Anhídrido Sulfuroso y Material Particulado, según el DS 185 de 1992 del Ministerio de Minería. Estos Planes han significado grandes inversiones para las Empresas del Estado. Según los antecedentes: <u>Situación Actual</u> Norma Anual SO_2: 80 ug/m^3N Norma Diaria SO_2: 365 ug/m^3N <u>Proposición de Normas</u> Norma Anual SO_2: 80 ug/m^3N Norma Diaria SO_2: 250 ug/m^3N Norma Horaria SO_2: 1.050 ug/m^3N Se aumenta la restricción para la Norma Diaria y se implementa la Norma Horaria. Debido a la cercanía a poblados que se encuentran casi en todas las Fundiciones de Cobre del país, no es posible que se puedan cumplir tal restricción en forma tan determinante como lo es "el día 1° del mes siguiente a la publicación en el Diario Oficial". La ocurrencia de episodios críticos, en la mayoría de las Fundiciones de Cobre, no solamente está supeditada a condiciones operacionales sino que en la mayoría y en un alto grado a condiciones de meteorología existentes. La Norma Horaria según antecedentes no se podría cumplir en las actuales condiciones de las Fundiciones del país, es dependiente de muchas variables no controlables, como lo es en un alto grado la meteorología local. Se solicita sea implementada la Norma Diaria con GRADUALIDAD que es uno de los Principios de la Ley sobre Bases Generales del Medio Ambiente, contenidos en el Mensaje de S.E. Presidente de la República, con el que envió al Congreso el Proyecto de la citada Ley en septiembre de 1992.	200. En efecto las Fundiciones de Cobre del país se encuentran implementando o terminando planes de descontaminación y esto es una situación que debe ser considerada si es que existe la necesidad de reformular los planes producto de la nueva normativa. Es importante de tener en cuenta, que el incumplimiento de una norma de calidad ambiental no es impotable de manera directa a una determinada fuente pues el instrumento mediante el cual se deben establecer las medidas para recuperar los niveles de calidad ambiental y en donde se asigna la responsabilidad a las fuentes emisoras es el Plan de Descontaminación. En cuanto al cumplimiento de las normas propuestas, se señala que técnicamente es posible. El punto es un tema de costos y plazos y que obviamente de ser necesario deben ser considerados al momento de implementar un Plan de Descontaminación o su reformulación.
Jaqueline Saintard Vera	14/11/00	201. Con respecto a la **<u>norma horaria para SO_2</u>**, esta Secretaría de Estado ha	201. En relación a lo observado respecto de la norma

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Ministra (S) de Minería		realizado una serie de comentarios basados en el estudio de soporte técnico de la consultora contratada por CONAMA para la elaboración de la norma, donde se señala en forma explícita, que **no** debe ser considerada una norma horaria para SO_2. En este sentido se señala lo que se indica a continuación.	de SO2 como concentración de 1 hora, se señala que la norma desde un punto de vista técnico se puede cumplir y que el punto es un tema relacionado a costos y plazos necesarios para ello. Sin embargo, se señala también que sobre la base de los antecedentes generados por la evaluación económica en cuanto a los costos, las observaciones formuladas y la necesidad de cuantificar mas en detalle los beneficios que se lograrían producto de su aplicación, se ha decidido postergar su implementación.
		202. Deben considerarse los Planes de Descontaminación realizados por las fundiciones del país, con sus correspondientes inversiones.	202. En la evaluación económica de los anteproyectos de normas se consideró esta información para efectos de estimar los costos y beneficios que generaría la implementación de la normativa.
		203. Las decisiones tomadas por las empresas respecto a las tecnologías de fusión y las inversiones asociadas, se contemplaron en un horizonte de 25 años, por lo que resulta difícil terminar un plan de descontaminación y entrar nuevamente a otro por los mismos contaminantes, estimándose que deban realizar nuevos cambios tecnológicos.	203. De ser necesario implementar nuevos planes de descontaminación o reformulación de los mismos, se deben evaluar los plazos necesarios para alcanzar el objetivo.
		204. La norma horaria para SO_2 conlleva a dificultades operacionales complicadas de resolver en períodos cortos de tiempo.	204. Ver observación N° 201
		205. Los modelos de dispersión de contaminantes atmosféricos, han resultado ser una herramienta útil y complementaria a los planes de descontaminación. Sin embargo, han demostrado no ser del todo confiables, por lo que resulta que ocasiones las empresas tienen considerados todos estos factores y aún así, sobrepasan las normas en casos puntuales.	205. Los modelos de dispersión pueden ser una herramienta muy util según los objetivos para los cuales se implementen. Sin embargo hay que tener claro para el modelo específico las limitaciones que este tiene y si es capaz de entregar los resultados que se esperan de él, de tal menera de no forzar los mismos.
		206. El Estado de Arizona en U.S.A. donde existen fundiciones, no tiene norma horaria, por considerar que esta medida resulta excesivamente restrictiva.	206. Estado Unidos tiene normas estatales y normas federales. Esto implica que los estados pueden establecer sus propias normativas, pero condicionado a que no deben ser menos estrictas que las Federales. Es así que, en algunos estados como el de Washington y California donde se han identificado problemas existen normas mucho mas estrictas que la vigente a nivel Federal.
		207. Los impactos agudos que pudieran presentarse en las operaciones, pueden ser abordados a través de un plan de manejo de episodios críticos.	207. En primer lugar, las medidas a adoptar frente a la superación de los niveles que definen situaciones de emergencia ambiental no son materia de esta norma, sino de otro instrumento de gestión ambiental (planes de descontaminación). En segundo lugar, si existen impactos agudos

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			como concentración de 1 hora importantes y representan un problema para la salud de la población, entonces lo que corresponde es fijar una norma de calidad ambiental que se haga cargo de esos efectos.
		208. Con respecto a la **norma diaria para SO_2** cabe señalar que a nivel federal, en Estados Unidos se exige un valor de 365 ug/m^3, el mismo valor que hoy se exige en Chile. El valor que propone CONAMA de 250 ug/m^3, corresponde a una recomendación internacional de la OMS. En el entendido que es un recomendación, sugerimos establecer una aplicación gradual para su cumplimiento.	208. Ver lo señalado en el N°206
		209. Cabe señalar, además, que el reglamento N°93/95 de la SEGPRES, para la dictación de normas de calidad ambiental y de emisión, señala que deben ser considerados estudios técnicos, científicos y económicos, entendiendo que con esta gama de criterios, estamos en condiciones de tomar la mejor decisión para la elaboración de normas ambientales.	209. Para la elaboración de los anteproyectos de normas y según consta en el expediente público de la norma, se han tenido en consideración todos los antecedentes disponibles a la fecha.
Sociedad Nacional de Minería Roberto Salinas Vicepresidente	14/11/00	210. De acuerdo a los antecedentes disponibles en el anteproyecto de norma, se concluye que el SO2 no presenta efectos tóxicos en las personas, no es cancerígeno y tampoco presenta limitantes para el desarrollo normal de las personas. Asimismo es posible concluir que en nuestro país no existe una relación directa entre este contaminante y la mortalidad, ya que los efectos causados por éste son un aumento de la tos y una disminución del flujo respiratorio forzado (FEV). La OMS solo recomienda que no se superen ciertos límites de concenteración, con el propósito de proteger a la población mas sensible a este contaminante. 211. La norma horaria propuesta para SO2 puede poner en serio riesgo la viabilidad de algunas fundiciones de Cobre estatales y privadas. No se ha estimado el costo económico que representan las inversiones que deberán implementarse, ni el impacto en acciones de prevención. Al respecto, cabe señalar que se ha demostrado que en ocasiones ni siquiera la eliminación de las emisiones por detención de la operación de la fuente emisora logra cumplir con el límite promedio horario propuesto. 212. Cabe señalar que Estados Unidos, uno de nuestros principales "socios económicos" y definitivamente con recursos muy superiores a los nuestros, ha evaluado y desistido de implementar una norma horaria.	210. Los antecedentes que constan en el expediente público de la norma indican que el SO2 en determinados niveles de concentración produce efectos negativos, agudos y crónicos sobre la salud de las personas. Basado en esto, es que a nivel internacional se regulan dichos efectos. 211. Ver lo señalado en el N° 206 212. En Estados Unidos a nivel Federal existe una norma horaria, pero a nivel estatal, en aquellos lugares en los cuales se ha identificado que existen problemas se ha implementado una norma de SO2 como concentración de 1 hora (por ej. Estados de Washington y California).
Viviana Hernández Pérez Secretario Regional Ministerial Vivienda y Urbanismo, IX Región	14/11/00	213. Señala que no presenta observaciones a los anteproyectos en consulta, respaldando la regulación sobre peresencia de contaminantes en el medio ambiente, a fin de prevenir un riesgo para la salud de las personas.	213. No formula observaciones a los Anteproyectos en consulta.
Hernán Varas Muñoz Jefe Depto, Higiene y C.	15/11/00	214. Existe poca claridad en la definición del concepto estación monitora con representatividad poblacional (EMRP), debido a que esta norma establece que	214. Se evaluará la manera de precisar de mejor forma la definición y se incorporará en los

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Ambiental Municipalidad de Providencia, Santiago		una estación de monitoreo podrá clasificarse como EMRP si existe a lo menos un área habitada en un radio de 2 km., medido desde la ubicación de la estación. No queda claro que se entiende por área habitada ya que al parecer conceptualmente bastaría una vivienda para justificar la implementación de dicha estación. Por otra parte la definición no0 incluye a los demás potenciales afectados que se desplazan por el sector contaminado, y que no necesariamente habitan dentro del radio definido. 215. Como parte de la metodología se sugiere que la medición de la concentración de los contaminantes, pueda realizarse mediante un método de cuya metodología de operación sea aprobada por un organísmo nacional calificado para este fín, en subsidio de los internacionales. 216. Esta de acuerdo que la norma para PTS no se justificaría debido a que actualmente esta legislado el PM10. 217. Es importante evaluar el grado de aplicabilidad de las normas y estándares propuestos, calculando con precisión el costo que tendría la paralización de las empresas o fuentes contaminantes cuando se sobrepasen las normas, o en su defecto los costos que implicaría la reconversión de los procesos productivos. 218. Es necesario estudiar a fondo el costo que tendría implementar las estaciones y equipos de monitoreo /estaciones, personal a cargo, etc..(, versus los beneficios factibles de obtener en función de la localización de la estación.	proyectos definitivos de norma. 215. En los anteproyectos se especifican las metodología de medición y se deja abierta la posibilidad de usar una alternativa la que se debe encontrar aprobada por un organismo internacional. El objetivo de ello, es dejar abierta la posibilidad de que se incorpore una nueva metodología sin tener que realizar la revisión de la norma. Se estableció para este punto un organismo internacional, puesto que las modificaciones a las metodologías o implementación de nuevas metodologías en general, primero se aprueban a nivel internacional. Se estableció un organísmo a nivel internacional, puesto que actualmente no existe en el país 216. 217. El proceso de dictación de normas de calidad ambiental y de emisión (D.S N° 94/95 del Ministerio secretaría General de la Presidencia) establece que una vez elaborado el anteproyecto de una norma se debe realizar una evaluación económica del anteproyecto de norma. 218. En los proyectos definitivos de norma se incorporará en la implementación de la norma
Compañía Minera Disputada de las Condes Miguel Angel Duran Gerente General Fundición Chagres	16/11/00	219. El plazo de cálculo de la concentración promedio, de una hora, hace muy difícil de cumplir con la norma, por cuanto el factor que tiene mayor incidencia en la concentración horaria es la meteorología, factor que esta fuera de control de las unidades operativas, en este caso la fundición. Está demostrado que ocasionalmente se dan condiciones meteorológicas en que la inercia propia del sistema emisión-concentración impide cumplir con la concentración promedio límite, a pesar de tomar todas las medidas posibles para minimizar la emisión. Por esta razón sugerimos que la nueva norma primaria considere un promedio de tres horas, igual a la norma de la EPA, USA, en lugar de una hora como se propone. 220. Para nuestra fundición, operacionalmente y por razones prácticas preocupa el	219. En base a los antecedentes aportados por la evaluación económica de los anteproyectos de las normas, en cuanto a los costos y beneficios asociados se ha decidido postergar la implementación de una norma horaria para SO_2 .Sin embargo, es importante clarificar que la norma propuesta en el Anteproyecto es posible de cumplir desde un punto de vista técnico. El punto es un tema asociado a costos y plazos. 220. Una norma primaria y secundaria apuntan a

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		hecho que podrían existir valores de normas diferentes para un mismo periodo de tiempo (norma horaria) como sería la primera propuesta y la norma secundaria existente del D: N° 185. En nuestra opinión, sería preferible contar con un solo valor a cumplir como promedio (o promedio de tres horas según el párrafo anterior). De hecho. Confiamos que el estándar secundario existente sea revisado a la brevedad posible para asimilarlo al estándar que finalmente se defina en esta revisión.	objetivos que son diferentes. En el primer caso el objetivo es la protección de salud de las personas y en el segundo es la protección del medio ambiente, recursos naturales o preservación de la naturaleza. Dado lo anterior, es posible que las normas puedan ser para un mismo contaminante diferentes entre si, por ejemplo en cuanto a su nivel y periodo de evaluación.
Luis Mariano Rendón Director Coordinadora Ecologista **Larisa Orbe** Salud Ambiental Coordinadora Ecologista Enviada a CONAMA a través de ORD. Nº002730 del 28/11/00 de Loreto Madrid Flores, Jefa Area Descontaminación del Aire CONAMA RM	16/11/00	221. Después de estudiado los antecedentes del Anteproyecto de Normas Primarias de Calidad del Aire, hemos constatado que éstas siguen sobrepasando las recomendaciones de la Organización Mundial de la Salud (WHO). Según se indica en cuadro adjunto (comparación de recomendaciones WHO-OMS y Anteproyectos). Básicamente el cuadro muestra lo siguiente: __Contaminante__ / __Tiempo__ / __OMS__ / __Anteproyecto__ O_3 / 8 horas / 120 ug/m^3 / 128 ug/m^3 (60 ppbv) NO_2 / 24 meses / 40 ug/m^3 / 65 ug/m^3 (53 ppbv) / 1 hora / 200 ug/m^3 / 260 ug/m^3 (212 ppbv) SO_2 / 24 horas / 125 ug/m^3 / 243 ug/m^3 (95 ppbv) / 24 meses / 50 ug/m^3 / 76 ug/m^3 (30 ppbv) CO / 1 horas / 30.000 ug/m^3 / 31.000 ug/m^3 (25 ppmv)	221. Las normas propuestas fueron establecidas teniendo en consideración los antecedentes mas recientes tanto nacionales como internacionales, respecto de efectos sobre la salud de las personas.
		222. Es preocupante el nivel de la norma permitida para el Anhídrido Sulfuroso (SO_2), ya que sobrepasa la norma recomendada de 125 ug/m^3 a 243 ug/m^3 para 24 horas y de 50 ug/m^3 a 76 ug/m^3 para un período de 24 meses. Tomando en cuenta que los sulfatos constituyen un peligro serio para la salud, habiéndose demostrado que concentraciones muy bajas de sulfatos (de 8 a 10 microgramos por metro cúbico) ejercen efectos adversos sobre los asmáticos, los ancianos y otras personas susceptibles con problemas respiratorios crónicos. Creemos que esta norma es insuficiente para proteger la salud pública.	222. Ver observación anterior.
		223. La acumulación de Dióxido de Nitrógeno en el cuerpo humano constituye un riesgo para las vías respiratorias ya que se ha comprobado que puede alterar la capacidad de respuesta de las células en el proceso inflamatorio, siendo más frecuente en casos de bronquitis crónica. La norma establecida en el anteproyecto rebasa significativamente las recomendaciones de la OMS, de 40 ug/m^3 a 65 ug/m^3 para períodos de 24 meses y de 200 ug/m^3 a 260 ug/m^3 para 1 hora.	223. Ver lo señalado en el punto 221
		224. Lamentamos que en el cuerpo del Anteproyecto no se establezcan valores comparables para una mejor comprensión de las normas. Esto significa un obstáculo a la Participación Ciudadana, por cuanto otras organizaciones que no cuentan con los medios necesarios se ven imposibilitadas para presentar sus observaciones. Incluso lo consideramos una violación al derecho a la información ambiental.	224. En los proyectos definitivos de normas se incorporaran los valores tanto en ug/m3N como en ppv o ppm según corresponda.

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Alberto Acuña Director Regional (S) CONAMA II Región de Antofagasta Remite observaciones a del Comité Regional.	16/11/00	225. En relación a la norma diaria propuesta para SO2 se acuerda que se acoge el nivel propuesto en el anteproyecto. Observaciones a este acuerdo señalan la necesidad de considerar gradualidad para la aplicación de la norma, se debería esperar la implementación del Plan de Descontaminación de Chuquicamata y la ampliación de fase 3 de Altonorte, ambas resolucuiones fueron otorgadas bajo normas del D.S N°185 y cubre hasta el año 2003. Se acoge el valor de la norma horaria propuesta para SO2 de 1050 ug/Nm3. Con las siguientes consideraciones: - Como Región consideramos que el Decreto Supremo deberá establecer o incluir gradualidad para el cumplimiento de esta norma. - Se adjunta información del conflicto en términos operativos que la aplicación de la norma trae consigo a nivel de la realidad regional. - Todas las observaciones y el análisis realizado por este Comité Regional han sido realizadas sin la información de la evaluación económica. Por lo tanto se considerar el estudio económico para la determinación de los niveles de esta normativa. - Se solicita que el Decreto Supremo incorpore que el organismo fiscalizador u otro, informe en forma periódica (anual, semestral, etc.) a la comunidad acerca del control y resultados de la fiscalización de la norma.	225. El incumplimiento de una norma de calidad ambiental no implica responsabilidad directa sobre una fuente emisora. Esto es materia del Plan de Dsecontaminación, en donde, además, se deben establecer las responsabilidades en cuanto a reducción de emisiones y plazos, entre otros. La gradualidad para el cumplimientos de las metas de emisión es un tema del plan de descontaminación. Es importante mencionar también que para el caso de los planes vigentes y si fuera necesario su reformulación, debe deberá tener encuentra los compromisos en emisiones y los plazos adoptados a la fecha. En cuanto a informar a la comunidad sobre los niveles de concentración de calidad de aire, esto será incorporado en los proyectos definitivos de normas.
Daniel Alvarez Pardo Director Regional CONAMA III Región de Atacama Remite comentarios del Consejo Consultivo de la COREMA Atacama realizada el 15/11/00 (Acuerdo Nº9.3 Sesión Ordinaria Nº9)	23/11/00	226. **Comentarios al Anteproyecto de Revisión de Norma Primaria de Calidad del Aire para Anhídrido Sulfuroso (SO_2)**. La Norma Horaria de carácter primario, tiene un profundo impacto negativo en áreas cercanas a importantes industrias de la III Región, en las que no se cumpliría este parámetro de la Calidad Primaria del Aire, no obstante haberse realizado importantes mejoras y cuantiosas inversiones recientemente.	226. En base a los resultados obtenidos de la evaluación económica de los anteproyectos de normas, respecto a los costos y beneficios asociados a su implementación, se ha decidido postergar la implementación de una norma horaria para SO2, por lo cual no será considerada establecida en esta revisión.
		227. De acuerdo a los especialistas, el cumplimiento de la Norma Horaria al nivel requerido, depende especialmente del comportamiento meteorológico en esas áreas y no de las actividades que puedan realizarse para mejorar esta componente de la Calidad del Aire.	227. Ver punto anterior. Sin embargo, es importante mencionar que la norma horaria propuesta en el anteproyecto de norma es posible cumplir desde un punto de vista técnico. El punto es un tema de costos y plazos asociado a ello.
		227. Se considera apresurada la propuesta de definición de tipo de Calidad Ambiental (es decir, la asociada al cumplimiento de una norma primaria horaria de SO_2). No existen suficientes estudios epidemiológicos en el país que avalen su implantación.	228. Ver punto anterior. Además se señala que en el proyecto definitivo se incorporara la necesidad de recopilar información sobre la incidencia y prevalencia de asma, especialmente en aquellas localidades circundantes a los grandes emisores de SO2.
		229. Para el parámetro horario referido, se considera suficiente incremento de exigencia respecto de la Norma Primaria existente, el que resulta del incremento de las exigencias en el Parámetro Diario de la Norma, lo que implica técnicamente una mayor exigencia de calidad a nivel horario.	229. Tal como se ha señalado en puntos anteriores, y teniendo en consideración los antecedentes disponibles, no se implementara una norma para dióxido de azufre como concentración de una hora.
		230. Por lo tanto, se acuerda eliminar la exigencia de Calidad Horaria del Aire para Anhídrido Sulfuroso del Anteproyecto de Norma (400 ppbv en 1 hora).	230. Ver punto anterior.

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Armando Arancibia Calderón Intendente Región de Atacama.	7/12/00	231. **Desde un punto de vista de las consideraciones relativas a los efectos en la salud:** tal como lo señala el pronunciamiento del Consejo Consultivo de la COREMA Atacama, no existen suficientes estudios epidemiológicos que justifiquen la incorporación de una norma horaria para SO2 en el país. la información de respaldo se refiere a estudios realizados con idividuos asmáticos expuestos voluntariamente a concentraciones controladas en periodos que van desde unos pocos minutos hasta una hora, produciendose los efectos a partir de los primeros minutos, sin que estos se incrementen con un aumento en los periodos de exposición. No existe evidencia de validación de estos experimentos en el medio real, distinto a las condiciones de confinamiento en cámara de concentración controlada. Por otro lado la EPA, sin perjuicio de concordar con la OMS, en relación a los niveles a partir de los cuales se producen los efectos, realiza una descriminación cuantitativa respecto del porcentaje de los asmáticos que presentarían tales efectos, el que no sería mayor al 10-20% mientras que los mismos efectos en individuos sanos podrían presentarse solo a partir de los 5000 ug/Nm3.	231. Ver punto anterior
		232. **Desde un punto de vista de la cantidad de población expuesta** a concentraciones por sobre los 1000 ug/Nm3 en periodos de exposición horarios, esta se reduce casi exclusivamente a las localidades cercanas a fundiciones, las que en la mayoría de los casos frente a la imposibilidad de controlar los episodios críticos con la tecnología al alcance de las fundiciones chilenas, la población ha sido o esta siendo erradicada. La norma horaria estaría orientada la protección de un pequeño porcentaje de la población mas sensible.. Por otro lado los habitantes de esas localidades tienen los mecanismos de protección asociados a los planes operacionales de control de episodios críticos en el contexto de los planes de descontaminación.	232. Ver punto anterior. Sin embargo se señala que desde un punto de vista técnico una fundición de cobre puede cumplir con la norma propuesta en el anteproyecto de norma para SO2. El punto es que en este escenario se requiere de un cambio tecnológico, que implica costos y plazos asociados.. De hecho, actualmente existe en el país una fundición de cobre que cumple con la norma propuesta.
		233. **Desde el punto de vista de factibilidad técnica de cumplimiento de una norma horaria con la tecnología actual,** ésta es muy difícil de cumplir. Las concentraciones horarias son independientes del nivel de emisiones (localidades ubicadas en áreas mas cercanas a las fundiciones) y dependen mas bien de la distancia del punto de medición a la fuente y de factores meteorológicos y topográficos que determinan los mecanismos de dispersión del contaminante.	233. Se concuerda que concuerda que con la tecnología actual la norma horaria propuesta es difícil de cumplir para las fundiciones de cobre, pero como se señalo en el punto anterior, el tema del cumplimiento esta asociado en este escenario a un cambio tecnológico que implica costos y plazos para ello.
		234. **Desde un punto de vista de la pertinencia de la introducción de una norma horaria en presencia de una norma diaria exigente,** Teniendo en consideración lo señalado anteriormente, si se introduce una norma diaria más exigente que la actual (SO2) indirectamente se estaría obligando a las fuentes emisoras a controlar los episodios críticos horarios para lograr por esta vía el cumplimiento de la norma diaria, lo que hace innecesaria la introducción de una norma horaria.	234. Los fundamentos técnicos de porque se propone incorporar una norma de concentración de un a hora para SO2 , se basan en los efectos sobre la salud de las personas y que en el país existe población expuesta a niveles muy superiores a aquel a partir del cual se han encontrado efectos sobre la población mas sensible (población asmática).
		235. **Desde el punto de vista del escenario de incumplimiento de la norma horaria propuesta y los costos de cumplimiento.** La proyección de incumplimiento para la fundición Hernán Videla Lira en base a datos del año	235. Este punto ya ha sido discutido en reiteradas ocasiones en los puntos anteriores.

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		1999 significaría 36 veces alrededor de la fundición, lo que obligaría a un nuevo plan d descontaminación , en circunstancias que este establecimiento fue obligado por la normativa vigente a restringir sus emisiones en un plan de descontaminación que costo del orden de 99 millones de dólares. La introducción de una norma horaria implicaría para las fundiciones chilenas un cambio demasiado drástico en el escenario normativo que no se condice con la política de reglas claras que se ha enunciado para el país en materia ambiental. 236. **Desde un punto de vista de la comparación con la realidad internacional.** De acuerdo a los antecedentes técnicos de respaldo, la normativa propuesta (norma horaria para SO_2) es bastante exigente si se considera que en Estados Unidos, la EPA resolvió en 1996 mantener como valor federal un nivel de 80 ug/Nm3 como norma anual y 365 ug/Nm3 como norma diaria y no consideró introducir una norma horaria. Por otro lado si bien en algunos Estados como Washington y California existen normas horarias iguales o mas estrictas que la propuesta, también existen otros estados con normas mas holgadas, como Georgia que tienen una norma para tres horas equivalente a 1310 ug/Nm3 Por otro lado, según información del Arizona Administrative Code, de la Secretaría de Estado de Arizona, Título 18, en Arizona, el Estado norteamericano donde se concentra la mayoría de las fundiciones de cobre no existe una norma horaria, como norma primaria de calidad de aire. **Se propone:** no establecer una norma horaria para SO_2 y establecer como norma diaria para SO_2el valor de 330 ug/Nm3 con percentil 99.	236. En Estados Unidos a diferencia de la legislación vigente en nuestro país, los estados pueden fijar normas más estrictas que las normas a nivel federal, si existen los fundamentos en salud para ello. Es por esto que en algunos estados, en los cuales existe un problema de salud asociado a exposiciones horarias se fijan normas. Respecto a la norma vigente en Estados Unidos de 1310 ug/Nm3 como promedio de tres horas, esta corresponde a una norma secundaria, cuyo objetivo de protección no es la salud de la población, por lo cual no puede ser comparada con la normativa propuesta en esta revisión cuyo objetivo de protección es la salud de la población (norma primaria de calidad de aire). Sin embargo, se señala que sobre la base de los antecedentes disponible, no se implementará una norma de SO_2 como concentración de una hora.
Consejo Consultivo Nacional, CONAMA	14/12/2000	237. Se señala que es necesario generar condiciones de confiabilidad del cumplimiento y condiciones de operación. 238. Se señala que se debe efectuar en aquellos casos que resulte pertinente un proceso de seguimiento, al estado de salud de la población mas expuesta, en particular para el caso del SO_2. 239. Se señala que en el artículo 11 de la Ley 19.300, se indica que para efectos de evaluar los riesgos y efectos adversos indicados en las letras a y b, del respectivo artículo, se debe considerar lo establecido en las normas de calidad y de emisión vigentes, sin embargo las normas no establecen el porcentaje, respecto del nivel de saturación, para dar lugar a un estudio de impacto ambiental. 240. Los periodos de medición de un determinado agente contaminante, para determinar si su nivel es tal que gatilla la implementación de un plan de descontaminación, debiera guardar cierta proporcionalidad con los tiempos de demora de un plan de descontaminación, es 3 años.	237. 238. En la elaboración de los proyectos definitivos de normas se tendrá en consideración lo observado. 239. Se tendrá en consideración en la elaboración de los proyectos definitivos de normas. 240. No es materia del proceso de las normas en revisión.

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	22 de Marzo de 2001 12 de Abril de 2001	241. Se solicita que los estudios económicos se realicen bajo las condiciones metodológicas de mayor rugorosidad.	241. El incumplimiento de una norma de calidad no establece responsabilidades a fuentes emisoras específicas. El Plan de Descontaminación establece la responsabilidades y establece los plazos necesarios requeridos para reducir las emisiones y alcanzar el cumplimiento de las normas de calidad de aire.
		242. Señalan que emitirán opinión final cuando se cuente con una propuesta definitiva de normas (proyecto definitivo).	242. Elaborado los proyectos definitivos de normas se pondrá en conocimiento del Consejo consultivo.
		243. Corregir plazo de entrada en vigencia para el PTS.	243. Se corregirá lo señalado.
		244. Respecto de las estaciones de monitoreo, que deben ser certificadas por el Servicio de Salud pertinente, se propone que la información de dichas estaciones de monitoreo, sean consideradas válidas o fidedignas, aquellas registradas con posterioridad a la certificación correspondiente.	244. En los proyectos definitivos de normas se tendrá en consideración lo señalado.
		245. Que el manual que se elaborará para la implementación de estas normas, defina una estrategia efectiva para informar a la ciudadanía.	245. El manual de aplicación de las normas deberá incorporar lo señalado.

RODRIGO LUCERO CH
Planes de Descontaminación y Normas
CONAMA

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Comisión Nacional del Medio Ambiente
Consejo Directivo
ASR

APRUEBA PROYECTOS DEFINITIVOS QUE INDICA.

Santiago, 3 de mayo de 2001

En Sesión de esta fecha, el Consejo Directivo de la Comisión Nacional del Medio Ambiente, reunido en sesión ordinaria, ha adoptado el siguiente:

Acuerdo N° 180/2001

Vistos y considerando: Los proyectos definitivos de las normas primarias de calidad de aire para Monóxido de Carbono (CO), Ozono (O_3), Dióxido de Nitrógeno (NO_2), Dióxido de Azufre (SO_2) y Partículas Totales en Suspensión (PTS); lo dispuesto en los artículos 22 y 23 del Reglamento para la Dictación de Normas de Calidad Ambiental y de Emisión y art. 72, letra "d" de la Ley 19.300,

SE ACUERDA:

Aprobar los proyecto definitivos mencionados en los vistos, que se entienden forman parte integrante del presente acuerdo, y someterlo a la consideración del Presidente de la República para su decisión.

ALVARO GARCIA HURTADO
Ministro Secretario General de la Presidencia.
Presidente
Consejo Directivo CONAMA

ADRIANA HOFFMANN JACOBY
Directora Ejecutiva de CONAMA
Secretario
Consejo Directivo CONAMA

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REPUBLICA DE CHILE
COMISION NACIONAL DEL MEDIO AMBIENTE
ASR/PMC

APRUEBA PROYECTO DEFINITIVO DE REVISION DE NORMA PRIMARIA DE CALIDAD DE AIRE PARA MONÓXIDO DE CARBONO (CO)

SANTIAGO,

VISTOS:

Lo dispuesto en el artículo 19 N° 8 de la Constitución Política; En el artículo 32 de la Ley 19.300; el Reglamento para la Dictación de Normas de Calidad Ambiental y de Emisión, aprobado por el Decreto Supremo N°93 de 1995, del Ministerio Secretaría General de la Presidencia; La Resolución N°1215 de 1978 del Delegado del Gobierno en el Servicio Nacional de Salud, que establece normas sanitarias mínimas destinadas a prevenir y controlar la contaminación atmosférica; La Resolución Exenta N° 1514 de 1999, de la Dirección Ejecutiva de la Comisión Nacional del Medio Ambiente, que dio inicio al proceso de revisión de las normas primarias de calidad de aire para anhídrido sulfuroso (SO2); partículas totales en suspensión (PTS); monóxido de carbono (CO); ozono (03) y dióxido de nitrógeno (NO2) ; La Resolución Exenta N° 912 del 2000, de la Dirección Ejecutiva de la Comisión Nacional del Medio Ambiente, que aprobó el anteproyecto de revisión de la norma primaria de calidad de aire para monóxido de carbono (CO), y los demás antecedentes que obran en el expediente público.

CONSIDERANDO

Que de acuerdo con lo preceptuado en la ley 19.300, es deber del Estado dictar normas para regular la presencia de contaminantes en el medio ambiente, de manera de prevenir que éstos puedan significar o representar, por sus niveles, concentraciones y periodos, un riesgo para la salud de las personas, la preservación de la naturaleza y la conservación del patrimonio ambiental.

Que sobre la base de los antecedentes disponibles y que constan en el expediente público, se revisó la norma primaria de calidad de aire para monóxido de carbono (CO), en conformidad al procedimiento y los contenidos establecidos en el Decreto Supremo N°93 de 1995, de Ministerio Secretaria General de la Presidencia.

Que la norma revisada se encuentran contenida en la Resolución 1215 de 1978, del Delegado del Gobierno en el Servicio Nacional de Salud.

Que la exposición al CO se puede evaluar a través de los niveles de carboxyhemoglobina (COHb) que se expresa como porcentaje de la hemoglobina (Hb) total que está unida al CO.

Que el pulmón es la principal ruta de excreción y absorción de CO y que los resultados de diversos estudios recientes han mostrado que el CO aparece asociado a efectos respiratorios y efectos cardiovasculares entre otros.

Que durante una exposición a una concentración fija de CO, la concentración de COHb aumenta rápidamente hasta situarse en los niveles de la exposición, después de 3 horas comienza a decaer y alcanza su condición estable después de 6-8 horas de exposición.

Que según la OMS (1999), no debiera ser excedido el nivel de 2.5% de COHb en la sangre de las personas expuestas a CO. Con lo anterior, se protege a la población no fumadora, de mediana y mayor edad con enfermedad de la arteria coronaria latente o reportada, de ataques de isquemia miocárdica aguda, y al feto en madres no fumadoras, de efectos hipóxicos adversos.

Que los automóviles con motores de combustión interna son una de las principales fuentes de emisión de monóxido de carbono. Las chimeneas, las calderas, los calentadores de agua o calefones y los aparatos domésticos que queman combustible, como las estufas u cocinas o los calentadores a Kerosene, también pueden emitir monóxido de carbono. El humo de cigarrillo puede ser una fuente significativa de monóxido de carbono en interiores.

Que el monóxido de carbono en áreas urbanas es el resultado, en casi un 90%, de las emisiones del tráfico de vehículos a combustión, estando las concentraciones más altas cerca de las calles, decreciendo a medida que nos alejamos de éstas.

DECRETO

TITULO I

Disposiciones Generales y Definiciones

Art.1.- La presente norma de calidad ambiental tiene por objetivo proteger la salud de la población de aquellos efectos agudos generados por la exposición a niveles de concentración de monóxido de carbono en el aire.

Art.2.- Para efectos de lo dispuesto en la presente norma, se entenderá por:

a. *ppmv:* Unidad de medida de concentración en volumen, correspondiente a una parte por millón.

b. *Concentración de monóxido de carbono*: Valor promedio temporal detectado en el aire expresado en partes por millón (ppmv) o en miligramos por metro cúbico normal (mg/m3N).

   La condición normal corresponde a la presión de una atmósfera (1 atm.) y una temperatura de 25 grados Celcius (25°C).

c. *Concentración de 1 hora*: Promedio aritmético de los valores de concentración de monóxido de carbono medidos en 1 hora.

d. *Concentración de 8 Horas*: Promedio aritmético de los valores de concentración de 1 hora de monóxido de carbono correspondientes a 8 horas sucesivas, promedio móvil.

e. *Año calendario*: Período que se inicia el 1 de enero, y culmina el 31 de diciembre del mismo año.

f. *Estación monitora con representatividad poblacional para gas monóxido de carbono (EMRPG):* Una estación de monitoreo que se encuentra localizada en un área habitada.

Se entiende como área habitada, a una porción del territorio donde vive habitual y permanentemente un conjunto de personas.

Una estación EMRPG tendrá un área de representatividad para la población expuesta correspondiente a un radio de dos kilómetros (2 km.), medidos desde la ubicación de la estación.

g. *Percentil:* Corresponde al valor "q" calculado a partir de valores de concentración aproximados al ppmv o mg/m3N más cercano. Todos los valores se anotarán en una lista establecida por orden creciente para cada estación de monitoreo.

$$X1 \leq X2 \leq X3 \ldots. \leq Xk \leq X\,n - 1 \leq Xn$$

El percentil será el valor del elemento de orden "k", para el que "k" se calculará por medio de la siguiente fórmula:

k = q X n , donde "q" = 0.99 para el Percentil 99, y "n" " corresponde al número de datos de una serie . El valor "k" se aproximará al número entero más próximo.

TITULO II

Nivel de Norma de Calidad Primaria para Monóxido de Carbono en Aire

Art.3.- La norma primaria de calidad de aire para monóxido de carbono como concentración de 8 horas será de 9 ppmv (10 mg/m3N).

Se considerará sobrepasada la norma primaria de calidad de aire para monóxido de carbono como concentración de 8 horas, cuando el promedio aritmético de tres años sucesivos, del percentil 99 de los máximos diarios de concentración de 8 horas registrados durante un año calendario, en cualquier estación monitora clasificada como EMRPG sea mayor o igual al nivel indicado en el inciso precedente.

Si el periodo de medición en una estación monitora clasificada como EMPRG no comenzare el 1 de enero, se considerarán los tres primeros periodos de 12 meses a partir del mes de inicio de las mediciones hasta disponer de tres años calendarios sucesivos de mediciones. Para evaluar si se sobrepasa la norma primaria de calidad de aire para monóxido de carbono como concentración de 8 horas, en el primer y segundo periodo de 12 meses a partir del mes de inicio de las mediciones, se reemplazará el percentil 99 de los máximos diarios de concentración de 8 horas para los periodos faltantes por cero.

Art.4.- La norma primaria de calidad de aire para monóxido de carbono como concentración de 1 hora será de 26 ppmv (30 mg/m3N).

Se considerará sobrepasada la norma primaria de calidad de aire para monóxido de carbono como concentración de 1 hora, cuando el promedio aritmético de tres años sucesivos, del percentil 99 de los máximos diarios de concentración de 1 hora registrados durante un año calendario, en cualquier estación monitora clasificada como EMRPG, sea mayor o igual al nivel indicado en el inciso precedente.

Si el periodo de medición en una estación monitora clasificada como EMPRG no comenzare el 1 de enero, se considerarán los tres primeros periodos de 12 meses a partir del mes de inicio de las mediciones hasta disponer de tres años calendarios sucesivos de mediciones. Para evaluar si se sobrepasa la norma primaria de calidad de aire para monóxido de carbono como concentración de 1 hora, en el primer y segundo periodo de 12 meses a partir del mes de inicio de las mediciones, se reemplazará el percentil 99 de los máximos diarios de concentración de 1 hora para los periodos faltantes por cero.

Art.5.- Los siguientes niveles originarán situaciones de emergencia ambiental para monóxido de carbono en concentración de ocho horas:

Nivel 1: 15 - 29 ppmv.	(17 - 33 mg/m3N)
Nivel 2: 30 - 34 ppmv	(34 - 39 mg/m3N)
Nivel 3: 35 ppmv o superior	(40 mg/m3N o superior)

Los niveles que originan situaciones de emergencia ambiental para monóxido de carbono podrán ser obtenidos mediante la aplicación de una metodología de pronóstico de calidad de aire aprobada por el Servicio de Salud respectivo, o por medio de la constatación de las concentraciones del contaminante a partir de alguna de las estaciones monitoras de calidad de aire clasificadas como EMRPG.

Una situación de emergencia ambiental se podrá omitir o dejar sin efecto si se detectare un cambio en las condiciones meteorológicas en forma posterior a la hora de comunicación del pronóstico o a la constatación de la superación de los niveles de calidad de aire, y siempre que dicho cambio asegure una mejoría tal en las condiciones de calidad de aire que invalide los resultados entregados por el pronóstico o que asegure la reducción de los niveles de concentración de calidad de aire por debajo de aquellos que definen situaciones de emergencia ambiental.

Art.6.- Para efectos de evaluar el cumplimiento de la norma y los niveles que definen situaciones de emergencia ambiental se utilizarán los valores de concentración expresados en ppmv.

TITULO III

Metodología de Medición de la Norma

Art.7.- La medición de la concentración de monóxido de carbono en el aire se realizará mediante uno cualesquiera de los siguientes métodos de medición

a. Fotometría infrarroja no dispersiva y,
b. Un método de medición de referencia o equivalente designado o aprobado por la Agencia de Protección Ambiental de los Estados Unidos o las Directivas de la Comunidad Europea.

El monitoreo de calidad de aire deberá realizarse con instrumentos que cumplen con los métodos de medición señalados en el inciso anterior y que hayan sido reconocidos, aprobados o certificados por la Agencia de Protección Ambiental de los Estados Unidos o las Directivas de la Comunidad Europea.

Art.8.- Para efectos de cumplir con lo establecido en el artículo 12, podrán utilizarse técnicas de medición alternativas a las señaladas en el artículo precedente, las que deberán ser aprobadas por el Servicio de Salud respectivo. Para el monitoreo mediante estas técnicas se deberá considerar lo establecido en la letra (f) del artículo 2 del presente decreto.

TITULO IV

Validación de la Información de Monitoreo de Calidad del Aire

Art.9.- La concentración de 8 horas se considerará válida, si, a lo menos el 75% de los datos de concentración de 1 hora para un periodo de 8 horas se encontraren disponibles.

En el evento de que se dispusiere de menos del 75% de los datos de concentración de 1 hora, la concentración de 8 horas será considerada, sólo para efectos de verificar el cumplimiento de la norma primaria de calidad de aire como concentración de 8 horas, si, al reemplazar por cero los datos que faltaren para completar el 75% requerido, la concentración de 8 horas es mayor o igual al nivel de la norma.

Si se dispusiere de datos de concentración de 1 hora para 6 o 7 horas, la concentración de 8 horas se calculará como el promedio aritmético de los datos de concentración de 1 hora disponibles, utilizando como divisor 6 o 7 según corresponda.

El percentil 99 de los máximos diarios de concentración de 8 horas registrados durante un año se considerará válido, si, a lo menos, el 75% de los datos de máximos diarios de concentración de 8 horas para el periodo de un año, se encontraren disponibles y den cuenta de la variación de los datos a lo largo de un año (ciclo estacional).

La concentración máxima diaria de 8 horas se considerará válida, si, a lo menos el 75% de los datos de concentración de 8 horas para un periodo de 24 horas se encontraren disponibles.

En el evento que se dispusiere de menos del 75% de los datos de concentración de 8 horas, la concentración máxima diaria de 8 horas será considerada, sólo para efectos de verificar el cumplimiento de la norma primaria de calidad de aire como concentración de 8 horas, si, la concentración máxima diaria de 8 horas es mayor o igual al nivel de la norma.

La concentración de una hora se considerará válida, si, a lo menos, se dispusiere de 30 minutos sucesivos de medición.

El percentil 99 de los máximos diarios de concentración de 1 hora registrados durante un año se considerará válido, si, a lo menos, el 75% de los datos de máximos diarios de concentración de 1 hora para el periodo de un año, se encontraren disponibles y den cuenta de la variación de los datos a lo de un año (ciclo estacional)

La concentración máxima diaria de 1 hora se considerará válida, si, a lo menos el 75% de los datos de concentración de 1 hora para un periodo de 24 horas se encontraren disponibles.

En el evento que se dispusiere de menos del 75% de los datos de concentración de 1 hora, la concentración máxima diaria de 1 hora será considerada, sólo para efectos de verificar el cumplimiento de la norma primaria de calidad de aire como concentración de 1 hora, si, la concentración máxima diaria de 1 hora es mayor o igual al nivel de la norma.

TITULO V

Fiscalización de la Norma

Art.10.- Corresponderá a los Servicios de Salud del país y, en la Región Metropolitana al Servicio de Salud Metropolitano del Ambiente, fiscalizar el cumplimiento de las disposiciones de la presente norma.

TITULO VI

Implementación de la Norma

Art.11.-Los Servicios de Salud respectivos deberán en un plazo máximo de seis meses contados desde la publicación del presente decreto en el Diario Oficial establecer mediante resolución fundada la clasificación de una estación monitora como EMRPG.

Art, 12.- Los Servicios de Salud respectivos deberán en un plazo máximo de tres años, contados desde la publicación del presente decreto en el Diario Oficial, realizar un diagnóstico de la calidad de aire para monóxido de carbono según sus competencias territoriales.

Dicho diagnóstico deberá considerar la información de calidad de aire disponible así como la que se genere a partir de organismos públicos y privados.

Los Servicios de Salud respectivos deberán en un plazo máximo de dos años, contado desde que se disponga del diagnóstico, elaborar e implementar un programa priorizado de monitoreo para el seguimiento de la norma primaria de calidad de aire para monóxido de carbono.

Dicho programa deberá ser revisado periódicamente en función de los nuevos antecedentes de calidad de aire de que se disponga, los cuales deberán incorporar la información tanto pública como privada.

Art.13.- El monitoreo de la calidad de aire según los métodos de medición señalados en los artículos séptimo y octavo del presente decreto, deberá realizarse de acuerdo a las disposiciones establecidas por el Servicio de Salud respectivo, el que deberá considerar, cuando se encuentre disponible, lo que señale el manual de aplicación de la norma.

El manual de aplicación de la norma deberá ser elaborado por la Comisión Nacional del Medio Ambiente dentro de un plazo máximo de un año contado desde la publicación del presente decreto en el Diario Oficial.

Art.14.- Los Servicios de Salud respectivos deberán tener a disposición de la ciudadanía, los datos de los niveles de concentración de calidad de aire para monóxido de carbono correspondientes a la presente norma, los que serán públicos.

TITULO VII

Entrada en Vigencia

Art. 15.- La presente norma entrará en vigencia a partir del día 1° del mes siguiente del de su publicación en el Diario Oficial quedando desde esa fecha sin efecto las normas primarias de calidad de aire para monóxido de carbono vigentes a dicha fecha.

TITULO VIII

Artículos Transitorios

Art. 16.- Para evaluar si se sobrepasa la norma primaria de calidad de aire para monóxido de carbono como concentración de 8 horas o de 1 hora en el periodo comprendido desde la entrada en vigencia de la norma y hasta disponer de tres años sucesivos de mediciones, en el primer y segundo periodo de 12 meses se reemplazará el percentil 99 de los máximos diarios de concentración de 8 horas o el percentil 99 de los máximos diarios de concentración de 1 hora para los periodos faltantes por cero, según corresponda.

Art. 17.- Las disposiciones contenidas en la presente norma serán incorporadas en lo que corresponda en los Planes de Prevención o de Descontaminación por monóxido de carbono que se encuentren vigentes o en trámite a la fecha de su entrada en vigencia, adelantando para estos efectos los plazos de revisión de dichos planes si fuere necesario.

REPUBLICA DE CHILE
COMISION NACIONAL DEL MEDIO AMBIENTE
ASR/PMC

APRUEBA PROYECTO DEFINITIVO DE REVISION DE NORMA PRIMARIA DE CALIDAD DE AIRE PARA OZONO (O3)

SANTIAGO,

VISTOS:

Lo dispuesto en el artículo 19 N° 8 de la Constitución Política; En el artículo 32 de la Ley 19.300; El Reglamento para la Dictación de Normas de Calidad Ambiental y de Emisión, aprobado por el Decreto Supremo N°93 de 1995, del Ministerio Secretaría General de la Presidencia; La Resolución N°1215 de 1978 del Delegado del Gobierno en el Servicio Nacional de Salud, que establece normas sanitarias mínimas destinadas a prevenir y controlar la contaminación atmosférica; La Resolución Exenta N° 1514 de 1999, de la Dirección Ejecutiva de la Comisión Nacional del Medio Ambiente, que dio inicio al proceso de revisión de las normas primarias de calidad de aire para anhídrido sulfuroso (SO2); partículas totales en suspensión (PTS); monóxido de carbono (CO); ozono (03) y dióxido de nitrógeno (NO2) ; La Resolución Exenta N° 913 del 2000, de la Dirección Ejecutiva de la Comisión Nacional del Medio Ambiente, que aprobó el anteproyecto de revisión de la norma primaria de calidad de aire para anhídrido sulfuroso (SO2), y los demás antecedentes que obran en el expediente público.

CONSIDERANDO

Que, de acuerdo con lo preceptuado en la ley 19.300, es deber del Estado dictar normas para regular la presencia de contaminantes en el medio ambiente, de manera de prevenir que estos puedan significar o representar, por sus niveles, concentraciones y periodos, un riesgo para la salud de las personas, la preservación de la naturaleza y la conservación del patrimonio ambiental.

Que sobre la base a los antecedentes disponibles y que constan en el expediente, se revisó la norma primaria de calidad de aire para ozono (O3), en conformidad al procedimiento y los contenidos establecidos en el Decreto Supremo N°93 de 1995, de Ministerio Secretaria General de la Presidencia.

Que la norma revisada se encuentran contenidas en la Resolución 1215 de 1978, del Delegado del Gobierno en el Servicio Nacional de Salud.

Que el ozono es un fotooxidante que se produce en la tropósfera por efecto de la oxidación de monóxido de carbono e hidrocarburos en presencia de óxidos de nitrógeno y luz solar. De este modo, los hidrocarburos, el monóxido de carbono y los oxidos de nitrógeno constituyen precursores en la formación de ozono.

Que las características dañinas del ozono en la salud de la población se originan en su gran capacidad oxidante que lo hace reaccionar con toda clase de sustancias orgánicas.

Que el ozono puede penetrar los tejidos de la región pulmonar pero la dosis máxima de contaminante la recibe las regiones bronquiales y alveolares.

Que los efectos típicos del ozono en la salud son cambios en la función pulmonar que van precedidos por irritación de ojos y síntomas del pecho y de las vías respiratorias en poblaciones sensibles.

Que respecto de lo anterior la Organización Mundial de la Salud (OMS) indica que en el caso del ozono, "los problemas de salud de mayor preocupación son: aumento en las admisiones hospitalarias, exacerbación del asma, inflamaciones pulmonares y alteraciones estructurales del pulmón" .

Que la OMS y la Agencia de Protección Ambiental de los Estados Unidos, señalan que los efectos del ozono sobre la salud de la población que se pueden asociar claramente con exposiciones de una duración de 6 a 8 horas y que son estadísticamente significativos.

Que el ozono puede presentar efectos adicionales a los de salud tales como efectos sobre los vegetación, ecosistemas y materiales expuestos a este contaminante.

DECRETO

TITULO I

Disposiciones Generales y Definiciones

Art.1.- La presente norma de calidad ambiental tiene por objetivo proteger la salud de la población de aquellos efectos agudos generados por la exposición a niveles de concentración de ozono en el aire.

Art.2.-Para efectos de lo dispuesto en la presente norma, se entenderá por:

a. *ppbv:* Unidad de medida de concentración en volumen, correspondiente a una milésima parte por millón.

b. *Concentración de Ozono*: Valor promedio temporal detectado en el aire expresado en partes por billón (ppbv) o en microgramos por metro cúbico normal (ug/m3N).

   La condición normal corresponde a la presión de una atmósfera (1 atm.) y una temperatura de 25 grados Celcius (25°C).

c. *Concentración de 8-Horas*: Promedio aritmético de los valores de concentración de 1 hora de ozono correspondientes a 8 horas sucesivas, promedio móvil.

d. *Año calendario:* Periodo que se inicia el 1° de enero, y culmina el 31 de diciembre del mismo año.

e. *Estación de monitoreo con representatividad poblacional para gas ozono (EMRPG):* Una estación de monitoreo que se encuentra localizada en un área habitada.

   Se entiende como área habitada, una porción del territorio donde vive habitual y permanentemente un conjunto de personas.

   Una estación EMRPG tendrá un área de representatividad para la población expuesta correspondiente a un radio de dos kilómetros (2 km.), medidos desde la ubicación de la estación.

f. *Percentil:* Corresponde al valor "q" calculado a partir de valores de concentración aproximados al ppvb o ug/m3N más cercano. Todos los valores se anotarán en una lista establecida por orden creciente para cada estación de monitoreo.

$$X1 \leq X2 \leq X3 \ldots \leq Xk \leq X n - 1 \leq Xn$$

El percentil será el valor del elemento de orden "k", para el que "k" se calculará por medio de la siguiente fórmula:

k = q X n , donde "q" = 0.99 para el Percentil 99, y "n" corresponde al número de datos de una serie. El valor "k" se aproximará al número entero más próximo

TITULO II

Nivel de Norma de Calidad Primaria para Ozono en Aire

Art.3.- La norma primaria de calidad de aire para ozono como concentración de 8-horas será de 61 ppbv. (120 ug/m3N)

Se considerará sobrepasada la norma primaria de calidad de aire para ozono como concentración de 8 horas, cuando el promedio aritmético de tres años sucesivos, del percentil 99 de los máximos diarios de concentración de 8 horas registrados durante un año calendario, en cualquier estación monitora clasificada como EMRPG, sea mayor o igual al nivel indicado en el inciso precedente.

Si el periodo de medición en una estación monitora clasificada como EMPRG no comienzare el 1 de enero, se considerarán los tres primeros periodos de 12 meses a partir del mes de inicio de las mediciones hasta disponer de tres años calendarios sucesivos de mediciones. Para evaluar si se sobrepasa la norma primaria de calidad de aire para ozono como concentración de 8 horas, en el primer y segundo periodo de 12 meses a partir del mes de inicio de las mediciones, se reemplazará el percentil 99 de los máximos diarios de concentración de 8 horas para los periodos faltantes por cero.

Art.4.- Los siguientes niveles originarán situaciones de emergencia ambiental para ozono, en concentración de una hora.

Nivel 1: 204 - 407 ppbv	(400 - 799 ug/m3N)
Nivel 2: 408 - 509 ppbv	(800 – 999 ug/m3N)
Nivel 3: 510 ppbv o superior	(1000 ug/m3N o superior)

Los niveles que originan situaciones de emergencia ambiental para ozono podrán ser obtenidos mediante la aplicación de una metodología de pronóstico de calidad de aire aprobada por el Servicio de Salud respectivo, o por medio de la constatación de las concentraciones del contaminante a partir de alguna de las estaciones monitoras de calidad de aire clasificadas como EMRPG.

Una situación de emergencia ambiental se podrá omitir o dejar sin efecto si se detectare un cambio en las condiciones meteorológicas en forma posterior a la hora de comunicación del pronóstico o a la constatación de la superación de los niveles de calidad de aire, y siempre que dicho cambio asegure una mejoría tal en las condiciones de calidad de aire que invalide los resultados entregados por el pronóstico o que asegure la reducción de los niveles de concentración de calidad de aire por debajo de aquellos que definen situaciones de emergencia ambiental.

Art.5.- Para efectos de evaluar el cumplimiento de la norma y los niveles que definen situaciones de emergencia ambiental se utilizarán los valores de concentración expresados en ppbv.

TITULO III

Metodología de Medición de la Norma

Art.6.- La medición de la concentración de ozono en el aire se realizará mediante uno cualesquiera de los siguientes métodos de medición:

a. Quimiluminiscencia con etileno;
b. Fotometría de absorción ultravioleta;
c. Cromatografía líquida gas/sólido;
d. Espectrometría de absorción óptica diferencial, con calibración in-situ y,
e. Un método de medición de referencia o equivalente designado o aprobado por la Agencia de Protección Ambiental de los Estados Unidos o las Directivas de la Comunidad Europea.

El monitoreo de calidad de aire deberá realizarse con instrumentos que cumplen con los métodos de medición señalados en el inciso anterior y que hayan sido reconocidos, aprobados o certificados, por la Agencia de Protección Ambiental de los Estados Unidos o las Directivas de la Comunidad Europea.

Art.7.- Para efectos de cumplir con lo establecido en el artículo 11, podrán utilizarse técnicas de medición alternativas a las señaladas en el artículo precedente, las que deberán ser aprobadas por el Servicio de Salud respectivo. Para el monitoreo mediante estas técnicas se deberá tener en considerar lo establecido en la letra (e) del artículo 2 del presente Decreto.

TITULO IV

Validación de la Información de Monitoreo de Calidad de Aire

Art.8.- La concentración de 8 horas se considerará válida, si, a lo menos el 75% de los datos de concentración de 1 hora para un periodo de 8 horas se encontraren disponibles.

En el evento de que se dispusiere de menos del 75% de los datos de concentración de 1 hora, la concentración de 8 horas será considerada, sólo para efectos de verificar el cumplimiento de la norma primaria de calidad de aire como concentración de 8 horas, si, al reemplazar por cero los datos que faltaren para completar el 75% requerido, la concentración de 8 horas es mayor o igual al nivel de la norma.

Si se dispusiere de datos de concentración de 1 hora para 6 o 7 horas, la concentración de 8 horas se calculará como el promedio aritmético de los datos de concentración de 1 hora disponibles, utilizando como divisor 6 o 7, según corresponda.

El percentil 99 de los máximos diarios de concentración de 8 horas registrados durante un año se considerará válido, si, a lo menos, el 75% de los datos de máximos diarios de concentración de 8 horas para el periodo de un año, se encontraren disponibles y den cuenta de la variación de los datos a lo largo de un año (ciclo estacional).

La concentración máxima diaria de 8 horas se considerará válida, si, a lo menos el 75% de los datos de concentración de 8 horas para un periodo de 24 horas se encontraren disponibles.

En el evento que se dispusiere de menos del 75% de los datos de concentración de 8 horas, la concentración máxima diaria de 8 horas será considerada, sólo para efectos de verificar el cumplimiento de la norma primaria de calidad de aire como concentración de 8 horas, si, la concentración máxima diaria de 8 horas es mayor o igual al nivel de la norma.

TITULO V

Fiscalización de la Norma

Art.9.- Corresponderá a los Servicios de Salud del país y, en la Región Metropolitana al Servicio de Salud Metropolitano del Ambiente, fiscalizar el cumplimiento de las disposiciones de la presente norma.

TITULO VI

Implementación de la Norma

Art.10.-Los Servicios de Salud respectivos deberán en un plazo máximo de seis meses contados desde la publicación del presente decreto en el Diario Oficial establecer mediante resolución fundada la clasificación de una estación monitora como EMRPG.

Art, 11.- Los Servicios de Salud respectivos deberán en un plazo máximo de tres años, contados desde la publicación del presente decreto en el Diario Oficial, realizar un diagnóstico de la calidad de aire para ozono según sus competencias territoriales.

Dicho diagnóstico deberá considerar la información de calidad de aire disponible así como la que se genere a partir de organismos públicos y privados.

Los Servicios de Salud respectivos deberán en un plazo máximo de dos años, contado desde que se disponga del diagnóstico, elaborar e implementar un programa priorizado de monitoreo para el seguimiento de la norma primaria de calidad de aire para ozono.

Dicho programa deberá ser revisado periódicamente en función de los nuevos antecedentes de calidad de aire de que se disponga, los cuales deberán incorporar la información tanto pública como privada.

Art.12.- El monitoreo de la calidad de aire según los métodos de medición señalados en los artículos sexto y séptimo del presente decreto, deberá realizarse de acuerdo a las disposiciones establecidas por el Servicio de Salud respectivo, el que deberá considerar, cuando se encuentre disponible, lo que señale el manual de aplicación de la norma.

El manual de aplicación de la norma deberá ser elaborado por la Comisión Nacional del Medio Ambiente dentro de un plazo máximo de un año contado desde la publicación del presente decreto en el Diario Oficial.

Art.13.- Los Servicios de Salud respectivos deberán tener a disposición de la ciudadanía, los datos de los niveles de concentración de calidad de aire para ozono correspondientes a la presente norma, los que serán públicos.

TITULO VII

Entrada en Vigencia

Art.14.- La presente norma entrará en vigencia a partir del día 1° del mes siguiente del de su publicación en el Diario Oficial quedando desde esa fecha sin efecto las normas primarias de calidad de aire para ozono vigentes a dicha fecha.

TITULO VIII

Artículos Transitorios

Art. 15.- Para evaluar si se sobrepasa la norma primaria de calidad de aire para ozono como concentración de 8 horas en el periodo comprendido desde la entrada en vigencia de la norma y hasta disponer de tres años sucesivos de mediciones, en el primer y segundo periodo de 12 meses se reemplazará el percentil 99 de los máximos diarios de concentración de 8 horas para los periodos faltantes por cero, según corresponda.

Art. 16.- Las disposiciones contenidas en la presente norma serán incorporadas en lo que corresponda en los Planes de Prevención o de Descontaminación por ozono que se encuentren vigentes o en trámite a la fecha de su entrada en vigencia, adelantando para estos efectos los plazos de revisión de dichos planes si fuere necesario.

REPUBLICA DE CHILE
COMISION NACIONAL DEL MEDIO AMBIENTE
ASR/PMC

APRUEBA PROYECTO DEFINITIVO DE REVISION DE NORMA PRIMARIA DE CALIDAD DE AIRE PARA DIOXIDO DE NITROGENO (NO2)

SANTIAGO,

VISTOS:

Lo dispuesto en el artículo 19 Nº 8 de la Constitución Política; En el artículo 32 de la Ley 19.300; El Reglamento para la Dictación de Normas de Calidad Ambiental y de Emisión, aprobado por el Decreto Supremo Nº93 de 1995, del Ministerio Secretaría General de la Presidencia; La Resolución N°1215 de 1978 del Delegado del Gobierno en el Servicio Nacional de Salud, que establece normas sanitarias mínimas destinadas a prevenir y controlar la contaminación atmosférica; La Resolución Exenta N° 1514 de 1999, de la Dirección Ejecutiva de la Comisión Nacional del Medio Ambiente, que dio inicio al proceso de revisión de las normas primarias de calidad de aire para anhídrido sulfuroso (SO2); partículas totales en suspensión (PTS); monóxido de carbono (CO); ozono (03) y dióxido de nitrógeno (NO2) ; La Resolución Exenta N° 914 del 2000, de la Dirección Ejecutiva de la Comisión Nacional del Medio Ambiente, que aprobó el anteproyecto de revisión de la norma primaria de calidad de aire para dióxido de nitrógeno (NO2), y los demás antecedentes que obran en el expediente público.

CONSIDERANDO:

Que de acuerdo con lo preceptuado en la ley 19.300, es deber del Estado dictar normas para regular la presencia de contaminantes en el medio ambiente, de manera de prevenir que estos puedan significar o representar, por sus niveles, concentraciones y periodos, un riesgo para la salud de las personas, la preservación de la naturaleza y la conservación del patrimonio ambiental.

Que sobre la base de los antecedentes disponibles y que constan en el expediente público, se revisó la norma primaria de calidad de aire para dióxido de nitrógeno, en conformidad al procedimiento y los contenidos establecidos en el Decreto Supremo N°93 de 1995, de Ministerio Secretaria General de la Presidencia.

Que la norma revisada se encuentra contenida en la Resolución 1215 de 1978, del Delegado del Gobierno en el Servicio Nacional de Salud.

Que la Organización Mundial de la Salud (OMS) reporta que la exposición a este contaminante puede producir efectos agudos y crónicos sobre la salud de las personas. En el caso de los efectos agudos, se ha reportado un amplio rango de efectos sobre la población asmática, la que probablemente constituye la población mas sensible.

Que la Agencia de Protección Ambiental de los Estados Unidos (EPA) reporta que la exposición a dióxido de nitrógeno puede irritar los pulmones y disminuir la resistencia ante infecciones respiratorias, particularmente en individuos con enfermedades respiratorias pre-existentes, tales como asma.

Que dióxido de nitrógeno (NO2) es producido directa e indirectamente por la quema de combustibles a altas temperaturas. En el proceso de combustión, el nitrógeno se oxida para formar principalmente monóxido de nitrógeno (NO) y en menor proporción dióxido de nitrógeno. El NO se transforma en NO2 mediante reacciones fotoquímicas.

Que el dióxido de nitrógeno puede combinarse con compuestos orgánicos volátiles en presencia de luz solar para formar ozono, así como con agua para formar ácido nítrico y nitratos. Esto contribuye a la producción de lluvia ácida y al aumento de los niveles de MP10 y MP2,5.

DECRETO

TITULO I

Disposiciones Generales y Definiciones

Art.1.- La presente norma de calidad ambiental tiene por objetivo proteger la salud de la población de aquellos efectos agudos y crónicos generados por la exposición a niveles de concentración de dióxido de nitrógeno en el aire.

Art.2.- Para efectos de lo dispuesto en la presente norma, se entenderá por:

a. *ppbv:* Unidad de medida de concentración en volumen, correspondiente a una milésima parte por millón.

b. *Concentración de Dióxido de Nitrógeno*: Valor promedio temporal detectado en el aire expresado en partes por billón (ppbv) o microgramos por metro cúbico normal (ug/m3N).

   La condición normal corresponde a la presión de una atmósfera (1 atm.) y una temperatura de 25 grados Celcius (25ºC).

c. *Concentración de 1 hora*: Promedio aritmético de los valores de concentración de dióxido de nitrógeno medidos en 1 hora.

d. *Concentración de 24 horas*: Promedio aritmético de los valores de concentración de 1 hora de dióxido de nitrógeno correspondientes a un bloque de 24 horas sucesivas, contadas desde las cero horas de cada día.

e. *Concentración trimestral:* Promedio aritmético de los valores de concentración de 24 horas de dióxido de nitrógeno correspondientes a un periodo de tres meses consecutivos.

g. *Concentración anual*: Promedio aritmético de los valores de concentración trimestral de dióxido de nitrógeno correspondientes a un año calendario.

h. *Año calendario*: Período que se inicia el 1 de enero, y culmina el 31 de diciembre del mismo año.

i. *Estación de monitoreo con representatividad poblacional para gas dióxido de nitrógeno (EMRPG):* Una estación de monitoreo que se encuentra localizada en un área habitada.

   Se entiende como área habitada, una porción del territorio donde vive habitual y permanentemente un conjunto de personas.

Una estación EMRPG tendrá un área de representatividad para la población expuesta correspondiente a dos kilómetros (2 km.), medidos desde la ubicación de la estación.

j. *Percentil:* Corresponde al valor "q" calculado a partir de valores de concentración aproximados al ppvb o ug/m3N más cercano. Todos los valores se anotarán en una lista establecida por orden creciente para cada estación de monitoreo.

$$X1 \leq X2 \leq X3 \ldots \leq Xk \leq X n - 1 \leq Xn$$

El percentil será el valor del elemento de orden "k", para el que "k" se calculará por medio de la siguiente fórmula:

k = q X n , donde "q" = 0.99 para el Percentil 99, y "n" corresponde a un número de datos de una serie. El valor "k" se aproximará al número entero más próximo

TITULO II

Nivel de Norma de Calidad Primaria para Dióxido de Nitrógeno en Aire

Art.3.- La norma primaria de calidad de aire para dióxido de nitrógeno como concentración anual será de 53 ppbv (100 ug/m3N).

Se considerará sobrepasada la norma primaria de calidad de aire para dióxido de nitrógeno como concentración anual, cuando el promedio aritmético de los valores de concentración anual de tres años calendarios sucesivos, en cualquier estación monitora clasificada como EMRPG, sea mayor o igual al nivel indicado en el inciso precedente.

Si el periodo de medición en una estación clasificada como EMRPG no comenzare el 1° de enero, se considerarán los tres primeros periodos de 12 meses a partir del mes de inicio de las mediciones hasta disponer de tres años calendarios sucesivos de mediciones. Para evaluar si se sobrepasa la norma primaria de calidad de aire para dióxido de nitrógeno como concentración anual, en el primer y segundo periodo de 12 meses a partir del mes de inicio de las mediciones, se reemplazará la concentración anual para los periodos faltantes por cero.

Art.4.-La norma primaria de calidad de aire para dióxido de nitrógeno como concentración de 1 hora será de 213 ppbv (400 ug/m3N).

Se considerará sobrepasada la norma primaria de calidad de aire para dióxido de nitrógeno como concentración de 1 hora, cuando el promedio aritmético de tres años sucesivos del percentil 99 de los máximos diarios de concentración de 1 hora registrados durante un año calendario, en cualquier estación monitora clasificada como EMRPG, sea mayor o igual al nivel indicado en el inciso precedente.

Si el periodo de medición en una estación monitora clasificada como EMPRG no comenzare el 1 de enero, se considerarán los tres primeros periodos de 12 meses a partir del mes de inicio de las mediciones hasta disponer de tres años calendarios consecutivos de mediciones. Para evaluar si se sobrepasa la norma primaria de calidad de aire para dióxido de nitrógeno como concentración de 1 hora, en el primer y segundo periodo de 12 meses a partir del mes de inicio de las mediciones, se reemplazará el percentil 99 de los máximos diarios de concentración de 1 hora para los periodos faltantes por cero.

Art.5.- Los siguientes niveles originarán situaciones de emergencia ambiental para dióxido de nitrógeno en concentración de una hora:

Nivel 1: 601-1201 ppbv	(1130 - 2259 ug/m3N)
Nivel 2: 1202 - 1595 ppbv	(2260 - 2999 ug/m3N)
Nivel 3: 1596 ppbv o superior	(3000 ug/m3N o superior)

Los niveles que originan situaciones de emergencia ambiental para dióxido de nitrógeno podrán ser obtenidos mediante la aplicación de una metodología de pronóstico de calidad de aire aprobada por el Servicio de Salud respectivo, o por medio de la constatación de las concentraciones del contaminante a partir de alguna de las estaciones monitoras de calidad de aire clasificadas como EMRPG.

Una situación de emergencia ambiental se podrá omitir o dejar sin efecto si se detectare un cambio en las condiciones meteorológicas en forma posterior a la hora de comunicación del pronóstico o a la constatación de la superación de los niveles de calidad de aire, y siempre que dicho cambio asegure una mejoría tal en las condiciones de calidad de aire que invalide los resultados entregados por el pronóstico o que asegure la reducción de los niveles de concentración de calidad de aire por debajo de aquellos que definen situaciones de emergencia ambiental.

Art.6.- Para efectos de evaluar el cumplimiento de la norma y los niveles que definen situaciones de emergencia ambiental se utilizarán los valores de concentración expresados en ppbv.

Art.7.- Cuando el dióxido de nitrógeno fuese precursor de otro contaminante normado, los planes de descontaminación o prevención que se establezcan para el control de este contaminante, podrán incluir medidas de reducción de emisiones del contaminante dióxido de nitrógeno, independientemente del cumplimiento de las normas de calidad de aire que esta norma establece.

TITULO III

Metodología de Medición de la Norma

Art.8.- La medición de la concentración de dióxido de nitrógeno en el aire se realizará mediante uno cualesquiera de los siguientes métodos de medición:

a. Quimiluminiscencia;
b. Los que se basen en el método modificado de Griess-Saltzmann;
c. Espectrometría de absorción óptica diferencial, con calibración in-situ y,
d. Un método de medición de referencia o equivalente designado o aprobado por la Agencia de Protección Ambiental de los Estados Unidos o las Directivas de la Comunidad Europea.

El monitoreo de calidad de aire deberá realizarse con instrumentos que cumplen con los métodos de medición señalados en el inciso anterior y que hayan sido reconocidos, aprobados o certificados por la Agencia de Protección Ambiental de los Estados Unidos o las Directivas de la Comunidad Europea..

Art.9.- Para efectos de cumplir con lo establecido el artículo 13 podrán utilizarse técnicas de medición alternativas a las señaladas en el artículo precedente, las que deberán ser aprobadas por el Servicio de Salud respectivo. Para el monitoreo mediante estas técnicas se deberá tener en consideración lo establecido en la letra (i) del artículo 2 del presente decreto.

TITULO IV

Validación de la Información de Monitoreo de Calidad de Aire

Art.10.- La concentración anual se considerará válida, si para cada uno de los trimestres de un año calendario, se dispusiere de a lo menos un 75% de los datos de concentración de 24 horas para ese periodo.

La concentración de 24 horas se considerará válida, si, a lo menos, el 75% de los datos de concentración de 1 hora para un periodo de 24 horas, se encontraren disponibles y den cuenta de la variación de los datos a lo largo de un día (ciclo diario).

En el evento de que se dispusiere de menos del 75% de los datos de concentración de 1 hora, la concentración de 24 horas será considerada, sólo para efectos de verificar el cumplimiento de la norma primaria de calidad de aire como concentración de 24 horas, si, al reemplazar por cero los datos que faltaren para completar el 75% requerido, la concentración de 24 horas es mayor o igual al valor de la norma.

Si se dispusiere de datos de concentración de 1 hora para 18, 19, 20, 21, 22 o 23 horas, la concentración de 24 horas se calculará como el promedio aritmético de los datos de concentración de 1 hora disponibles, utilizando como divisor 18, 19, 20, 21, 22 o 23, según corresponda.

La concentración de una hora se considerará válida, si, a lo menos, se dispusiere de 30 minutos seguidos de medición.

El percentil 99 de los máximos diarios de concentración de 1 hora registrados durante un año se considerará válido, si, a lo menos, el 75% de los datos de máximos diarios de concentración de 1 hora para el periodo de un año, se encontraren disponibles y den cuenta de la variación de los datos a lo largo de un año (ciclo estacional).

La concentración máxima diaria de 1 hora se considerará válida, si, a lo menos el 75% de los datos de concentración de 1 hora para un periodo de 24 horas se encontraren disponibles.

En el evento que se dispusiere de menos del 75% de los datos de concentración de 1 hora, la concentración máxima diaria de 1 hora será considerada, sólo para efectos de verificar el cumplimiento de la norma primaria de calidad de aire como concentración de 1 hora, si, la concentración máxima diaria de 1 hora es mayor o igual al nivel de la norma.

TITULO V

Fiscalización de la Norma

Art.11.- Corresponderá a los Servicios de Salud del país y, en la Región Metropolitana al Servicio de Salud Metropolitano del Ambiente, fiscalizar el cumplimiento de las disposiciones de la presente norma.

TITULO VI

Implementación de la Norma

Art.12.-Los Servicios de Salud respectivos deberán en un plazo máximo de seis meses contados desde la publicación del presente decreto en el Diario Oficial establecer mediante resolución fundada la clasificación de una estación monitora como EMRPG.

Art, 13.- Los Servicios de Salud respectivos deberán en un plazo máximo de tres años, contados desde la publicación del presente decreto en el Diario Oficial, realizar un diagnóstico de la calidad de aire para dióxido de nitrógeno según sus competencias territoriales.

Dicho diagnóstico deberá considerar la información de calidad de aire disponible así como la que se genere a partir de organismos públicos y privados.

Los Servicios de Salud respectivos deberán un plazo máximo de dos años, contado desde que se disponga del diagnóstico, elaborar e implementar un programa priorizado de monitoreo para el seguimiento de la norma primaria de calidad de aire para dióxido de nitrógeno.

Dicho programa deberá ser revisado periódicamente en función de los nuevos antecedentes de calidad de aire de que se disponga, los cuales deberán incorporar la información tanto pública como privada.

Art.14.- El monitoreo de la calidad de aire según los métodos de medición señalados en los artículos octavo y noveno del presente decreto, deberá realizarse de acuerdo a las disposiciones establecidas por el Servicio de Salud respectivo, el que deberá considerar, cuando se encuentre disponible, lo que señale el manual de aplicación de la norma.

El manual de aplicación de la norma deberá ser elaborado por la Comisión Nacional del Medio Ambiente dentro de un plazo máximo de un año contado desde la publicación del presente decreto en el Diario Oficial.

Art.15.- Los Servicios de Salud respectivos deberán tener a disposición de la ciudadanía, los datos de los niveles de concentración de calidad de aire para dióxido de nitrógeno correspondientes a la presente norma, los que serán públicos.

TITULO VII

Entrada en Vigencia

Art.16.- La presente norma entrará en vigencia a partir del día 1° del mes siguiente del de su publicación en el Diario Oficial quedando desde esa fecha sin efecto las normas primarias de calidad de aire para dióxido de nitrógeno vigentes a dicha fecha.

TITULO VIII

Artículos Transitorios

Art. 17.- Para evaluar si se sobrepasa la norma primaria de calidad de aire para dióxido de nitrógeno como concentración anual o de 1 hora en el periodo comprendido desde la entrada en vigencia de la norma y hasta disponer de tres años sucesivos de mediciones, en el primer y segundo periodo de 12 meses se reemplazará la concentración anual o el percentil 99 de los máximos diarios de concentración de 1 hora para los periodos faltantes por cero, según corresponda.

Art. 18.- Las disposiciones contenidas en la presente norma serán incorporadas en lo que corresponda en los Planes de Prevención o de Descontaminación por dióxido de azufre que se encuentren vigentes o en trámite a la fecha de su entrada en vigencia, adelantando para estos efectos los plazos de revisión de dichos planes si fuere necesario.

REPUBLICA DE CHILE
COMISION NACIONAL DEL MEDIO AMBIENTE
ASR/PMC

APRUEBA PROYECTO DEFINITIVO DE REVISION DE NORMA PRIMARIA DE CALIDAD DE AIRE PARA DIOXIDO DE AZUFRE (SO2)

SANTIAGO,

VISTOS:

Lo dispuesto en el artículo 19 N° 8 de la Constitución Política; En el artículo 32 de la Ley 19.300; El Reglamento para la Dictación de Normas de Calidad Ambiental y de Emisión, aprobado por el Decreto Supremo N°93 de 1995, del Ministerio Secretaría General de la Presidencia; El Decreto Supremo N°185 de 1991, del Ministerio de Minería, que Reglamenta el Funcionamiento de los Establecimientos Emisores de Anhídrido Sulfuroso, Material Particulado y Arsénico en todo el Territorio de La Republica; La Resolución N°1215 de 1978 del Delegado del Gobierno en el Servicio Nacional de Salud, que establece normas sanitarias mínimas destinadas a prevenir y controlar la contaminación atmosférica; La Resolución Exenta N° 1514 de 1999, de la Dirección Ejecutiva de la Comisión Nacional del Medio Ambiente, que dio inicio al proceso de revisión de las normas primarias de calidad de aire para anhídrido sulfuroso (SO2); partículas totales en suspensión (PTS); monóxido de carbono (CO); ozono (03) y dióxido de nitrógeno (NO2) ; La Resolución Exenta N° 915 del 2000, de la Dirección Ejecutiva de la Comisión Nacional del Medio Ambiente, que aprobó el anteproyecto de revisión de la norma primaria de calidad de aire para anhídrido sulfuroso (SO2), y los demás antecedentes que obran en el expediente público.

CONSIDERANDO:

Que de acuerdo con lo preceptuado en la Ley 19.300, es deber del Estado dictar y revisar normas para regular la presencia de contaminantes en el medio ambiente, de manera de prevenir que éstos puedan significar o representar, por sus niveles, concentraciones y periodos, un riesgo para la salud de las personas, la preservación de la naturaleza y la conservación del patrimonio ambiental.

Que sobre la base de los antecedentes disponibles y que constan en el expediente público, se revisó la norma primaria de calidad de aire para anhídrido sulfuroso o dióxido de azufre (SO2), en conformidad al procedimiento y los contenidos establecidos en el Decreto Supremo N°93 de 1995, de Ministerio Secretaria General de la Presidencia.

Que la norma revisada se encuentran contenida en la Resolución 1215 de 1978, del Delegado del Gobierno en el Servicio Nacional de Salud y en el Decreto Supremo N°185 de 1991, del Ministerio de Minería.

Que el dióxido de azufre es un importante broncoconstrictor, desde los primeros minutos de exposición y su efecto aumenta con la actividad física, con la hiperventilación, al respirar aire frío y seco y en personas con hiperreactividad bronquial.

Que la exposición a este contaminante puede producir efectos agudos y crónicos sobre la salud de las personas.

Que el dióxido de azufre se origina de la combustión del azufre contenido en los combustibles fósiles (petróleos combustibles, gasolina, petróleo diesel, carbón, etc.), de la fundición de minerales que contienen azufre y de otros procesos industriales.

Que el dióxido de azufre puede presentar efectos adicionales a los de salud tales como efectos sobre los vegetación, ecosistemas y materiales expuestos a este contaminante.

Que el dióxido de azufre es un precursor de aerosoles secundarios.

Que a nivel nacional existen localidades con población expuesta a altas concentraciones de dióxido de azufre en el aire por periodos cortos de exposición, producto de las emisiones generadas por fuentes específicas.

Que a objeto de estudiar estos efectos se requiere recopilar información sobre la incidencia y prevalencia de asmáticos y los niveles de concentración de calidad de aire para dióxido de azufre en periodos cortos de exposición.

DECRETO:

TITULO I

Disposiciones Generales y Definiciones

Art.1.- La presente norma de calidad ambiental tiene por objetivo proteger la salud de la población de aquellos efectos agudos y crónicos generados por la exposición a niveles de concentración de dióxido de azufre en el aire.

Art.2.- Para efectos de lo dispuesto en la presente norma, se entenderá por:

a. *ppbv*: Unidad de medida de concentración en volumen, correspondiente a una milésima parte por millón.

b. *Concentración de Dióxido de Azufre*: Valor promedio temporal detectado en el aire expresado en partes por billón (ppbv) o en microgramos por metro cúbico normal (ug/m3N).

   La condición normal corresponde a la presión de una atmósfera (1 atm.) y una temperatura de 25 grados Celcius (25°C).

c. *Concentración de 1 hora*: Promedio aritmético de los valores de concentración de dióxido de azufre medidos en una 1 hora.

d. *Concentración de 24 horas*: Promedio aritmético de los valores de concentración de 1 hora de dióxido de azufre correspondientes a un bloque de 24 horas sucesivas, contadas desde las cero horas de cada día.

e. *Concentración trimestral:* Promedio aritmético de los valores de concentración de 24 horas de dióxido de azufre correspondientes a un periodo de tres meses secesivos.

f. *Concentración anual*: Promedio aritmético de los valores de concentración trimestral de dióxido de azufre correspondientes a un año.

g. *Año calendario:* Período que se inicia el 1 de enero y culmina el 31 de diciembre del mismo año.

h. *Estación monitora con representatividad poblacional para gas dióxido de azufre (EMRPG):* Una estación de monitoreo que se encuentra localizada en un área habitada.

Se entiende como área habitada, una porción del territorio donde vive habitual y permanentemente un conjunto de personas.

Una estación EMRPG tendrá un área de representatividad para la población expuesta correspondiente a dos kilómetros (2 km.), medidos desde la ubicación de la estación.

i. *Percentil*: Corresponde al valor "q" calculado a partir de valores de concentración aproximados al ppbv o ug/m3N más cercano. Todos los valores se anotarán en una lista establecida por orden creciente para cada estación de monitoreo.

$$X1 \leq X2 \leq X3 \ldots \leq Xk \leq X\,n - 1 \leq Xn$$

El percentil será el valor del elemento de orden "k", para el que "k" se calculará por medio de la siguiente fórmula:

k = q X n , donde "q" = 0.99 para el Percentil 99, y "n" corresponde al número de datos de una serie. El valor "k" se aproximará al número entero más próximo.

TITULO II

Nivel de Norma de Calidad Primaria para Dióxido de Azufre en Aire

Art.3.- La norma primaria de calidad de aire para dióxido de azufre como concentración anual será de 31 ppbv (80 ug/m3N).

Se considerará sobrepasada la norma primaria de calidad de aire para dióxido de azufre como concentración anual, cuando el promedio aritmético de los valores de concentración anual de tres años calendarios sucesivos, en cualquier estación monitora clasificada como EMRPG, sea mayor o igual al nivel indicado en el inciso precedente.

Si el periodo de medición en una estación monitora clasificada como EMRPG no comenzare el 1° de enero, se considerarán los tres primeros periodos de 12 meses a partir del mes de inicio de las mediciones hasta disponer de tres años calendarios sucesivos de mediciones. Para evaluar si se sobrepasa la norma primaria de calidad de aire para dióxido de azufre como concentración anual, en el primer y segundo periodo de 12 meses a partir del mes de inicio de las mediciones, se reemplazará la concentración anual para los periodos faltantes por cero.

Art.4.- La norma primaria de calidad de aire para dióxido de azufre como concentración de 24 horas será de 96 ppbv (250 ug/m3N).

Se considerará sobrepasada la norma primaria de calidad de aire para dióxido de azufre como concentración de 24 horas, cuando el promedio aritmético de tres años sucesivos, del percentil 99 de las concentraciones de 24 horas registradas durante un año calendario, en cualquier estación monitora clasificada como EMRPG, sea mayor o igual al nivel indicado en el inciso precedente.

Si el periodo de medición en una estación monitora clasificada como EMRPG no comenzare el 1° de enero, se considerarán los tres primeros periodos de 12 meses a partir del mes de inicio de las mediciones hasta disponer de tres años calendarios sucesivos de mediciones. Para evaluar si se sobrepasa la norma primaria de calidad de aire para dióxido de azufre como concentración de 24 horas, en el primer y segundo periodo de 12 meses a partir del mes de inicio de las mediciones, se reemplazará el percentil 99 de las concentraciones de 24 horas para los periodos faltantes por cero.

Art.5.- Los siguientes niveles originarán situaciones de emergencia ambiental para dióxido de azufre, en concentración de una hora:

Nivel 1: 750 - 999 ppbv	(1.962 - 2.615 ug/m3N)
Nivel 2: 1.000 – 1.499 ppbv	(2.616 - 3.923 ug/m3N)
Nivel 3: 1.500 ppbv o superior	(3.924 ug/m3N o superior)

Los niveles que originan situaciones de emergencia ambiental para dióxido de azufre podrán ser obtenidos mediante la aplicación de una metodología de pronóstico de calidad de aire aprobada por el Servicio de Salud respectivo, o por medio de la constatación de las concentraciones del contaminante a partir de alguna de las estaciones monitoras de calidad de aire clasificadas como EMRPG.

Una situación de emergencia ambiental se podrá omitir o dejar sin efecto si se detectare un cambio en las condiciones meteorológicas en forma posterior a la hora de comunicación del pronóstico o a la constatación de la superación de los niveles de calidad de aire, y siempre que dicho cambio asegure una mejoría tal en las condiciones de calidad de aire que invalide los resultados entregados por el pronóstico o que asegure la reducción de los niveles de concentración de calidad de aire por debajo de aquellos que definen situaciones de emergencia ambiental.

Art.6.- Para efectos de evaluar el cumplimiento de la norma y los valores que definen situaciones de emergencia ambiental se utilizarán los valores de concentración expresados en ppbv.

Art.7.- Cuando el dióxido de azufre fuese precursor de otro contaminante normado, los planes de descontaminación o prevención que se establezcan para el control de este contaminante, podrán incluir medidas de reducción de emisiones del contaminante dióxido de azufre, independientemente del cumplimiento de las normas de calidad de aire que esta norma establece.

TITULO III

Metodología de Medición de la Norma

Art.8.- La medición de la concentración de dióxido de azufre en el aire se realizará mediante uno cualesquiera de los siguientes métodos de medición:

a. Fluorescencia ultravioleta;
b. Espectrometría de absorción diferencial con calibración in – situ y,
c. Un método de medición de referencia o equivalente designado o aprobado por la Agencia de Protección Ambiental de los Estados Unidos o las Directivas de la Comunidad Europea.

El monitoreo de calidad de aire deberá realizarse con instrumentos que cumplen con los métodos de medición señalados en el inciso anterior y que hayan sido reconocidos, aprobados o certificados por la Agencia de Protección Ambiental de los Estados Unidos o las Directivas de la Comunidad Europea..

Art.9.- Para efectos de cumplir con lo establecido en el artículo 13, podrán utilizarse técnicas de medición alternativas a las señaladas en el artículo precedente, las que deberán ser aprobadas por el Servicio de Salud respectivo. Para el monitoreo mediante estas técnicas se deberá considerar lo establecido en la letra (h) del artículo 2 del presente decreto.

TITULO IV

Validación de la Información de Monitoreo de Calidad de Aire

Art.10.- La concentración anual se considerará válida, si para cada uno de los trimestres de un año, se dispusiere de a lo menos un 75% de los datos de concentración de 24 horas para ese periodo.

El percentil 99 de las concentraciones de 24 horas registradas en un año se considerará válido , si, a lo menos, el 75% de los datos de concentración de 24 horas para el periodo de un año, se encontraren disponibles y den cuenta de la variación de los datos a lo largo de un año (ciclo estacional).

La concentración de 24 horas se considerará válida, si, a lo menos, el 75% de los datos de concentración de 1 hora para un periodo de 24 horas, se encontraren disponibles y den cuenta de la variación de los datos a lo largo de un día (ciclo diario).

En el evento de que se dispusiere de menos del 75% de los datos de concentración de 1 hora, la concentración de 24 horas será considerada, sólo para efectos de verificar el cumplimiento de la norma primaria de calidad de aire como concentración de 24 horas, si, al reemplazar por cero los datos que faltaren para completar el 75% requerido, la concentración de 24 horas es mayor o igual al valor de la norma.

Si se dispusiere de datos de concentración de 1 hora para 18, 19, 20, 21, 22 o 23 horas, la concentración de 24 horas se calculará como el promedio aritmético de los datos de concentración de 1 hora disponibles, utilizando como divisor 18, 19, 20, 21, 22 o 23, según corresponda.

La concentración de 1 hora se considerará válida, si, a lo menos, se dispusiere de 30 minutos sucesivos de medición.

TITULO V

Fiscalización de la Norma

Art.11.- Corresponderá a los Servicios de Salud del país y, en la Región Metropolitana al Servicio de Salud Metropolitano del Ambiente, fiscalizar el cumplimiento de las disposiciones de la presente norma.

TITULO VI

Implementación de la Norma

Art.12.-Los Servicios de Salud respectivos deberán en un plazo máximo de seis meses contados desde la publicación del presente decreto en el Diario Oficial establecer mediante resolución fundada la clasificación de una estación monitora como EMRPG.

Art. 13.- Los Servicios de Salud respectivos deberán en un plazo máximo de tres años, contados desde la publicación del presente decreto en el Diario Oficial, realizar un diagnóstico de la calidad de aire para dióxido de azufre según sus competencias territoriales.

Dicho diagnóstico deberá considerar la información de calidad de aire disponible así como la que se genere a partir de organismos públicos y privados.

Los Servicios de Salud respectivos deberán en un plazo máximo de dos años, contado desde que se disponga del diagnóstico, elaborar e implementar un programa priorizado de monitoreo para el seguimiento de la norma primaria de calidad de aire para dióxido de azufre.

Dicho programa deberá ser revisado periódicamente en función de los nuevos antecedentes de calidad de aire de que se disponga, los cuales deberán incorporar la información tanto pública como privada.

Art.14.- El monitoreo de la calidad de aire según los métodos de medición señalados en los artículos octavo y noveno del presente decreto, deberá realizarse de acuerdo a las disposiciones establecidas por el Servicio de Salud respectivo, el que deberá considerar, cuando se encuentre disponible, lo que señale el manual de aplicación de la norma.

El manual de aplicación de la norma deberá ser elaborado por la Comisión Nacional del Medio Ambiente dentro de un plazo máximo de un año contado desde la publicación de presente decreto en el Diario Oficial.

Art.15.- Los Servicios de Salud respectivos deberán tener a disposición de la ciudadanía, los datos de los niveles de concentración de calidad de aire para dióxido de azufre correspondientes a la presente norma, los que serán públicos.

TITULO VII

Entrada en Vigencia

Art.16.- La presente norma entrará en vigencia a partir del día primero del mes siguiente del de su publicación en el Diario Oficial, quedando desde esa fecha sin efecto las normas primarias de calidad de aire para dióxido de azufre o anhídrido sulfuroso vigentes a dicha fecha.

TITULO VIII

Generación de Antecedentes para la Regulación de Efectos Agudos

Art. 17.- Los Servicios de Salud respectivos deberán en forma sistemática recopilar la siguiente información:

- Niveles de concentración de calidad de aire para dióxido de azufre como concentración de 5 minutos y una hora, a partir del monitoreo de la calidad de aire de dióxido de azufre.

- Incidencia y prevalencia de asma, en especial en aquellas localidades en las que existe población expuesta a altos niveles de concentración de dióxido de azufre en periodos cortos de exposición.

TITULO IX

Artículos Transitorios

Art. 18.- Para evaluar si se sobrepasa la norma primaria de calidad de aire para dióxido de azufre como concentración anual o de 24 horas en el periodo comprendido desde la entrada en vigencia de la norma y hasta disponer de tres años sucesivos de mediciones, en el primer y segundo periodo de 12 meses se reemplazará la concentración anual o el percentil 99 de las concentraciones de 24 horas para los periodos faltantes por cero, según corresponda.

Art. 19.- Las disposiciones contenidas en la presente norma serán incorporadas en lo que corresponda en los Planes de Prevención o de Descontaminación por dióxido de azufre que se encuentren vigentes o en trámite a la fecha de su entrada en vigencia, adelantando para estos efectos los plazos de revisión de dichos planes si fuere necesario.

REPUBLICA DE CHILE
COMISION NACIONAL DEL MEDIO AMBIENTE
ASR/PMC

APRUEBA PROYECTO DEFINITIVO DE REVISION DE NORMA PRIMARIA DE CALIDAD DE AIRE PARA PARTICULAS TOTALES EN SUSPENSION (PTS)

SANTIAGO,

VISTOS:

Lo dispuesto en el artículo 19 N° 8 de la Constitución Política; En el artículo 32 de la Ley 19.300; El Reglamento para la Dictación de Normas de Calidad Ambiental y de Emisión, aprobado por el Decreto Supremo N°93 de 1995, del Ministerio Secretaría General de la Presidencia; La Resolución N°1215 de 1978 del Delegado del Gobierno en el Servicio Nacional de Salud, que establece normas sanitarias mínimas destinadas a prevenir y controlar la contaminación atmosférica; La Resolución Exenta N° 1514 de 1999, de la Dirección Ejecutiva de la Comisión Nacional del Medio Ambiente, que dio inicio al proceso de revisión de las normas primarias de calidad de aire para anhídrido sulfuroso (SO2); partículas totales en suspensión (PTS); monóxido de carbono (CO); ozono (03) y dióxido de nitrógeno (NO2) ; La Resolución Exenta N° 916 del 2000, de la Dirección Ejecutiva de la Comisión Nacional del Medio Ambiente, que aprobó el anteproyecto de revisión de la norma primaria de calidad de aire para anhídrido sulfuroso (SO2), y los demás antecedentes que obran en el expediente público.

CONSIDERANDO

Que de acuerdo con lo preceptuado en la Ley 19.300, es deber del Estado dictar normas para regular la presencia de contaminantes en el medio ambiente, de manera de prevenir que estos puedan significar o representar, por sus niveles, concentraciones y periodos, un riesgo para la salud de las personas, la preservación de la naturaleza y la conservación del patrimonio ambiental.

Que sobre la base de los antecedentes disponibles y que constan en el expediente público, se revisó la norma primaria de calidad de aire para partículas totales en suspensión (PTS), en conformidad al procedimiento y los contenidos establecidos en el Decreto Supremo N°93 de 1995, de Ministerio Secretaria General de la Presidencia.

Que la norma revisada se encuentran contenida en la Resolución 1215 de 1978, del Delegado del Gobierno en el Servicio Nacional de Salud.

Que históricamente se consideró que todas las partículas suspendidas en el aire (PTS) afectaban la salud de las personas de la misma forma. Sin embargo, recientemente se ha demostrado que las partículas que más la afectan son aquellas con un diámetro aerodinámico menor a 10 um. (MP10) y más aún, aquellas con diámetro aerodinámico menor a 2.5 um. (MP2.5).

Que la fracción del PTS mayor a 10 micrones corresponde a partículas no respirables. Estas se depositan en la traquea y son limpiadas por los cilios a través de la formación de mucus y expulsadas a través de la tos o de la deglución.

Que el documento de guías globales de calidad del aire de la Organización Mundial de la Salud (OMS) sostiene que no puede establecerse un nivel umbral para los efectos del material particulado en la salud, por lo que las guías para material particulado son representadas por asociaciones estadísticamente significativas entre el incremento en los efectos observados y el incremento de las concentraciones, específicamente de MP10 y MP2.5. No estableciéndose ningún tipo de guía para aquella fracción mayor a 10 micrones.

Que no se cuenta con una evaluación de riesgo que evidencie relación entre la exposición a PTS y en particular a los compuestos tóxicos contenidos en éste y la ocurrencia de alguna enfermedad.

Que en Chile, se regulan los efectos en salud generados por la fracción respirable del material particulado inferior a 10 micrones, a través de una norma primaria de calidad de aire para material particulado respirable (MP10) como concentración de 24 horas.

DECRETO:

Artículo Unico.- Déjase sin efecto la norma primaria de calidad de aire para partículas totales en suspensión (PTS) contenida en la Resolución N°1215 de 1978, del Delegado del Gobierno en el Servicio Nacional de Salud.

GOBIERNO DE CHILE
Comisión Nacional del Medio Ambiente
Región de Atacama

COMISION NACIONAL DEL MEDIO AMBIENTE
OFICINA DE PARTES Y ARCHIVO
NO INGRESO: 7522 - 4788
FECHA: 25 JUN 2001
DESPACHO:
OBS.: Alvarez Pardo

ORD.: N° 00522 / 001272

ANT.: No hay.

MAT. Remite observaciones que indica.

COPIAPO, 22 JUN 2001

DE : DIRECTOR REGIONAL COMISION NACIONAL DEL MEDIO AMBIENTE REGION DE ATACAMA

A : SRA. PATRICIA MATUS CORREA
DEPTO. DESCONTAMINACION PLANES Y NORMAS
COMISION NACIONAL DEL MEDIO AMBIENTE.

A propósito de una consulta realizada al profesional de ese departamento, señor Rodrigo Lucero recibimos copia del Proyecto Definitivo de Revisión de Norma Primaria de Calidad de Aire para Dióxido de Azufre (SO2).
Por parecernos que los artículos transitorios del documento debieran permitir a la Autoridad resolver las situaciones relacionadas con clasificación de zonas de calidad del aire durante todo el periodo de vigencia de las nuevas normas, nos permitimos sugerir una modificación al artículo 18 transitorio, por las razones que se expresan en el documento adjunto.

Sin otro particular, saluda atentamente a Ud.

COMISION NACIONAL DEL MEDIO AMBIENTE
DIRECTOR
REGION DE ATACAMA

DANIEL ALVAREZ PARDO
DIRECTOR REGIONAL
COMISION NACIONAL DEL MEDIO AMBIENTE

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DIRECCION REGIONAL
COMISIÓN NACIONAL DEL MEDIO AMBIENTE
REGION DE ATACAMA
UNIDAD DE PLANES Y NORMAS

OBSERVACIONES AL PROYECTO DEFINITIVO DE REVISIÓN DE NORMA PRIMARIA DE CALIDAD DE AIRE PARA DIOXIDO DE AZUFRE (SO2)

1. ARTÍCULOS OBSERVADOS.

Los artículos sujetos a observaciones son los siguientes:

Artículo 3, Párrafo 3 , segunda parte: " Para evaluar si se sobrepasa la norma primaria de calidad del aire para dióxido de azufre como concentración anual, en el primer y segundo periodo de 12 meses a partir del mes de inicio de las mediciones, se reemplazará la concentración anual para los periodos faltantes por cero.

Artículo 4, Párrafo 3, segunda parte: " Para evaluar si se sobrepasa la norma primaria de calidad de aire para dióxido de azufre como concentración de 24 horas, en el primer y segundo período de 12 meses a partir del mes de inicio de las mediciones, se reemplazará el percentil 99 de las concentraciones de 24 horas para los períodos faltantes por cero".

Artículo 18 (transitorio) : " Para evaluar si se sobrepasa la norma primaria de calidad del aire para dióxido de azufre como concentración anual o de 24 horas en el periodo comprendido desde la entrada en vigencia de la norma y hasta disponer de tres años sucesivos de mediciones, en el primer y segundo período de 12 meses se reemplazará la concentración anual o el percentil 99 de las concentraciones de 24 horas para los periodos faltantes por cero, según corresponda".

2. OBSERVACIONES.

2.1 Después de analizar el texto del proyecto definitivo de norma elaborado por el Comité Operativo a cargo de la revisión de la norma actual, esta Dirección Regional concuerda con los valores establecidos por el proyecto para las normas primarias diaria y anual, así como con la forma de cálculo de las concentraciones de referencia para evaluar si estas normas son sobrepasadas, definidos a partir del promedios de tres años del percentil 99 para la norma diaria y el promedio de tres años para la norma anual.

2.2. No obstante lo anterior, se estima que el texto de la segunda parte de los artículos 3 y 4, así como el artículo 18, que tiene carácter de transitorio, si fuere aprobado tal como está presentado en el proyecto, producirá un efecto inhibitorio de las facultades que tiene la autoridad de gobierno para proceder a la declaración de zona saturada o latente y proteger la salud de la población mediante un plan de prevención o descontaminación. Este efecto inhibitorio sería, al menos, por un periodo de tres años, antes de que sea posible contar con tres periodos de monitoreo de calidad del aire, comparables con las nuevas normas. No obstante, para los efectos de aplicación de medidas concretas de protección en salud, este periodo podría extenderse por más de cinco años, si se considera el tiempo que dista normalmente entre la solicitud de una zona como saturada o latente hasta que se publique un plan de descontaminación o de prevención.

2.3. Este problema resulta de la forma de cálculo de la concentración de referencia para evaluar si las normas son sobrepasadas, la que consiste en asignar el valor cero al percentil 99 de los promedios diarios de la concentración de anhídrido sulfuroso de los años faltantes para contar con tres años de monitoreo de calidad del aire, para los efectos de evaluar si se sobrepasa la norma diaria, y asignar el valor cero a la concentración anual de los años faltantes para completar tres años de monitoreo para determinar si se sobrepasa la norma anual. Lo anterior, durante los tres primeros años de la vigencia de las nuevas normas.

2.4. Si se aprueba el proyecto tal como está presentado, la Autoridad estaría impedida de declarar una zona como saturada o latente, a menos que la situación fuera tan grave que en el primer año de monitoreo el promedio anual o el percentil 99 de los promedios diarios superara la norma en un 300 %. Esta situación implicaría un grave riesgo para la salud de la población que quedaría indefensa por un período entre 3 y 5 años.

2.5. Por otro lado, al dividir por tres el valor de concentración del primer año, sumado a valores de cero se estaría dando por cumplida la norma aún en aquellos casos en que el valor de la concentración resultante del cálculo fuere muy superior a los 80 microgramos por metro cúbico para la concentración anual o 250 microgramos para la concentración diaria. De manera que se podría considerar como libre de saturación una zona en la que las concentraciones están hasta por sobre un 299% del valor de la nueva norma de calidad del aire.

3. PROPUESTA DE MODIFICACIÓN AL TEXTO DEL PROYECTO DEFINITIVO DE NORMA.

Considerando las razones que se han expuesto en los puntos precedentes y los fundamentos que se expondrán más adelante, se propone lo siguiente:

a) **Suprimir del texto del proyecto en sus artículos 3 y 4 la segunda parte del tercer párrafo.**

b) **Reemplazar el texto del artículo 18 (transitorio) por el siguiente:**

"Durante el periodo comprendido desde la entrada en vigencia de las normas primarias diaria y anual de calidad del aire para dióxido de azufre, hasta disponer de tres años sucesivos de mediciones y sólo para los efectos de que la Autoridad resuelva sobre la declaración de una zona como saturada o latente, o sobre la derogación de un Decreto Supremo que así lo establezca, se considerará sobrepasada la norma primaria de calidad de aire para dióxido de azufre como concentración anual cuando el promedio aritmético de los valores de concentración de uno o de dos años calendario sucesivos en cualquier estación monitora clasificada como EMRPG, sea mayor o igual a 31ppbv (80 ug/m3N).

Para los mismos fines y en el mismo período señalado en el párrafo precedente, se considerará sobrepasada la norma primaria de calidad de aire para dióxido de azufre como concentración de 24 horas, cuando el promedio aritmético de uno o de dos años calendario sucesivos del percentil 99 de las concentraciones de 24 horas registradas durante un año calendario, en cualquier estación monitora clasificada como EMRPG, sea mayor a 96 ppbv (250 ug/m3N)."

4. FUNDAMENTOS DE LA PROPUESTA.

4.1. Se estima que la redacción propuesta permite a la Autoridad reguladora aplicar los instrumentos de gestión ambiental tales como declarar una zona saturada o latente, establecer un plan de prevención o un plan de descontaminación, en todo momento sin quedar jurídicamente imposibilitada en el periodo de transición como ocurriría si se aprueba el texto actual del proyecto.

4.2. La flexibilidad que le otorga a la Autoridad la redacción propuesta se ve fortalecida por el hecho de que la Declaración de una zona saturada o latente, no es automática cuando se dan condiciones de superación de norma o latencia, por lo que se minimiza el riesgo de equivocarse a la hora de resolver sobre la declaración o la derogación de un decreto que establezca una zona latente o saturada. La Autoridad siempre podrá considerar otros antecedentes aparte de la situación ambiental a la hora de considerar la clasificación o reclasificación de una zona de calidad del aire, tales como la tendencia de las emisiones, las proyecciones de crecimiento o inversión tecnológica u otros antecedentes, como por ejemplo el hecho que un establecimiento no puede incrementar sus emisiones o su producción sin tener que ingresar al Sistema de Evaluación de Impacto Ambiental, que es otra forma de prevenir que se incrementen las emisiones en un área donde existe el riesgo de latencia o saturación.
Cabe destacar que con las normas que propone el proyecto, correspondientes a 80 ug/m3N para el promedio anual y de 250 ug/m3N, para el promedio de 24 horas, las Comisiones Regionales del Medio Ambiente tienen la posibilidad de utilizar las herramientas predictivas de los estudios de impacto ambiental, para prevenir que por la vía de modificación de proyectos existentes o por la incorporación de nuevas fuentes emisoras las emisiones de dióxido de azufre puedan alcanzar valores que se traduzcan en concentraciones en el aire que superen los 64 ug/m3N en el periodo anual o los 200 ug/m3N para el periodo diario, concentraciones correspondientes a los valores de latencia (80% de la norma anual y diaria respectivamente) que regirían con la nueva normativa en proyecto.

4.3. La redacción que se propone, aparte de mantener para la Autoridad las facultad de utilizar los instrumentos de gestión ambiental de la legislación vigente incluso en el período en que no se cuente con tres años sucesivos de monitoreo, permite además que se pueda reclasificar durante ese periodo una zona que en la actualidad se encuentre oficialmente declarada saturada por Decreto Supremo, y en la cual las nuevas normas se estén cumpliendo. Se evita por esta vía que a causa de un impedimento legal (como sería el tener que esperar tres años para reclasificar una zona saturada) proyectos inmobiliarios públicos o privados sean obligados innecesariamente a someterse al Sistema de Evaluación de Impacto Ambiental por estar "oficialmente" localizados en zona saturada. Tal como ocurre en la actualidad con proyectos inmobiliarios que se pretender ejecutar en sectores cercanos a la Fundición Hernán Videla Lira, que concluyó con éxito su Plan de Descontaminación y que sin embargo pesa sobre esos sectores un decreto de Declaración de Zona saturada que los obliga a someterse al SEIA, de acurdo a lo dispuesto en el artículo 3 letra h del Reglamento del sistema de evaluación de Impacto Ambiental, encareciendo los proyectos y atrasando las inversiones con los correspondientes efectos adversos sobre el empleo. Lo anterior sin considerar que desde el punto de vista de la inversión privada la plusvalía y el atractivo comercial de terrenos destinados a la construcción es muy distinta si se trata de terrenos ubicados en zonas saturadas respecto de aquellos que se encuentran libres de saturación.

4.4. Finalmente, el hecho que la forma de cálculo definida por el artículo transitorio que se propone rige sólo para los efectos de clasificación o reclasificación de zonas de calidad del aire impide que los Servicios de Salud del país sancionen por incumplimiento de norma a aquellos establecimientos que no están protegidos por los plazos de un plan de descontaminación.

4.5. En resumen, esta Dirección Regional propone las modificaciones necesarias, que bien podrían tener otra forma, pero que en esencia buscan tres objetivos básicos.

4.5.1. Proteger la salud de la población durante todo el período de vigencia de la norma.

4.5.2. Proteger la inversión y el empleo en el desarrollo de proyectos inmobiliarios que están instalados en lugares declarados saturados por Decreto Supremo , pero que, sin embargo, cumplen en la práctica con la nueva normativa.

4.5.3. Aplicar el principio de gradualismo en la fiscalización de los establecimientos a los cuales le es aplicable la normativa sobre calidad del aire.

001277

GOBIERNO DE CHILE
COMISIÓN NACIONAL DEL MEDIO AMBIENTE

OF. ORD. D.E. Nº 013137 /

MAT: Remite decretos supremos para la firma.

SANTIAGO, 02 AGO 2001

DE : SRA. ADRIANA HOFFMANN JACOBY
DIRECTORA EJECUTIVA
COMISIÓN NACIONAL DEL MEDIO AMBIENTE.

A : SR. CARLOS CARMONA
JEFE DIVISION JURIDICA
MINISTERIO SECRETARIA GENERAL DE LA PRESIDENCIA.

Adjunto al presente, los ejemplares impresos de los siguientes decretos supremos.

1. D.S. que establece Norma de Calidad de Aire para Monóxido de Carbono (CO),
2. D.S. que establece Norma de Calidad de Aire para Ozono (O3)
3. D.S. que establece Norma de Calidad de Aire Dióxido de Nitrógeno (NO2)
4. D.S. que establece Norma de Calidad de Aire Anhídrido Sulfuroso (SO2)
5. D.S. que deroga la Norma de Calidad para Partículas Totales en Suspensión (PTS)

Un archivo computacional conteniendo los mismos ejemplares fue remitido por correo electrónico a la abogado Susana Rioseco, de la División Jurídica del Ministerio Secretaría General de la Presidencia de la República.

Sin otro particular, saluda atentamente a Ud.

COMISION NACIONAL DEL MEDIO AMBIENTE * DIRECTOR EJECUTIVO

ADRIANA HOFFMANN JACOBY
Directora Ejecutiva
Comisión Nacional del Medio Ambiente

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REPUBLICA DE CHILE
Ministerio
Secretaría General de la Presidencia de la República

ESTABLECE NORMA PRIMARIA DE CALIDAD DE AIRE PARA MONÓXIDO DE CARBONO (CO)

SANTIAGO,

DECRETO N° ______________/

VISTOS:

Lo dispuesto en el artículo 19 N°8 de la Constitución Política; En el artículo 32 de la Ley 19.300; el Reglamento para la Dictación de Normas de Calidad Ambiental y de Emisión, aprobado por el Decreto Supremo N°93 de 1995, del Ministerio Secretaría General de la Presidencia; La Resolución N°1215 de 1978 del Delegado del Gobierno en el Servicio Nacional de Salud, que establece normas sanitarias mínimas destinadas a prevenir y controlar la contaminación atmosférica; La Resolución Exenta N° 1514 de 1999, de la Dirección Ejecutiva de la Comisión Nacional del Medio Ambiente, que dio inicio al proceso de revisión de las normas primarias de calidad de aire para anhídrido sulfuroso (SO2); partículas totales en suspensión (PTS); monóxido de carbono (CO); ozono (03) y dióxido de nitrógeno (NO2) ; La Resolución Exenta N° 912 del 2000, de la Dirección Ejecutiva de la Comisión Nacional del Medio Ambiente, que aprobó el anteproyecto de revisión de la norma primaria de calidad de aire para monóxido de carbono (CO), el análisis general del impacto económico y social de la norma señalada; las observaciones formuladas en la etapa de consulta al anteproyecto de norma; el acuerdo N°180 de 3 de mayo de 2001, del Consejo Directivo de la Comisión Nacional del Medio Ambiente, que aprobó el proyecto definitivo de la norma de calidad; los demás antecedentes que obran en el expediente público respectivo y lo dispuesto en la Resolución N°520 de 1996, de la Contraloría General de la República que fija el texto refundido, coordinado y sistematizado de la Resolución N° 55 de 1992, de la Contraloría General de la República.

CONSIDERANDO

Que de acuerdo con lo preceptuado en la ley 19.300, es deber del Estado dictar normas para regular la presencia de contaminantes en el medio ambiente, de manera de prevenir que éstos puedan significar o representar, por sus niveles, concentraciones y periodos, un riesgo para la salud de las personas.

Que sobre la base de los antecedentes disponibles y que constan en el expediente público, se revisó la norma primaria de calidad de aire para monóxido de carbono (CO), contenida en la Resolución 1215 de 1978, del Delegado del Gobierno en el Servicio Nacional de

Salud, en conformidad al procedimiento y los contenidos establecidos en el Decreto Supremo N°93 de 1995, de Ministerio Secretaria General de la Presidencia.

Que la exposición al CO se puede evaluar a través de los niveles de carboxyhemoglobina (COHb) que se expresa como porcentaje de la hemoglobina (Hb) total que está unida al CO.

Que según la OMS (1999), no debiera ser excedido el nivel de 2.5% de COHb en la sangre de las personas expuestas a CO. Con lo anterior, se protege a la población no fumadora, de mediana y mayor edad con enfermedad de la arteria coronaria latente o reportada, de ataques de isquemia miocárdica aguda, y al feto en madres no fumadoras, de efectos hipóxicos adversos.

Que el pulmón es la principal ruta de excreción y absorción de CO y que los resultados de diversos estudios recientes han mostrado que el CO aparece asociado a efectos respiratorios y efectos cardiovasculares entre otros.

DECRETO

TITULO I

Disposiciones Generales y Definiciones

Artículo 1.- La presente norma de calidad ambiental tiene por objetivo proteger la salud de la población de aquellos efectos agudos generados por la exposición a niveles de concentración de monóxido de carbono en el aire.

Artículo 2.- Para efectos de lo dispuesto en la presente norma, se entenderá por:

a. *ppmv:* Unidad de medida de concentración en volumen, correspondiente a una parte por millón.

b. *Concentración de monóxido de carbono*: Valor promedio temporal detectado en el aire expresado en partes por millón (ppmv) o en miligramos por metro cúbico normal (mg/m3N) .

   La condición normal corresponde a la presión de una atmósfera (1 atm.) y una temperatura de 25 grados Celcius (25°C).

c. *Concentración de 1 hora*: Promedio aritmético de los valores de concentración de monóxido de carbono medidos en 1 hora.

d. *Concentración de 8 Horas*: Promedio aritmético de los valores de concentración de 1 hora de monóxido de carbono correspondientes a 8 horas sucesivas, promedio móvil.

e. *Año calendario*: Período que se inicia el 1° de enero y culmina el 31 de diciembre del mismo año.

f. *Estación monitora con representatividad poblacional para gas monóxido de carbono (EMRPG):* Una estación de monitoreo que se encuentra localizada en un área habitada.

   Se entiende como área habitada, a una porción del territorio donde vive habitual y permanentemente un conjunto de personas.

g. *Percentil:* Corresponde al valor "q" calculado a partir de valores de concentración aproximados al ppmv o mg/m3N más cercano. Todos los valores se anotarán en una lista establecida por orden creciente para cada estación de monitoreo.

$$X1 \leq X2 \leq X3 \ldots. \leq Xk \leq X\, n - 1 \leq Xn$$

El percentil será el valor del elemento de orden "k", para el que "k" se calculará por medio de la siguiente fórmula:

k = q X n , donde "q" = 0.99 para el Percentil 99, y "n" corresponde al número de datos de una serie . El valor "k" se aproximará al número entero más próximo.

TITULO II

Nivel de Norma de Calidad Primaria para Monóxido de Carbono en Aire

Artículo 3.- La norma primaria de calidad de aire para monóxido de carbono como concentración de 8 horas será de 9 ppmv (10 mg/m3N).

Se considerará sobrepasada la norma primaria de calidad de aire para monóxido de carbono como concentración de 8 horas, cuando el promedio aritmético de tres años sucesivos, del percentil 99 de los máximos diarios de concentración de 8 horas registrados durante un año calendario, en cualquier estación monitora EMRPG fuere mayor o igual al nivel indicado en el inciso precedente.

Si el periodo de medición en una estación monitora EMPRG no comenzare el 1º de enero, se considerarán los tres primeros periodos de 12 meses a partir del mes de inicio de las mediciones hasta disponer de tres años calendarios sucesivos de mediciones.

Se considerará sobrepasada la norma primaria de calidad de aire para monóxido de carbono como concentración de 8 horas, si en el primer o segundo periodo de 12 meses a partir del mes de inicio de las mediciones y, al reemplazar el percentil 99 de los máximos diarios de concentración de 8 horas para los periodos faltantes por cero, el promedio aritmético de los tres periodos resultare mayor o igual al nivel de la norma.

Artículo 4.- La norma primaria de calidad de aire para monóxido de carbono como concentración de 1 hora será de 26 ppmv (30 mg/m3N).

Se considerará sobrepasada la norma primaria de calidad de aire para monóxido de carbono como concentración de 1 hora, cuando el promedio aritmético de tres años sucesivos, del percentil 99 de los máximos diarios de concentración de 1 hora registrados durante un año calendario, en cualquier estación monitora EMRPG, fuere mayor o igual al nivel indicado en el inciso precedente.

Si el periodo de medición en una estación monitora EMPRG no comenzare el 1º de enero, se considerarán los tres primeros periodos de 12 meses a partir del mes de inicio de las mediciones hasta disponer de tres años calendarios sucesivos de mediciones.

Se considerará sobrepasada la norma primaria de calidad de aire para monóxido de carbono como concentración de 1 hora, si en el primer o segundo periodo de 12 meses a partir del mes de inicio de las mediciones y, al reemplazar el percentil 99 de los máximos diarios de concentración de 1 hora para los periodos faltantes por cero, el promedio aritmético de los tres periodos resultare mayor o igual al nivel de la norma.

Artículo 5.- Los siguientes niveles originarán situaciones de emergencia ambiental para monóxido de carbono en concentración de ocho horas:

Nivel 1: 15 - 29 ppmv.	(17 - 33 mg/m3N)
Nivel 2: 30 - 34 ppmv	(34 - 39 mg/m3N)
Nivel 3: 35 ppmv o superior	(40 mg/m3N o superior)

Los niveles que originan situaciones de emergencia ambiental para monóxido de carbono podrán ser obtenidos mediante la aplicación de una metodología de pronóstico de calidad de aire aprobada por el Servicio de Salud respectivo, o por medio de la constatación de las concentraciones del contaminante a partir de alguna de las estaciones monitoras de calidad de aire EMRPG.

Se podrá omitir o dejar sin efecto una situación de emergencia ambiental si se detectare un cambio en las condiciones meteorológicas en forma posterior a la hora de comunicación del pronóstico o a la constatación de la superación de los niveles de calidad de aire, y siempre que dicho cambio asegure una mejoría tal en las condiciones de calidad de aire que invalide los resultados entregados por el pronóstico o que asegure la reducción de los niveles de concentración de calidad de aire por debajo de aquellos que originan situaciones de emergencia ambiental.

Artículo 6.- Para efectos de evaluar el cumplimiento de la norma y los niveles que originan situaciones de emergencia ambiental se utilizarán los valores de concentración expresados en ppmv.

TITULO III

Metodología de Medición de la Norma

Artículo 7.- La medición de la concentración de monóxido de carbono en el aire se realizará mediante uno cualesquiera de los siguientes métodos de medición:

a. Fotometría infrarroja no dispersiva y,
b. Un método de medición de referencia o equivalente designado o aprobado por la Agencia de Protección Ambiental de los Estados Unidos o por las Directivas de la Comunidad Europea.

El monitoreo de calidad de aire deberá realizarse con instrumentos que cumplen con los métodos de medición señalados en el inciso anterior y que hayan sido reconocidos, aprobados o certificados por la Agencia de Protección Ambiental de los Estados Unidos o por las Directivas de la Comunidad Europea.

Artículo 8.- Para efectos de cumplir con lo establecido en el artículo 12, podrán utilizarse técnicas de medición alternativas a las señaladas en el artículo precedente, las que deberán ser aprobadas por el Servicio de Salud respectivo. Para el monitoreo mediante estas técnicas se deberá considerar lo establecido en la letra (f) del artículo 2 del presente decreto.

TITULO IV

Validación de la Información de Monitoreo de Calidad del Aire

Artículo 9.- Se considerará válida la concentración de 8 horas, si, a lo menos el 75% de los datos de concentración de 1 hora para un periodo de 8 horas se encontraren disponibles.

En el evento de que se dispusiere de menos del 75% de los datos de concentración de 1 hora, la concentración de 8 horas será considerada, sólo para efectos de verificar el cumplimiento de la norma primaria de calidad de aire como concentración de 8 horas, si, al reemplazar por cero los datos que faltaren para completar el 75% requerido, la concentración de 8 horas fuere mayor o igual al nivel de la norma.

Si se dispusiere de datos de concentración de 1 hora para 6 o 7 horas, la concentración de 8 horas se calculará como el promedio aritmético de los datos de concentración de 1 hora disponibles, utilizando como divisor 6 o 7 según corresponda.

Se considerará válido el percentil 99 de los máximos diarios de concentración de 8 horas registrados durante un año, si, a lo menos, el 75% de los datos de máximos diarios de concentración de 8 horas para el periodo de un año, se encontraren disponibles y dan cuenta de la variación de los datos a lo largo de un año (ciclo estacional).

Se considerará válida la concentración máxima diaria de 8 horas, si, a lo menos el 75% de los datos de concentración de 8 horas para un periodo de 24 horas se encontraren disponibles.

En el evento que se dispusiere de menos del 75% de los datos de concentración de 8 horas, la concentración máxima diaria de 8 horas será considerada, sólo para efectos de verificar el cumplimiento de la norma primaria de calidad de aire como concentración de 8 horas, si, la concentración máxima diaria de 8 horas fuere mayor o igual al nivel de la norma.

Se considerará válida la concentración de una hora, si, a lo menos, se dispusiere de 30 minutos sucesivos de medición.

Se considerará válido el percentil 99 de los máximos diarios de concentración de 1 hora registrados durante un año, si, a lo menos, el 75% de los datos de máximos diarios de concentración de 1 hora para el periodo de un año, se encontraren disponibles y dan cuenta de la variación de los datos a lo largo de un año (ciclo estacional)

Se considerará válida la concentración máxima diaria de 1 hora, si, a lo menos el 75% de los datos de concentración de 1 hora para un periodo de 24 horas se encontraren disponibles.

En el evento que se dispusiere de menos del 75% de los datos de concentración de 1 hora, la concentración máxima diaria de 1 hora será considerada, sólo para efectos de verificar el cumplimiento de la norma primaria de calidad de aire como concentración de 1 hora, si, la concentración máxima diaria de 1 hora fuere mayor o igual al nivel de la norma.

TITULO V

Fiscalización de la Norma

Artículo 10.- Corresponderá a los Servicios de Salud del país y, en la Región Metropolitana al Servicio de Salud Metropolitano del Ambiente, fiscalizar el cumplimiento de las disposiciones de la presente norma.

TITULO VI

Implementación de la Norma

Artículo 11.-Los Servicios de Salud respectivos deberán dentro del plazo de seis meses, contados desde la publicación del presente decreto en el Diario Oficial, determinar mediante resolución fundada aquellas estaciones monitoras que se considerarán como EMRPG.

Artículo 12.- Los Servicios de Salud respectivos deberán dentro del plazo de tres años, contados desde la publicación del presente decreto en el Diario Oficial, realizar un diagnóstico de la calidad de aire para monóxido de carbono según sus competencias territoriales.

Dicho diagnóstico deberá considerar la información de calidad de aire disponible así como la que se genere a partir de organismos públicos y privados.

Los Servicios de Salud respectivos deberán dentro del plazo de dos años, contados desde que se disponga del diagnóstico, elaborar e implementar un programa priorizado de monitoreo para el seguimiento de la norma primaria de calidad de aire para monóxido de carbono.

Dicho programa deberá ser revisado periódicamente en función de los nuevos antecedentes de calidad de aire de que se disponga, los cuales deberán incorporar la información tanto pública como privada.

Artículo 13.- El monitoreo de la calidad de aire según los métodos de medición señalados en los artículos séptimo y octavo del presente decreto, deberá realizarse de acuerdo a las disposiciones establecidas por el Servicio de Salud respectivo, el que deberá considerar, cuando se encuentre disponible, lo que señale el manual de aplicación de la norma.

El manual de aplicación de la norma deberá ser elaborado por la Comisión Nacional del Medio Ambiente dentro del plazo de un año, contado desde la publicación del presente decreto en el Diario Oficial.

Artículo 14.- Los Servicios de Salud respectivos deberán tener a disposición de la ciudadanía, los datos de los niveles de concentración de calidad de aire para monóxido de carbono correspondientes a la presente norma, los que serán públicos.

TITULO VII

Entrada en Vigencia

Artículo 15.- La presente norma entrará en vigencia a partir del día 1° del mes siguiente del de su publicación en el Diario Oficial quedando desde esa fecha sin efecto las normas primarias de calidad de aire para monóxido de carbono vigentes a dicha fecha.

TITULO VIII

Artículos Transitorios

Artículo primero transitorio.- En el periodo comprendido desde la entrada en vigencia de la norma y hasta disponer de tres años sucesivos de mediciones, la norma primaria de calidad de aire para monóxido de carbono como concentración de 8 horas o de 1 hora se considerará sobrepasada, si en el primer o segundo periodo de 12 meses y, al reemplazar el percentil 99 de los máximos diarios de concentración de 8 horas o el percentil 99 de los máximos diarios de concentración de 1 hora para los periodos faltantes por cero, el promedio aritmético de los tres periodos resultare igual o mayor al nivel de la norma correspondiente.

Artículo segundo transitorio.- Las disposiciones contenidas en el presente decreto serán incorporadas en lo que corresponda en los planes de prevención o de descontaminación por monóxido de carbono que se encuentren vigentes o en trámite a la fecha de su entrada en vigencia, adelantando para estos efectos los plazos de revisión de dichos planes si fuere necesario.

ANÓTESE, TÓMESE RAZÓN Y PUBLÍQUESE.

RICARDO LAGOS ESCOBAR
Presidente de la República

ALVARO GARCÍA HURTADO
Ministro
Secretario General de la Presidencia

MICHELLE BACHELET JERIA
Ministra de Salud

REPUBLICA DE CHILE
Ministerio
Secretaría General de la Presidencia de la República

ESTABLECE NORMA PRIMARIA DE CALIDAD DE AIRE PARA OZONO (O_3)

SANTIAGO,

VISTOS:

Lo dispuesto en el artículo 19 Nº 8 de la Constitución Política; En el artículo 32 de la Ley 19.300; El Reglamento para la Dictación de Normas de Calidad Ambiental y de Emisión, aprobado por el Decreto Supremo Nº93 de 1995, del Ministerio Secretaría General de la Presidencia; La Resolución N°1215 de 1978 del Delegado del Gobierno en el Servicio Nacional de Salud, que establece normas sanitarias mínimas destinadas a prevenir y controlar la contaminación atmosférica; La Resolución Exenta N° 1514 de 1999, de la Dirección Ejecutiva de la Comisión Nacional del Medio Ambiente, que dio inicio al proceso de revisión de las normas primarias de calidad de aire para anhídrido sulfuroso (SO2); partículas totales en suspensión (PTS); monóxido de carbono (CO); ozono (03) y dióxido de nitrógeno (NO2) ; La Resolución Exenta N° 913 del 2000, de la Dirección Ejecutiva de la Comisión Nacional del Medio Ambiente, que aprobó el anteproyecto de revisión de la norma primaria de calidad de aire para anhídrido sulfuroso (SO2); El análisis general del impacto económico y social de la norma señalada; Las observaciones formuladas en la etapa de consulta al anteproyecto de norma; El acuerdo Nº180 de 3 de mayo de 2001, del Consejo Directivo de la Comisión Nacional del Medio Ambiente, que aprobó el proyecto definitivo de la norma de calidad; los demás antecedentes que obran en el expediente público respectivo y lo dispuesto en la Resolución Nº520 de 1996, de la Contraloría General de la República que fija el texto refundido, coordinado y sistematizado de la Resolución Nº 55 de 1992, de la Contraloría General de la República.

CONSIDERANDO

Que, de acuerdo con lo preceptuado en la ley 19.300, es deber del Estado dictar normas para regular la presencia de contaminantes en el medio ambiente, de manera de prevenir que estos puedan significar o representar, por sus niveles, concentraciones y periodos, un riesgo para la salud de las personas.

Que sobre la base a los antecedentes disponibles y que constan en el expediente, se revisó la norma primaria de calidad de aire para ozono (O3), contenida en la Resolución 1215 de 1978, del Delegado del Gobierno en el Servicio Nacional de Salud, en conformidad al procedimiento y los contenidos establecidos en el Decreto Supremo N°93 de 1995, de Ministerio Secretaria General de la Presidencia.

Que el ozono es un fotooxidante que se produce en la tropósfera por efecto de la oxidación de monóxido de carbono e hidrocarburos en presencia de óxidos de nitrógeno y luz solar. De este modo, los hidrocarburos, el monóxido de carbono y los óxidos de nitrógeno constituyen precursores en la formación de ozono.

Que las características dañinas del ozono en la salud de la población se originan en su gran capacidad oxidante que lo hace reaccionar con toda clase de sustancias orgánicas.

Que el ozono puede penetrar los tejidos de la región pulmonar pero la dosis máxima de contaminante la recibe las regiones bronquiales y alveolares.

Que los efectos típicos del ozono en la salud son cambios en la función pulmonar que van precedidos por irritación de ojos y síntomas del pecho y de las vías respiratorias en poblaciones sensibles.

Que respecto de lo anterior la Organización Mundial de la Salud (OMS) indica que en el caso del ozono, "los problemas de salud de mayor preocupación son: aumento en las admisiones hospitalarias, exacerbación del asma, inflamaciones pulmonares y alteraciones estructurales del pulmón" .

Que la OMS y la Agencia de Protección Ambiental de los Estados Unidos, señalan que los efectos del ozono sobre la salud de la población se pueden asociar claramente con exposiciones de una duración de 6 a 8 horas y que son estadísticamente significativos.

Que el ozono puede presentar efectos adicionales a los de salud tales como efectos sobre los vegetación, ecosistemas y materiales expuestos a este contaminante.

DECRETO

TITULO I

Disposiciones Generales y Definiciones

Artículo 1.- La presente norma de calidad ambiental tiene por objetivo proteger la salud de la población de aquellos efectos agudos generados por la exposición a niveles de concentración de ozono en el aire.

Artículo 2.-Para efectos de lo dispuesto en la presente norma, se entenderá por:

a. *ppbv:* Unidad de medida de concentración en volumen, correspondiente a una milésima parte por millón.

b. *Concentración de Ozono*: Valor promedio temporal detectado en el aire expresado en partes por billón (ppbv) o en microgramos por metro cúbico normal (ug/m3N).

   La condición normal corresponde a la presión de una atmósfera (1 atm.) y una temperatura de 25 grados Celcius (25°C).

c. *Concentración de 8-Horas*: Promedio aritmético de los valores de concentración de 1 hora de ozono correspondientes a 8 horas sucesivas, promedio móvil.

d. *Año calendario:* Periodo que se inicia el 1° de enero y culmina el 31 de diciembre del mismo año.

e. *Estación de monitoreo con representatividad poblacional para gas ozono (EMRPG):* Una estación de monitoreo que se encuentra localizada en un área habitada.

   Se entiende como área habitada, una porción del territorio donde vive habitual y permanentemente un conjunto de personas.

f. *Percentil:* Corresponde al valor "q" calculado a partir de valores de concentración aproximados al ppvb o ug/m3N más cercano. Todos los valores se anotarán en una lista establecida por orden creciente para cada estación de monitoreo.

$$X1 \leq X2 \leq X3 .... \leq Xk \leq X n - 1 \leq Xn$$

El percentil será el valor del elemento de orden "k", para el que "k" se calculará por medio de la siguiente fórmula:

k = q X n , donde "q" = 0.99 para el Percentil 99, y "n" corresponde al número de datos de una serie. El valor "k" se aproximará al número entero más próximo

TITULO II

Nivel de Norma de Calidad Primaria para Ozono en Aire

Artículo 3.- La norma primaria de calidad de aire para ozono como concentración de 8-horas será de 61 ppbv. (120 ug/m3N)

Se considerará sobrepasada la norma primaria de calidad de aire para ozono como concentración de 8 horas, cuando el promedio aritmético de tres años sucesivos, del percentil 99 de los máximos diarios de concentración de 8 horas registrados durante un año calendario, en cualquier estación monitora EMRPG, fuere mayor o igual al nivel indicado en el inciso precedente.

Si el periodo de medición en una estación monitora EMPRG no comenzare el 1° de enero, se considerarán los tres primeros periodos de 12 meses a partir del mes de inicio de las mediciones hasta disponer de tres años calendarios sucesivos de mediciones.

Se considerará sobrepasada la norma primaria de calidad de aire para ozono como concentración de 8 horas, si en el primer o segundo periodo de 12 meses a partir del mes de inicio de las mediciones y, al reemplazar el percentil 99 de los máximos diarios de concentración de 8 horas para los periodos faltantes por cero, el promedio aritmético de los tres periodos resultare mayor o igual al nivel de la norma.

Artículo 4.- Los siguientes niveles originarán situaciones de emergencia ambiental para ozono, en concentración de una hora.

Nivel 1: 204 - 407 ppbv	(400 - 799 ug/m3N)
Nivel 2: 408 - 509 ppbv	(800 – 999 ug/m3N)
Nivel 3: 510 ppbv o superior	(1000 ug/m3N o superior)

Los niveles que originan situaciones de emergencia ambiental para ozono podrán ser obtenidos mediante la aplicación de una metodología de pronóstico de calidad de aire aprobada por el Servicio de Salud respectivo, o por medio de la constatación de las concentraciones del contaminante a partir de alguna de las estaciones monitoras de calidad de aire EMRPG.

Se podrá omitir o dejar sin efecto una situación de emergencia ambiental si se detectare un cambio en las condiciones meteorológicas en forma posterior a la hora de comunicación del pronóstico o a la constatación de la superación de los niveles de calidad de aire, y siempre que dicho cambio asegure una mejoría tal en las condiciones de calidad de aire que invalide los resultados entregados por el pronóstico o que asegure la reducción de los niveles de concentración de calidad de aire por debajo de aquellos que originan situaciones de emergencia ambiental.

Artículo 5.- Para efectos de evaluar el cumplimiento de la norma y los niveles que originan situaciones de emergencia ambiental se utilizarán los valores de concentración expresados en ppbv.

TITULO III

Metodología de Medición de la Norma

Artículo 6.- La medición de la concentración de ozono en el aire se realizará mediante uno cualesquiera de los siguientes métodos de medición:

a. Quimiluminiscencia con etileno;
b. Fotometría de absorción ultravioleta;
c. Cromatografía líquida gas/sólido;
d. Espectrometría de absorción óptica diferencial, con calibración in-situ y,
e. Un método de medición de referencia o equivalente designado o aprobado por la Agencia de Protección Ambiental de los Estados Unidos o por las Directivas de la Comunidad Europea.

El monitoreo de calidad de aire deberá realizarse con instrumentos que cumplen con los métodos de medición señalados en el inciso anterior y que hayan sido reconocidos, aprobados o certificados, por la Agencia de Protección Ambiental de los Estados Unidos o por las Directivas de la Comunidad Europea.

Artículo 7.- Para efectos de cumplir con lo establecido en el artículo 11, podrán utilizarse técnicas de medición alternativas a las señaladas en el artículo precedente, las que deberán ser aprobadas por el Servicio de Salud respectivo. Para el monitoreo mediante estas técnicas se deberá tener en consideración lo establecido en la letra (e) del artículo 2 del presente Decreto.

TITULO IV

Validación de la Información de Monitoreo de Calidad de Aire

Artículo 8.- Se considerará válida la concentración de 8 horas, si, a lo menos, el 75% de los datos de concentración de 1 hora para un periodo de 8 horas se encontraren disponibles.

En el evento de que se dispusiere de menos del 75% de los datos de concentración de 1 hora, la concentración de 8 horas será considerada, sólo para efectos de verificar el cumplimiento de la norma primaria de calidad de aire como concentración de 8 horas, si al reemplazar por cero los datos que faltaren para completar el 75% requerido, la concentración de 8 horas fuere mayor o igual al nivel de la norma.

Si se dispusiere de datos de concentración de 1 hora para 6 o 7 horas, la concentración de 8 horas se calculará como el promedio aritmético de los datos de concentración de 1 hora disponibles, utilizando como divisor 6 o 7, según corresponda.

Se considerará válido el percentil 99 de los máximos diarios de concentración de 8 horas registrados durante un año, si, a lo menos, el 75% de los datos de los máximos diarios de concentración de 8 horas para el periodo de un año, se encontraren disponibles y dan cuenta de la variación de los datos a lo largo de un año (ciclo estacional).

Se considerará válida la concentración máxima diaria de 8 horas, si, a lo menos, el 75% de los datos de concentración de 8 horas para un periodo de 24 horas se encontraren disponibles.

En el evento que se dispusiere de menos del 75% de los datos de concentración de 8 horas, la concentración máxima diaria de 8 horas será considerada, sólo para efectos de verificar el cumplimiento de la norma primaria de calidad de aire como concentración de 8 horas, si, la concentración máxima diaria de 8 horas fuere mayor o igual al nivel de la norma.

TITULO V

Fiscalización de la Norma

Artículo 9.- Corresponderá a los Servicios de Salud del país y, en la Región Metropolitana al Servicio de Salud Metropolitano del Ambiente, fiscalizar el cumplimiento de las disposiciones de la presente norma.

TITULO VI

Implementación de la Norma

Artículo 10.-Los Servicios de Salud respectivos deberán dentro del plazo de seis meses, contados desde la publicación del presente decreto en el Diario Oficial, determinar mediante resolución fundada aquellas estaciones monitoras que se considerarán como EMRPG.

Artículo 11.- Los Servicios de Salud respectivos deberán dentro del plazo de tres años, contados desde la publicación del presente decreto en el Diario Oficial, realizar un diagnóstico de la calidad de aire para ozono según sus competencias territoriales.

Dicho diagnóstico deberá considerar la información de calidad de aire disponible así como la que se genere a partir de organismos públicos y privados.

Los Servicios de Salud respectivos deberán dentro del plazo de dos años, contados desde que se disponga del diagnóstico, elaborar e implementar un programa priorizado de monitoreo para el seguimiento de la norma primaria de calidad de aire para ozono.

Dicho programa deberá ser revisado periódicamente en función de los nuevos antecedentes de calidad de aire de que se disponga, los cuales deberán incorporar la información tanto pública como privada.

Artículo 12.- El monitoreo de la calidad de aire según los métodos de medición señalados en los artículos sexto y séptimo del presente decreto, deberá realizarse de acuerdo a las disposiciones establecidas por el Servicio de Salud respectivo, el que deberá considerar, cuando se encuentre disponible, lo que señale el manual de aplicación de la norma.

El manual de aplicación de la norma deberá ser elaborado por la Comisión Nacional del Medio Ambiente dentro del plazo de un año contado desde la publicación del presente decreto en el Diario Oficial.

Artículo 13.- Los Servicios de Salud respectivos deberán tener a disposición de la ciudadanía, los datos de los niveles de concentración de calidad de aire para ozono correspondientes a la presente norma, los que serán públicos.

TITULO VII

Entrada en Vigencia

Artículo 14.- La presente norma entrará en vigencia a partir del día 1° del mes siguiente del de su publicación en el Diario Oficial quedando desde esa fecha sin efecto las normas primarias de calidad de aire para ozono vigentes a dicha fecha.

Artículos Transitorios

Artículo primero transitorio.- En el periodo comprendido desde la entrada en vigencia de la norma y hasta disponer de tres años sucesivos de mediciones, la norma primaria de calidad de aire para ozono como concentración de 8 horas se considerará sobrepasada, si en el primer o segundo periodo de 12 meses y, al reemplazar el percentil 99 de los máximos diarios de concentración de 8 horas para los periodos faltantes por cero, el promedio aritmético de los tres periodos resultare mayor o igual al nivel de la norma.

Artículo segundo transitorio.- Las disposiciones contenidas en la presente norma serán incorporadas en lo que corresponda en los planes de prevención o de descontaminación por ozono que se encuentren vigentes o en trámite a la fecha de su entrada en vigencia, adelantando para estos efectos los plazos de revisión de dichos planes si fuere necesario.

ANÓTESE, TÓMESE RAZÓN Y PUBLÍQUESE.

RICARDO LAGOS ESCOBAR
Presidente de la República

ALVARO GARCÍA HURTADO
Ministro
Secretario General de la Presidencia

MICHELLE BACHELET JERIA
Ministra de Salud

REPUBLICA DE CHILE
Ministerio
Secretaría General de la Presidencia de la República

ESTABLECE NORMA PRIMARIA DE CALIDAD DE AIRE PARA DIOXIDO DE NITROGENO (NO_2)

SANTIAGO,

VISTOS:

Lo dispuesto en el artículo 19 N° 8 de la Constitución Política; En el artículo 32 de la Ley 19.300; El Reglamento para la Dictación de Normas de Calidad Ambiental y de Emisión, aprobado por el Decreto Supremo N°93 de 1995, del Ministerio Secretaría General de la Presidencia; La Resolución N°1215 de 1978 del Delegado del Gobierno en el Servicio Nacional de Salud, que establece normas sanitarias mínimas destinadas a prevenir y controlar la contaminación atmosférica; La Resolución Exenta N° 1514 de 1999, de la Dirección Ejecutiva de la Comisión Nacional del Medio Ambiente, que dio inicio al proceso de revisión de las normas primarias de calidad de aire para anhídrido sulfuroso (SO2); partículas totales en suspensión (PTS); monóxido de carbono (CO); ozono (03) y dióxido de nitrógeno (NO2) ; La Resolución Exenta N° 914 del 2000, de la Dirección Ejecutiva de la Comisión Nacional del Medio Ambiente, que aprobó el anteproyecto de revisión de la norma primaria de calidad de aire para dióxido de nitrógeno (NO2); El análisis general del impacto económico y social de la norma señalada; Las observaciones formuladas en la etapa de consulta al anteproyecto de norma; El acuerdo N°180 de 3 de mayo de 2001, del Consejo Directivo de la Comisión Nacional del Medio Ambiente, que aprobó el proyecto definitivo de la norma de calidad; los demás antecedentes que obran en el expediente público respectivo y lo dispuesto en la Resolución N°520 de 1996, de la Contraloría General de la República que fija el texto refundido, coordinado y sistematizado de la Resolución N° 55 de 1992, de la Contraloría General de la República.

CONSIDERANDO:

Que de acuerdo con lo preceptuado en la ley 19.300, es deber del Estado dictar normas para regular la presencia de contaminantes en el medio ambiente, de manera de prevenir que estos puedan significar o representar, por sus niveles, concentraciones y periodos, un riesgo para la salud de las personas.

Que sobre la base de los antecedentes disponibles y que constan en el expediente público, se revisó la norma primaria de calidad de aire para dióxido de nitrógeno contenida en la Resolución 1215 de 1978, del Delegado del Gobierno en el Servicio Nacional de Salud, en conformidad al procedimiento y los contenidos establecidos en el Decreto Supremo N°93 de 1995, de Ministerio Secretaria General de la Presidencia.

Que la Organización Mundial de la Salud (OMS) reporta que la exposición a este contaminante puede producir efectos agudos y crónicos sobre la salud de las personas. En el caso de los efectos agudos, se ha reportado un amplio rango de efectos sobre la población asmática, la que probablemente constituye la población mas sensible.

Que la Agencia de Protección Ambiental de los Estados Unidos (EPA) reporta que la exposición a dióxido de nitrógeno puede irritar los pulmones y disminuir la resistencia ante infecciones respiratorias, particularmente en individuos con enfermedades respiratorias pre-existentes, tales como asma.

Que dióxido de nitrógeno (NO2) es producido directa e indirectamente por la quema de combustibles a altas temperaturas. En el proceso de combustión, el nitrógeno se oxida para formar principalmente monóxido de nitrógeno (NO) y en menor proporción dióxido de nitrógeno. El NO se transforma en NO2 mediante reacciones fotoquímicas.

Que el dióxido de nitrógeno puede combinarse con compuestos orgánicos volátiles en presencia de luz solar para formar ozono, así como con agua para formar ácido nítrico y nitratos. Esto contribuye a la producción de lluvia ácida y al aumento de los niveles de MP10 y MP2,5.

DECRETO

TITULO I

Disposiciones Generales y Definiciones

Artículo 1.- La presente norma de calidad ambiental tiene por objetivo proteger la salud de la población de aquellos efectos agudos y crónicos generados por la exposición a niveles de concentración de dióxido de nitrógeno en el aire.

Artículo 2.- Para efectos de lo dispuesto en la presente norma, se entenderá por:

a. *ppbv:* Unidad de medida de concentración en volumen, correspondiente a una milésima parte por millón.

b. *Concentración de Dióxido de Nitrógeno*: Valor promedio temporal detectado en el aire expresado en partes por billón (ppbv) o microgramos por metro cúbico normal (ug/m3N).

   La condición normal corresponde a la presión de una atmósfera (1 atm.) y una temperatura de 25 grados Celcius (25°C).

c. *Concentración de 1 hora*: Promedio aritmético de los valores de concentración de dióxido de nitrógeno medidos en 1 hora.

d. *Concentración de 24 horas*: Promedio aritmético de los valores de concentración de 1 hora de dióxido de nitrógeno correspondientes a un bloque de 24 horas sucesivas, contadas desde las cero horas de cada día.

e. *Concentración trimestral:* Promedio aritmético de los valores de concentración de 24 horas de dióxido de nitrógeno correspondientes a un periodo de tres meses consecutivos.

g. *Concentración anual*: Promedio aritmético de los valores de concentración trimestral de dióxido de nitrógeno correspondientes a un año calendario.

h. *Año calendario*: Período que se inicia el 1° de enero y culmina el 31 de diciembre del mismo año.

i. *Estación de monitoreo con representatividad poblacional para gas dióxido de nitrógeno (EMRPG):* Una estación de monitoreo que se encuentra localizada en un área habitada.

Se entiende como área habitada, una porción del territorio donde vive habitual y permanentemente un conjunto de personas.

j. *Percentil:* Corresponde al valor "q" calculado a partir de valores de concentración aproximados al ppvb o ug/m3N más cercano. Todos los valores se anotarán en una lista establecida por orden creciente para cada estación de monitoreo.

$$X1 \leq X2 \leq X3 \ldots \leq Xk \leq X\,n - 1 \leq Xn$$

El percentil será el valor del elemento de orden "k", para el que "k" se calculará por medio de la siguiente fórmula:

k = q X n , donde "q" = 0.99 para el Percentil 99, y "n" corresponde a un número de datos de una serie. El valor "k" se aproximará al número entero más próximo

TITULO II

Nivel de Norma de Calidad Primaria para Dióxido de Nitrógeno en Aire

Artículo 3.- La norma primaria de calidad de aire para dióxido de nitrógeno como concentración anual será de 53 ppbv (100 ug/m3N).

Se considerará sobrepasada la norma primaria de calidad de aire para dióxido de nitrógeno como concentración anual, cuando el promedio aritmético de los valores de concentración anual de tres años calendarios sucesivos, en cualquier estación monitora EMRPG, fuere mayor o igual al nivel indicado en el inciso precedente.

Si el periodo de medición en una estación monitora EMRPG no comenzare el 1° de enero, se considerarán los tres primeros periodos de 12 meses a partir del mes de inicio de las mediciones hasta disponer de tres años calendarios sucesivos de mediciones.

Se considerará sobrepasada la norma primaria de calidad de aire para dióxido de nitrógeno como concentración anual, si en el primer o segundo periodo de 12 meses a partir del mes de inicio de las mediciones y, al reemplazar la concentración anual para los periodos faltantes por cero, el promedio aritmético de los tres periodos resultare mayor o igual al nivel de la norma.

Artículo 4.-La norma primaria de calidad de aire para dióxido de nitrógeno como concentración de 1 hora será de 213 ppbv (400 ug/m3N).

Se considerará sobrepasada la norma primaria de calidad de aire para dióxido de nitrógeno como concentración de 1 hora, cuando el promedio aritmético de tres años sucesivos del percentil 99 de los máximos diarios de concentración de 1 hora registrados durante un año calendario, en cualquier estación monitora EMRPG, fuere mayor o igual al nivel indicado en el inciso precedente.

Si el periodo de medición en una estación monitora EMPRG no comenzare el 1 de enero, se considerarán los tres primeros periodos de 12 meses a partir del mes de inicio de las mediciones hasta disponer de tres años calendarios consecutivos de mediciones.

Se considerará sobrepasada la norma primaria de calidad de aire para dióxido de nitrógeno como concentración de 1 hora, si en el primer o segundo periodo de 12 meses a partir del mes de inicio de las mediciones y, al reemplazar el percentil 99 de los máximos diarios de concentración de 1 hora para los periodos faltantes por cero, el promedio aritmético de los tres periodos resultare mayor o igual al nivel de la norma.

Artículo 5.- Los siguientes niveles originarán situaciones de emergencia ambiental para dióxido de nitrógeno en concentración de una hora:

Nivel 1: 601-1201 ppbv	(1130 - 2259 ug/m3N)
Nivel 2: 1202 - 1595 ppbv	(2260 - 2999 ug/m3N)
Nivel 3: 1596 ppbv o superior	(3000 ug/m3N o superior)

Los niveles que originan situaciones de emergencia ambiental para dióxido de nitrógeno podrán ser obtenidos mediante la aplicación de una metodología de pronóstico de calidad de aire aprobada por el Servicio de Salud respectivo, o por medio de la constatación de las concentraciones del contaminante a partir de alguna de las estaciones monitoras de calidad de aire EMRPG.

Se podrá omitir o dejar sin efecto una situación de emergencia ambiental si se detectare un cambio en las condiciones meteorológicas en forma posterior a la hora de comunicación del pronóstico o a la constatación de la superación de los niveles de calidad de aire, y siempre que dicho cambio asegure una mejoría tal en las condiciones de calidad de aire que invalide los resultados entregados por el pronóstico o que asegure la reducción de los niveles de concentración de calidad de aire por debajo de aquellos que originan situaciones de emergencia ambiental.

Artículo 6.- Para efectos de evaluar el cumplimiento de la norma y los niveles que originan situaciones de emergencia ambiental se utilizarán los valores de concentración expresados en ppbv.

Artículo 7.- Cuando el dióxido de nitrógeno fuese precursor de otro contaminante normado, los planes de descontaminación o prevención que se establezcan para el control de este contaminante, podrán incluir medidas de reducción de emisiones del contaminante dióxido de nitrógeno, independientemente del cumplimiento de las normas de calidad de aire que esta norma establece.

TITULO III

Metodología de Medición de la Norma

Artículo 8.- La medición de la concentración de dióxido de nitrógeno en el aire se realizará mediante uno cualesquiera de los siguientes métodos de medición:

a. Quimiluminiscencia;
b. Los que se basen en el método modificado de Griess-Saltzmann;
c. Espectrometría de absorción óptica diferencial, con calibración in-situ y,
d. Un método de medición de referencia o equivalente designado o aprobado por la Agencia de Protección Ambiental de los Estados Unidos o por las Directivas de la Comunidad Europea.

El monitoreo de calidad de aire deberá realizarse con instrumentos que cumplen con los métodos de medición señalados en el inciso anterior y que hayan sido reconocidos, aprobados o certificados por la Agencia de Protección Ambiental de los Estados Unidos o por las Directivas de la Comunidad Europea..

Artículo 9.- Para efectos de cumplir con lo establecido el artículo 13 podrán utilizarse técnicas de medición alternativas a las señaladas en el artículo precedente, las que deberán ser aprobadas por el Servicio de Salud respectivo. Para el monitoreo mediante estas técnicas se deberá tener en consideración lo establecido en la letra (i) del artículo 2 del presente decreto.

TITULO IV

Validación de la Información de Monitoreo de Calidad de Aire

Artículo 10.- Se considerará válida la concentración anual, si para cada uno de los trimestres de un año, se dispusiere de a lo menos un 75% de los datos de concentración de 24 horas para ese periodo.

Se considerará válida la concentración de 24 horas si, a lo menos, el 75% de los datos de concentración de 1 hora para un periodo de 24 horas, se encontraren disponibles y dan cuenta de la variación de los datos a lo largo de un día (ciclo diario).

En el evento de que se dispusiere de menos del 75% de los datos de concentración de 1 hora, la concentración de 24 horas será considerada, sólo para efectos de verificar el cumplimiento de la norma primaria de calidad de aire como concentración de 24 horas, si, al reemplazar por cero los datos que faltaren para completar el 75% requerido, la concentración de 24 horas fuere mayor o igual al valor de la norma.

Si se dispusiere de datos de concentración de 1 hora para 18, 19, 20, 21, 22 o 23 horas, la concentración de 24 horas se calculará como el promedio aritmético de los datos de concentración de 1 hora disponibles, utilizando como divisor 18, 19, 20, 21, 22 o 23, según corresponda.

Se considerará válida la concentración de una hora, si, a lo menos, se dispusiere de 30 minutos seguidos de medición.

Se considerará válido el percentil 99 de los máximos diarios de concentración de 1 hora registrados durante un año, si, a lo menos, el 75% de los datos de máximos diarios de concentración de 1 hora para el periodo de un año, se encontraren disponibles y dan cuenta de la variación de los datos a lo largo de un año (ciclo estacional).

Se considerará válida la concentración máxima diaria de 1 hora, si, a lo menos el 75% de los datos de concentración de 1 hora para un periodo de 24 horas se encontraren disponibles.

En el evento que se dispusiere de menos del 75% de los datos de concentración de 1 hora, la concentración máxima diaria de 1 hora será considerada, sólo para efectos de verificar el cumplimiento de la norma primaria de calidad de aire como concentración de 1 hora, si, la concentración máxima diaria de 1 hora fuere mayor o igual al nivel de la norma.

TITULO V

Fiscalización de la Norma

Artículo 11.- Corresponderá a los Servicios de Salud del país y, en la Región Metropolitana al Servicio de Salud Metropolitano del Ambiente, fiscalizar el cumplimiento de las disposiciones de la presente norma.

TITULO VI.

Implementación de la Norma

Artículo 12.-Los Servicios de Salud respectivos deberán dentro del plazo de seis meses, contados desde la publicación del presente decreto en el Diario Oficial determinar mediante resolución fundada aquellas estaciones monitoras que se considerarán como EMRPG.

Artículo 13.- Los Servicios de Salud respectivos deberán dentro del plazo de tres años, contados desde la publicación del presente decreto en el Diario Oficial, realizar un diagnóstico de la calidad de aire para dióxido de nitrógeno según sus competencias territoriales.

Dicho diagnóstico deberá considerar la información de calidad de aire disponible así como la que se genere a partir de organismos públicos y privados.

Los Servicios de Salud respectivos deberán dentro del plazo de dos años, contados desde que se disponga del diagnóstico, elaborar e implementar un programa priorizado de monitoreo para el seguimiento de la norma primaria de calidad de aire para dióxido de nitrógeno.

Dicho programa deberá ser revisado periódicamente en función de los nuevos antecedentes de calidad de aire de que se disponga, los cuales deberán incorporar la información tanto pública como privada.

Artículo 14.- El monitoreo de la calidad de aire según los métodos de medición señalados en los artículos octavo y noveno del presente decreto, deberá realizarse de acuerdo a las disposiciones establecidas por el Servicio de Salud respectivo, el que deberá considerar, cuando se encuentre disponible, lo que señale el manual de aplicación de la norma.

El manual de aplicación de la norma deberá ser elaborado por la Comisión Nacional del Medio Ambiente dentro del plazo de un año, contado desde la publicación del presente decreto en el Diario Oficial.

Artículo 15.- Los Servicios de Salud respectivos deberán tener a disposición de la ciudadanía, los datos de los niveles de concentración de calidad de aire para dióxido de nitrógeno correspondientes a la presente norma, los que serán públicos.

TITULO VII

Entrada en Vigencia

Artículo 16.- La presente norma entrará en vigencia a partir del día 1° del mes siguiente del de su publicación en el Diario Oficial quedando desde esa fecha sin efecto las normas primarias de calidad de aire para dióxido de nitrógeno vigentes a dicha fecha.

TITULO VIII

Artículos Transitorios

Artículo primero transitorio.- En el periodo comprendido desde la entrada en vigencia de la norma y hasta disponer de tres años sucesivos de mediciones, la norma primaria de calidad de aire para dióxido de nitrógeno como concentración anual o de 1 hora se considerará sobrepasada, si en el primer o segundo periodo de 12 meses y, al reemplazar la concentración anual o el percentil 99 de los máximos diarios de concentración de 1 hora para los periodos faltantes por cero, el promedio aritmético de los tres periodos resultare mayor o igual al nivel de la norma correspondiente.

Artículo segundo transitorio.- Las disposiciones contenidas en el presente decreto serán incorporadas en lo que corresponda en los planes de prevención o de descontaminación por dióxido de azufre que se encuentren vigentes o en trámite a la fecha de su entrada en vigencia, adelantando para estos efectos los plazos de revisión de dichos planes si fuere necesario.

ANÓTESE, TÓMESE RAZÓN Y PUBLÍQUESE.

RICARDO LAGOS ESCOBAR
Presidente de la República

ALVARO GARCÍA HURTADO
Ministro
Secretario General de la Presidencia

MICHELLE BACHELET JERIA
Ministra de Salud

REPUBLICA DE CHILE
COMISION NACIONAL DEL MEDIO AMBIENTE
ASR/PMC

ESTABLECE NORMA PRIMARIA DE CALIDAD DE AIRE PARA DIOXIDO DE AZUFRE (SO_2)

SANTIAGO,

VISTOS:

Lo dispuesto en el artículo 19 N° 8 de la Constitución Política; En el artículo 32 de la Ley 19.300; El Reglamento para la Dictación de Normas de Calidad Ambiental y de Emisión, aprobado por el Decreto Supremo N°93 de 1995, del Ministerio Secretaría General de la Presidencia; El Decreto Supremo N°185 de 1991, del Ministerio de Minería, que Reglamenta el Funcionamiento de los Establecimientos Emisores de Anhídrido Sulfuroso, Material Particulado y Arsénico en todo el Territorio de La Republica; La Resolución N°1215 de 1978 del Delegado del Gobierno en el Servicio Nacional de Salud, que establece normas sanitarias mínimas destinadas a prevenir y controlar la contaminación atmosférica; La Resolución Exenta N° 1514 de 1999, de la Dirección Ejecutiva de la Comisión Nacional del Medio Ambiente, que dio inicio al proceso de revisión de las normas primarias de calidad de aire para anhídrido sulfuroso (SO2); partículas totales en suspensión (PTS); monóxido de carbono (CO); ozono (03) y dióxido de nitrógeno (NO2) ; La Resolución Exenta N° 915 del 2000, de la Dirección Ejecutiva de la Comisión Nacional del Medio Ambiente, que aprobó el anteproyecto de revisión de la norma primaria de calidad de aire para anhídrido sulfuroso (SO2); El análisis general del impacto económico y social de la norma señalada; Las observaciones formuladas en la etapa de consulta al anteproyecto de norma; El acuerdo N°180 de 3 de mayo de 2001, del Consejo Directivo de la Comisión Nacional del Medio Ambiente, que aprobó el proyecto definitivo de la norma de calidad; Los demás antecedentes que obran en el expediente público respectivo y lo dispuesto en la Resolución N°520 de 1996, de la Contraloría General de la República que fija el texto refundido, coordinado y sistematizado de la Resolución N° 55 de 1992, de la Contraloría General de la República.

CONSIDERANDO:

Que de acuerdo con lo preceptuado en la Ley 19.300, es deber del Estado dictar y revisar normas para regular la presencia de contaminantes en el medio ambiente, de manera de prevenir que éstos puedan significar o representar, por sus niveles, concentraciones y periodos, un riesgo para la salud de las personas.

Que sobre la base de los antecedentes disponibles y que constan en el expediente público, se revisó la norma primaria de calidad de aire para anhídrido sulfuroso o dióxido de azufre (SO2), contenida en la Resolución 1215 de 1978, del Delegado del Gobierno en el Servicio Nacional de Salud y en el Decreto Supremo N°185 de 1991, del Ministerio de Minería, en conformidad al procedimiento y los contenidos establecidos en el Decreto Supremo N°93 de 1995, de Ministerio Secretaria General de la Presidencia.

Que el dióxido de azufre es un importante broncoconstrictor, desde los primeros minutos de exposición y su efecto aumenta con la actividad física, con la hiperventilación, al respirar aire frío y seco y en personas con hiperreactividad bronquial.

Que la exposición a este contaminante puede producir efectos agudos y crónicos sobre la salud de las personas.

Que el dióxido de azufre se origina de la combustión del azufre contenido en los combustibles fósiles (petróleos combustibles, gasolina, petróleo diesel, carbón, etc.), de la fundición de minerales que contienen azufre y de otros procesos industriales.

Que el dióxido de azufre puede presentar efectos adicionales a los de salud tales como efectos sobre la vegetación, ecosistemas y materiales expuestos a este contaminante.

Que el dióxido de azufre es un precursor de aerosoles secundarios.

Que a nivel nacional existen localidades con población expuesta a altas concentraciones de dióxido de azufre en el aire por periodos cortos de exposición, producto de las emisiones generadas por fuentes específicas. A objeto de estudiar los efectos que se producen en la salud de las personas, se requiere recopilar información sobre la incidencia y prevalencia de asmáticos y los niveles de concentración de calidad de aire para dióxido de azufre en periodos cortos de exposición.

DECRETO:

TITULO I

Disposiciones Generales y Definiciones

Artículo 1.- La presente norma de calidad ambiental tiene por objetivo proteger la salud de la población de aquellos efectos agudos y crónicos generados por la exposición a niveles de concentración de dióxido de azufre en el aire.

Artículo 2.- Para efectos de lo dispuesto en la presente norma, se entenderá por:

a. *ppbv*: Unidad de medida de concentración en volumen, correspondiente a una milésima parte por millón.

b. *Concentración de Dióxido de Azufre*: Valor promedio temporal detectado en el aire expresado en partes por billón (ppbv) o en microgramos por metro cúbico normal (ug/m3N).

   La condición normal corresponde a la presión de una atmósfera (1 atm.) y una temperatura de 25 grados Celcius (25°C).

c. *Concentración de 1 hora*: Promedio aritmético de los valores de concentración de dióxido de azufre medidos en una 1 hora.

d. *Concentración de 24 horas*: Promedio aritmético de los valores de concentración de 1 hora de dióxido de azufre correspondientes a un bloque de 24 horas sucesivas, contadas desde las cero horas de cada día.

e. *Concentración trimestral:* Promedio aritmético de los valores de concentración de 24 horas de dióxido de azufre correspondientes a un periodo de tres meses sucesivos.

f. *Concentración anual*: Promedio aritmético de los valores de concentración trimestral de dióxido de azufre correspondientes a un año.

g. *Año calendario:* Período que se inicia el 1° de enero y culmina el 31 de diciembre del mismo año.

h. *Estación monitora con representatividad poblacional para gas dióxido de azufre (EMRPG):* Una estación de monitoreo que se encuentra localizada en un área habitada.

Se entiende como área habitada, una porción del territorio donde vive habitual y permanentemente un conjunto de personas.

i. *Percentil*: Corresponde al valor "q" calculado a partir de valores de concentración aproximados al ppbv o ug/m3N más cercano. Todos los valores se anotarán en una lista establecida por orden creciente para cada estación de monitoreo.

$$X1 \leq X2 \leq X3 \ldots\leq Xk \leq X\,n-1 \leq Xn$$

El percentil será el valor del elemento de orden "k", para el que "k" se calculará por medio de la siguiente fórmula:

k = q X n , donde "q" = 0.99 para el Percentil 99, y "n" corresponde al número de datos de una serie. El valor "k" se aproximará al número entero más próximo.

TITULO II

Nivel de Norma de Calidad Primaria para Dióxido de Azufre en Aire

Artículo 3.- La norma primaria de calidad de aire para dióxido de azufre como concentración anual será de 31 ppbv (80 ug/m3N).

Se considerará sobrepasada la norma primaria de calidad de aire para dióxido de azufre como concentración anual, cuando el promedio aritmético de los valores de concentración anual de tres años calendarios sucesivos, en cualquier estación monitora EMRPG, fuere mayor o igual al nivel indicado en el inciso precedente.

Si el periodo de medición en una estación monitora EMRPG no comenzare el 1° de enero, se considerarán los tres primeros periodos de 12 meses a partir del mes de inicio de las mediciones hasta disponer de tres años calendarios sucesivos de mediciones.

Se considerará sobrepasada la norma primaria de calidad de aire para dióxido de azufre como concentración anual, si en el primer o segundo periodo de 12 meses a partir del mes de inicio de las mediciones y, al reemplazar la concentración anual para los periodos faltantes por cero, el promedio aritmético de los tres periodos resultare mayor o igual al nivel de la norma.

Artículo 4.- La norma primaria de calidad de aire para dióxido de azufre como concentración de 24 horas será de 96 ppbv (250 ug/m3N).

Se considerará sobrepasada la norma primaria de calidad de aire para dióxido de azufre como concentración de 24 horas, cuando el promedio aritmético de tres años sucesivos, del percentil 99 de las concentraciones de 24 horas registradas durante un año calendario, en cualquier estación monitora EMRPG, fuere mayor o igual al nivel indicado en el inciso precedente.

Si el periodo de medición en una estación monitora EMRPG no comenzare el 1° de enero, se considerarán los tres primeros periodos de 12 meses a partir del mes de inicio de las mediciones hasta disponer de tres años calendarios sucesivos de mediciones.

Se considerará sobrepasada la norma primaria de calidad de aire para dióxido de azufre como concentración de 24 horas, si en el primer o segundo periodo de 12 meses a partir del mes de inicio de las mediciones y, al reemplazar el percentil 99 de las concentraciones de 24 horas para los periodos faltantes por cero, el promedio aritmético de los tres periodos resultare mayor o igual al nivel de la norma.

Artículo 5.- Los siguientes niveles originarán situaciones de emergencia ambiental para dióxido de azufre, en concentración de una hora:

Nivel 1: 750 - 999 ppbv	(1.962 - 2.615 ug/m3N)
Nivel 2: 1.000 – 1.499 ppbv	(2.616 - 3.923 ug/m3N)
Nivel 3: 1.500 ppbv o superior	(3.924 ug/m3N o superior)

Los niveles que originan situaciones de emergencia ambiental para dióxido de azufre podrán ser obtenidos mediante la aplicación de una metodología de pronóstico de calidad de aire aprobada por el Servicio de Salud respectivo, o por medio de la constatación de las concentraciones del contaminante a partir de alguna de las estaciones monitoras de calidad de aire EMRPG.

Se podrá omitir o dejar sin efecto una situación de emergencia ambiental si se detectare un cambio en las condiciones meteorológicas en forma posterior a la hora de comunicación del pronóstico o a la constatación de la superación de los niveles de calidad de aire, y siempre que dicho cambio asegure una mejoría tal en las condiciones de calidad de aire que invalide los resultados entregados por el pronóstico o que asegure la reducción de los niveles de concentración de calidad de aire por debajo de aquellos que originan situaciones de emergencia ambiental.

Artículo 6.- Para efectos de evaluar el cumplimiento de la norma y los valores que originan situaciones de emergencia ambiental se utilizarán los valores de concentración expresados en ppbv.

Artículo 7.- Cuando el dióxido de azufre fuese precursor de otro contaminante normado, los planes de descontaminación o prevención que se establezcan para el control de este contaminante, podrán incluir medidas de reducción de emisiones del contaminante dióxido de azufre, independientemente del cumplimiento de las normas de calidad de aire que esta norma establece.

TITULO III

Metodología de Medición de la Norma

Artículo 8.- La medición de la concentración de dióxido de azufre en el aire se realizará mediante uno cualesquiera de los siguientes métodos de medición:

a. Fluorescencia ultravioleta;
b. Espectrometría de absorción diferencial con calibración in – situ y,
c. Un método de medición de referencia o equivalente designado o aprobado por la Agencia de Protección Ambiental de los Estados Unidos o por las Directivas de la Comunidad Europea.

El monitoreo de calidad de aire deberá realizarse con instrumentos que cumplen con los métodos de medición señalados en el inciso anterior y que hayan sido reconocidos.

aprobados o certificados por la Agencia de Protección Ambiental de los Estados Unidos o por las Directivas de la Comunidad Europea.

Artículo 9.- Para efectos de cumplir con lo establecido en el artículo 13, podrán utilizarse técnicas de medición alternativas a las señaladas en el artículo precedente, las que deberán ser aprobadas por el Servicio de Salud respectivo. Para el monitoreo mediante estas técnicas se deberá considerar lo establecido en la letra (h) del artículo 2 del presente decreto.

TITULO IV

Validación de la Información de Monitoreo de Calidad de Aire

Artículo 10.- Se considerará válida la concentración anual, si para cada uno de los trimestres de un año, se dispusiere de a lo menos un 75% de los datos de concentración de 24 horas para ese periodo.

Se considerará válido el percentil 99 de las concentraciones de 24 horas registradas en un año , si, a lo menos, el 75% de los datos de concentración de 24 horas para el periodo de un año, se encontraren disponibles y dan cuenta de la variación de los datos a lo largo de un año (ciclo estacional).

Se considerará válida la concentración de 24 horas, si, a lo menos, el 75% de los datos de concentración de 1 hora para un periodo de 24 horas, se encontraren disponibles y dan cuenta de la variación de los datos a lo largo de un día (ciclo diario).

En el evento de que se dispusiere de menos del 75% de los datos de concentración de 1 hora, la concentración de 24 horas será considerada, sólo para efectos de verificar el cumplimiento de la norma primaria de calidad de aire como concentración de 24 horas, si, al reemplazar por cero los datos que faltaren para completar el 75% requerido, la concentración de 24 horas fuere mayor o igual al valor de la norma.

Si se dispusiere de datos de concentración de 1 hora para 18, 19, 20, 21, 22 o 23 horas, la concentración de 24 horas se calculará como el promedio aritmético de los datos de concentración de 1 hora disponibles, utilizando como divisor 18, 19, 20, 21, 22 o 23, según corresponda.

Se considerará válida la concentración de 1 hora, si, a lo menos, se dispusiere de 30 minutos sucesivos de medición.

TITULO V

Fiscalización de la Norma

Artículo 11.- Corresponderá a los Servicios de Salud del país y, en la Región Metropolitana al Servicio de Salud Metropolitano del Ambiente, fiscalizar el cumplimiento de las disposiciones de la presente norma.

TITULO VI

Implementación de la Norma

Artículo 12.-Los Servicios de Salud respectivos deberán dentro del plazo de seis meses, contados desde la publicación del presente decreto en el Diario Oficial, determinar mediante resolución fundada aquellas estaciones monitoras que se considerarán como EMRPG.

Artículo 13.- Los Servicios de Salud respectivos deberán dentro del plazo de tres años, contados desde la publicación del presente decreto en el Diario Oficial, realizar un diagnóstico de la calidad de aire para dióxido de azufre según sus competencias territoriales.

Dicho diagnóstico deberá considerar la información de calidad de aire disponible así como la que se genere a partir de organismos públicos y privados.

Los Servicios de Salud respectivos deberán dentro del plazo de dos años, contados desde que se disponga del diagnóstico, elaborar e implementar un programa priorizado de monitoreo para el seguimiento de la norma primaria de calidad de aire para dióxido de azufre.

Dicho programa deberá ser revisado periódicamente en función de los nuevos antecedentes de calidad de aire de que se disponga, los cuales deberán incorporar la información tanto pública como privada.

Artículo 14.- El monitoreo de la calidad de aire según los métodos de medición señalados en los artículos octavo y noveno del presente decreto, deberá realizarse de acuerdo a las disposiciones establecidas por el Servicio de Salud respectivo, el que deberá considerar, cuando se encuentre disponible, lo que señale el manual de aplicación de la norma.

El manual de aplicación de la norma deberá ser elaborado por la Comisión Nacional del Medio Ambiente dentro del plazo de un año contado desde la publicación de presente decreto en el Diario Oficial.

Artículo 15.- Los Servicios de Salud respectivos deberán tener a disposición de la ciudadanía, los datos de los niveles de concentración de calidad de aire para dióxido de azufre correspondientes a la presente norma, los que serán públicos.

TITULO VII

Generación de Antecedentes para la Regulación de Efectos Agudos

Artículo 16.- Los Servicios de Salud respectivos deberán en forma sistemática recopilar la siguiente información:

- Niveles de concentración de calidad de aire para dióxido de azufre como concentración de 5 minutos y una hora, a partir del monitoreo de la calidad de aire de dióxido de azufre.

- Incidencia y prevalencia de asma, en especial en aquellas localidades en las que existe población expuesta a altos niveles de concentración de dióxido de azufre en periodos cortos de exposición.

TITULO VIII

Entrada en Vigencia

Artículo 17.- La presente norma de calidad ambiental entrará en vigencia a partir del día primero del mes siguiente al de su publicación en el Diario Oficial, quedando desde esa fecha sin efecto las normas primarias de calidad de aire para dióxido de azufre o anhídrido sulfuroso vigentes a esa fecha.

Artículos Transitorios

Artículo primero transitorio.- En el periodo comprendido desde la entrada en vigencia de la norma y hasta disponer de tres años sucesivos de mediciones, la norma primaria de calidad de aire para dióxido de azufre como concentración anual o de 24 horas se considerará sobrepasada, si en el primer o segundo periodo de 12 meses y, al reemplazar la concentración anual o el percentil 99 de las concentraciones de 24 horas para los periodos faltantes por cero, el promedio aritmético de los tres periodos resultare mayor o igual al nivel de la norma correspondiente.

Artículo segundo transitorio.- Las disposiciones contenidas en la presente norma serán incorporadas, en lo que corresponda, en los planes de prevención o de descontaminación por dióxido de azufre que se encuentren vigentes o en trámite a la fecha de su entrada en vigencia, adelantando para estos efectos los plazos de revisión de dichos planes si fuere necesario.

ANÓTESE, TÓMESE RAZÓN Y PUBLÍQUESE.

RICARDO LAGOS ESCOBAR
Presidente de la República

ALVARO GARCÍA HURTADO
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MICHELLE BACHELET JERIA
Ministra de Salud

REPUBLICA DE CHILE
Ministerio
Secretaría General de la Presidencia de la República

DEJA SIN EFECTO NORMA PRIMARIA DE CALIDAD DE AIRE PARA PARTICULAS TOTALES EN SUSPENSION (PTS)

SANTIAGO,

VISTOS:

Lo dispuesto en el artículo 19 N° 8 de la Constitución Política; En el artículo 32 de la Ley 19.300; El Reglamento para la Dictación de Normas de Calidad Ambiental y de Emisión, aprobado por el Decreto Supremo N°93 de 1995, del Ministerio Secretaría General de la Presidencia; La Resolución N°1215 de 1978 del Delegado del Gobierno en el Servicio Nacional de Salud, que establece normas sanitarias mínimas destinadas a prevenir y controlar la contaminación atmosférica; La Resolución Exenta N° 1514 de 1999, de la Dirección Ejecutiva de la Comisión Nacional del Medio Ambiente, que dio inicio al proceso de revisión de las normas primarias de calidad de aire para anhídrido sulfuroso (SO2); partículas totales en suspensión (PTS); monóxido de carbono (CO); ozono (03) y dióxido de nitrógeno (NO2) ; La Resolución Exenta N° 916 del 2000, de la Dirección Ejecutiva de la Comisión Nacional del Medio Ambiente, que aprobó el anteproyecto de revisión de la norma primaria de calidad de aire para anhídrido sulfuroso (SO2); El análisis general del impacto económico y social de la norma señalada; Las observaciones formuladas en la etapa de consulta al anteproyecto de norma; El acuerdo N°180 de 3 de mayo de 2001, del Consejo Directivo de la Comisión Nacional del Medio Ambiente, que aprobó el proyecto definitivo de la norma de calidad; los demás antecedentes que obran en el expediente público respectivo y lo dispuesto en la Resolución N°520 de 1996, de la Contraloría General de la República que fija el texto refundido, coordinado y sistematizado de la Resolución N° 55 de 1992, de la Contraloría General de la República.

CONSIDERANDO

Que de acuerdo con lo preceptuado en la Ley 19.300, es deber del Estado dictar normas para regular la presencia de contaminantes en el medio ambiente, de manera de prevenir que estos puedan significar o representar, por sus niveles, concentraciones y periodos, un riesgo para la salud de las personas.

Que sobre la base de los antecedentes disponibles y que constan en el expediente público, se revisó la norma primaria de calidad de aire para partículas totales en suspensión (PTS), contenida en la Resolución 1215 de 1978, del Delegado del Gobierno en el Servicio Nacional de Salud, en conformidad al procedimiento y los contenidos establecidos en el Decreto Supremo N°93 de 1995, de Ministerio Secretaria General de la Presidencia.

Que históricamente se consideró que todas las partículas suspendidas en el aire (PTS) afectaban la salud de las personas de la misma forma. Sin embargo, recientemente se ha demostrado que las partículas que más la afectan son aquellas con un diámetro aerodinámico menor a 10 um. (MP10) y más aún, aquellas con diámetro aerodinámico menor a 2.5 um. (MP2.5).

Que la fracción del PTS mayor a 10 micrones corresponde a partículas no respirables. Estas se depositan en la traquea y son limpiadas por los cilios a través de la formación de mucus y expulsadas a través de la tos o de la deglución.

Que el documento de guías globales de calidad del aire de la Organización Mundial de la Salud (OMS) sostiene que no puede establecerse un nivel umbral para los efectos del material particulado en la salud, por lo que las guías para material particulado son representadas por asociaciones estadísticamente significativas entre el incremento en los efectos observados y el incremento de las concentraciones, específicamente de MP10 y MP2.5. No estableciéndose ningún tipo de guía para aquella fracción mayor a 10 micrones.

Que no se cuenta con una evaluación de riesgo que evidencie relación entre la exposición a PTS y en particular a los compuestos tóxicos contenidos en éste y la ocurrencia de alguna enfermedad.

Que en Chile, se regulan los efectos en salud generados por la fracción respirable del material particulado inferior a 10 micrones, a través de una norma primaria de calidad de aire para material particulado respirable (MP10) como concentración de 24 horas.

DECRETO:

Artículo Único.- Déjase sin efecto la norma primaria de calidad de aire para partículas totales en suspensión (PTS) contenida en la Resolución N°1215 de 1978, del Delegado del Gobierno en el Servicio Nacional de Salud.

ANÓTESE, TÓMESE RAZÓN Y PUBLÍQUESE.

RICARDO LAGOS ESCOBAR
Presidente de la República

ALVARO GARCÍA HURTADO
Ministro
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MICHELLE BACHELET JERIA
Ministra de Salud

V. DE LA APLICACION DE MEDIDAS POR SUPERACION DE LOS NIVELES QUE DEFINEN SITUACIONES DE EMERGENCIA AMBIENTAL PARA MATERIAL PARTICULADO RESPIRABLE MP10.

Artículo 9º Las medidas particulares asociadas a cada uno de los niveles definidos en el artículo anterior, serán determinadas en el plan operacional para enfrentar episodios críticos de contaminación, contenido en el respectivo plan de descontaminación.

VI. CONTROL DE EPISODIOS CRITICOS DE LA CONTAMINACION POR MATERIAL PARTICULADO RESPIRABLE MP10

Artículo 10º Corresponderá a las Comisiones Regionales del Medio Ambiente (COREMA) la coordinación de los distintos servicios públicos en la gestión de los episodios críticos de contaminación, en la forma definida en el respectivo Plan. Cuando se vea afectada más de una región, la coordinación la realizará la Comisión Nacional del Medio Ambiente.

La información recabada por los distintos organismos públicos respecto a las materias contenidas en esta norma, se entregará a las autoridades o instituciones con competencia en materia ambiental, a las personas u organizaciones que lo soliciten y, en general, será puesta a disposición de la comunidad.

VII. FISCALIZACION DE LA NORMA

Artículo 11º Corresponderá a los Servicios de Salud del país y, en la Región Metropolitana al Servicio de Salud del Ambiente de la Región Metropolitana, fiscalizar el cumplimiento de las disposiciones de la presente norma.

VIII. VIGENCIA

Artículo 12º La presente norma entrará en vigencia 15 días después de su publicación en el Diario Oficial.

IX. DEROGACIONES O MODIFICACIONES

Artículo 13º Modifícanse a contar de la fecha de vigencia de esta norma las siguientes disposiciones en la forma que a continuación se indica:

1º Decreto Supremo Nº 185 de 1991 del Ministerio de Minería:

a) En el artículo 3º, suprímase en la letra b) la frase "o de material particulado".

b) En el artículo 4º, suprímanse las frases "material particulado respirable" y "Material particulado respirable: Ciento cincuenta microgramos por metro cúbico normal (150 µg/Nm3) como concentración media aritmética diaria, y".

c) En el artículo 9º, suprímase en el inciso 3º la frase "o de material particulado".

d) En el artículo 35º.

d.1.- suprímase en la letra a) el siguiente párrafo: "-Para material particulado respirable: Muestreador gravimétrico de alto volumen equipado con cabezal PM-10".

d.2.- elimínese la letra b), pasando la actual letra c) a ser la nueva b), y modifíquese la ordenación correlativa.

2º Resolución exenta Nº369, de 1988, del Ministerio de Salud:

a.- Elimínese el punto 2.-

b.- En el punto 3.- reeemplácese la frase "Tanto el ICA como el ICAP darán origen", por la siguiente: "El ICA dará origen".

3º Toda norma, resolución o disposición anterior en la parte que fuere contraria o incompatible con las disposiciones señaladas en esta norma.

X. ARTICULOS TRANSITORIOS

Artículo 1º Transitorio Las disposiciones contenidas en esta norma serán incorporadas en lo que corresponda a los planes de prevención o descontaminación por material particulado que se encuentren vigentes o en trámite a la fecha de su entrada en vigencia, adelantando para estos efectos los plazos de revisión de dichos planes si fuere necesario.

En el caso de que exista una diferencia en cuanto a la denominación de los distintos niveles de episodios críticos, se entenderán modificados por esta norma sin necesidad de revisión posterior.

En cualquier caso, el uso de la metodología de pronóstico establecida en esta norma estará sujeta a la oficialización de su aplicación concreta para un caso particular.

Artículo 2º Transitorio Para la primera aplicación de la metodología de pronóstico contemplada en esta norma que se establezca para una zona determinada, se observarán las siguientes condiciones:

a) se podrá utilizar una metodología de pronóstico cuya confiabilidad en al menos el 66% de las estaciones de monitoreo clasificadas como EMRP para material particulado respirable MP10 y a utilizar en la metodología de pronóstico, sea mayor que 65%, y

b) que todas las estaciones de monitoreo clasificadas como EMRP para material particulado respirable MP10 y a utilizar en la metodología de pronóstico cumplan con una confiabilidad mayor que 50%.

Las condiciones indicadas en este artículo sólo podrán utilizarse siempre que dicha aplicación sea implementada dentro de los 180 días siguientes a la entrada en vigencia de esta norma.

Anótese, tómese razón, comuníquese y archívese.- EDUARDO FREI RUIZ-TAGLE, Presidente de la República.- Juan Villarzú Rohde, Ministro Secretario General de la Presidencia.- Alex Figueroa Muñoz, Ministro de Salud.

Lo que transcribo a Ud. para su conocimiento.- Saluda Atte. a Ud., Carlos Carmona Santander, Subsecretario (S) General de la Presidencia de la República.

CONTRALORIA GENERAL DE LA REPUBLICA

División Jurídica

Cursa con alcance el decreto Nº 59, de 1998, del Ministerio Secretaría General de la Presidencia de la República

Núm. 17.670.- Santiago, 19 de Mayo de 1998.-

La Contraloría General ha dado curso regular al documento del rubro, mediante el cual se establece la norma primaria de calidad ambiental para material particulado respirable MP10, por cuanto se ajusta a derecho.

Sin perjuicio de lo anterior, cumple con hacer presente que la referencia que se hace en su artículo 9º al "artículo anterior" debe -de conformidad con los antecedentes adjuntos y el contexto de las disposiciones correspondientes- entenderse efectuada al artículo 3º del mismo acto administrativo.

Con el alcance que precede se ha tomado razón del decreto individualizado en el epígrafe.

Dios guarde a US.- Arturo Aylwin Azócar, Contralor General de la República.

Al señor
Ministro Secretario General
de la Presidencia de la República
PRESENTE

OTRAS ENTIDADES

Banco Central de Chile

TIPOS DE CAMBIO Y PARIDADES DE MONEDAS EXTRANJERAS PARA EFECTOS DEL NUMERO 6 DEL CAPITULO I DEL TITULO I DEL COMPENDIO DE NORMAS DE CAMBIOS INTERNACIONALES Y CAPITULO II.B.3. DEL COMPENDIO DE NORMAS FINANCIERAS AL 25 DE MAYO DE 1998

	Tipo de Cambio $ (Nº 6 del C.N.C.I.)	Paridad Respecto US$
Dólar EE.UU. *	453,70	1,000000
Dólar Canadá	313,70	1,446300
Dólar Australia	286,70	1,582500
Dólar Neozelandés	243,05	1,866700
Libra Esterlina	740,86	0,612400
Marco Alemán	258,34	1,756200
Yen Japonés	3,35	135,625900
Franco Francés	77,08	5,886400
Franco Suizo	310,10	1,463100
Franco Belga	12,53	36,217500
Florín Holandés	229,29	1,978700
Lira Italiana	0,26	1729,942400
Corona Danesa	67,81	6,690400
Corona Noruega	61,11	7,423900
Corona Sueca	59,31	7,649900
Peseta	3,04	149,167100
Renminby	54,80	8,279600
Schilling Austria	36,72	12,354400
Markka	84,89	5,344500
ECU	508,52	0,892200
DEG	609,78	0,744038

* Tipo de cambio que rige para efectos del Capítulo II.B.3. Sistemas de reajustabilidad autorizados por el Banco Central de Chile (Acuerdo Nº 05-07-900105) del Compendio de Normas Financieras.

Santiago, Mayo 22 de 1998.- Miguel Angel Nacrur Gazali, Ministro de Fe.

TIPO DE CAMBIO PARA EFECTOS DEL NUMERO 7 DEL CAPITULO I DEL TITULO I DEL COMPENDIO DE NORMAS DE CAMBIOS INTERNACIONALES

El tipo de cambio "dólar acuerdo" (a que se refiere el inciso primero del Nº 7 del Capítulo I, Título I del Compendio de Normas de Cambios Internacionales), fue de $470,62 por dólar, moneda de los Estados Unidos de América, para el día 22 de mayo de 1998.- Miguel Angel Nacrur Gazali, Ministro de Fe.

ACUERDO ADOPTADO POR EL CONSEJO DEL BANCO CENTRAL DE CHILE EN SU SESION Nº 677

Certifico que el Consejo del Banco Central de Chile en su Sesión Nº 677, celebrada el 20 de mayo de 1998, adoptó el siguiente Acuerdo:

677-04-980520 - Modifica Capítulo XXVI del Título I del Compendio de Normas de Cambios Internacionales.

Se acordó efectuar las siguientes modificaciones en el Capítulo XXVI del Título I del Compendio de Normas de Cambios Internacionales:

1.- Agregar el siguiente párrafo al final del inciso primero del numeral 10.1:

"Asimismo, podrán acogerse a lo dispuesto en este numeral 10.1, las acciones que personas domiciliadas y residentes en el extranjero adquieran directamente de la Sociedad Receptora, con ocasión del ejercicio del derecho de suscripción preferente adquirido a accionistas, para suscribir acciones de pago, conforme lo previsto en el numeral 13.1 de este Capítulo."

2.- Reemplazar el inciso segundo del numeral 10.1 por los siguientes:

"En los casos señalados precedentemente, los inversionistas deberán efectuar el ingreso del capital necesario para adquirir las pertinentes acciones y para pagar los gastos e impuestos correspondientes a su adquisición, entendiéndose que tienen la calidad de parte en la Convención aludida en este Capítulo, siempre que efectúen el respectivo ingreso en la forma dispuesta en los incisos segundo y tercero del numeral 4.1 anterior indicando, adicionalmente: "Nº 10 del Capítulo XXVI".

En el evento que se trate de acciones que deban ser adquiridas a través de las Bolsas o directamente de la Sociedad Receptora, en virtud del ejercicio del derecho de suscripción preferente, los inversionistas deberán acreditar, ante la Gerencia de División Internacional, que con el producto de la liquidación de tal capital, han procedido a adquirir, dentro del plazo de 5 días hábiles bancarios contados desde la liquidación, las respectivas acciones."

3.- Reemplazar el numeral 13.1 por el siguiente:

"Deberán acogerse a la o las Convenciones vigentes, las acciones correspondientes a aumentos de capital que, en uso del derecho de suscripción preferente, adquieran, a través de la Empresa Bancaria, los titulares de ADRs o sus cesionarios de la respectiva opción, siempre que sean personas domiciliadas y residentes en el extranjero; o los titulares, también personas domiciliadas y residentes en el extranjero, de

(4)

3) Agrégase al artículo 2° los siguientes incisos 4°, 5° y final, nuevos:

"A contar del día 1° de enero del año 2012, la norma primaria de calidad del aire para el contaminante Material Particulado Respirable MP10, será de ciento veinte microgramos por metro cúbico normal (120 μg/m3N) como concentración de 24 horas, salvo que a dicha fecha haya entrado en vigencia una norma de calidad ambiental para Material Particulado Fino MP2,5, en cuyo caso se mantendrá el valor de la norma establecido en el inciso primero.

La norma primaria de calidad del aire para el contaminante Material Particulado Respirable MP10, es cincuenta microgramos por metro cúbico normal (50 ug/m3N) como concentración anual.

Se considerará sobrepasada la norma primaria anual de calidad del aire para material particulado respirable MP10, cuando la concentración anual calculada como promedio aritmético de tres años calendario consecutivos en cualquier estación monitora clasificada como EMRP, sea mayor o igual que 50 ug/m3, si correspondiere de acuerdo a lo que se indica en el punto IV. Metodologías de Pronóstico y Medición".

4) Agrégase al artículo 7°, los siguientes incisos:

"Los datos que, sobre la base de información objetiva verificada por el Servicio de Salud respectivo, sean el resultado de fenómenos excepcionales y transitorios que afecten la representatividad temporal y/o espacial de la muestra, no se incluirán en las mediciones a considerar para los efectos de entender verificada la condición que hace procedente la declaración de una zona como latente o saturada.

Se considerará como valor de concentración anual válido, aquel determinado a partir de mediciones realizadas durante a lo menos 11 meses del año calendario. En caso que durante un año calendario se disponga de mediciones para más de 8 y menos de 11 meses, para completar el período mínimo señalado, se considerará como valor mensual de cada mes faltante, la concentración mensual más alta medida en los 12 meses anteriores a cada mes faltante. Si se dispone de valores sólo para 8 o menos meses, no se podrá calcular un valor de concentración anual para la estación de monitoreo correspondiente.".

5) Agrégase a continuación del artículo 7°, el siguiente artículo 7° bis:

"Artículo 7° bis: Para efectos de determinar los lugares prioritarios dentro del país, en que se deberá instalar redes de monitoreo a fin de evaluar el cumplimiento de la presente norma, deberán considerarse los siguientes antecedentes, en el siguiente orden de importancia:

a) Composición química del Material Particulado Respirable MP10, en términos de su toxicidad, a la que está expuesta la población y la cantidad de población urbana expuesta en la zona en estudio;

b) Valores absolutos de concentraciones de Material Particulado Respirable MP10 medido, y tendencias históricas, positivas o negativas, de dichos valores;

c) Presencia de desarrollos industriales significativos que produzcan un impacto por emisiones de material particulado respirable sobre la zona en estudio y volumen del parque automotor existente en la zona en estudio.".

6) Intercálase el siguiente Título X, nuevo, pasando el actual a ser Título XI:

"X. Sistema de Vigilancia Epidemiológica de los efectos en salud de la contaminación atmosférica

Artículo 14°.- Los Servicios de Salud, que el Ministerio de Salud determine, deberán establecer un procedimiento sistemático que permita evaluar, en períodos de 5 años, la efectividad de los niveles fijados en la presente norma en relación a la prevención de efectos crónicos en la salud de la población, priorizando aquellas zonas del país en que exista mayor concentración poblacional.

Artículo segundo: Sólo podrán declararse zonas saturadas o latentes en virtud de la norma anual de Material Particulado Respirable MP10, a partir de la información que se genere a contar del 1° de enero siguiente a la entrada en vigencia del presente decreto.

Artículo tercero: El presente decreto entrará en vigencia el primer día del mes subsiguiente a su publicación en el Diario Oficial.

Anótese, tómese razón y publíquese.- RICARDO LAGOS ESCOBAR, Presidente de la República.- Alvaro García Hurtado, Ministro Secretario General de la Presidencia.- Michelle Bachelet Jeria, Ministra de Salud.

Lo que transcribo a Ud. para su conocimiento.- Saluda atte. a Ud., Eduardo Dockendorff Vallejos, Subsecretario General de la Presidencia de la República.

OTRAS ENTIDADES

Banco Central de Chile

TIPOS DE CAMBIO Y PARIDADES DE MONEDAS EXTRANJERAS PARA EFECTOS DEL NUMERO 6 DEL CAPITULO I DEL COMPENDIO DE NORMAS DE CAMBIOS INTERNACIONALES Y CAPITULO II.B.3. DEL COMPENDIO DE NORMAS FINANCIERAS AL 11 DE SEPTIEMBRE DE 2001

	Tipo de Cambio $ (Nº6 del C.N.C.I.)	Paridad Respecto US$
Dólar EE.UU. *	667,34	1,000000
Dólar Canadá	427,15	1,562300
Dólar Australia	343,02	1,945500
Dólar Neozelandés	287,82	2,318600
Libra Esterlina	973,37	0,685600
Marco Alemán	306,92	2,174300
Yen Japonés	5,52	120,930000
Franco Francés	91,51	7,292300
Franco Suizo	396,07	1,684900
Franco Belga	14,88	44,845900
Florín Holandés	272,39	2,449900
Lira Italiana	0,31	2152,551400
Corona Danesa	80,73	8,266500
Corona Noruega	75,15	8,880500
Corona Sueca	62,80	10,625900
Peseta	3,61	184,971300
Yuan	80,63	8,276800
Schilling Austria	43,62	15,297300
Markka	100,96	6,609900
Euro	600,29	1,111700
DEG	855,15	0,780378

* Tipo de cambio que rige para efectos del Capítulo II.B.3. Sistemas de reajustabilidad autorizados por el Banco Central de Chile (Acuerdo Nº 05-07-900105) del Compendio de Normas Financieras.

Santiago, septiembre 10de 2001.- Miguel Angel Nacrur Gazali, Ministro de Fe.

TIPO DE CAMBIO PARA EFECTOS DEL NUMERO 7 DEL CAPITULO I DEL COMPENDIO DE NORMAS DE CAMBIOS INTERNACIONALES

El tipo de cambio "dólar acuerdo" (a que se refiere el inciso primero del Nº 7 del Capítulo I del Compendio de Normas de Cambios Internacionales), fue de $538,32 por dólar, moneda de los Estados Unidos de América, para el día 10 de septiembre de 2001.- Miguel Angel Nacrur Gazali, Ministro de Fe.

Normas Particulares

Ministerio del Interior

SUBSECRETARIA DEL INTERIOR

Intendencia Región Metropolitana

AUTORIZA A FUNDACION MARIA JESUS VERGARA ARTHUR PARA EFECTUAR COLECTA PUBLICA

(Resolución)

Núm. 1.354 exenta.- Santiago, 20 de agosto de 2001.- Vistos: Lo solicitado por la entidad denominada Fundación María Jesús Vergara Arthur, mediante presentaciones de 14.05.01, 10.07.01, y 08.08.01; lo dispuesto en el D.S. Nº 955 de 1974 de Interior, y sus modificaciones, Art. 2° de la ley Nº 19.175 y resolución Nº 55/92 de la Contraloría General de la República,

Resuelvo:

1.- Autorízase a la Fundación María Jesús Vergara Arthur, para efectuar una colecta pública el día 16 de octubre del 2001, en la Región Metropolitana.

2.- Los fondos recaudados serán destinados a mantener la casa de acogida denominada "Hogar de la Familia", el cual recibe niños enfermos de cáncer de escasos recursos.

3.- La colecta estará a cargo de las siguientes personas:

María Carolina de la Maza Ugarte	C.I. 7.014.354-0
María Isabel Riveros Guzmán	C.I. 5.718.093-5
Katia Gabriela Solar Riveros	C.I. 8.321.796-0

4.- Las erogaciones sólo podrán recibirse en alcancías numeradas y controladas por esta Intendencia.

5.- La Fundación María Jesús Vergara Arthur, deberá remitir a la Intendencia Regional Acta de Apertura de las Alcancías, su número y recaudación, conjuntamente con un informe de la inversión de los recursos dentro del plazo de 60 días, contado desde la fecha de realización de la colecta. Además, adjuntará un listado con el nombre completo y Rol Unico Nacional de todas las personas que colaboraron en la recepción de las erogaciones.

6.- La entidad recurrente, debe dar cumplimiento a las disposiciones que establece el D.S. Nº 955 de 1974.

Anótese, comuníquese y publíquese.- Por orden del Presidente de la República, Sergio Galilea Ocon, Intendente Región Metropolitana.- Monserrat Otayza Rojas, Ministro de Fe.

Ministerio de Economía, Fomento y Reconstrucción

SUBSECRETARIA DE ECONOMIA, FOMENTO Y RECONSTRUCCION

Departamento de Propiedad Industrial

Solicitudes de Registro de Marcas

Solicitud 530.356.- **LITTLEFEET, INC., EST**
DOS UNIDOS DE AMERICA.- Etiqueta: Producto
CLASE 9 TODOS LOS PRODUCTOS DE LA CLAS
ETIQUETA CONSISTENTE EN FIGURA ESTILIZAI
DE PIE, EN COLOR NEGRO SOBRE FONDO BLANC

Solicitud 530.357.- **LITTLEFEET, INC., EST**
DOS UNIDOS DE AMERICA.- Etiqueta: Servicios: CL
SE 42 SERVICIOS DE CONSULTORIA EN EL CAM
DE INSTALACION Y OPERACION DE SISTEMA
REDES DE TELECOMUNICACIONES; SERVICIOS
DESARROLLO E INGENIERIA EN DISEÑO DE SER
CIOS DE PROCESAMIENTO DE TELECOMUNIC
CIONES E INFORMACION, DE INSTALACIONE
FACILIDADES Y DE REDES DE TELECOMUNICAC
NES; SERVICIOS DE INGENIERIA EN DISEÑO
SISTEMAS Y REDES DE TELECOMUNICACIONE
SUS PARTES; SERVICIOS DE DESARROLLO Y GE
RACION PARA OTROS DE APARATOS E INST
MENTOS DE TELECOMUNICACIONES, DISPOS
VOS Y REDES; SERVICIOS DE LEASING DE APA
TOS E INSTRUMENTOS DE TELECOMUNICAC
NES, DISPOSITIVOS Y REDES. ETIQUETA CON
TENTE EN FIGURA ESTILIZADA DE PIE, EN CO
NEGRO SOBRE FONDO BLANCO.

Solicitud 530.385.-**WHITE AMBER, INC., SO**
DAD ORGANIZADA BAJO LAS LEYES DEL EST
DE DELAWARE, ESTADOS UNIDOS DE AMERI
Etiqueta: Servicios: CLASE 35 PROPORCIONAR SE
CIOS DE INFORMACION EN LINEA PARA OT
REFERENTE A LA ADQUISICION Y ADMINIS
CION DE EMPLEADOS PERMANENTES Y TEMPO
LES; SERVICIOS DE CONSULTORIA PARA OT
RELACIONADOS CON LA ADQUISICION Y A
NISTRACION DE EMPLEADOS PERMANENT
TEMPORALES.- ETIQUETA CONSISTENTE EN I
ÑO COMPUESTO POR CIRCULO DE BORDE NE
SOBRE EL CUAL SE APRECIA CUADRADO DE BO
NEGRO EN CUYO INTERIOR SE APRECIAN DOS T
GULOS RECTANGULOS, UNO APOYADO EN EL
SUPERIOR DEL CUADRADO, CUYO ANGULO R
APUNTA HACIA ABAJO PERO FUE ELIMINADO
SU LUGAR SE APRECIA CURVA CONCAVA,
OTRO APOYADO EN LADO INFERIOR DEL CUA
DO CUYO ANGULO RECTO APUNTA HACIA AI
PERO FUE ELIMINADO Y EN SU LUGAR SE AP
CURVA CONVEXA, TODO DIVIDIDO POR LINE
GRA VERTICAL SOBRE FONDO BLANCO.

Solicitud 536.583.- **DERMO PHARM**
CHILE.- Etiqueta: Productos: CLASE 3 TODO
PRODUCTOS DE LA CLASE. ETIQUETA CONS
TE EN UNA ESFERA AZUL CIRCUNSCRITA
ELEMENTO TRIANGULAR AMARILLO DE CO
NOS IRREGULARES, CUYA BASE SE ENCU
ADOSADA A UNA CINTA ONDULANTE DE
ROSADO.

Solicitud 536.584.- **DERMO PHARM**
CHILE.- Etiqueta: Productos: CLASE 5 TODO
PRODUCTOS DE LA CLASE. ETIQUETA CONS
TE EN UNA ESFERA AZUL CIRCUNSCRITA
ELEMENTO TRIANGULAR AMARILLO D
TORNOS IRREGULARES, CUYA BASE SE EN
TRA ADOSADA A UNA CINTA ONDULAN
COLOR ROSADO.

1.- Ley Nº 19.669 (D.O. 05.05.2000), art. 4º, Nº 1, letra a), modifica inciso como aparece en el texto.
2.- Ley Nº 19.669 (D.O. 05.05.2000), art. 4º, Nº 1, letra b), sustituye "20%" por "30%" y expresión "exclusivamente" por "preferentemente".
3.- Ley Nº 19.478 (D.O. 24.10.96), art. 1º, letra a), Nº 1, sustituye "al uso habitación" por "a oficinas o al uso habitacional".
4.- Ley Nº 19.478 (D.O. 24.10.96), art. 1º, letra a), Nº 2, agrega al final del inciso "a excepción de aquellos vehículos especiales fuera de carretera con maquinaria montada".
5.- Ley Nº 19.669 (D.O. 05.05.2000), art. 4º, Nº 1, letra c), sustituye "1998" por "2007" y "2020" por "2030".
6.- Ley Nº 19.669 (D.O. 05.05.2000), art. 4º, Nº 1, letra d), agrega inciso final nuevo que aparece en el texto.
7.- Ley Nº 19.478 (D.O. 24.10.96), art. 1º, letra b), sustituye "precedente" por "primero".
8.- Ley Nº 19.478 (D.O. 24.10.96), art. 1º, letra c), reemplaza expresión "de lavado de dinero y narcotráfico" por las palabras "contemplados en la ley Nº 19.366".
9.- Ley Nº 19.478 (D.O. 24.10.1996), art. 1º, letra d), sustituye expresión "administrados" por "administradores".
10.- Ley Nº 19.669 (D.O. 05.05.2000), art. 4º, Nº 2, sustituye expresión "materias primas, partes y piezas" por vocablo "mercancías".
11.- Ley Nº 19.478 (D.O. 24.10.96), art. 1º, letra e), elimina expresión "o nacionalizadas".
12.- Ley Nº 19.669 (D.O. 05.05.2000), art. 4º, Nº 3, sustituye expresión "materias primas, partes y piezas" por "mercancías", las tres veces que aparece.
13.- Ley Nº 19.669 (D.O. 05.05.2000), art. 4º, Nº 3, sustituye expresión "materias primas, partes y piezas" por "mercancías", las tres veces que aparece.
14.- Ley Nº 19.669 (D.O. 05.05.2000), art. 4º, Nº 4, sustituye expresión "estará exenta" por "estará permitida y exenta".
15.- Ley Nº 19.669 (D.O. 05.05.2000), art. 4º, Nº 5, letras a), b). Letra a) sustituye en inciso primero "75", que fue rebajado a "50" por D.F.L. Nº 3, de Hacienda, de 1996, por "15". Letra b) agrega en el inciso primero, a continuación del punto aparte ( ), que pasa a ser punto seguido, la frase que comienza: "Para efectos de ...".
16.- Ley Nº 19.669 (D.O. 05.05.2000), art. 4º, Nº 5, letra c), suprime el inciso segundo de este artículo. Este inciso contenía la facultad que dio origen al D.F.L. Nº 3, de Hacienda, de 1996.
17.- Ley Nº 19.669 (D.O. 05.05.2000), art. 4º, Nº 6, agrega a continuación de la palabra "Arica", la siguiente oración que comienza: "y las que actualmente conforman ...".
18.- Ley Nº 19.669 (D.O. 05.05.2000), art. 4º, Nº 7, suprime el inciso segundo de este artículo. Ese inciso señalaba que se exceptuaban de dicho artículo las tierras ubicadas dentro de los diez kilómetros medidos desde la frontera.
19.- Ley Nº 19.478 (D.O. 24.10.96), art. 1º, letra g), reemplaza el ordinal "8º" por el ordinal "7".
20.- Ley Nº 19.478 (D.O. 24.10.96), art. 1º, letra h). Sustituye en esta letra a), mediante el cual se modifica el artículo 1º de la ley Nº 19.288, los términos "el Aeropuerto Arturo Merino Benítez de Santiago y en el Aeropuerto Internacional de Chacalluta de Arica" por la frase los Aeropuertos Internacionales Arturo Merino Benítez de Santiago, Chacalluta de Arica y Diego Aracena de Iquique".
21.- Ley Nº 19.669 (D.O. 05.05.2000), art. 4º, Nº 8, sustituye la expresión "será de US$9.000,00" por la frase "y de las franquicias del artículo 35 de la ley Nº 13.039, será de US$9.000,00 el que se incrementará en un 15% para accesorios opcionales".
22.- Ley Nº 19.669 (D.O. 05.05.2000), art. 4º, Nº 9, agrega el artículo 35 nuevo que aparece en el texto.
23.- Ley Nº 19.669 (D.O. 05.05.2000), art. 4º, Nº 9, agrega el artículo 36 nuevo que aparece en el texto.
24.- Ley Nº 19.669 (D.O. 05.05.2000), art. 4º, Nº 9, agrega el artículo 37 nuevo que aparece en el texto.

Nota 1.- El art. 3º transitorio de la ley Nº 19.669 dispone que las modificaciones introducidas al presente artículo regirán desde el 1º de enero del año 2000.

Nota 2.- Ver decreto supremo Nº 1.046, de 1998, del Ministerio de Hacienda (D.O. 01.09.98), prorrogó plazo hasta el 31 de diciembre de 1999.

Nota 3.- La ley Nº 19.606 (D.O. 14.04.99), art. 14, modificó el inciso 7º y suprime el inciso 8º, del art. 36 del decreto ley Nº 825, de 1974.

Nota 4.- El art. 4º transitorio de la ley Nº 19.669, dispone que el valor de US$9.000, se reajustará, por primera vez, a partir del 1º de julio del año 2000, en la forma prevista en este art. 32.

Nota 5.- El art. 2º de la ley Nº 19.478 (D.O. 24.10.96), declaró, interpretando el real sentido y alcance del art. 34 de la ley Nº 19.420, que el cabotaje a que se refiere esta disposición es exclusivamente el realizado por naves de marinas mercantes extranjeras.

AUTORIZA AL SERVICIO DE TESORERIAS A EMITIR PAGARES EXPRESADOS EN UNIDADES DE FOMENTO

Núm. 795.- Santiago, 8 de agosto de 2001.- Vistos: El artículo 32 Nº 8 de la Constitución Política de la República de Chile; el artículo 70 del decreto ley Nº 1.263, de 1975, Ley Orgánica de Administración Financiera del Estado; artículo 2º del decreto con fuerza de ley Nº 1, de 1994, del Ministerio de Hacienda, Ley Orgánica del Servicio de Tesorerías; la ley Nº 19.568 y la ley 19.702, sobre Presupuesto del Sector Público del año 2001.

Considerando: Que la Ley de Presupuesto del Sector Público del año 2001, dispuso en la partida 50 del Tesoro Público-Fisco, Operaciones Complementarias, que los pagarés reajustables de Tesorería con que se documenten las cuotas, por concepto de indemnización determinadas conforme a la ley Nº 19.568, se expresarán en unidades de fomento, y que los ya emitidos y expresados en unidades tributarias, podrán ser sustituidos por su equivalente en dicha unidad de fomento.

Teniendo presente: El artículo 32 Nº 8 de la Constitución Política de la República de Chile y la glosa 07 del programa 03 de la Partida 50 Tesoro Público,

Decreto:

Autorízase al Tesorero General de la República para emitir o sustituir los pagarés reajustables de Tesorerías, ya emitidos y no vencidos expresados en unidades tributarias mensuales, por pagarés reajustables de Tesorerías expresados en unidades de fomento, previa solicitud del interesado.

Tómese razón, comuníquese y publíquese.- Por orden del Presidente de la República, Nicolás Eyzaguirre Guzmán, Ministro de Hacienda.

Lo que transcribo a Ud. para su conocimiento.- Saluda atentamente a Ud., María Eugenia Wagner Brizzi, Subsecretaria de Hacienda.

Ministerio Secretaría General de la Presidencia

MODIFICA DECRETO Nº 59, DE 1998, QUE ESTABLECE LA NORMA DE CALIDAD PRIMARIA PARA MATERIAL PARTICULADO RESPIRABLE MP10

Núm. 45.- Santiago, 23 de marzo de 2001.- Vistos: Lo establecido en la Constitución Política de la República, en sus artículos 19 Nº 8 y 32 Nº 8; lo dispuesto en la ley 19.300; el decreto supremo Nº 93, de 1995, del Ministerio Secretaría General de la Presidencia, Reglamento para la Dictación de Normas de Calidad Ambiental y de Emisión; el acuerdo Nº 80/98 del Consejo Directivo de la Comisión Nacional del Medio Ambiente, de fecha 8 de agosto de 1998, que aprobó la revisión de la Norma de Calidad Primaria para Material Particulado Respirable MP10, establecida por el decreto supremo Nº 59, de 1998, del Ministerio Secretaría General de la Presidencia; la resolución exenta Nº 129, de 16 de febrero de 1999, del Director Ejecutivo de la Comisión Nacional del Medio Ambiente, publicada en el Diario Oficial de 22 de febrero de 1999 y en el diario La Nación, el día 19 de febrero de 1999, que dio inicio al proceso de revisión de la norma de emisión; la resolución exenta Nº 867, del Director Ejecutivo de la Comisión Nacional del Medio Ambiente, de 22 de julio de 1999, que aprobó el anteproyecto de revisión de la norma de calidad, cuyo extracto se publicó en el Diario Oficial de 2 de agosto de 1999 y en el diario La Nación, el día 8 de agosto del mismo año; los estudios científicos, el análisis general del impacto económico y social de la misma; las observaciones formuladas al anteproyecto de revisión de la norma en la etapa de consulta; el análisis de las observaciones señaladas; la opinión del Consejo Consultivo de la Comisión Nacional del Medio Ambiente, de fecha 16 de diciembre de 1999; el acuerdo Nº 162, de 28 de julio de 2000, del Consejo Directivo de la Comisión Nacional del Medio Ambiente, que aprobó el proyecto definitivo de revisión de la norma de calidad; los demás antecedentes que obran en el expediente público respectivo, y lo dispuesto en la resolución Nº 520, de 1996, de la Contraloría General de la República, y

Considerando:

1) Que para la regulación integral del contaminante denominado Material Particulado Respirable MP10, es necesario considerar los efectos crónicos de este contaminante en la salud de las personas.

Al efecto, debe considerarse que el riesgo de ocurrencia de enfermedades crónicas y de cáncer aumenta cuando existe exposición prolongada a partículas de menor diámetro y más tóxicas y que los procesos de combustión generan material particulado con tales características.

En consecuencia, se hace necesario normar las exposiciones prolongadas (anual) a este contaminante.

2) Que, por otra parte, es conveniente aplicar conceptos de Vigilancia Epidemiológica para el seguimiento de los resultados de la aplicación de la norma de emisión en la salud de la población.

La Vigilancia Epidemiológica es un diseño metodológico objetivo, que permite conocer y cuantificar durante distintos períodos del año los efectos en la salud de la población, de la contaminación atmosférica.

3) Que, adicionalmente, es necesario explicitar una relación entre el Material Particulado Respirable MP10 y el Material Particulado Fino MP2.5.

En este ámbito, estudios epidemiológicos recientes han demostrado una relación más directa y categórica entre los efectos sobre la salud de comunidades expuestas a la presencia de Material Particulado Fino MP2,5, que en el caso del Material Particulado Respirable MP10. Esto, en todo caso, no descarta el efecto que sobre la salud produce el Material Particulado Respirable MP10, motivación para tener en Chile una norma anual para este contaminante.

4) Que, por último, resulta aconsejable efectuar algunos ajustes técnicos a la norma revisada, de modo de considerar la variable del entorno de las estaciones de monitoreo existentes al momento de la fiscalización de la norma.

Decreto:

Artículo primero: Modifícase el decreto supremo Nº 59, de 1998, del Ministerio Secretaría General de la Presidencia, que establece la Norma de Calidad Primaria para Material Particulado Respirable MP10, en especial de los valores que definen situaciones de emergencia, en la siguiente forma:

1) Agrégase a la letra f) del artículo 1º, el siguiente inciso final:

"En caso que una estación de monitoreo no cumpla con los criterios ii) o iii) señalados precedentemente, el Servicio de Salud respectivo podrá igualmente clasificarla como EMRP si existen antecedentes de que dicho incumplimiento no genera interferencia en la calidad de la información aportada por el monitoreo. Para tal efecto, se deberán tomar en consideración aspectos tales como el bajo flujo vehicular en calles o avenidas, el material del que están construidas las calles o avenidas, o bien, la operación esporádica y/o circunstancial de fuentes fijas como las indicadas.".

2) Agrégase al artículo 1º las siguientes definiciones:

"k) Efectos crónicos: aquellos producidos por la acción de concentraciones variables de contaminantes durante períodos prolongados de exposición. Se manifiestan por un aumento de la incidencia y la gravedad de enfermedades tales como asma bronquial, bronquitis obstructiva crónica, enfisema pulmonar y cáncer.

l) Concentración mensual: media aritmética de los valores efectivamente medidos de concentración de 24 horas en cada estación monitora, en un mes calendario. Sólo se considerará como valor de concentración mensual válido, aquel que resulte de al menos el 75% de las mediciones programadas para el mes, de acuerdo a la periodicidad de monitoreo previamente definida.

m) Concentración anual: media aritmética de los valores de concentración mensual en cada estación monitora, en un año calendario.

n) Año calendario: período que se inicia el 1º de enero y culmina el 31 de diciembre del mismo año.

ñ) Mes calendario: período que se inicia el día 1º de un mes y culmina el día anterior al día 1º del mes siguiente.

o) Material particulado fino MP2,5: Material particulado con diámetro aerodinámico menor o igual que 2,5 micrones.

p) Vigilancia epidemiológica: Diseño metodológico que permite conocer y cuantificar durante distintos períodos del año, los efectos de la contaminación atmosférica en la salud de la población.".

REPUBLICA DE CHILE
COMISION NACIONAL DEL MEDIO AMBIENTE
ASR/PMC

001310

ESTABLECE NORMA PRIMARIA DE CALIDAD DE AIRE PARA DIOXIDO DE AZUFRE (SO_2)

SANTIAGO,

VISTOS:

Lo dispuesto en el artículo 19 N° 8 de la Constitución Política; En el artículo 32 de la Ley 19.300; El Reglamento para la Dictación de Normas de Calidad Ambiental y de Emisión, aprobado por el Decreto Supremo N°93 de 1995, del Ministerio Secretaría General de la Presidencia; El Decreto Supremo N°185 de 1991, del Ministerio de Minería, que Reglamenta el Funcionamiento de los Establecimientos Emisores de Anhídrido Sulfuroso, Material Particulado y Arsénico en todo el Territorio de La Republica; La Resolución N°1215 de 1978 del Delegado del Gobierno en el Servicio Nacional de Salud, que establece normas sanitarias mínimas destinadas a prevenir y controlar la contaminación atmosférica; La Resolución Exenta N° 1514 de 1999, de la Dirección Ejecutiva de la Comisión Nacional del Medio Ambiente, que dio inicio al proceso de revisión de las normas primarias de calidad de aire para anhídrido sulfuroso (SO2); partículas totales en suspensión (PTS); monóxido de carbono (CO); ozono (03) y dióxido de nitrógeno (NO2) ; La Resolución Exenta N° 915 del 2000, de la Dirección Ejecutiva de la Comisión Nacional del Medio Ambiente, que aprobó el anteproyecto de revisión de la norma primaria de calidad de aire para anhídrido sulfuroso (SO2); El análisis general del impacto económico y social de la norma señalada; Las observaciones formuladas en la etapa de consulta al anteproyecto de norma; El acuerdo N°180 de 3 de mayo de 2001, del Consejo Directivo de la Comisión Nacional del Medio Ambiente, que aprobó el proyecto definitivo de la norma de calidad; Los demás antecedentes que obran en el expediente público respectivo y lo dispuesto en la Resolución N°520 de 1996, de la Contraloría General de la República que fija el texto refundido, coordinado y sistematizado de la Resolución N° 55 de 1992, de la Contraloría General de la República.

CONSIDERANDO:

Que de acuerdo con lo preceptuado en la Ley 19.300, es deber del Estado dictar y revisar normas para regular la presencia de contaminantes en el medio ambiente, de manera de prevenir que éstos puedan significar o representar, por sus niveles, concentraciones y periodos, un riesgo para la salud de las personas.

Que sobre la base de los antecedentes disponibles y que constan en el expediente público, se revisó la norma primaria de calidad de aire para anhídrido sulfuroso o dióxido de azufre (SO2), contenida en la Resolución 1215 de 1978, del Delegado del Gobierno en el Servicio Nacional de Salud y en el Decreto Supremo N°185 de 1991, del Ministerio de Minería, en conformidad al procedimiento y los contenidos establecidos en el Decreto Supremo N°93 de 1995, de Ministerio Secretaria General de la Presidencia.

Que el dióxido de azufre es un importante broncoconstrictor, desde los primeros minutos de exposición y su efecto aumenta con la actividad física, con la hiperventilación, al respirar aire frío y seco y en personas con hiperreactividad bronquial.

Que la exposición a este contaminante puede producir efectos agudos y crónicos sobre la salud de las personas.

Que el dióxido de azufre se origina de la combustión del azufre contenido en los combustibles fósiles (petróleos combustibles, gasolina, petróleo diesel, carbón, etc.), de la fundición de minerales que contienen azufre y de otros procesos industriales.

Que el dióxido de azufre puede presentar efectos adicionales a los de salud tales como efectos sobre la vegetación, ecosistemas y materiales expuestos a este contaminante.

Que el dióxido de azufre es un precursor de aerosoles secundarios.

Que a nivel nacional existen localidades con población expuesta a altas concentraciones de dióxido de azufre en el aire por periodos cortos de exposición, producto de las emisiones generadas por fuentes específicas. A objeto de estudiar los efectos que se producen en la salud de las personas, se requiere recopilar información sobre la incidencia y prevalencia de asmáticos y los niveles de concentración de calidad de aire para dióxido de azufre en periodos cortos de exposición.

DECRETO:

TITULO I

Disposiciones Generales y Definiciones

Artículo 1.- La presente norma de calidad ambiental tiene por objetivo proteger la salud de la población de aquellos efectos agudos y crónicos generados por la exposición a niveles de concentración de dióxido de azufre en el aire.

Artículo 2.- Para efectos de lo dispuesto en la presente norma, se entenderá por:

a. *ppbv*: Unidad de medida de concentración en volumen, correspondiente a una milésima parte por millón.

b. *Concentración de Dióxido de Azufre*: Valor promedio temporal detectado en el aire expresado en partes por billón (ppbv) o en microgramos por metro cúbico normal (ug/m3N).

   La condición normal corresponde a la presión de una atmósfera (1 atm.) y una temperatura de 25 grados Celcius (25°C).

c. *Concentración de 1 hora*: Promedio aritmético de los valores de concentración de dióxido de azufre medidos en una 1 hora.

d. *Concentración de 24 horas*: Promedio aritmético de los valores de concentración de 1 hora de dióxido de azufre correspondientes a un bloque de 24 horas sucesivas, contadas desde las cero horas de cada día.

e. *Concentración trimestral:* Promedio aritmético de los valores de concentración de 24 horas de dióxido de azufre correspondientes a un periodo de tres meses sucesivos.

f. *Concentración anual*: Promedio aritmético de los valores de concentración trimestral de dióxido de azufre correspondientes a un año.

g. *Año calendario:* Período que se inicia el 1º de enero y culmina el 31 de diciembre del mismo año.

h. *Estación monitora con representatividad poblacional para gas dióxido de azufre (EMRPG):* Una estación de monitoreo que se encuentra localizada en un área habitada.

Se entiende como área habitada, una porción del territorio donde vive habitual y permanentemente un conjunto de personas.

i. *Percentil*: Corresponde al valor "q" calculado a partir de valores de concentración aproximados al ppbv o ug/m3N más cercano. Todos los valores se anotarán en una lista establecida por orden creciente para cada estación de monitoreo.

$$X1 \leq X2 \leq X3 \ldots \leq Xk \leq X\,n - 1 \leq Xn$$

El percentil será el valor del elemento de orden "k", para el que "k" se calculará por medio de la siguiente fórmula:

k = q X n , donde "q" = 0.99 para el Percentil 99, y "n" corresponde al número de datos de una serie. El valor "k" se aproximará al número entero más próximo.

TITULO II

Nivel de Norma de Calidad Primaria para Dióxido de Azufre en Aire

Artículo 3.- La norma primaria de calidad de aire para dióxido de azufre como concentración anual será de 31 ppbv (80 ug/m3N).

Se considerará sobrepasada la norma primaria de calidad de aire para dióxido de azufre como concentración anual, cuando el promedio aritmético de los valores de concentración anual de tres años calendarios sucesivos, en cualquier estación monitora EMRPG, fuere mayor o igual al nivel indicado en el inciso precedente.

Si el periodo de medición en una estación monitora EMRPG no comenzare el 1° de enero, se considerarán los tres primeros periodos de 12 meses a partir del mes de inicio de las mediciones hasta disponer de tres años calendarios sucesivos de mediciones.

Se considerará sobrepasada la norma primaria de calidad de aire para dióxido de azufre como concentración anual, si en el primer o segundo periodo de 12 meses a partir del mes de inicio de las mediciones y, al reemplazar la concentración anual para los periodos faltantes por cero, el promedio aritmético de los tres periodos resultare mayor o igual al nivel de la norma.

Artículo 4.- La norma primaria de calidad de aire para dióxido de azufre como concentración de 24 horas será de 96 ppbv (250 ug/m3N).

Se considerará sobrepasada la norma primaria de calidad de aire para dióxido de azufre como concentración de 24 horas, cuando el promedio aritmético de tres años sucesivos, del percentil 99 de las concentraciones de 24 horas registradas durante un año calendario, en cualquier estación monitora EMRPG, fuere mayor o igual al nivel indicado en el inciso precedente.

Si el periodo de medición en una estación monitora EMRPG no comenzare el 1° de enero, se considerarán los tres primeros periodos de 12 meses a partir del mes de inicio de las mediciones hasta disponer de tres años calendarios sucesivos de mediciones.

Se considerará sobrepasada la norma primaria de calidad de aire para dióxido de azufre como concentración de 24 horas, si en el primer o segundo periodo de 12 meses a partir del mes de inicio de las mediciones y, al reemplazar el percentil 99 de las concentraciones de 24 horas para los periodos faltantes por cero, el promedio aritmético de los tres periodos resultare mayor o igual al nivel de la norma.

Artículo 5.- Los siguientes niveles originarán situaciones de emergencia ambiental para dióxido de azufre, en concentración de una hora:

Nivel 1: 750 - 999 ppbv	(1.962 - 2.615 ug/m3N)
Nivel 2: 1.000 – 1.499 ppbv	(2.616 - 3.923 ug/m3N)
Nivel 3: 1.500 ppbv o superior	(3.924 ug/m3N o superior)

Los niveles que originan situaciones de emergencia ambiental para dióxido de azufre podrán ser obtenidos mediante la aplicación de una metodología de pronóstico de calidad de aire aprobada por el Servicio de Salud respectivo, o por medio de la constatación de las concentraciones del contaminante a partir de alguna de las estaciones monitoras de calidad de aire EMRPG.

Se podrá omitir o dejar sin efecto una situación de emergencia ambiental si se detectare un cambio en las condiciones meteorológicas en forma posterior a la hora de comunicación del pronóstico o a la constatación de la superación de los niveles de calidad de aire, y siempre que dicho cambio asegure una mejoría tal en las condiciones de calidad de aire que invalide los resultados entregados por el pronóstico o que asegure la reducción de los niveles de concentración de calidad de aire por debajo de aquellos que originan situaciones de emergencia ambiental.

Artículo 6.- Para efectos de evaluar el cumplimiento de la norma y los valores que originan situaciones de emergencia ambiental se utilizarán los valores de concentración expresados en ppbv.

Artículo 7.- Cuando el dióxido de azufre fuese precursor de otro contaminante normado, los planes de descontaminación o prevención que se establezcan para el control de este contaminante, podrán incluir medidas de reducción de emisiones del contaminante dióxido de azufre, independientemente del cumplimiento de las normas de calidad de aire que esta norma establece.

TITULO III

Metodología de Medición de la Norma

Artículo 8.- La medición de la concentración de dióxido de azufre en el aire se realizará mediante uno cualesquiera de los siguientes métodos de medición:

a. Fluorescencia ultravioleta;
b. Espectrometría de absorción diferencial con calibración in – situ y,
c. Un método de medición de referencia o equivalente designado o aprobado por la Agencia de Protección Ambiental de los Estados Unidos o por las Directivas de la Comunidad Europea.

El monitoreo de calidad de aire deberá realizarse con instrumentos que cumplen con los métodos de medición señalados en el inciso anterior y que hayan sido reconocidos, aprobados o certificados por la Agencia de Protección Ambiental de los Estados Unidos o por las Directivas de la Comunidad Europea.

Artículo 9.- Para efectos de cumplir con lo establecido en el artículo 13, podrán utilizarse técnicas de medición alternativas a las señaladas en el artículo precedente, las que deberán ser aprobadas por el Servicio de Salud respectivo. Para el monitoreo mediante estas técnicas se deberá considerar lo establecido en la letra (h) del artículo 2 del presente decreto.

TITULO IV

Validación de la Información de Monitoreo de Calidad de Aire

Artículo 10.- Se considerará válida la concentración anual, si para cada uno de los trimestres de un año, se dispusiere de a lo menos un 75% de los datos de concentración de 24 horas para ese periodo.

Se considerará válido el percentil 99 de las concentraciones de 24 horas registradas en un año , si, a lo menos, el 75% de los datos de concentración de 24 horas para el periodo de un año, se encontraren disponibles y dan cuenta de la variación de los datos a lo largo de un año (ciclo estacional).

Se considerará válida la concentración de 24 horas, si, a lo menos, el 75% de los datos de concentración de 1 hora para un periodo de 24 horas, se encontraren disponibles y dan cuenta de la variación de los datos a lo largo de un día (ciclo diario).

En el evento de que se dispusiere de menos del 75% de los datos de concentración de 1 hora, la concentración de 24 horas será considerada, sólo para efectos de verificar el cumplimiento de la norma primaria de calidad de aire como concentración de 24 horas, si, al reemplazar por cero los datos que faltaren para completar el 75% requerido, la concentración de 24 horas fuere mayor o igual al valor de la norma.

Si se dispusiere de datos de concentración de 1 hora para 18, 19, 20, 21, 22 o 23 horas, la concentración de 24 horas se calculará como el promedio aritmético de los datos de concentración de 1 hora disponibles, utilizando como divisor 18, 19, 20, 21, 22 o 23, según corresponda.

Se considerará válida la concentración de 1 hora, si, a lo menos, se dispusiere de 30 minutos sucesivos de medición.

TITULO V

Fiscalización de la Norma

Artículo 11.- Corresponderá a los Servicios de Salud del país y, en la Región Metropolitana al Servicio de Salud Metropolitano del Ambiente, fiscalizar el cumplimiento de las disposiciones de la presente norma.

TITULO VI

Implementación de la Norma

Artículo 12.-Los Servicios de Salud respectivos deberán dentro del plazo de seis meses, contados desde la publicación del presente decreto en el Diario Oficial, determinar mediante resolución fundada aquellas estaciones monitoras que se considerarán como EMRPG.

Artículo 13.- Los Servicios de Salud respectivos deberán dentro del plazo de tres años, contados desde la publicación del presente decreto en el Diario Oficial, realizar un diagnóstico de la calidad de aire para dióxido de azufre según sus competencias territoriales.

Dicho diagnóstico deberá considerar la información de calidad de aire disponible así como la que se genere a partir de organismos públicos y privados.

Los Servicios de Salud respectivos deberán dentro del plazo de dos años, contados desde que se disponga del diagnóstico, elaborar e implementar un programa priorizado de monitoreo para el seguimiento de la norma primaria de calidad de aire para dióxido de azufre.

Dicho programa deberá ser revisado periódicamente en función de los nuevos antecedentes de calidad de aire de que se disponga, los cuales deberán incorporar la información tanto pública como privada.

Artículo 14.- El monitoreo de la calidad de aire según los métodos de medición señalados en los artículos octavo y noveno del presente decreto, deberá realizarse de acuerdo a las disposiciones establecidas por el Servicio de Salud respectivo, el que deberá considerar, cuando se encuentre disponible, lo que señale el manual de aplicación de la norma.

El manual de aplicación de la norma deberá ser elaborado por la Comisión Nacional del Medio Ambiente dentro del plazo de un año contado desde la publicación de presente decreto en el Diario Oficial.

Artículo 15.- Los Servicios de Salud respectivos deberán tener a disposición de la ciudadanía, los datos de los niveles de concentración de calidad de aire para dióxido de azufre correspondientes a la presente norma, los que serán públicos.

TITULO VII

Generación de Antecedentes para la Regulación de Efectos Agudos

Artículo 16.- Los Servicios de Salud respectivos deberán en forma sistemática recopilar la siguiente información:

- Niveles de concentración de calidad de aire para dióxido de azufre como concentración de 5 minutos y una hora, a partir del monitoreo de la calidad de aire de dióxido de azufre.

- Incidencia y prevalencia de asma, en especial en aquellas localidades en las que existe población expuesta a altos niveles de concentración de dióxido de azufre en periodos cortos de exposición.

TITULO VIII

Entrada en Vigencia

Artículo 17.- La presente norma de calidad ambiental entrará en vigencia a partir del día primero del mes siguiente al de su publicación en el Diario Oficial, quedando desde esa fecha sin efecto las normas primarias de calidad de aire para dióxido de azufre o anhídrido sulfuroso vigentes a esa fecha.

Artículos Transitorios

Artículo primero transitorio.- En el periodo comprendido desde la entrada en vigencia de la norma y hasta disponer de tres años sucesivos de mediciones, la norma primaria de calidad de aire para dióxido de azufre como concentración anual o de 24 horas se considerará sobrepasada, si en el primer o segundo periodo de 12 meses y, al reemplazar la concentración anual o el percentil 99 de las concentraciones de 24 horas para los periodos faltantes por cero, el promedio aritmético de los tres periodos resultare mayor o igual al nivel de la norma correspondiente.

Artículo segundo transitorio.- Las disposiciones contenidas en la presente norma serán incorporadas, en lo que corresponda, en los planes de prevención o de descontaminación por dióxido de azufre que se encuentren vigentes o en trámite a la fecha de su entrada en vigencia, adelantando para estos efectos los plazos de revisión de dichos planes si fuere necesario.

ANÓTESE, TÓMESE RAZÓN Y PUBLÍQUESE.

RICARDO LAGOS ESCOBAR
Presidente de la República

ALVARO GARCÍA HURTADO
Ministro
Secretario General de la Presidencia

MICHELLE BACHELET JERIA
Ministra de Salud

AGREGAR.

1- CRITERIOS OBJETIVOS PARA METODOLOGÍA DE DIAGNÓSTICO.

2- PUBLICACIÓN EN EL DIARIO OFICIAL EN EXTRACTO.

ARTÍCULO 12: PARA EL DECRETO,

3- MAYOR ASESORÍA TÉCNICA DE LA CONAMA.

4- MAYOR EXPERIENCIA [illegible].

5- [illegible]

[illegible]

6- [illegible]

5)

- Publicación extracto Diario Nacional.
- Programa priorizado.

001317

REPUBLICA DE CHILE
Ministerio
Secretaría General de la Presidencia de la República

/08

ESTABLECE NORMA PRIMARIA DE CALIDAD DE AIRE PARA OZONO (O_3)

SANTIAGO,

VISTOS:

Lo dispuesto en el artículo 19 N° 8 de la Constitución Política; En el artículo 32 de la Ley 19.300; El Reglamento para la Dictación de Normas de Calidad Ambiental y de Emisión, aprobado por el Decreto Supremo N°93 de 1995, del Ministerio Secretaría General de la Presidencia; La Resolución N°1215 de 1978 del Delegado del Gobierno en el Servicio Nacional de Salud, que establece normas sanitarias mínimas destinadas a prevenir y controlar la contaminación atmosférica; La Resolución Exenta N° 1514 de 1999, de la Dirección Ejecutiva de la Comisión Nacional del Medio Ambiente, que dio inicio al proceso de revisión de las normas primarias de calidad de aire para anhídrido sulfuroso (SO_2); partículas totales en suspensión (PTS); monóxido de carbono (CO); ozono (03) y dióxido de nitrógeno (NO_2) ; La Resolución Exenta N° 913 del 2000, de la Dirección Ejecutiva de la Comisión Nacional del Medio Ambiente, que aprobó el anteproyecto de revisión de la norma primaria de calidad de aire para anhídrido sulfuroso (SO_2); El análisis general del impacto económico y social de la norma señalada; Las observaciones formuladas en la etapa de consulta al anteproyecto de norma; El acuerdo N°180 de 3 de mayo de 2001, del Consejo Directivo de la Comisión Nacional del Medio Ambiente, que aprobó el proyecto definitivo de la norma de calidad; los demás antecedentes que obran en el expediente público respectivo y lo dispuesto en la Resolución N°520 de 1996, de la Contraloría General de la República que fija el texto refundido, coordinado y sistematizado de la Resolución N° 55 de 1992, de la Contraloría General de la República.

CONSIDERANDO

Que, de acuerdo con lo preceptuado en la ley 19.300, es deber del Estado dictar normas para regular la presencia de contaminantes en el medio ambiente, de manera de prevenir que estos puedan significar o representar, por sus niveles, concentraciones y periodos, un riesgo para la salud de las personas.

Que sobre la base a los antecedentes disponibles y que constan en el expediente, se revisó la norma primaria de calidad de aire para ozono (O_3), contenida en la Resolución 1215 de 1978, del Delegado del Gobierno en el Servicio Nacional de Salud, en conformidad al procedimiento y los contenidos establecidos en el Decreto Supremo N°93 de 1995, de Ministerio Secretaria General de la Presidencia.

Que el ozono es un fotooxidante que se produce en la tropósfera por efecto de la oxidación de monóxido de carbono e hidrocarburos en presencia de óxidos de nitrógeno y luz solar. De este modo, los hidrocarburos, el monóxido de carbono y los óxidos de nitrógeno constituyen precursores en la formación de ozono.

Que las características dañinas del ozono en la salud de la población se originan en su gran capacidad oxidante que lo hace reaccionar con toda clase de sustancias orgánicas.

Que el ozono puede penetrar los tejidos de la región pulmonar pero la dosis máxima de contaminante la recibe las regiones bronquiales y alveolares.

Que los efectos típicos del ozono en la salud son cambios en la función pulmonar que van precedidos por irritación de ojos y síntomas del pecho y de las vías respiratorias en poblaciones sensibles.

Que respecto de lo anterior la Organización Mundial de la Salud (OMS) indica que en el caso del ozono, "los problemas de salud de mayor preocupación son: aumento en las admisiones hospitalarias, exacerbación del asma, inflamaciones pulmonares y alteraciones estructurales del pulmón" .

Que la OMS y la Agencia de Protección Ambiental de los Estados Unidos, señalan que los efectos del ozono sobre la salud de la población se pueden asociar claramente con exposiciones de una duración de 6 a 8 horas y que son estadísticamente significativos.

Que el ozono puede presentar efectos adicionales a los de salud tales como efectos sobre los vegetación, ecosistemas y materiales expuestos a este contaminante.

DECRETO

TITULO I

Disposiciones Generales y Definiciones

Artículo 1.- La presente norma de calidad ambiental tiene por objetivo proteger la salud de la población de aquellos efectos agudos generados por la exposición a niveles de concentración de ozono en el aire.

Artículo 2.-Para efectos de lo dispuesto en la presente norma, se entenderá por:

a. *ppbv:* Unidad de medida de concentración en volumen, correspondiente a una milésima parte por millón.

b. *Concentración de Ozono*: Valor promedio temporal detectado en el aire expresado en partes por billón (ppbv) o en microgramos por metro cúbico normal (ug/m3N).

   La condición normal corresponde a la presión de una atmósfera (1 atm.) y una temperatura de 25 grados Celcius (25°C).

c. *Concentración de 8-Horas*: Promedio aritmético de los valores de concentración de 1 hora de ozono correspondientes a 8 horas sucesivas, promedio móvil.

d. *Año calendario:* Periodo que se inicia el 1° de enero y culmina el 31 de diciembre del mismo año.

e. *Estación de monitoreo con representatividad poblacional para gas ozono (EMRPG):* Una estación de monitoreo que se encuentra localizada en un área habitada.

   Se entiende como área habitada, una porción del territorio donde vive habitual y permanentemente un conjunto de personas.

f. *Percentil:* Corresponde al valor "q" calculado a partir de valores de concentración aproximados al ppvb o ug/m3N más cercano. Todos los valores se anotarán en una lista establecida por orden creciente para cada estación de monitoreo.

$$X1 \leq X2 \leq X3 \ldots. \leq Xk \leq X\,n-1 \leq Xn$$

El percentil será el valor del elemento de orden "k", para el que "k" se calculará por medio de la siguiente fórmula:

k = q X n , donde "q" = 0.99 para el Percentil 99, y "n" corresponde al número de datos de una serie. El valor "k" se aproximará al número entero más próximo

TITULO II

Nivel de Norma de Calidad Primaria para Ozono en Aire

Artículo 3.- La norma primaria de calidad de aire para ozono como concentración de 8-horas será de 61 ppbv. (120 ug/m3N)

Se considerará sobrepasada la norma primaria de calidad de aire para ozono como concentración de 8 horas, cuando el promedio aritmético de tres años sucesivos, del percentil 99 de los máximos diarios de concentración de 8 horas registrados durante un año calendario, en cualquier estación monitora EMRPG, fuere mayor o igual al nivel indicado en el inciso precedente.

Si el periodo de medición en una estación monitora EMPRG no comenzare el 1° de enero, se considerarán los tres primeros periodos de 12 meses a partir del mes de inicio de las mediciones hasta disponer de tres años calendarios sucesivos de mediciones.

Se considerará sobrepasada la norma primaria de calidad de aire para ozono como concentración de 8 horas, si en el primer o segundo periodo de 12 meses a partir del mes de inicio de las mediciones y, al reemplazar el percentil 99 de los máximos diarios de concentración de 8 horas para los periodos faltantes por cero, el promedio aritmético de los tres periodos resultare mayor o igual al nivel de la norma.

Artículo 4.- Los siguientes niveles originarán situaciones de emergencia ambiental para ozono, en concentración de una hora.

Nivel 1: 204 - 407 ppbv	(400 - 799 ug/m3N)
Nivel 2: 408 - 509 ppbv	(800 – 999 ug/m3N)
Nivel 3: 510 ppbv o superior	(1000 ug/m3N o superior)

Los niveles que originan situaciones de emergencia ambiental para ozono podrán ser obtenidos mediante la aplicación de una metodología de pronóstico de calidad de aire aprobada por el Servicio de Salud respectivo, o por medio de la constatación de las concentraciones del contaminante a partir de alguna de las estaciones monitoras de calidad de aire EMRPG.

Se podrá omitir o dejar sin efecto una situación de emergencia ambiental si se detectare un cambio en las condiciones meteorológicas en forma posterior a la hora de comunicación del pronóstico o a la constatación de la superación de los niveles de calidad de aire, y siempre que dicho cambio asegure una mejoría tal en las condiciones de calidad de aire que invalide los resultados entregados por el pronóstico o que asegure la reducción de los niveles de concentración de calidad de aire por debajo de aquellos que originan situaciones de emergencia ambiental.

Artículo 5.- Para efectos de evaluar el cumplimiento de la norma y los niveles que originan situaciones de emergencia ambiental se utilizarán los valores de concentración expresados en ppbv.

TITULO III

Metodología de Medición de la Norma

Artículo 6.- La medición de la concentración de ozono en el aire se realizará mediante uno cualesquiera de los siguientes métodos de medición:

a. Quimiluminiscencia con etileno;
b. Fotometría de absorción ultravioleta;
c. Cromatografía líquida gas/sólido;
d. Espectrometría de absorción óptica diferencial, con calibración in-situ y,
e. Un método de medición de referencia o equivalente designado o aprobado por la Agencia de Protección Ambiental de los Estados Unidos o por las Directivas de la Comunidad Europea.

El monitoreo de calidad de aire deberá realizarse con instrumentos que cumplen con los métodos de medición señalados en el inciso anterior y que hayan sido reconocidos, aprobados o certificados, por la Agencia de Protección Ambiental de los Estados Unidos o por las Directivas de la Comunidad Europea.

Artículo 7.- Para efectos de cumplir con lo establecido en el artículo 11, podrán utilizarse técnicas de medición alternativas a las señaladas en el artículo precedente, las que deberán ser aprobadas por el Servicio de Salud respectivo. Para el monitoreo mediante estas técnicas se deberá tener en consideración lo establecido en la letra (e) del artículo 2 del presente Decreto.

TITULO IV

Validación de la Información de Monitoreo de Calidad de Aire

Artículo 8.- Se considerará válida la concentración de 8 horas, si, a lo menos, el 75% de los datos de concentración de 1 hora para un periodo de 8 horas se encontraren disponibles.

En el evento de que se dispusiere de menos del 75% de los datos de concentración de 1 hora, la concentración de 8 horas será considerada, sólo para efectos de verificar el cumplimiento de la norma primaria de calidad de aire como concentración de 8 horas, si al reemplazar por cero los datos que faltaren para completar el 75% requerido, la concentración de 8 horas fuere mayor o igual al nivel de la norma.

Si se dispusiere de datos de concentración de 1 hora para 6 o 7 horas, la concentración de 8 horas se calculará como el promedio aritmético de los datos de concentración de 1 hora disponibles, utilizando como divisor 6 o 7, según corresponda.

Se considerará válido el percentil 99 de los máximos diarios de concentración de 8 horas registrados durante un año, si, a lo menos, el 75% de los datos de los máximos diarios de concentración de 8 horas para el periodo de un año, se encontraren disponibles y dan cuenta de la variación de los datos a lo largo de un año (ciclo estacional).

Se considerará válida la concentración máxima diaria de 8 horas, si, a lo menos, el 75% de los datos de concentración de 8 horas para un periodo de 24 horas se encontraren disponibles.

En el evento que se dispusiere de menos del 75% de los datos de concentración de 8 horas, la concentración máxima diaria de 8 horas será considerada, sólo para efectos de verificar el cumplimiento de la norma primaria de calidad de aire como concentración de 8 horas, si, la concentración máxima diaria de 8 horas fuere mayor o igual al nivel de la norma.

TITULO V

Fiscalización de la Norma

Artículo 9.- Corresponderá a los Servicios de Salud del país y, en la Región Metropolitana al Servicio de Salud Metropolitano del Ambiente, fiscalizar el cumplimiento de las disposiciones de la presente norma.

TITULO VI

Implementación de la Norma

Artículo 10.-Los Servicios de Salud respectivos deberán dentro del plazo de seis meses, contados desde la publicación del presente decreto en el Diario Oficial, determinar mediante resolución fundada aquellas estaciones monitoras que se considerarán como EMRPG.

Artículo 11.- Los Servicios de Salud respectivos deberán dentro del plazo de tres años, contados desde la publicación del presente decreto en el Diario Oficial, realizar un diagnóstico de la calidad de aire para ozono según sus competencias territoriales.

Dicho diagnóstico deberá considerar la información de calidad de aire disponible así como la que se genere a partir de organismos públicos y privados.

Los Servicios de Salud respectivos deberán dentro del plazo de dos años, contados desde que se disponga del diagnóstico, elaborar e implementar un programa priorizado de monitoreo para el seguimiento de la norma primaria de calidad de aire para ozono.

Dicho programa deberá ser revisado periódicamente en función de los nuevos antecedentes de calidad de aire de que se disponga, los cuales deberán incorporar la información tanto pública como privada.

Artículo 12.- El monitoreo de la calidad de aire según los métodos de medición señalados en los artículos sexto y séptimo del presente decreto, deberá realizarse de acuerdo a las disposiciones establecidas por el Servicio de Salud respectivo, el que deberá considerar, cuando se encuentre disponible, lo que señale el manual de aplicación de la norma.

El manual de aplicación de la norma deberá ser elaborado por la Comisión Nacional del Medio Ambiente dentro del plazo de un año contado desde la publicación del presente decreto en el Diario Oficial.

Artículo 13.- Los Servicios de Salud respectivos deberán tener a disposición de la ciudadanía, los datos de los niveles de concentración de calidad de aire para ozono correspondientes a la presente norma, los que serán públicos.

TITULO VII

Entrada en Vigencia

Artículo 14.- La presente norma entrará en vigencia a partir del día 1° del mes siguiente del de su publicación en el Diario Oficial quedando desde esa fecha sin efecto las normas primarias de calidad de aire para ozono vigentes a dicha fecha.

Artículos Transitorios

Artículo primero transitorio.- En el periodo comprendido desde la entrada en vigencia de la norma y hasta disponer de tres años sucesivos de mediciones, la norma primaria de calidad de aire para ozono como concentración de 8 horas se considerará sobrepasada, si en el primer o segundo periodo de 12 meses y, al reemplazar el percentil 99 de los máximos diarios de concentración de 8 horas para los periodos faltantes por cero, el promedio aritmético de los tres periodos resultare mayor o igual al nivel de la norma.

Artículo segundo transitorio.- Las disposiciones contenidas en la presente norma serán incorporadas en lo que corresponda en los planes de prevención o de descontaminación por ozono que se encuentren vigentes o en trámite a la fecha de su entrada en vigencia, adelantando para estos efectos los plazos de revisión de dichos planes si fuere necesario.

ANÓTESE, TÓMESE RAZÓN Y PUBLÍQUESE.

RICARDO LAGOS ESCOBAR
Presidente de la República

ALVARO GARCÍA HURTADO
Ministro
Secretario General de la Presidencia

MICHELLE BACHELET JERIA
Ministra de Salud

001323

REPUBLICA DE CHILE
Ministerio
Secretaría General de la Presidencia de la República

ESTABLECE NORMA PRIMARIA DE CALIDAD DE AIRE PARA DIOXIDO DE NITROGENO (NO_2)

SANTIAGO,

VISTOS:

Lo dispuesto en el artículo 19 N° 8 de la Constitución Política; En el artículo 32 de la Ley 19.300; El Reglamento para la Dictación de Normas de Calidad Ambiental y de Emisión, aprobado por el Decreto Supremo N°93 de 1995, del Ministerio Secretaría General de la Presidencia; La Resolución N°1215 de 1978 del Delegado del Gobierno en el Servicio Nacional de Salud, que establece normas sanitarias mínimas destinadas a prevenir y controlar la contaminación atmosférica; La Resolución Exenta N° 1514 de 1999, de la Dirección Ejecutiva de la Comisión Nacional del Medio Ambiente, que dio inicio al proceso de revisión de las normas primarias de calidad de aire para anhídrido sulfuroso (SO2); partículas totales en suspensión (PTS); monóxido de carbono (CO); ozono (03) y dióxido de nitrógeno (NO2) ; La Resolución Exenta N° 914 del 2000, de la Dirección Ejecutiva de la Comisión Nacional del Medio Ambiente, que aprobó el anteproyecto de revisión de la norma primaria de calidad de aire para dióxido de nitrógeno (NO2); El análisis general del impacto económico y social de la norma señalada; Las observaciones formuladas en la etapa de consulta al anteproyecto de norma; El acuerdo N°180 de 3 de mayo de 2001, del Consejo Directivo de la Comisión Nacional del Medio Ambiente, que aprobó el proyecto definitivo de la norma de calidad; los demás antecedentes que obran en el expediente público respectivo y lo dispuesto en la Resolución N°520 de 1996, de la Contraloría General de la República que fija el texto refundido, coordinado y sistematizado de la Resolución N° 55 de 1992, de la Contraloría General de la República.

CONSIDERANDO:

Que de acuerdo con lo preceptuado en la ley 19.300, es deber del Estado dictar normas para regular la presencia de contaminantes en el medio ambiente, de manera de prevenir que estos puedan significar o representar, por sus niveles, concentraciones y periodos, un riesgo para la salud de las personas.

Que sobre la base de los antecedentes disponibles y que constan en el expediente público, se revisó la norma primaria de calidad de aire para dióxido de nitrógeno contenida en la Resolución 1215 de 1978, del Delegado del Gobierno en el Servicio Nacional de Salud, en conformidad al procedimiento y los contenidos establecidos en el Decreto Supremo N°93 de 1995, de Ministerio Secretaria General de la Presidencia.

Que la Organización Mundial de la Salud (OMS) reporta que la exposición a este contaminante puede producir efectos agudos y crónicos sobre la salud de las personas. En el caso de los efectos agudos, se ha reportado un amplio rango de efectos sobre la población asmática, la que probablemente constituye la población mas sensible.

Que la Agencia de Protección Ambiental de los Estados Unidos (EPA) reporta que la exposición a dióxido de nitrógeno puede irritar los pulmones y disminuir la resistencia ante infecciones respiratorias, particularmente en individuos con enfermedades respiratorias pre-existentes, tales como asma.

Que dióxido de nitrógeno (NO2) es producido directa e indirectamente por la quema de combustibles a altas temperaturas. En el proceso de combustión, el nitrógeno se oxida para formar principalmente monóxido de nitrógeno (NO) y en menor proporción dióxido de nitrógeno. El NO se transforma en NO2 mediante reacciones fotoquímicas.

Que el dióxido de nitrógeno puede combinarse con compuestos orgánicos volátiles en presencia de luz solar para formar ozono, así como con agua para formar ácido nítrico y nitratos. Esto contribuye a la producción de lluvia ácida y al aumento de los niveles de MP10 y MP2,5.

DECRETO

TITULO I

Disposiciones Generales y Definiciones

Artículo 1.- La presente norma de calidad ambiental tiene por objetivo proteger la salud de la población de aquellos efectos agudos y crónicos generados por la exposición a niveles de concentración de dióxido de nitrógeno en el aire.

Artículo 2.- Para efectos de lo dispuesto en la presente norma, se entenderá por:

a. *ppbv:* Unidad de medida de concentración en volumen, correspondiente a una milésima parte por millón.

b. *Concentración de Dióxido de Nitrógeno*: Valor promedio temporal detectado en el aire expresado en partes por billón (ppbv) o microgramos por metro cúbico normal (ug/m3N).

   La condición normal corresponde a la presión de una atmósfera (1 atm.) y una temperatura de 25 grados Celcius (25°C).

c. *Concentración de 1 hora*: Promedio aritmético de los valores de concentración de dióxido de nitrógeno medidos en 1 hora.

d. *Concentración de 24 horas*: Promedio aritmético de los valores de concentración de 1 hora de dióxido de nitrógeno correspondientes a un bloque de 24 horas sucesivas, contadas desde las cero horas de cada día.

e. *Concentración trimestral:* Promedio aritmético de los valores de concentración de 24 horas de dióxido de nitrógeno correspondientes a un periodo de tres meses consecutivos.

g. *Concentración anual*: Promedio aritmético de los valores de concentración trimestral de dióxido de nitrógeno correspondientes a un año calendario.

h. *Año calendario*: Período que se inicia el 1° de enero y culmina el 31 de diciembre del mismo año.

i. *Estación de monitoreo con representatividad poblacional para gas dióxido de nitrógeno (EMRPG):* Una estación de monitoreo que se encuentra localizada en un área habitada.

Se entiende como área habitada, una porción del territorio donde vive habitual y permanentemente un conjunto de personas.

j. *Percentil:* Corresponde al valor "q" calculado a partir de valores de concentración aproximados al ppvb o ug/m3N más cercano. Todos los valores se anotarán en una lista establecida por orden creciente para cada estación de monitoreo.

$$X1 \leq X2 \leq X3 \ldots. \leq Xk \leq X\,n - 1 \leq Xn$$

El percentil será el valor del elemento de orden "k", para el que "k" se calculará por medio de la siguiente fórmula:

k = q X n , donde "q" = 0.99 para el Percentil 99, y "n" corresponde a un número de datos de una serie. El valor "k" se aproximará al número entero más próximo

TITULO II

Nivel de Norma de Calidad Primaria para Dióxido de Nitrógeno en Aire

Artículo 3.- La norma primaria de calidad de aire para dióxido de nitrógeno como concentración anual será de 53 ppbv (100 ug/m3N).

Se considerará sobrepasada la norma primaria de calidad de aire para dióxido de nitrógeno como concentración anual, cuando el promedio aritmético de los valores de concentración anual de tres años calendarios sucesivos, en cualquier estación monitora EMRPG, fuere mayor o igual al nivel indicado en el inciso precedente.

Si el periodo de medición en una estación monitora EMRPG no comenzare el 1° de enero, se considerarán los tres primeros periodos de 12 meses a partir del mes de inicio de las mediciones hasta disponer de tres años calendarios sucesivos de mediciones.

Se considerará sobrepasada la norma primaria de calidad de aire para dióxido de nitrógeno como concentración anual, si en el primer o segundo periodo de 12 meses a partir del mes de inicio de las mediciones y, al reemplazar la concentración anual para los periodos faltantes por cero, el promedio aritmético de los tres periodos resultare mayor o igual al nivel de la norma.

Artículo 4.-La norma primaria de calidad de aire para dióxido de nitrógeno como concentración de 1 hora será de 213 ppbv (400 ug/m3N).

Se considerará sobrepasada la norma primaria de calidad de aire para dióxido de nitrógeno como concentración de 1 hora, cuando el promedio aritmético de tres años sucesivos del percentil 99 de los máximos diarios de concentración de 1 hora registrados durante un año calendario, en cualquier estación monitora EMRPG, fuere mayor o igual al nivel indicado en el inciso precedente.

Si el periodo de medición en una estación monitora EMPRG no comenzare el 1 de enero, se considerarán los tres primeros periodos de 12 meses a partir del mes de inicio de las mediciones hasta disponer de tres años calendarios consecutivos de mediciones.

Se considerará sobrepasada la norma primaria de calidad de aire para dióxido de nitrógeno como concentración de 1 hora, si en el primer o segundo periodo de 12 meses a partir del mes de inicio de las mediciones y, al reemplazar el percentil 99 de los máximos diarios de concentración de 1 hora para los periodos faltantes por cero, el promedio aritmético de los tres periodos resultare mayor o igual al nivel de la norma.

Artículo 5.- Los siguientes niveles originarán situaciones de emergencia ambiental para dióxido de nitrógeno en concentración de una hora:

Nivel 1: 601-1201 ppbv	(1130 - 2259 ug/m3N)
Nivel 2: 1202 - 1595 ppbv	(2260 - 2999 ug/m3N)
Nivel 3: 1596 ppbv o superior	(3000 ug/m3N o superior)

Los niveles que originan situaciones de emergencia ambiental para dióxido de nitrógeno podrán ser obtenidos mediante la aplicación de una metodología de pronóstico de calidad de aire aprobada por el Servicio de Salud respectivo, o por medio de la constatación de las concentraciones del contaminante a partir de alguna de las estaciones monitoras de calidad de aire EMRPG.

Se podrá omitir o dejar sin efecto una situación de emergencia ambiental si se detectare un cambio en las condiciones meteorológicas en forma posterior a la hora de comunicación del pronóstico o a la constatación de la superación de los niveles de calidad de aire, y siempre que dicho cambio asegure una mejoría tal en las condiciones de calidad de aire que invalide los resultados entregados por el pronóstico o que asegure la reducción de los niveles de concentración de calidad de aire por debajo de aquellos que originan situaciones de emergencia ambiental.

Artículo 6.- Para efectos de evaluar el cumplimiento de la norma y los niveles que originan situaciones de emergencia ambiental se utilizarán los valores de concentración expresados en ppbv.

Artículo 7.- Cuando el dióxido de nitrógeno fuese precursor de otro contaminante normado, los planes de descontaminación o prevención que se establezcan para el control de este contaminante, podrán incluir medidas de reducción de emisiones del contaminante dióxido de nitrógeno, independientemente del cumplimiento de las normas de calidad de aire que esta norma establece.

TITULO III

Metodología de Medición de la Norma

Artículo 8.- La medición de la concentración de dióxido de nitrógeno en el aire se realizará mediante uno cualesquiera de los siguientes métodos de medición:

a. Quimiluminiscencia;
b. Los que se basen en el método modificado de Griess-Saltzmann;
c. Espectrometría de absorción óptica diferencial, con calibración in-situ y,
d. Un método de medición de referencia o equivalente designado o aprobado por la Agencia de Protección Ambiental de los Estados Unidos o por las Directivas de la Comunidad Europea.

El monitoreo de calidad de aire deberá realizarse con instrumentos que cumplen con los métodos de medición señalados en el inciso anterior y que hayan sido reconocidos, aprobados o certificados por la Agencia de Protección Ambiental de los Estados Unidos o por las Directivas de la Comunidad Europea..

Artículo 9.- Para efectos de cumplir con lo establecido el artículo 13 podrán utilizarse técnicas de medición alternativas a las señaladas en el artículo precedente, las que deberán ser aprobadas por el Servicio de Salud respectivo. Para el monitoreo mediante estas técnicas se deberá tener en consideración lo establecido en la letra (i) del artículo 2 del presente decreto.

TITULO IV

Validación de la Información de Monitoreo de Calidad de Aire

Artículo 10.- Se considerará válida la concentración anual, si para cada uno de los trimestres de un año, se dispusiere de a lo menos un 75% de los datos de concentración de 24 horas para ese periodo.

Se considerará válida la concentración de 24 horas, si, a lo menos, el 75% de los datos de concentración de 1 hora para un periodo de 24 horas, se encontraren disponibles y dan cuenta de la variación de los datos a lo largo de un día (ciclo diario).

En el evento de que se dispusiere de menos del 75% de los datos de concentración de 1 hora, la concentración de 24 horas será considerada, sólo para efectos de verificar el cumplimiento de la norma primaria de calidad de aire como concentración de 24 horas, si, al reemplazar por cero los datos que faltaren para completar el 75% requerido, la concentración de 24 horas fuere mayor o igual al valor de la norma.

Si se dispusiere de datos de concentración de 1 hora para 18, 19, 20, 21, 22 o 23 horas, la concentración de 24 horas se calculará como el promedio aritmético de los datos de concentración de 1 hora disponibles, utilizando como divisor 18, 19, 20, 21, 22 o 23, según corresponda.

Se considerará válida la concentración de una hora, si, a lo menos, se dispusiere de 30 minutos seguidos de medición.

Se considerará válido el percentil 99 de los máximos diarios de concentración de 1 hora registrados durante un año, si, a lo menos, el 75% de los datos de máximos diarios de concentración de 1 hora para el periodo de un año, se encontraren disponibles y dan cuenta de la variación de los datos a lo largo de un año (ciclo estacional).

Se considerará válida la concentración máxima diaria de 1 hora, si, a lo menos el 75% de los datos de concentración de 1 hora para un periodo de 24 horas se encontraren disponibles.

En el evento que se dispusiere de menos del 75% de los datos de concentración de 1 hora, la concentración máxima diaria de 1 hora será considerada, sólo para efectos de verificar el cumplimiento de la norma primaria de calidad de aire como concentración de 1 hora, si, la concentración máxima diaria de 1 hora fuere mayor o igual al nivel de la norma.

TITULO V

Fiscalización de la Norma

Artículo 11.- Corresponderá a los Servicios de Salud del país y, en la Región Metropolitana al Servicio de Salud Metropolitano del Ambiente, fiscalizar el cumplimiento de las disposiciones de la presente norma.

TITULO VI.

Implementación de la Norma

Artículo 12.-Los Servicios de Salud respectivos deberán dentro del plazo de seis meses, contados desde la publicación del presente decreto en el Diario Oficial determinar mediante resolución fundada aquellas estaciones monitoras que se considerarán como EMRPG.

Artículo 13.- Los Servicios de Salud respectivos deberán dentro del plazo de tres años, contados desde la publicación del presente decreto en el Diario Oficial, realizar un diagnóstico de la calidad de aire para dióxido de nitrógeno según sus competencias territoriales.

Dicho diagnóstico deberá considerar la información de calidad de aire disponible así como la que se genere a partir de organismos públicos y privados.

Los Servicios de Salud respectivos deberán dentro del plazo de dos años, contados desde que se disponga del diagnóstico, elaborar e implementar un programa priorizado de monitoreo para el seguimiento de la norma primaria de calidad de aire para dióxido de nitrógeno.

Dicho programa deberá ser revisado periódicamente en función de los nuevos antecedentes de calidad de aire de que se disponga, los cuales deberán incorporar la información tanto pública como privada.

Artículo 14.- El monitoreo de la calidad de aire según los métodos de medición señalados en los artículos octavo y noveno del presente decreto, deberá realizarse de acuerdo a las disposiciones establecidas por el Servicio de Salud respectivo, el que deberá considerar, cuando se encuentre disponible, lo que señale el manual de aplicación de la norma.

El manual de aplicación de la norma deberá ser elaborado por la Comisión Nacional del Medio Ambiente dentro del plazo de un año, contado desde la publicación del presente decreto en el Diario Oficial.

Artículo 15.- Los Servicios de Salud respectivos deberán tener a disposición de la ciudadanía, los datos de los niveles de concentración de calidad de aire para dióxido de nitrógeno correspondientes a la presente norma, los que serán públicos.

TITULO VII

Entrada en Vigencia

Artículo 16.- La presente norma entrará en vigencia a partir del día 1° del mes siguiente del de su publicación en el Diario Oficial quedando desde esa fecha sin efecto las normas primarias de calidad de aire para dióxido de nitrógeno vigentes a dicha fecha.

TITULO VIII

Artículos Transitorios

Artículo primero transitorio.- En el periodo comprendido desde la entrada en vigencia de la norma y hasta disponer de tres años sucesivos de mediciones, la norma primaria de calidad de aire para dióxido de nitrógeno como concentración anual o de 1 hora se considerará sobrepasada, si en el primer o segundo periodo de 12 meses y, al reemplazar la concentración anual o el percentil 99 de los máximos diarios de concentración de 1 hora para los periodos faltantes por cero, el promedio aritmético de los tres periodos resultare mayor o igual al nivel de la norma correspondiente.

Artículo segundo transitorio.- Las disposiciones contenidas en el presente decreto serán incorporadas en lo que corresponda en los planes de prevención o de descontaminación por dióxido de azufre que se encuentren vigentes o en trámite a la fecha de su entrada en vigencia, adelantando para estos efectos los plazos de revisión de dichos planes si fuere necesario.

ANÓTESE, TÓMESE RAZÓN Y PUBLÍQUESE.

RICARDO LAGOS ESCOBAR
Presidente de la República

ALVARO GARCÍA HURTADO
Ministro
Secretario General de la Presidencia

MICHELLE BACHELET JERIA
Ministra de Salud

COMUNES

1. METODOLOGÍA DE PRONÓSTICO. (X) (OK).
- MÍNIMO MINIMORUM.

2. METODOLOGÍAS ALTERNATIVAS: ✓ 8 y 12

3. APROBACIÓN "ESTACIÓN MONITORA CON REPRESENTATIVIDAD ✓ POBLACIONAL"

4. MANUAL DE LA NORMA. (P) MANUAL (X)

5.

ESPECÍFICAS :

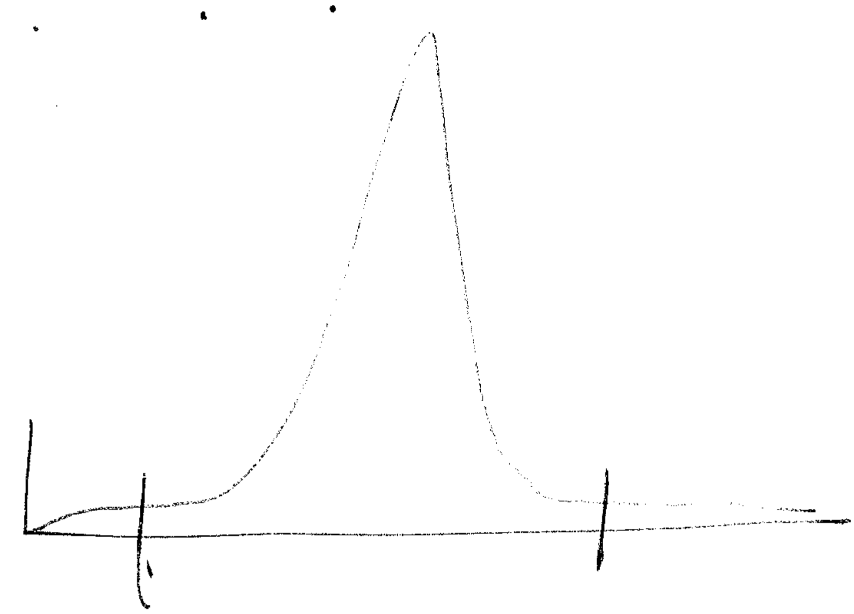
OZONO:

1- VISTOS: O3 Y NO SO2. (PTS) REVISAR TODO.
2- ART 2 : ARAUCANÍA : (OK)
3. ART 4 : EPISODIO CRÍTICO

120

120 100 120 140

204
108



i) PTS. VISTOS
2. NO2 :

REPUBLICA DE CHILE
Ministerio
Secretaría General de la Presidencia de la República

001360

DEJA SIN EFECTO NORMA PRIMARIA DE CALIDAD DE AIRE PARA PARTICULAS TOTALES EN SUSPENSION (PTS)

SANTIAGO,

VISTOS:

Lo dispuesto en el artículo 19 Nº 8 de la Constitución Política; En el artículo 32 de la Ley 19.300; El Reglamento para la Dictación de Normas de Calidad Ambiental y de Emisión, aprobado por el Decreto Supremo Nº93 de 1995, del Ministerio Secretaría General de la Presidencia; La Resolución N°1215 de 1978 del Delegado del Gobierno en el Servicio Nacional de Salud, que establece normas sanitarias mínimas destinadas a prevenir y controlar la contaminación atmosférica; La Resolución Exenta N° 1514 de 1999, de la Dirección Ejecutiva de la Comisión Nacional del Medio Ambiente, que dio inicio al proceso de revisión de las normas primarias de calidad de aire para anhídrido sulfuroso (SO_2); partículas totales en suspensión (PTS); monóxido de carbono (CO); ozono (03) y dióxido de nitrógeno (NO_2) ; La Resolución Exenta N° 916 del 2000, de la Dirección Ejecutiva de la Comisión Nacional del Medio Ambiente, que aprobó el anteproyecto de revisión de la norma primaria de calidad de aire para anhídrido sulfuroso (SO_2); El análisis general del impacto económico y social de la norma señalada; Las observaciones formuladas en la etapa de consulta al anteproyecto de norma; El acuerdo N°180 de 3 de mayo de 2001, del Consejo Directivo de la Comisión Nacional del Medio Ambiente, que aprobó el proyecto definitivo de la norma de calidad; los demás antecedentes que obran en el expediente público respectivo y lo dispuesto en la Resolución N°520 de 1996, de la Contraloría General de la República que fija el texto refundido, coordinado y sistematizado de la Resolución Nº 55 de 1992, de la Contraloría General de la República.

CONSIDERANDO

Que de acuerdo con lo preceptuado en la Ley 19.300, es deber del Estado dictar normas para regular la presencia de contaminantes en el medio ambiente, de manera de prevenir que estos puedan significar o representar, por sus niveles, concentraciones y periodos, un riesgo para la salud de las personas.

Que sobre la base de los antecedentes disponibles y que constan en el expediente público, se revisó la norma primaria de calidad de aire para partículas totales en suspensión (PTS), contenida en la Resolución 1215 de 1978, del Delegado del Gobierno en el Servicio Nacional de Salud, en conformidad al procedimiento y los contenidos establecidos en el Decreto Supremo N°93 de 1995, de Ministerio Secretaria General de la Presidencia.

Que históricamente se consideró que todas las partículas suspendidas en el aire (PTS) afectaban la salud de las personas de la misma forma. Sin embargo, recientemente se ha demostrado que las partículas que más la afectan son aquellas con un diámetro aerodinámico menor a 10 um. (MP10) y más aún, aquellas con diámetro aerodinámico menor a 2.5 um. (MP2.5).

Que la fracción del PTS mayor a 10 micrones corresponde a partículas no respirables. Estas se depositan en la traquea y son limpiadas por los cilios a través de la formación de mucus y expulsadas a través de la tos o de la deglución.

Que el documento de guías globales de calidad del aire de la Organización Mundial de la Salud (OMS) sostiene que no puede establecerse un nivel umbral para los efectos del material particulado en la salud, por lo que las guías para material particulado son representadas por asociaciones estadísticamente significativas entre el incremento en los efectos observados y el incremento de las concentraciones, específicamente de MP10 y MP2.5. No estableciéndose ningún tipo de guía para aquella fracción mayor a 10 micrones.

Que no se cuenta con una evaluación de riesgo que evidencie relación entre la exposición a PTS y en particular a los compuestos tóxicos contenidos en éste y la ocurrencia de alguna enfermedad.

Que en Chile, se regulan los efectos en salud generados por la fracción respirable del material particulado inferior a 10 micrones, a través de una norma primaria de calidad de aire para material particulado respirable (MP10) como concentración de 24 horas.

DECRETO:

Artículo Único.- Déjase sin efecto la norma primaria de calidad de aire para partículas totales en suspensión (PTS) contenida en la Resolución N°1215 de 1978, del Delegado del Gobierno en el Servicio Nacional de Salud.

ANÓTESE, TÓMESE RAZÓN Y PUBLÍQUESE.

RICARDO LAGOS ESCOBAR
Presidente de la República

ALVARO GARCÍA HURTADO
Ministro
Secretario General de la Presidencia

MICHELLE BACHELET JERIA
Ministra de Salud

1) Revisar validación de elaboración.

REPUBLICA DE CHILE
Ministerio
Secretaría General de la Presidencia de la República

ESTABLECE NORMA PRIMARIA DE CALIDAD DE AIRE PARA MONÓXIDO DE CARBONO (CO)

SANTIAGO,

DECRETO Nº _______________/

VISTOS:

Lo dispuesto en el artículo 19 Nº8 de la Constitución Política; En el artículo 32 de la Ley 19.300; el Reglamento para la Dictación de Normas de Calidad Ambiental y de Emisión, aprobado por el Decreto Supremo Nº93 de 1995, del Ministerio Secretaría General de la Presidencia; La Resolución N°1215 de 1978 del Delegado del Gobierno en el Servicio Nacional de Salud, que establece normas sanitarias mínimas destinadas a prevenir y controlar la contaminación atmosférica; La Resolución Exenta N° 1514 de 1999, de la Dirección Ejecutiva de la Comisión Nacional del Medio Ambiente, que dio inicio al proceso de revisión de las normas primarias de calidad de aire para anhídrido sulfuroso (SO_2); partículas totales en suspensión (PTS); monóxido de carbono (CO); ozono (03) y dióxido de nitrógeno (NO_2) ; La Resolución Exenta N° 912 del 2000, de la Dirección Ejecutiva de la Comisión Nacional del Medio Ambiente, que aprobó el anteproyecto de revisión de la norma primaria de calidad de aire para monóxido de carbono (CO), el análisis general del impacto económico y social de la norma señalada; las observaciones formuladas en la etapa de consulta al anteproyecto de norma; el acuerdo N°180 de 3 de mayo de 2001, del Consejo Directivo de la Comisión Nacional del Medio Ambiente, que aprobó el proyecto definitivo de la norma de calidad; los demás antecedentes que obran en el expediente público respectivo y lo dispuesto en la Resolución Nº520 de 1996, de la Contraloría General de la República que fija el texto refundido, coordinado y sistematizado de la Resolución Nº 55 de 1992, de la Contraloría General de la República.

CONSIDERANDO

Que de acuerdo con lo preceptuado en la ley 19.300, es deber del Estado dictar normas para regular la presencia de contaminantes en el medio ambiente, de manera de prevenir que éstos puedan significar o representar, por sus niveles, concentraciones y periodos, un riesgo para la salud de las personas.

Que sobre la base de los antecedentes disponibles y que constan en el expediente público, se revisó la norma primaria de calidad de aire para monóxido de carbono (CO), contenida en la Resolución 1215 de 1978, del Delegado del Gobierno en el Servicio Nacional de

Salud, en conformidad al procedimiento y los contenidos establecidos en el Decreto Supremo N°93 de 1995, de Ministerio Secretaria General de la Presidencia.

Que la exposición al CO se puede evaluar a través de los niveles de carboxyhemoglobina (COHb) que se expresa como porcentaje de la hemoglobina (Hb) total que está unida al CO.

Que según la OMS (1999), no debiera ser excedido el nivel de 2.5% de COHb en la sangre de las personas expuestas a CO. Con lo anterior, se protege a la población no fumadora, de mediana y mayor edad con enfermedad de la arteria coronaria latente o reportada, de ataques de isquemia miocárdica aguda, y al feto en madres no fumadoras, de efectos hipóxicos adversos.

Que el pulmón es la principal ruta de excreción y absorción de CO y que los resultados de diversos estudios recientes han mostrado que el CO aparece asociado a efectos respiratorios y efectos cardiovasculares entre otros.

DECRETO

TITULO I

Disposiciones Generales y Definiciones

Artículo 1.- La presente norma de calidad ambiental tiene por objetivo proteger la salud de la población de aquellos efectos agudos generados por la exposición a niveles de concentración de monóxido de carbono en el aire.

Artículo 2.- Para efectos de lo dispuesto en la presente norma, se entenderá por:

a. *ppmv:* Unidad de medida de concentración en volumen, correspondiente a una parte por millón.

b. *Concentración de monóxido de carbono*: Valor promedio temporal detectado en el aire expresado en partes por millón (ppmv) o en miligramos por metro cúbico normal (mg/m3N) .

   La condición normal corresponde a la presión de una atmósfera (1 atm.) y una temperatura de 25 grados Celcius (25°C).

c. *Concentración de 1 hora*: Promedio aritmético de los valores de concentración de monóxido de carbono medidos en 1 hora.

d. *Concentración de 8 Horas*: Promedio aritmético de los valores de concentración de 1 hora de monóxido de carbono correspondientes a 8 horas sucesivas, promedio móvil.

e. *Año calendario*: Período que se inicia el 1° de enero y culmina el 31 de diciembre del mismo año.

f. *Estación monitora con representatividad poblacional para gas monóxido de carbono (EMRPG):* Una estación de monitoreo que se encuentra localizada en un área habitada.

   Se entiende como área habitada, a una porción del territorio donde vive habitual y permanentemente un conjunto de personas.

g. *Percentil:* Corresponde al valor "q" calculado a partir de valores de concentración aproximados al ppmv o mg/m3N más cercano. Todos los valores se anotarán en una lista establecida por orden creciente para cada estación de monitoreo.

$$X1 \leq X2 \leq X3 \ldots \leq Xk \leq X\,n-1 \leq Xn$$

El percentil será el valor del elemento de orden "k", para el que "k" se calculará por medio de la siguiente fórmula:

k = q X n , donde "q" = 0.99 para el Percentil 99, y "n" corresponde al número de datos de una serie . El valor "k" se aproximará al número entero más próximo.

TITULO II

Nivel de Norma de Calidad Primaria para Monóxido de Carbono en Aire

Artículo 3.- La norma primaria de calidad de aire para monóxido de carbono como concentración de 8 horas será de 9 ppmv (10 mg/m3N).

Se considerará sobrepasada la norma primaria de calidad de aire para monóxido de carbono como concentración de 8 horas, cuando el promedio aritmético de tres años sucesivos, del percentil 99 de los máximos diarios de concentración de 8 horas registrados durante un año calendario, en cualquier estación monitora EMRPG fuere mayor o igual al nivel indicado en el inciso precedente.

Si el periodo de medición en una estación monitora EMPRG no comenzare el 1° de enero, se considerarán los tres primeros periodos de 12 meses a partir del mes de inicio de las mediciones hasta disponer de tres años calendarios sucesivos de mediciones.

Se considerará sobrepasada la norma primaria de calidad de aire para monóxido de carbono como concentración de 8 horas, si en el primer o segundo periodo de 12 meses a partir del mes de inicio de las mediciones y, al reemplazar el percentil 99 de los máximos diarios de concentración de 8 horas para los periodos faltantes por cero, el promedio aritmético de los tres periodos resultare mayor o igual al nivel de la norma.

Artículo 4.- La norma primaria de calidad de aire para monóxido de carbono como concentración de 1 hora será de 26 ppmv (30 mg/m3N).

Se considerará sobrepasada la norma primaria de calidad de aire para monóxido de carbono como concentración de 1 hora, cuando el promedio aritmético de tres años sucesivos, del percentil 99 de los máximos diarios de concentración de 1 hora registrados durante un año calendario, en cualquier estación monitora EMRPG, fuere mayor o igual al nivel indicado en el inciso precedente.

Si el periodo de medición en una estación monitora EMPRG no comenzare el 1° de enero, se considerarán los tres primeros periodos de 12 meses a partir del mes de inicio de las mediciones hasta disponer de tres años calendarios sucesivos de mediciones.

Se considerará sobrepasada la norma primaria de calidad de aire para monóxido de carbono como concentración de 1 hora, si en el primer o segundo periodo de 12 meses a partir del mes de inicio de las mediciones y, al reemplazar el percentil 99 de los máximos diarios de concentración de 1 hora para los periodos faltantes por cero, el promedio aritmético de los tres periodos resultare mayor o igual al nivel de la norma.

Artículo 5.- Los siguientes niveles originarán situaciones de emergencia ambiental para monóxido de carbono en concentración de ocho horas:

Nivel 1: 15 - 29 ppmv.	(17 - 33 mg/m3N)
Nivel 2: 30 - 34 ppmv	(34 - 39 mg/m3N)
Nivel 3: 35 ppmv o superior	(40 mg/m3N o superior)

Los niveles que originan situaciones de emergencia ambiental para monóxido de carbono podrán ser obtenidos mediante la aplicación de una metodología de pronóstico de calidad de aire aprobada por el Servicio de Salud respectivo, o por medio de la constatación de las concentraciones del contaminante a partir de alguna de las estaciones monitoras de calidad de aire EMRPG.

Se podrá omitir o dejar sin efecto una situación de emergencia ambiental si se detectare un cambio en las condiciones meteorológicas en forma posterior a la hora de comunicación del pronóstico o a la constatación de la superación de los niveles de calidad de aire, y siempre que dicho cambio asegure una mejoría tal en las condiciones de calidad de aire que invalide los resultados entregados por el pronóstico o que asegure la reducción de los niveles de concentración de calidad de aire por debajo de aquellos que originan situaciones de emergencia ambiental.

Artículo 6.- Para efectos de evaluar el cumplimiento de la norma y los niveles que originan situaciones de emergencia ambiental se utilizarán los valores de concentración expresados en ppmv.

TITULO III

Metodología de Medición de la Norma

Artículo 7.- La medición de la concentración de monóxido de carbono en el aire se realizará mediante uno cualesquiera de los siguientes métodos de medición:

a. Fotometría infrarroja no dispersiva y,
b. Un método de medición de referencia o equivalente designado o aprobado por la Agencia de Protección Ambiental de los Estados Unidos o por las Directivas de la Comunidad Europea.

El monitoreo de calidad de aire deberá realizarse con instrumentos que cumplen con los métodos de medición señalados en el inciso anterior y que hayan sido reconocidos, aprobados o certificados por la Agencia de Protección Ambiental de los Estados Unidos o por las Directivas de la Comunidad Europea.

Artículo 8.- Para efectos de cumplir con lo establecido en el artículo 12, podrán utilizarse técnicas de medición alternativas a las señaladas en el artículo precedente, las que deberán ser aprobadas por el Servicio de Salud respectivo. Para el monitoreo mediante estas técnicas se deberá considerar lo establecido en la letra (f) del artículo 2 del presente decreto.

TITULO IV

Validación de la Información de Monitoreo de Calidad del Aire

Artículo 9.- Se considerará válida la concentración de 8 horas, si, a lo menos el 75% de los datos de concentración de 1 hora para un periodo de 8 horas se encontraren disponibles.

En el evento de que se dispusiere de menos del 75% de los datos de concentración de 1 hora, la concentración de 8 horas será considerada, sólo para efectos de verificar el cumplimiento de la norma primaria de calidad de aire como concentración de 8 horas, si, al reemplazar por cero los datos que faltaren para completar el 75% requerido, la concentración de 8 horas fuere mayor o igual al nivel de la norma.

Si se dispusiere de datos de concentración de 1 hora para 6 o 7 horas, la concentración de 8 horas se calculará como el promedio aritmético de los datos de concentración de 1 hora disponibles, utilizando como divisor 6 o 7 según corresponda.

Se considerará válido el percentil 99 de los máximos diarios de concentración de 8 horas registrados durante un año, si, a lo menos, el 75% de los datos de máximos diarios de concentración de 8 horas para el periodo de un año, se encontraren disponibles y dan cuenta de la variación de los datos a lo largo de un año (ciclo estacional).

Se considerará válida la concentración máxima diaria de 8 horas, si, a lo menos el 75% de los datos de concentración de 8 horas para un periodo de 24 horas se encontraren disponibles.

En el evento que se dispusiere de menos del 75% de los datos de concentración de 8 horas, la concentración máxima diaria de 8 horas será considerada, sólo para efectos de verificar el cumplimiento de la norma primaria de calidad de aire como concentración de 8 horas, si, la concentración máxima diaria de 8 horas fuere mayor o igual al nivel de la norma.

Se considerará válida la concentración de una hora, si, a lo menos, se dispusiere de 30 minutos sucesivos de medición.

Se considerará válido el percentil 99 de los máximos diarios de concentración de 1 hora registrados durante un año, si, a lo menos, el 75% de los datos de máximos diarios de concentración de 1 hora para el periodo de un año, se encontraren disponibles y dan cuenta de la variación de los datos a lo largo de un año (ciclo estacional)

Se considerará válida la concentración máxima diaria de 1 hora, si, a lo menos el 75% de los datos de concentración de 1 hora para un periodo de 24 horas se encontraren disponibles.

En el evento que se dispusiere de menos del 75% de los datos de concentración de 1 hora, la concentración máxima diaria de 1 hora será considerada, sólo para efectos de verificar el cumplimiento de la norma primaria de calidad de aire como concentración de 1 hora, si, la concentración máxima diaria de 1 hora fuere mayor o igual al nivel de la norma.

TITULO V

Fiscalización de la Norma

Artículo 10.- Corresponderá a los Servicios de Salud del país y, en la Región Metropolitana al Servicio de Salud Metropolitano del Ambiente, fiscalizar el cumplimiento de las disposiciones de la presente norma.

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TITULO VI

Implementación de la Norma

Artículo 11.-Los Servicios de Salud respectivos deberán dentro del plazo de seis meses, contados desde la publicación del presente decreto en el Diario Oficial, determinar mediante resolución fundada aquellas estaciones monitoras que se considerarán como EMRPG.

Artículo 12.- Los Servicios de Salud respectivos deberán dentro del plazo de tres años, contados desde la publicación del presente decreto en el Diario Oficial, realizar un diagnóstico de la calidad de aire para monóxido de carbono según sus competencias territoriales.

Dicho diagnóstico deberá considerar la información de calidad de aire disponible así como la que se genere a partir de organismos públicos y privados.

Los Servicios de Salud respectivos deberán dentro del plazo de dos años, contados desde que se disponga del diagnóstico, elaborar e implementar un programa priorizado de monitoreo para el seguimiento de la norma primaria de calidad de aire para monóxido de carbono.

Dicho programa deberá ser revisado periódicamente en función de los nuevos antecedentes de calidad de aire de que se disponga, los cuales deberán incorporar la información tanto pública como privada.

Artículo 13.- El monitoreo de la calidad de aire según los métodos de medición señalados en los artículos séptimo y octavo del presente decreto, deberá realizarse de acuerdo a las disposiciones establecidas por el Servicio de Salud respectivo, el que deberá considerar, cuando se encuentre disponible, lo que señale el manual de aplicación de la norma.

El manual de aplicación de la norma deberá ser elaborado por la Comisión Nacional del Medio Ambiente dentro del plazo de un año, contado desde la publicación del presente decreto en el Diario Oficial.

Artículo 14.- Los Servicios de Salud respectivos deberán tener a disposición de la ciudadanía, los datos de los niveles de concentración de calidad de aire para monóxido de carbono correspondientes a la presente norma, los que serán públicos.

TITULO VII

Entrada en Vigencia

Artículo 15.- La presente norma entrará en vigencia a partir del día 1° del mes siguiente del de su publicación en el Diario Oficial quedando desde esa fecha sin efecto las normas primarias de calidad de aire para monóxido de carbono vigentes a dicha fecha.

TITULO VIII

Artículos Transitorios

Artículo primero transitorio.- En el periodo comprendido desde la entrada en vigencia de la norma y hasta disponer de tres años sucesivos de mediciones, la norma primaria de calidad de aire para monóxido de carbono como concentración de 8 horas o de 1 hora se considerará sobrepasada, si en el primer o segundo periodo de 12 meses y, al reemplazar el percentil 99 de los máximos diarios de concentración de 8 horas o el percentil 99 de los máximos diarios de concentración de 1 hora para los periodos faltantes por cero, el promedio aritmético de los tres periodos resultare igual o mayor al nivel de la norma correspondiente.

Artículo segundo transitorio.- Las disposiciones contenidas en el presente decreto serán incorporadas en lo que corresponda en los planes de prevención o de descontaminación por monóxido de carbono que se encuentren vigentes o en trámite a la fecha de su entrada en vigencia, adelantando para estos efectos los plazos de revisión de dichos planes si fuere necesario.

ANÓTESE, TÓMESE RAZÓN Y PUBLÍQUESE.

RICARDO LAGOS ESCOBAR
Presidente de la República

ALVARO GARCÍA HURTADO
Ministro
Secretario General de la Presidencia

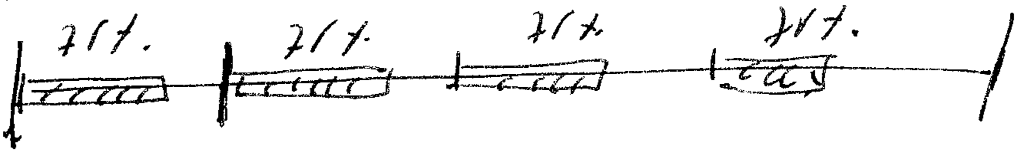
MICHELLE BACHELET JERIA
Ministra de Salud

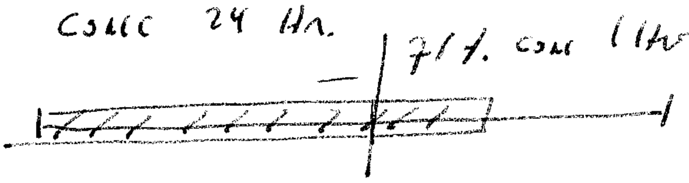
502:

ANUAL
- 24 Hs

1) ANUAL

$\bar{X}_1$ $\bar{X}_2$ $\bar{X}_3$ X_4





com 24 h → $\bar{X}$ $\frac{1h \dots}{24}$

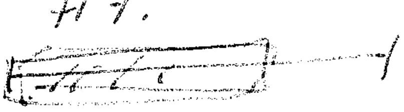
ANO. 1

Como anual: $\frac{X_{T_1} + X_{T_2} + X_{T_3} + X_{T_4}}{4}$

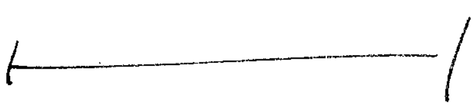
Como mês: $\frac{\sum_1 X_{24_1} + X_{24_2} + \dots X_{24_{30}} + \dots X_{24n}}{30\ \text{dias}}$

Como 24 h: $\frac{\sum_1 X_1 + X_2 \dots X_{24}}{24}$

Com 1 h: 30 medições



$\bar{X}_{1 \dots 30}$



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REPUBLICA DE CHILE
COMISION NACIONAL DEL MEDIO AMBIENTE
ASR/PMC

ESTABLECE NORMA PRIMARIA DE CALIDAD DE AIRE PARA DIOXIDO DE AZUFRE (SO_2)

SANTIAGO,

VISTOS:

Lo dispuesto en el artículo 19 Nº 8 de la Constitución Política; En el artículo 32 de la Ley 19.300; El Reglamento para la Dictación de Normas de Calidad Ambiental y de Emisión, aprobado por el Decreto Supremo Nº93 de 1995, del Ministerio Secretaría General de la Presidencia; El Decreto Supremo N°185 de 1991, del Ministerio de Minería, que Reglamenta el Funcionamiento de los Establecimientos Emisores de Anhídrido Sulfuroso, Material Particulado y Arsénico en todo el Territorio de La República; La Resolución N°1215 de 1978 del Delegado del Gobierno en el Servicio Nacional de Salud, que establece normas sanitarias mínimas destinadas a prevenir y controlar la contaminación atmosférica; La Resolución Exenta N° 1514 de 1999, de la Dirección Ejecutiva de la Comisión Nacional del Medio Ambiente, que dio inicio al proceso de revisión de las normas primarias de calidad de aire para anhídrido sulfuroso (SO2); partículas totales en suspensión (PTS); monóxido de carbono (CO); ozono (03) y dióxido de nitrógeno (NO2) ; La Resolución Exenta N° 915 del 2000, de la Dirección Ejecutiva de la Comisión Nacional del Medio Ambiente, que aprobó el anteproyecto de revisión de la norma primaria de calidad de aire para anhídrido sulfuroso (SO2); El análisis general del impacto económico y social de la norma señalada; Las observaciones formuladas en la etapa de consulta al anteproyecto de norma; El acuerdo Nº180 de 3 de mayo de 2001, del Consejo Directivo de la Comisión Nacional del Medio Ambiente, que aprobó el proyecto definitivo de la norma de calidad; Los demás antecedentes que obran en el expediente público respectivo y lo dispuesto en la Resolución Nº520 de 1996, de la Contraloría General de la República que fija el texto refundido, coordinado y sistematizado de la Resolución Nº 55 de 1992, de la Contraloría General de la República.

CONSIDERANDO:

Que de acuerdo con lo preceptuado en la Ley 19.300, es deber del Estado dictar y revisar normas para regular la presencia de contaminantes en el medio ambiente, de manera de prevenir que éstos puedan significar o representar, por sus niveles, concentraciones y periodos, un riesgo para la salud de las personas.

Que sobre la base de los antecedentes disponibles y que constan en el expediente público, se revisó la norma primaria de calidad de aire para anhídrido sulfuroso o dióxido de azufre (SO2), contenida en la Resolución 1215 de 1978, del Delegado del Gobierno en el Servicio Nacional de Salud y en el Decreto Supremo N°185 de 1991, del Ministerio de Minería, en conformidad al procedimiento y los contenidos establecidos en el Decreto Supremo N°93 de 1995, de Ministerio Secretaria General de la Presidencia.

Que el dióxido de azufre es un importante broncoconstrictor, desde los primeros minutos de exposición y su efecto aumenta con la actividad física, con la hiperventilación, al respirar aire frío y seco y en personas con hiperreactividad bronquial.

Que la exposición a este contaminante puede producir efectos agudos y crónicos sobre la salud de las personas.

Que el dióxido de azufre se origina de la combustión del azufre contenido en los combustibles fósiles (petróleos combustibles, gasolina, petróleo diesel, carbón, etc.), de la fundición de minerales que contienen azufre y de otros procesos industriales.

Que el dióxido de azufre puede presentar efectos adicionales a los de salud tales como efectos sobre la vegetación, ecosistemas y materiales expuestos a este contaminante.

Que el dióxido de azufre es un precursor de aerosoles secundarios.

Que a nivel nacional existen localidades con población expuesta a altas concentraciones de dióxido de azufre en el aire por periodos cortos de exposición, producto de las emisiones generadas por fuentes específicas. A objeto de estudiar los efectos que se producen en la salud de las personas, se requiere recopilar información sobre la incidencia y prevalencia de asmáticos y los niveles de concentración de calidad de aire para dióxido de azufre en periodos cortos de exposición.

DECRETO:

TITULO I

Disposiciones Generales y Definiciones

Artículo 1.- La presente norma de calidad ambiental tiene por objetivo proteger la salud de la población de aquellos efectos agudos y crónicos generados por la exposición a niveles de concentración de dióxido de azufre en el aire.

Artículo 2.- Para efectos de lo dispuesto en la presente norma, se entenderá por:

a. *ppbv*: Unidad de medida de concentración en volumen, correspondiente a una milésima parte por millón.

b. *Concentración de Dióxido de Azufre*: Valor promedio temporal detectado en el aire expresado en partes por billón (ppbv) o en microgramos por metro cúbico normal (ug/m3N).

   La condición normal corresponde a la presión de una atmósfera (1 atm.) y una temperatura de 25 grados Celcius (25°C).

c. *Concentración de 1 hora*: Promedio aritmético de los valores de concentración de dióxido de azufre medidos en una 1 hora.

d. *Concentración de 24 horas*: Promedio aritmético de los valores de concentración de 1 hora de dióxido de azufre correspondientes a un bloque de 24 horas sucesivas, contadas desde las cero horas de cada día.

e. *Concentración trimestral:* Promedio aritmético de los valores de concentración de 24 horas de dióxido de azufre correspondientes a un periodo de tres meses sucesivos.

f. *Concentración anual*: Promedio aritmético de los valores de concentración trimestral de dióxido de azufre correspondientes a un año.

g. *Año calendario:* Período que se inicia el 1° de enero y culmina el 31 de diciembre del mismo año.

h. *Estación monitora con representatividad poblacional para gas dióxido de azufre (EMRPG):* Una estación de monitoreo que se encuentra localizada en un área habitada.

Se entiende como área habitada, una porción del territorio donde vive habitual y permanentemente un conjunto de personas.

i. *Percentil*: Corresponde al valor "q" calculado a partir de valores de concentración aproximados al ppbv o ug/m3N más cercano. Todos los valores se anotarán en una lista establecida por orden creciente para cada estación de monitoreo.

$$X1 \leq X2 \leq X3 \ldots \leq Xk \leq X\,n-1 \leq Xn$$

El percentil será el valor del elemento de orden "k", para el que "k" se calculará por medio de la siguiente fórmula:

k = q X n , donde "q" = 0.99 para el Percentil 99, y "n" corresponde al número de datos de una serie. El valor "k" se aproximará al número entero más próximo.

TITULO II

Nivel de Norma de Calidad Primaria para Dióxido de Azufre en Aire

Artículo 3.- La norma primaria de calidad de aire para dióxido de azufre como concentración anual será de 31 ppbv (80 ug/m3N).

Se considerará sobrepasada la norma primaria de calidad de aire para dióxido de azufre como concentración anual, cuando el promedio aritmético de los valores de concentración anual de tres años calendarios sucesivos, en cualquier estación monitora EMRPG, fuere mayor o igual al nivel indicado en el inciso precedente.

Si el periodo de medición en una estación monitora EMRPG no comenzare el 1° de enero, se considerarán los tres primeros periodos de 12 meses a partir del mes de inicio de las mediciones hasta disponer de tres años calendarios sucesivos de mediciones.

Se considerará sobrepasada la norma primaria de calidad de aire para dióxido de azufre como concentración anual, si en el primer o segundo periodo de 12 meses a partir del mes de inicio de las mediciones y, al reemplazar la concentración anual para los periodos faltantes por cero, el promedio aritmético de los tres periodos resultare mayor o igual al nivel de la norma.

Artículo 4.- La norma primaria de calidad de aire para dióxido de azufre como concentración de 24 horas será de 96 ppbv (250 ug/m3N).

Se considerará sobrepasada la norma primaria de calidad de aire para dióxido de azufre como concentración de 24 horas, cuando el promedio aritmético de tres años sucesivos, del percentil 99 de las concentraciones de 24 horas registradas durante un año calendario, en cualquier estación monitora EMRPG, fuere mayor o igual al nivel indicado en el inciso precedente.

Si el periodo de medición en una estación monitora EMRPG no comenzare el 1° de enero, se considerarán los tres primeros periodos de 12 meses a partir del mes de inicio de las mediciones hasta disponer de tres años calendarios sucesivos de mediciones.

Se considerará sobrepasada la norma primaria de calidad de aire para dióxido de azufre como concentración de 24 horas, si en el primer o segundo periodo de 12 meses a partir del mes de inicio de las mediciones y, al reemplazar el percentil 99 de las concentraciones de 24 horas para los periodos faltantes por cero, el promedio aritmético de los tres periodos resultare mayor o igual al nivel de la norma.

Artículo 5.- Los siguientes niveles originarán situaciones de emergencia ambiental para dióxido de azufre, en concentración de una hora:

Nivel 1: 750 - 999 ppbv	(1.962 - 2.615 ug/m3N)
Nivel 2: 1.000 – 1.499 ppbv	(2.616 - 3.923 ug/m3N)
Nivel 3: 1.500 ppbv o superior	(3.924 ug/m3N o superior)

Los niveles que originan situaciones de emergencia ambiental para dióxido de azufre podrán ser obtenidos mediante la aplicación de una metodología de pronóstico de calidad de aire aprobada por el Servicio de Salud respectivo, mediante resolución fundada, o por medio de la constatación de las concentraciones del contaminante a partir de alguna de las estaciones monitoras de calidad de aire EMRPG.

Para los efectos de lo señalado anteriormente, se entenderá por metodología de pronóstico de calidad de aire a aquella que:

a. Entregue un procedimiento mediante el cual es posible predecir la ocurrencia de alguno de los niveles que originan situaciones de emergencia ambiental para dióxido de azufre.

b. Entregue el grado de confiabilidad de la metodología de pronóstico.

c. Considere, además, los siguientes elementos:

- La zona geofráfica de aplicación, y
- La evaluación y validación de la metodología de pronóstico.

d. Considere, según la situación especial en la cual va a ser aplicada, entre otras, las siguientes variables:

- Emisiones de dióxido de azufre,
- Condiciones meteorológicas,
- Condiciones topográficas,
- Procesos de acumulación y remoción de contaminantes

Para la aprobación de la metodología de pronóstico deberá considerarse como antecedente un informe técnico realizado por expertos nacionales o internacionales sobre la metodología de pronóstico.

Se podrá omitir o dejar sin efecto una situación de emergencia ambiental si se detectare un cambio en las condiciones meteorológicas en forma posterior a la hora de comunicación del pronóstico o a la constatación de la superación de los niveles de calidad de aire, y siempre que dicho cambio asegure una mejoría tal en las condiciones de calidad de aire que invalide los resultados entregados por el pronóstico o que asegure la reducción de los niveles de concentración de calidad de aire por debajo de aquellos que originan situaciones de emergencia ambiental.

Artículo 6.- Para efectos de evaluar el cumplimiento de la norma y los valores que originan situaciones de emergencia ambiental se utilizarán los valores de concentración expresados en ppbv.

Artículo 7.- Cuando el dióxido de azufre fuese precursor de otro contaminante normado, los planes de descontaminación o prevención que se establezcan para el control de este contaminante, podrán incluir medidas de reducción de emisiones del contaminante dióxido de azufre, independientemente del cumplimiento de las normas de calidad de aire que esta norma establece.

TITULO III

Metodología de Medición de la Norma

Artículo 8.- La medición de la concentración de dióxido de azufre en el aire se realizará mediante uno cualesquiera de los siguientes métodos de medición:

a. Fluorescencia ultravioleta;
b. Espectrometría de absorción diferencial con calibración in – situ y,
c. Un método de medición de referencia o equivalente designado o aprobado por la Agencia de Protección Ambiental de los Estados Unidos o por las Directivas de la Comunidad Europea.

El monitoreo de calidad de aire deberá realizarse con instrumentos que cumplen con los métodos de medición señalados en el inciso anterior y que hayan sido reconocidos, aprobados o certificados por la Agencia de Protección Ambiental de los Estados Unidos o por las Directivas de la Comunidad Europea.

Artículo 9.- Para efectos de cumplir con lo establecido en el artículo 13, podrán utilizarse técnicas de medición alternativas a las señaladas en el artículo precedente, las que deberán ser aprobadas por el Servicio de Salud respectivo. Para el monitoreo mediante estas técnicas se deberá considerar lo establecido en la letra (h) del artículo 2 del presente decreto.

TITULO IV

Validación de la Información de Monitoreo de Calidad de Aire

Artículo 10.- Se considerará válida la concentración anual, si para cada uno de los trimestres de un año, se dispusiere de a lo menos un 75% de los datos de concentración de 24 horas para ese periodo.

Se considerará válido el percentil 99 de las concentraciones de 24 horas registradas en un año , si, a lo menos, el 75% de los datos de concentración de 24 horas para el periodo de un año, se encontraren disponibles y dan cuenta de la variación de los datos a lo largo de un año (ciclo estacional).

Se considerará válida la concentración de 24 horas, si, a lo menos, el 75% de los datos de concentración de 1 hora para un periodo de 24 horas, se encontraren disponibles y dan cuenta de la variación de los datos a lo largo de un día (ciclo diario).

En el evento de que se dispusiere de menos del 75% de los datos de concentración de 1 hora, la concentración de 24 horas será considerada, sólo para efectos de verificar el cumplimiento de la norma primaria de calidad de aire como concentración de 24 horas y como concentración anual, si, al reemplazar por cero los datos que faltaren para completear el 75% requerido, la concentración de 24 horas fuere mayor o igual al valor de la norma primaria de calidad de aire como concentración de 24 horas.

Si se dispusiere de datos de concentración de 1 hora para 18, 19, 20, 21, 22 o 23 horas, la concentración de 24 horas se calculará como el promedio aritmético de los datos de concentración de 1 hora disponibles, utilizando como divisor 18, 19, 20, 21, 22 o 23, según corresponda.

Se considerará válida la concentración de 1 hora, si, a lo menos, se dispusiere de 30 minutos sucesivos de medición.

TITULO V

Fiscalización de la Norma

Artículo 11.- Corresponderá a los Servicios de Salud del país y, en la Región Metropolitana al Servicio de Salud Metropolitano del Ambiente, fiscalizar el cumplimiento de las disposiciones de la presente norma.

TITULO VI

Implementación de la Norma

Artículo 12.-Los Servicios de Salud respectivos deberán dentro del plazo de seis meses, contados desde la publicación del presente decreto en el Diario Oficial, determinar mediante resolución fundada aquellas estaciones monitoras que se considerarán como EMRPG.

Artículo 13.- Los Servicios de Salud respectivos deberán dentro del plazo de tres años, contados desde la publicación del presente decreto en el Diario Oficial, realizar un diagnóstico de la calidad de aire para dióxido de azufre según sus competencias territoriales.

Dicho diagnóstico deberá considerar la información de calidad de aire disponible así como la que se genere a partir de organismos públicos y privados.

Los Servicios de Salud respectivos deberán dentro del plazo de dos años, contados desde que se disponga del diagnóstico, elaborar e implementar un programa priorizado de monitoreo para el seguimiento de la norma primaria de calidad de aire para dióxido de azufre.

Dicho programa deberá ser revisado periódicamente en función de los nuevos antecedentes de calidad de aire de que se disponga, los cuales deberán incorporar la información tanto pública como privada.

Artículo 14.- El monitoreo de la calidad de aire según los métodos de medición señalados en los artículos octavo y noveno del presente decreto, deberá realizarse de acuerdo a las disposiciones establecidas por el Servicio de Salud respectivo, el que deberá considerar, cuando se encuentre disponible, lo que señale el manual de aplicación técnico de la norma.

El manual de aplicación técnico de la norma deberá ser elaborado por la Comisión Nacional del Medio Ambiente .~~dentro del plazo de un año contado desde la publicación del presente decreto en el diario oficial.~~

Artículo 15.- Los Servicios de Salud respectivos deberán tener a disposición de la ciudadanía, los datos de los niveles de concentración de calidad de aire para dióxido de azufre correspondientes a la presente norma, los que serán públicos.

TITULO VII

Generación de Antecedentes para la Regulación de Efectos Agudos

Artículo 16.- Los Servicios de Salud respectivos deberán en forma sistemática recopilar la siguiente información:

- Niveles de concentración de calidad de aire para dióxido de azufre como concentración de 5 minutos y una hora, a partir del monitoreo de la calidad de aire de dióxido de azufre.

- Incidencia y prevalencia de asma, en especial en aquellas localidades en las que existe población expuesta a altos niveles de concentración de dióxido de azufre en periodos cortos de exposición.

TITULO VIII

Entrada en Vigencia

Artículo 17.- La presente norma de calidad entrará en vigencia a partir del día primero del mes siguiente al de su publicación en el Diario Oficial. ~~quedando desde esa fecha sin efecto las normas primarias de calidad de aire para dióxido de azufre o anhídrido sulfuroso vigentes a esa fecha.~~

Artículos Transitorios

Artículo primero transitorio.- En el periodo comprendido desde la entrada en vigencia de la norma y hasta disponer de tres años sucesivos de mediciones, la norma primaria de calidad de aire para dióxido de azufre como concentración anual o de 24 horas se considerará sobrepasada, si en el primer o segundo periodo de 12 meses y, al reemplazar la concentración anual o el percentil 99 de las concentraciones de 24 horas para los periodos faltantes por cero, el promedio aritmético de los tres periodos resultare mayor o igual al nivel de la norma correspondiente.

Artículo segundo transitorio.- Las ~~áreas~~ zonas del territorio de la República que hayan sido declaradas latentes o saturadas para dióxido de azufre, mantendrán ~~su vigencia~~ dicha calidad mientras no se cuente con las mediciones efectuadas en la forma y periodos señalados en el presente decreto~~, en tanto se mantengan las condiciones que las hacen procedentes.~~

~~Las disposiciones contenidas en la presente norma serán incorporadas, en lo que corresponda, en los planes de prevención y de descontaminación por dióxido de azufre que se encuentren vigentes o en trámite a la fecha de su entrada en vigencia, adelantando para esos efectos los plazos de revisión de dichos planes si fuere necesario.~~

ANÓTESE, TÓMESE RAZÓN Y PUBLÍQUESE.

RICARDO LAGOS ESCOBAR

Presidente de la República

ALVARO GARCÍA HURTADO
Ministro
Secretario General de la Presidencia

MICHELLE BACHELET JERIA
Ministra de Salud

Nacional de Vehículos Motorizados. Demás estipulaciones constan en escritura extractada. Santiago, 24 de marzo de 1998.

EXTRACTO

Kamel Saquel Zaror, Notario Público Titular 40ª Notaría Santiago, con oficio calle Teatinos Nº 335, Santiago, Certifico: Por escritura pública hoy, ante mí, don **Jorge Luis Acevedo Caroca**, domiciliado San Alberto 0237, Puente Alto, Santiago, constituyó prenda Ley 18.112, en favor Banco de Crédito e Inversiones, Huérfanos Nº 1134, Santiago, representado por don Mario Sarrat González, para garantizar todas las obligaciones que le adeude o le adeudare en el futuro sobre siguiente bien de su propiedad: Automóvil, marca Nissan, modelo Sentra, 1.6 LX Sedan, Motor E16398175 M, Chassis PB12MD74208, color café oscuro metálico, año 1991, inscrito bajo el Nº HY.6036-7. Santiago, 23 de marzo de 1998.

EXTRACTO

Fernando Opazo Larraín, Titular 9ª Notaría Stgo., Huérfanos 1313, 4º piso, certifica: Por escritura hoy ante mí, **Lina de los Angeles Acevedo López,** transportista, Sócrates 910 depto. 101, Ñuñoa; a fin de garantizar al Banco Sud Americano, Morandé 226, Santiago, el exacto, oportuno e íntegro cumplimiento de todas y cada una de las obligaciones que José Manuel Astudillo Figueroa actualmente tuviere o en el futuro contrajere con el Banco referido, indicadas escritura extractada, constituye prenda sin desplazamiento, de garantía general y primer grado, sobre un furgón marca Hyundai, modelo Grace Van, color amarillo, año 1998, motor Nº G4CSV-465498, chasis KMFFD27GPWU-384744, inscrito en el R.N.V.M. bajo el Nº SA.8414-5 demás estipulaciones escritura extractada.- Stgo. 27/03/98.

EXTRACTO

Hugo Leonardo Pérez Pousa, Notario Público, Titular 20ª Notaría Santiago, Amunátegui Nº333, certifico que por escritura hoy, ante mí, don **Alvaro Alberto Acuña Rojas,** chileno, casado, empleado, domiciliado en Jerez 3922, Conchalí, c.n.i. 9.807.286-1, constituyó en favor del Banco Santiago, el que aceptó representado por don Ramón Cifuentes Ovalle, chileno, casado, abogado, c.n.i. 6.524.108-0, ambos domiciliados Bandera 201, Santiago, prenda sin desplazamiento conforme ley 18.112, sobre: Automóvil marca Nissan, modelo V16 Sentra 1.6, color rojo oscuro, año de fabricación 1994, motor NºE16717014M, chassis Nº3N1BJAB13R010221, inscrito LP 2500-2 Registro Vehículos Motorizados. Prenda se constituyó con cláusula garantía general a fin caucionar cumplimiento todas las obligaciones que el constituyente tenga o en el futuro tuviera con señalado Banco. Santiago, 31 de marzo de 1998.

EXTRACTO

Sergio Alfonso Gana Rojas, Notario Público, Suplente del titular René Ernesto Pica Pemjean, Campos 377, Rancagua, certifico: Por escritura de hoy ante mí, la **"Agrícola Las Raíces Limitada"**, representada por don Alejandro Raúl Isidro Herrera Pérez, chileno, casado, agricultor, C.I. Nº 2.627.987-9, ambos domiciliados en Cristóbal Colón 490, Rancagua, constituyó en favor del Banco de Chile, sociedad anónima bancaria, representada por don Francisco Javier Contreras Soto, chileno, casado, empleado, C.I. Nº 8.876.052-2, ambos con domicilio en Rancagua, calle Independencia Nº 500, prenda sin desplazamiento, en conformidad a la Ley 18.112, para garantizar todas las obligaciones de crédito de dinero contraídas o que contrajere en el futuro Fénix S.A., sobre: Las plantaciones que se indican más adelante, que se encuentran ubicadas en resto de la Hijuela número seis o Hijuela El Peral del Fundo Santa Elena de Callejones, ubicada en la Comuna de Codegua, inscrito a nombre de la sociedad a fs. 6052 vta. Nº 4104 del Registro de Propiedad del Conservador de Bienes Raíces de Rancagua, correspondiente al año 1987: a) 148 plantas de manzanos de la variedad Granny Smith, plantadas en el año 1988 a una distancia de 3 por 5 metros cada una, cubriendo una superficie de 0,22 hectáreas; b) 996 plantas de manzanos de la variedad Red King Oregon, plantadas en el año 1988 a una distancia de 3 por 5 metros cada una, cubriendo una superficie de 1,49 hectáreas; c) 1375 plantas de manzanos de la variedad Royal Gala, injertadas en el año 1991, a una distancia de 3 por 5 metros cada una, cubriendo una superficie de 2,06 hectáreas; d) 113 plantas de manzanos de la variedad Granny Smith, plantadas en el año 1990 a una distancia de 5 por 5 metros cada una, cubriendo una superficie de 0,28 hectáreas; e) 798 plantas de manzanos de la variedad Red King Oregon, plantadas en el año 1990 a una distancia de 5 por 5 metros cada una, cubriendo una superficie de 2 hectáreas; f) 607 plantas de manzanos de la variedad Royal Gala, injertadas en el año 1991, a una distancia de 5 por 5 metros cada una, cubriendo una superficie de 1,52 hectáreas; g) 656 plantas de manzanos de la variedad Royal Gala injertados en el año 1997, a una distancia de 5 por 5 metros cada una, las que se encuentran intercaladas entre las plantas de la variedad Red King Oregon; h) 4784 plantas de perales de la variedad Red Bartlett, plantadas en el año 1987, a una distancia de 2,5 por 5 metros, cubriendo una superficie de 5,98 hectáreas; i) 2216 plantas de perales de la variedad Beurre Bosc, plantadas en el año 1987, a una distancia de 2,5 por 5 metros, cubriendo una superficie de 2,77 hectáreas; j) 528 plantas de perales de la variedad Red Bartlett, plantadas en el año 1989, a una distancia de 1,25 por 5 metros, cubriendo una superficie de 0,33 hectáreas; k) 595 plantas de perales de la variedad Beurre Bosc, plantadas en el año 1989, a una distancia de 1,25 por 5 metros, cubriendo una superficie de 0,37 Bosc, plantadas en el año 1989, a una distancia de 1,25 por 5 metros, cubriendo una superficie de 0,37 hectáreas; l) 488 plantas de nectarines de la variedad Flame Kist, plantadas en el año 1987, a una distancia de 2,5 por 4 metros, cubriendo una superficie de 0,49 hectáreas; m) 968 plantas de nectarines de la variedad Fantasía, plantadas en el año 1987, a una distancia de 2,5 por 4 metros, cubriendo una superficie de 0,97 hectáreas; n) 993 plantas de duraznenos de la variedad O'Henry, plantadas en el año 1987, a una distancia de 2,5 por 4 metros, cubriendo una superficie de 0,99 hectáreas; ñ) 337 plantas de cerezos de la variedad Van, plantadas en el año 1990, a una distancia de 5 por 6,5 metros cubriendo una superficie de 1,10; o) 891 plantas de cerezos de la variedad Bing, plantadas en el año 1990, a una distancia de 5 por 6,5 metros, cubriendo una superficie de 2,90 hectáreas; p) 100 plantas de cerezos de la variedad Black Tartarian, plantadas en el año 1990, a una distancia de 5 por 6,5 metros, cubriendo una superficie de 0,33 hectá-

Comisión Nacional del Medio Ambiente

TERCER PROGRAMA PRIORIZADO DE NORMAS

EXTRACTO

De conformidad con lo dispuesto en decreto supremo Nº93 de 1995, del Ministerio Secretaría General de la Presidencia, con fecha 27 de marzo de 1998, el Consejo Directivo de la Comisión Nacional del Medio Ambiente aprobó el tercer Programa Priorizado de Normas, que corresponde al que sigue:

1. Recurso Atmosférico
1.1 Normas nuevas
1.1.1 Normas de Emisión (fuentes estacionarias) para óxidos de nitrógeno (NOx), compuestos orgánicos volátiles (COV) y monóxido de carbono (CO) en la industria de cemento, vidrio, acero, calderas y turbinas: Región Metropolitana.
1.1.2 Normas de Emisión (fuentes móviles) para óxidos de nitrógeno (NOx) para revisión técnica de vehículos con convertidor catalítico: Región Metropolitana.
1.1.3 Normas de Emisión (fuentes móviles) para motocicletas: Región Metropolitana

1.2 Revisión de Normas
1.2.1 Revisión de Norma Primaria de Calidad de Anhídrido Sulfuroso (SO2)
1.2.2 Revisión de Norma Primaria de Calidad de Partículas Totales en Suspensión (PTS).
1.2.3 Revisión de Norma Primaria de Calidad de Monóxido de Carbono (CO).
1.2.4 Revisión de Norma Primaria de Calidad de Oxidantes Fotoquímicos expresados como Ozono (O3).
1.2.5 Revisión de Norma Primaria de Calidad de Dióxido de Nitrógeno (NO2)
1.2.6 Revisión de Norma de Emisión (fuentes estacionarias) de Material Particulado (MP): Región Metropolitana.
1.2.7 Revisión de Normas de Emisión (fuentes móviles) de Monóxido de Carbono (CO), Hidrocarburos Totales (HC), Oxidos de Nitrógeno (NOx) y Material Particulado (MP) para buses con motores diesel y vehículos pesados: Región Metropolitana.

2. Recurso Hídrico
2.1 Normas nuevas
2.1.1 Norma Secundaria de Calidad para Aguas Marinas: Región del Bío Bío.

Abril 1998 - **DIRECCION EJECUTIVA**

MINISTERIO DE VIVIENDA Y URBANISMO

CONCURSO

Llámase a Concurso de Antecedentes y Oposición, si procediere, para proveer los cargos que se indican de la Planta Nacional de Cargos de esta Secretaría de Estado, con destino en los organismos que se señalan:

SECRETARIA MINISTERIAL DE VIVIENDA Y URBANISMO
I REGION - IQUIQUE
Patricio Lynch Nº50 - Iquique
2 Cargos de Profesional grado 12 EUR
1 Cargo de Profesional grado 14 EUR
1 Cargo de Profesional grado 17 EUR

SERVICIO DE VIVIENDA Y URBANIZACION
VI REGION - RANCAGUA
Alameda Bernardo O'Higgins Nº176 - Rancagua
2 Cargos de Profesional grado 12 EUR

SECRETARIA MINISTERIAL DE VIVIENDA Y URBANISMO
X REGION - PUERTO MONTT

Edificio Intendencia Regional, 3º piso - Anexo B - Puerto Montt.
1 Cargo de jefe Sección grado 12 EUR

REQUISISTOS GENERALES PARA TODOS LOS CARGOS: Los establecidos en el artículo 3º de la ley Nº19.179, que sustituyó la Planta Nacional de Cargos del Ministerio de Vivienda y Urbanismo y los fijados para el ingreso a la Administración Pública en la ley Nº18.834, que aprueba el Estatuto Administrativo.
Las bases de los concursos estarán disponibles para los interesados en las direcciones indicadas, desde el 15 al 28 de abril de 1998, inclusive, dentro del mismo plazo podrán presentar las postulaciones a los correspondientes cargos y organismos, adjuntando para esos efectos carta solicitud, curriculum vitae y demás antecedentes.
Los concursos se resolverán a más tardar el 12 de junio de 1998.
No se devolverán antecedentes.
NOTA: Déjase sin efecto el concurso publicado el 15.02.97, en lo que se refiere a la provisión de 2 cargos de Profesional grado 12 EUR, en Serviu VI Región.

SERGIO GONZALEZ TAPIA
(15) **Subsecretario de Vivienda y Urbanismo**

ción, cuya masa en orden de marcha es menor o igual a 680 Kg.

b) Masa en orden de marcha: Corresponde a la masa del vehículo, incluido su equipamiento estándar y los fluidos propios de la operación.

Artículo 3º.- Los vehículos señalados en el artículo 1º, deberán cumplir en condiciones normalizadas, con los niveles máximos de emisión de Monóxido de Carbono (CO) e Hidrocarburos Totales (HCT), medidos ambos en gramos por kilómetros de recorrido (gr/km), que se indican en el siguiente cuadro.

Contaminante	Unidad	Límite Máximo Permitido
Monóxido de Carbono (CO)	gr/km	12
Hidrocarburos Totales (HCT)	gr/km	5

Artículo 4º.- Para los efectos de certificar el cumplimiento de la presente norma de emisión, las condiciones normalizadas de medición serán las establecidas por la Agencia de Protección Ambiental de los Estados Unidos de Norteamérica (Usepa), en el llamado Code of Federal Regulation, título 40, parte 86-Control of Air Pollution from new vehicles engines, en el método Federal Test Procedure 75 (FTP 75).

Artículo 5º.- Corresponderá al Ministerio de Transportes y Telecomunicaciones certificar y fiscalizar el cumplimiento de la norma de emisión.

Artículo 6º.- Los fabricantes, importadores, armadores o distribuidores de motocicletas deberán acreditar ante el Ministerio de Transportes y Telecomunicaciones, conforme a las pautas dictadas, que el modelo de que se trata cumple con los niveles máximos de emisión señalados en el artículo 3º.

Artículo 7º.- El Ministerio de Transportes y Telecomunicaciones determinará, de ser necesario, las características de la rotulación y autoadhesivos que deberán ser incorporados en estos vehículos para fiscalizar el cumplimiento de la norma.

Artículo 8º.- Esta norma entrará en vigencia el 1 de septiembre del año 2001.

Anótese, tómese razón, publíquese.- RICARDO LAGOS ESCOBAR, Presidente de la República.- Carlos Cruz Lorenzen, Ministro de Transportes y Telecomunicaciones.- Alvaro García Hurtado, Ministro Secretario General de la Presidencia.

Lo que transcribo para su conocimiento.- Saluda a Ud., Jorge Lobos Díaz, Jefe Administrativo Subrogante.

Ministerio Secretaría General de la Presidencia

Comisión Nacional del Medio Ambiente

APRUEBA ANTEPROYECTOS DE NORMAS DE CALIDAD DE AIRE PARA MONOXIDO DE CARBONO (CO), OZONO (O3), DIOXIDO DE NITROGENO (NO2), ANHIDRIDO SULFUROSO (SO2) Y PARTICULAS TOTALES EN SUSPENSION (PTS)

(Extracto)

Por resoluciones exentas números 912, 913, 914, 915 y 916, de la Directora Ejecutiva de la Comisión Nacional del Medio Ambiente, de fecha 8 de agosto de 2000, se aprobaron los Anteproyectos de Revisión de las Normas de Calidad de Aire para Monóxido de Carbono (CO), Ozono (O3), Dióxido de Nitrógeno (NO2), Anhídrido Sulfuroso (SO2) y Partículas Totales en Suspensión (PTS) y se ordenó someterlos a consulta. Las mismas resoluciones ordenan publicarlos en extracto y es del tenor siguiente:

1. FUNDAMENTOS

El conocimiento de los efectos de los contaminantes monóxido de carbono, ozono, dióxido de nitrógeno, anhídrido sulfuroso y partículas totales en suspensión en la salud de la población, sobre la base de antecedentes nacionales, procesos normativos internacionales y recomendaciones de la Organización Mundial de la Salud (OMS), permite realizar proposiciones de niveles objetivo para ser cumplidos a través de normas ambientales, por lo que los valores de normas de calidad primaria vigentes para estos contaminantes contenidos en la resolución 1.215 de 1978, del Delegado de Gobierno en el Servicio Nacional de Salud y para el caso del anhídrido sulfuroso también en el decreto supremo Nº185 de 1991, del Ministerio de Minería, requieren ser revisados a la luz de tales resultados.

2. OBJETIVOS DE LAS NORMAS

Las presentes normas tienen por objetivo proteger la salud de la población de aquellos efectos agudos generados por la exposición a monóxido de carbono, ozono, dióxido de nitrógeno y anhídrido sulfuroso, y de aquellos efectos crónicos generados por la exposición a dióxido de nitrógeno y anhídrido sulfuroso.

3. NORMA DE CALIDAD DE AIRE PARA MONOXIDO DE CARBONO, OZONO, DIOXIDO DE NITROGENO, ANHIDRIDO SULFUROSO Y PARTICULAS TOTALES EN SUSPENSION

Contaminante	Norma	Período
CO	25 ppmv 9 ppmv	1 hora 8 horas
O3	60 ppbv	8 horas
NO2	53 ppbv 212 ppbv	Anual 1 hora
SO2	30 ppbv 95 ppbv 400 ppbv	Anual 24 horas 1 hora
PTS	Sin valores de concentración	

4. NIVELES QUE ORIGINAN SITUACIONES DE EMERGENCIA AMBIENTAL

Contaminante	Nivel	Periodo
CO	Nivel 1: 15 29 ppmv Nivel 2: 30 34 ppmv Nivel 3: 35 ppmv o superior	8 horas 8 horas 8 horas
O3	Nivel 1: 200 399 ppbv Nivel 2: 400 499 ppbv Nivel 3: 500 ppbv o superior	1 hora 1 hora 1 hora
NO2	Nivel 1: 600 1.199 ppbv Nivel 2: 1.200 1.599 ppbv Nivel 3: 1.600 ppbv o superior	1 hora 1 hora 1 hora
SO2	Nivel 1: 750 999 ppbv Nivel 2: 1.000 1.499 ppbv Nivel 3: 1.500 ppbv o superior	1 hora 1 hora 1 hora

5. METODOLOGIA DE MEDICION Y CONTROL DE LAS NORMAS

Contaminante	Método de Medición
CO O3	- Fotometría infrarroja no dispersiva - Quimiluminiscencia con etileno - Fotometría absorción ultravioleta - Cromatografía líquida gas/sólido - Espectrometría de absorción óptica diferencial, con calibración in-situ.
NO2	- Quimiluminiscencia - Los que se basen en el método modificado de Griess-Saltzmann - Espectrometría de absorción óptica diferencial, con calibración in-situ.
SO2	- Fluorescencia ultravioleta - Espectrometría de absorción óptica diferencial, con calibración in-situ.

6. FISCALIZACION DE LAS NORMAS

Corresponderá a los Servicios de Salud del país y, en la Región Metropolitana al Servicio de Salud Metropolitano del Ambiente.

7. PLAZO PARA SU ENTRADA EN VIGENCIA

Las normas de calidad ambiental contenidas en los presentes anteproyectos entrarán en vigencia el día 1º del mes siguiente de la publicación en el Diario Oficial del decreto supremo que las establezca.

Sométase a consulta los presentes anteproyectos de normas de calidad de aire.- Directora Ejecutiva.

C01349

REPUBLICA DE CHILE
COMISION NACIONAL DEL MEDIO AMBIENTE
ASR/PMC

ESTABLECE NORMA PRIMARIA DE CALIDAD DE AIRE PARA DIOXIDO DE AZUFRE (SO_2)

SANTIAGO,

VISTOS:

Lo dispuesto en el artículo 19 Nº 8 de la Constitución Política; En el artículo 32 de la Ley 19.300; El Reglamento para la Dictación de Normas de Calidad Ambiental y de Emisión, aprobado por el Decreto Supremo Nº93 de 1995, del Ministerio Secretaría General de la Presidencia; El Decreto Supremo Nº185 de 1991, del Ministerio de Minería, que Reglamenta el Funcionamiento de los Establecimientos Emisores de Anhídrido Sulfuroso, Material Particulado y Arsénico en todo el Territorio de La República; La Resolución Nº1215 de 1978 del Delegado del Gobierno en el Servicio Nacional de Salud, que establece normas sanitarias mínimas destinadas a prevenir y controlar la contaminación atmosférica; La Resolución Exenta Nº 1514 de 1999, de la Dirección Ejecutiva de la Comisión Nacional del Medio Ambiente, que dio inicio al proceso de revisión de las normas primarias de calidad de aire para anhídrido sulfuroso (SO2); partículas totales en suspensión (PTS); monóxido de carbono (CO); ozono (03) y dióxido de nitrógeno (NO2) ; La Resolución Exenta Nº 915 del 2000, de la Dirección Ejecutiva de la Comisión Nacional del Medio Ambiente, que aprobó el anteproyecto de revisión de la norma primaria de calidad de aire para anhídrido sulfuroso (SO2); El análisis general del impacto económico y social de la norma señalada; Las observaciones formuladas en la etapa de consulta al anteproyecto de norma; El acuerdo Nº180 de 3 de mayo de 2001, del Consejo Directivo de la Comisión Nacional del Medio Ambiente, que aprobó el proyecto definitivo de la norma de calidad; Los demás antecedentes que obran en el expediente público respectivo y lo dispuesto en la Resolución Nº520 de 1996, de la Contraloría General de la República que fija el texto refundido, coordinado y sistematizado de la Resolución Nº 55 de 1992, de la Contraloría General de la República.

CONSIDERANDO:

Que de acuerdo con lo preceptuado en la Ley 19.300, es deber del Estado dictar y revisar normas para regular la presencia de contaminantes en el medio ambiente, de manera de prevenir que éstos puedan significar o representar, por sus niveles, concentraciones y periodos, un riesgo para la salud de las personas.

Que sobre la base de los antecedentes disponibles y que constan en el expediente público, se revisó la norma primaria de calidad de aire para anhídrido sulfuroso o dióxido de azufre (SO_2), contenida en la Resolución 1215 de 1978, del Delegado del Gobierno en el Servicio Nacional de Salud y en el Decreto Supremo N°185 de 1991, del Ministerio de Minería, en conformidad al procedimiento y los contenidos establecidos en el Decreto Supremo N°93 de 1995, de Ministerio Secretaria General de la Presidencia.

Que el dióxido de azufre es un importante broncoconstrictor, desde los primeros minutos de exposición y su efecto aumenta con la actividad física, con la hiperventilación, al respirar aire frío y seco y en personas con hiperreactividad bronquial.

Que la exposición a este contaminante puede producir efectos agudos y crónicos sobre la salud de las personas.

Que el dióxido de azufre se origina de la combustión del azufre contenido en los combustibles fósiles (petróleos combustibles, gasolina, petróleo diesel, carbón, etc.), de la fundición de minerales que contienen azufre y de otros procesos industriales.

Que el dióxido de azufre puede presentar efectos adicionales a los de salud tales como efectos sobre la vegetación, ecosistemas y materiales expuestos a este contaminante.

Que el dióxido de azufre es un precursor de aerosoles secundarios.

Que a nivel nacional existen localidades con población expuesta a altas concentraciones de dióxido de azufre en el aire por periodos cortos de exposición, producto de las emisiones generadas por fuentes específicas. A objeto de estudiar los efectos que se producen en la salud de las personas, se requiere recopilar información sobre la incidencia y prevalencia de asmáticos y los niveles de concentración de calidad de aire para dióxido de azufre en periodos cortos de exposición.

DECRETO:

TITULO I

Disposiciones Generales y Definiciones

Artículo 1.- La presente norma de calidad ambiental tiene por objetivo proteger la salud de la población de aquellos efectos agudos y crónicos generados por la exposición a niveles de concentración de dióxido de azufre en el aire.

Artículo 2.- Para efectos de lo dispuesto en la presente norma, se entenderá por:

a. *ppbv*: Unidad de medida de concentración en volumen, correspondiente a una milésima parte por millón.

b. *Concentración de Dióxido de Azufre*: Valor promedio temporal detectado en el aire expresado en partes por billón (ppbv) o en microgramos por metro cúbico normal (ug/m3N).

   La condición normal corresponde a la presión de una atmósfera (1 atm.) y una temperatura de 25 grados Celcius (25°C).

c. *Concentración de 1 hora*: Promedio aritmético de los valores de concentración de dióxido de azufre medidos en una 1 hora.

d. *Concentración de 24 horas*: Promedio aritmético de los valores de concentración de 1 hora de dióxido de azufre correspondientes a un bloque de 24 horas sucesivas, contadas desde las cero horas de cada día.

e. *Concentración trimestral:* Promedio aritmético de los valores de concentración de 24 horas de dióxido de azufre correspondientes a un periodo de tres meses sucesivos. ([illegible]) bloque ?

f. *Concentración anual*: Promedio aritmético de los valores de concentración trimestral de dióxido de azufre correspondientes a un año. ~~calendario~~ ¿?

g. *Año calendario:* Período que se inicia el 1° de enero y culmina el 31 de diciembre del mismo año.

h. *Estación monitora con representatividad poblacional para gas dióxido de azufre (EMRPG):* Una estación de monitoreo que se encuentra localizada en un área habitada.

   Se entiende como área habitada, una porción del territorio donde vive habitual y permanentemente un conjunto de personas.

i. *Percentil*: Corresponde al valor "q" calculado a partir de valores de concentración aproximados al ppbv o ug/m3N más cercano. Todos los valores se anotarán en una lista establecida por orden creciente para cada estación de monitoreo.

$$X1 \le X2 \le X3 \ldots\ldots \le Xk \le X\, n - 1 \le Xn$$

   El percentil será el valor del elemento de orden "k", para el que "k" se calculará por medio de la siguiente fórmula:

   k = q X n , donde "q" = 0.99 para el Percentil 99, y "n" corresponde al número de datos de una serie. El valor "k" se aproximará al número entero más próximo.

TITULO II

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Nivel de Norma de Calidad Primaria para Dióxido de Azufre en Aire

Artículo 3.- La norma primaria de calidad de aire para dióxido de azufre como concentración anual será de 31 ppbv (80 ug/m3N).

Se considerará sobrepasada la norma primaria de calidad de aire para dióxido de azufre como concentración anual, cuando el promedio aritmético de los valores de concentración anual de tres años calendarios sucesivos, en cualquier estación monitora EMRPG, fuere mayor o igual al nivel indicado en el inciso precedente.

Si el periodo de medición en una estación monitora EMRPG no comenzare el 1° de enero, se considerarán los tres primeros periodos de 12 meses a partir del mes de inicio de las mediciones hasta disponer de tres años calendarios sucesivos de mediciones.

(*) OK

Se considerará sobrepasada la norma primaria de calidad de aire para dióxido de azufre como concentración anual, si en el primer o segundo periodo de 12 meses a partir del mes de inicio de las mediciones y, al reemplazar la concentración anual para los periodos faltantes por cero, el promedio aritmético de los tres periodos resultare mayor o igual al nivel de la norma.

Artículo 4.- La norma primaria de calidad de aire para dióxido de azufre como concentración de 24 horas será de 96 ppbv (250 ug/m3N).

Se considerará sobrepasada la norma primaria de calidad de aire para dióxido de azufre como concentración de 24 horas, cuando el promedio aritmético de tres años sucesivos del percentil 99 de las concentraciones de 24 horas registradas durante un año calendario, en cualquier estación monitora EMRPG, fuere mayor o igual al nivel indicado en el inciso precedente.

Si el periodo de medición en una estación monitora EMRPG no comenzare el 1° de enero, se considerarán los tres primeros periodos de 12 meses a partir del mes de inicio de las mediciones hasta disponer de tres años calendarios sucesivos de mediciones.

(*) OK

Se considerará sobrepasada la norma primaria de calidad de aire para dióxido de azufre como concentración de 24 horas, si en el primer o segundo periodo de 12 meses a partir del mes de inicio de las mediciones y, al reemplazar el percentil 99 de las concentraciones de 24 horas para los periodos faltantes por cero, el promedio aritmético de los tres periodos resultare mayor o igual al nivel de la norma.

Artículo 5.- Los siguientes niveles originarán situaciones de emergencia ambiental para dióxido de azufre, en concentración de una hora:

Nivel 1: 750 - 999 ppbv	(1.962 - 2.615 ug/m3N)
Nivel 2: 1.000 – 1.499 ppbv	(2.616 - 3.923 ug/m3N)
Nivel 3: 1.500 ppbv o superior	(3.924 ug/m3N o superior)

Los niveles que originan situaciones de emergencia ambiental para dióxido de azufre podrán ser obtenidos mediante la aplicación de una metodología de pronóstico de calidad de aire aprobada por el Servicio de Salud respectivo, mediante resolución fundada, o por medio de la constatación de las concentraciones del contaminante a partir de alguna de las estaciones monitoras de calidad de aire EMRPG.

Para los efectos de lo señalado anteriormente, se entenderá por metodología de pronóstico de calidad de aire a aquella que:

a. Entregue un procedimiento mediante el cual es posible predecir la ocurrencia de alguno de los niveles que originan situaciones de emergencia ambiental para dióxido de azufre.

b. Entregue el grado de confiabilidad de la metodología de pronóstico.

c. Considere, además, los siguientes elementos:

   - La zona geofráfica de aplicación, y
   - La evaluación y validación de la metodología de pronóstico.

d. Considere, según la situación especial en la cual va a ser aplicada, entre otras, las siguientes variables:

   - Emisiones de dióxido de azufre,
   - Condiciones meteorológicas,
   - Condiciones topográficas,
   - Procesos de acumulación y remoción de contaminantes

Para la aprobación de la metodología de pronóstico deberá considerarse como antecedente un informe técnico realizado por expertos nacionales o internacionales sobre la metodología de pronóstico.

Se podrá omitir o dejar sin efecto una situación de emergencia ambiental si se detectare un cambio en las condiciones meteorológicas en forma posterior a la hora de comunicación del pronóstico o a la constatación de la superación de los niveles de calidad de aire, y siempre que dicho cambio asegure una mejoría tal en las condiciones de calidad de aire que invalide los resultados entregados por el pronóstico o que asegure la reducción de los niveles de concentración de calidad de aire por debajo de aquellos que originan situaciones de emergencia ambiental.

Artículo 6.- Para efectos de evaluar el cumplimiento de la norma y los valores que originan situaciones de emergencia ambiental se utilizarán los valores de concentración expresados en ppbv.

Artículo 7.- Cuando el dióxido de azufre fuese precursor de otro contaminante normado, los planes de descontaminación o prevención que se establezcan para el control de este contaminante, podrán incluir medidas de reducción de emisiones del contaminante dióxido de azufre, independientemente del cumplimiento de las normas de calidad de aire que esta norma establece.

TITULO III

Metodología de Medición de la Norma

Artículo 8.- La medición de la concentración de dióxido de azufre en el aire se realizará mediante uno cualesquiera de los siguientes métodos de medición:

a. Fluorescencia ultravioleta;
b. Espectrometría de absorción diferencial con calibración in – situ y,
c. Un método de medición de referencia o equivalente designado o aprobado por la Agencia de Protección Ambiental de los Estados Unidos o por las Directivas de la Comunidad Europea.

El monitoreo de calidad de aire deberá realizarse con instrumentos que cumplen con los métodos de medición señalados en el inciso anterior y que hayan sido reconocidos, aprobados o certificados por la Agencia de Protección Ambiental de los Estados Unidos o por las Directivas de la Comunidad Europea.

Artículo 9.- Para efectos de cumplir con lo establecido en el artículo 13, podrán utilizarse técnicas de medición alternativas a las señaladas en el artículo precedente, las que deberán ser aprobadas por el Servicio de Salud respectivo. Para el monitoreo mediante estas técnicas se deberá considerar lo establecido en la letra (h) del artículo 2 del presente decreto.

TITULO IV

Validación de la Información de Monitoreo de Calidad de Aire

Artículo 10.- Se considerará válida la concentración anual, si para cada uno de los trimestres de un año, se dispusiere de a lo menos un 75% de los datos de concentración de 24 horas para ese periodo. ¿representativo de un ciclo estacional

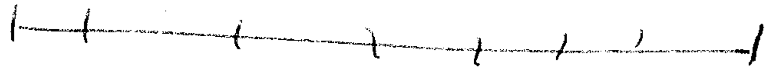
Se considerará válido el percentil 99 de las concentraciones de 24 horas registradas en un año, si, a lo menos, el 75% de los datos de concentración de 24 horas para el periodo de un año, se encontraren disponibles y dan cuenta de la variación de los datos a lo largo de un año (ciclo estacional). ¿Esto es realmente necesario?

Se considerará válida la concentración de 24 horas, si, a lo menos, el 75% de los datos de concentración de 1 hora para un periodo de 24 horas, se encontraren disponibles y dan cuenta de la variación de los datos a lo largo de un día (ciclo diario).

$\frac{X_1 + X_2 + X_3}{3}$ PPP conc 24 hs

$\frac{PPP_1 + PPP_2 + PPP_3}{3}$

PPP



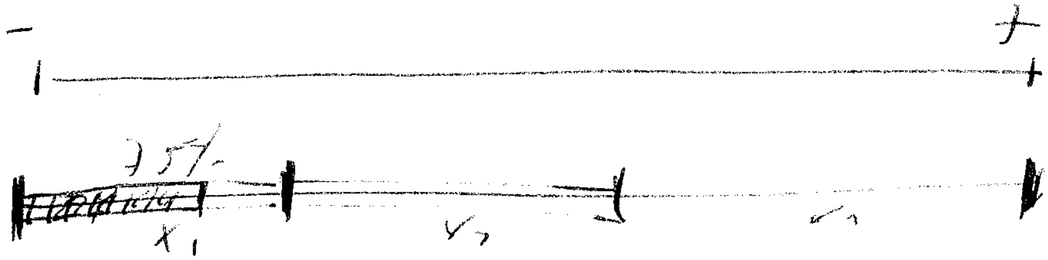
$\frac{C24_1 + C24}{n}$

Conc 24 : $\frac{X_1 + --- X_{24}}{24}$ 75% datos

$\frac{X_1 + --- X_{18}}{18}$ ∴ sólo 18.

$\bar{X}_{24}$: $\frac{X_1 + -- X_{18}}{18}$ ≥ Vm de 24 hs

PPP 365



1 AÑO.

$\frac{X_1 + X_2 + X_3}{3}$ ≥ N

X_1

$X_{24_1} + X_{24_2}$ - - - - X.

y la norma anual 001355

En el evento de que se dispusiere de menos del 75% de los datos de concentración de 1 hora, la concentración de 24 horas será considerada, sólo para efectos de verificar el cumplimiento de la norma primaria de calidad de aire como concentración de 24 horas y ~~como concentración anual~~, si, al reemplazar por cero los datos que faltaren para completar el 75% requerido, la concentración de 24 horas fuere mayor o igual al valor de la ~~norma primaria de calidad de aire como concentración de 24 horas~~.

Si se dispusiere de datos de concentración de 1 hora para 18, 19, 20, 21, 22 o 23 horas, la concentración de 24 horas se calculará como el promedio aritmético de los datos de concentración de 1 hora disponibles, utilizando como divisor 18, 19, 20, 21, 22 o 23, según corresponda.

Se considerará válida la concentración de 1 hora, si, a lo menos, se dispusiere de 30 minutos sucesivos de medición.

TITULO V

Fiscalización de la Norma

Artículo 11.- Corresponderá a los Servicios de Salud del país y, en la Región Metropolitana al Servicio de Salud Metropolitano del Ambiente, fiscalizar el cumplimiento de las disposiciones de la presente norma.

TITULO VI

Implementación de la Norma

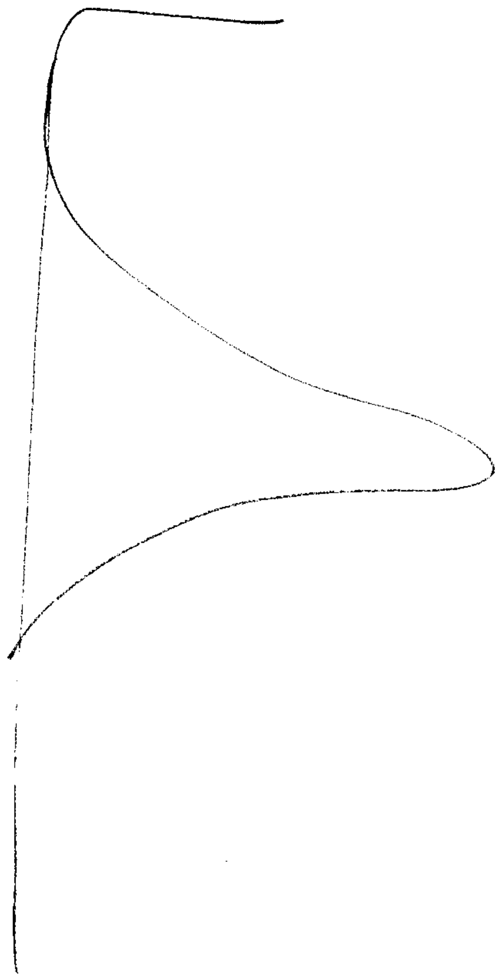
Artículo 12.-Los Servicios de Salud respectivos deberán dentro del plazo de seis meses, contados desde la publicación del presente decreto en el Diario Oficial, determinar mediante resolución fundada aquellas estaciones monitoras que se considerarán como EMRPG.

Artículo 13.- Los Servicios de Salud respectivos deberán dentro del plazo de tres años, contados desde la publicación del presente decreto en el Diario Oficial, realizar un diagnóstico de la calidad de aire para dióxido de azufre según sus competencias territoriales.

Dicho diagnóstico deberá considerar la información de calidad de aire disponible así como la que se genere a partir de organismos públicos y privados.

Los Servicios de Salud respectivos deberán dentro del plazo de dos años, contados desde que se disponga del diagnóstico, elaborar e implementar un programa priorizado de monitoreo para el seguimiento de la norma primaria de calidad de aire para dióxido de azufre.

¿y de inv. de emisiones? algunos pts no requieren medir, como lo hace en función de la calidad del aire?



Dicho programa deberá ser revisado periódicamente en función de los nuevos antecedentes de calidad de aire de que se disponga, los cuales deberán incorporar la información tanto pública como privada.

Artículo 14.- El monitoreo de la calidad de aire según los métodos de medición señalados en los artículos octavo y noveno del presente decreto, deberá realizarse de acuerdo a las disposiciones establecidas por el Servicio de Salud respectivo, el que deberá considerar, cuando se encuentre disponible, lo que señale el manual de aplicación técnico de la norma.

El manual de aplicación técnico de la norma deberá ser elaborado por la Comisión Nacional del Medio Ambiente ~~.dentro del plazo de un año contado desde la publicación del presente decreto en el diario oficial.~~

Artículo 15.- Los Servicios de Salud respectivos deberán tener a disposición de la ciudadanía, los datos de los niveles de concentración de calidad de aire para dióxido de azufre correspondientes a la presente norma, los que serán públicos.

TITULO VII

Generación de Antecedentes para la Regulación de Efectos Agudos

Artículo 16.- Los Servicios de Salud respectivos deberán en forma sistemática recopilar la siguiente información:

- Niveles de concentración de calidad de aire para dióxido de azufre como concentración de 5 minutos y una hora, a partir del monitoreo de la calidad de aire de dióxido de azufre.

- Incidencia y prevalencia de asma, en especial en aquellas localidades en las que existe población expuesta a altos niveles de concentración de dióxido de azufre en periodos cortos de exposición.

TITULO VIII

Entrada en Vigencia

Artículo 17.- La presente norma de calidad entrará en vigencia a partir del día primero del mes siguiente al de su publicación en el Diario Oficial. ~~quedando desde esa fecha sin efecto las normas primarias de calidad de aire para dióxido de azufre o anhídrido sulfuroso vigentes a esa fecha.~~

Artículos Transitorios

Artículo primero transitorio.- En el periodo comprendido desde la entrada en vigencia de la norma y hasta disponer de tres años sucesivos de mediciones, la norma primaria de

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calidad de aire para dióxido de azufre como concentración anual o de 24 horas se considerará sobrepasada, si en el primer o segundo periodo de 12 meses y, al reemplazar la concentración anual o el percentil 99 de las concentraciones de 24 horas para los periodos faltantes por cero, el promedio aritmético de los tres periodos resultare mayor o igual al nivel de la norma correspondiente.

Artículo segundo transitorio.- Las áreas del territorio de la República que hayan sido declaradas zona latente o saturada para dióxido de azufre, mantendrán su vigencia mientras no se cuente con las mediciones efectuadas en la forma y periodos señalados en el presente decreto y en tanto se mantengan las condiciones que las hacen procedentes.

~~Las disposiciones contenidas en la presente norma serán incorporadas, en lo que corresponda, en los planes de prevención y de descontaminación por dióxido de azufre que se encuentren vigentes o en trámite a la fecha de su entrada en vigencia, adelantando para esos efectos los plazos de revisión de dichos planes si fuere necesario.~~

ANÓTESE, TÓMESE RAZÓN Y PUBLÍQUESE.

RICARDO LAGOS ESCOBAR
Presidente de la República

Fernández
~~ALVARO GARCÍA HURTADO~~
Ministro
Secretario General de la Presidencia

~~MICHELLE BACHELET JERIA~~
Ministra de Salud

CM I LO

REPUBLICA DE CHILE
COMISION NACIONAL DEL MEDIO AMBIENTE
ASR/PMC

001353

ESTABLECE NORMA PRIMARIA DE CALIDAD DE AIRE PARA DIOXIDO DE AZUFRE (SO_2)

SANTIAGO,

VISTOS:

Lo dispuesto en el artículo 19 Nº 8 de la Constitución Política; En el artículo 32 de la Ley 19.300; El Reglamento para la Dictación de Normas de Calidad Ambiental y de Emisión, aprobado por el Decreto Supremo Nº93 de 1995, del Ministerio Secretaría General de la Presidencia; El Decreto Supremo Nº185 de 1991, del Ministerio de Minería, que Reglamenta el Funcionamiento de los Establecimientos Emisores de Anhídrido Sulfuroso, Material Particulado y Arsénico en todo el Territorio de La Republica; La Resolución Nº1215 de 1978 del Delegado del Gobierno en el Servicio Nacional de Salud, que establece normas sanitarias mínimas destinadas a prevenir y controlar la contaminación atmosférica; La Resolución Exenta Nº 1514 de 1999, de la Dirección Ejecutiva de la Comisión Nacional del Medio Ambiente, que dio inicio al proceso de revisión de las normas primarias de calidad de aire para anhídrido sulfuroso (SO2); partículas totales en suspensión (PTS); monóxido de carbono (CO); ozono (03) y dióxido de nitrógeno (NO2) ; La Resolución Exenta Nº 915 del 2000, de la Dirección Ejecutiva de la Comisión Nacional del Medio Ambiente, que aprobó el anteproyecto de revisión de la norma primaria de calidad de aire para anhídrido sulfuroso (SO2); El análisis general del impacto económico y social de la norma señalada; Las observaciones formuladas en la etapa de consulta al anteproyecto de norma; El acuerdo Nº180 de 3 de mayo de 2001, del Consejo Directivo de la Comisión Nacional del Medio Ambiente, que aprobó el proyecto definitivo de la norma de calidad; Los demás antecedentes que obran en el expediente público respectivo y lo dispuesto en la Resolución Nº520 de 1996, de la Contraloría General de la República que fija el texto refundido, coordinado y sistematizado de la Resolución Nº 55 de 1992, de la Contraloría General de la República.

CONSIDERANDO:

Que de acuerdo con lo preceptuado en la Ley 19.300, es deber del Estado dictar y revisar normas para regular la presencia de contaminantes en el medio ambiente, de manera de prevenir que éstos puedan significar o representar, por sus niveles, concentraciones y periodos, un riesgo para la salud de las personas.

Que sobre la base de los antecedentes disponibles y que constan en el expediente público, se revisó la norma primaria de calidad de aire para anhídrido sulfuroso o dióxido de azufre (SO2), contenida en la Resolución 1215 de 1978, del Delegado del Gobierno en el Servicio Nacional de Salud y en el Decreto Supremo Nº185 de 1991, del Ministerio de Minería, en conformidad al procedimiento y los contenidos establecidos en el Decreto Supremo Nº93 de 1995, de Ministerio Secretaria General de la Presidencia.

Que el dióxido de azufre es un importante broncoconstrictor, desde los primeros minutos de exposición y su efecto aumenta con la actividad física, con la hiperventilación, al respirar aire frío y seco y en personas con hiperreactividad bronquial.

Que la exposición a este contaminante puede producir efectos agudos y crónicos sobre la salud de las personas.

Que el dióxido de azufre se origina de la combustión del azufre contenido en los combustibles fósiles (petróleos combustibles, gasolina, petróleo diesel, carbón, etc.), de la fundición de minerales que contienen azufre y de otros procesos industriales.

Que el dióxido de azufre puede presentar efectos adicionales a los de salud tales como efectos sobre la vegetación, ecosistemas y materiales expuestos a este contaminante.

Que el dióxido de azufre es un precursor de aerosoles secundarios.

Que a nivel nacional existen localidades con población expuesta a altas concentraciones de dióxido de azufre en el aire por periodos cortos de exposición, producto de las emisiones generadas por fuentes específicas. A objeto de estudiar los efectos que se producen en la salud de las personas, se requiere recopilar información sobre la incidencia y prevalencia de asmáticos y los niveles de concentración de calidad de aire para dióxido de azufre en periodos cortos de exposición.

DECRETO:

TITULO I

Disposiciones Generales y Definiciones

Artículo 1.- Establécese la norma primaria de calidad de aire para dióxido de azufre.

La presente norma de calidad ambiental tiene por objetivo proteger la salud de la población de aquellos efectos agudos y crónicos generados por la exposición a niveles de concentración de dióxido de azufre en el aire.

Artículo 2.- Para efectos de lo dispuesto en la presente norma, se entenderá por:

a. *ppbv*: Unidad de medida de concentración en volumen, correspondiente a una milésima parte por millón.

b. *Concentración de Dióxido de Azufre*: Valor promedio temporal detectado en el aire expresado en partes por billón (ppbv) o en microgramos por metro cúbico normal (ug/m3N).

   La condición normal corresponde a la presión de una atmósfera (1 atm.) y una temperatura de 25 grados Celcius (25°C).

c. *Concentración de 1 hora*: Promedio aritmético de los valores de concentración de dióxido de azufre medidos en una 1 hora.

d. *Concentración de 24 horas*: Promedio aritmético de los valores de concentración de 1 hora de dióxido de azufre correspondientes a un bloque de 24 horas sucesivas, contadas desde las cero horas de cada día.

e. *Concentración trimestral:* Promedio aritmético de los valores de concentración de 24 horas de dióxido de azufre correspondientes a un periodo de tres meses sucesivos.

f. *Concentración anual*: Promedio aritmético de los valores de concentración trimestral de dióxido de azufre correspondientes a un año.

g. *Año calendario:* Período que se inicia el 1° de enero y culmina el 31 de diciembre del mismo año.

h. *Estación monitora con representatividad poblacional para gas dióxido de azufre (EMRPG):* Una estación de monitoreo que se encuentra localizada en un área habitada.

   Se entiende como área habitada, una porción del territorio donde vive habitual y permanentemente un conjunto de personas.

i. *Percentil*: Corresponde al valor "q" calculado a partir de valores de concentración aproximados al ppbv o ug/m3N más cercano. Todos los valores se anotarán en una lista establecida por orden creciente para cada estación de monitoreo.

$$X1 \leq X2 \leq X3 \ldots \leq Xk \leq X\,n-1 \leq Xn$$

   El percentil será el valor del elemento de orden "k", para el que "k" se calculará por medio de la siguiente fórmula:

   k = q X n , donde "q" = 0.99 para el Percentil 99, y "n" corresponde al número de datos de una serie. El valor "k" se aproximará al número entero más próximo.

TITULO II

Nivel de Norma de Calidad Primaria para Dióxido de Azufre en Aire

Artículo 3.- La norma primaria de calidad de aire para dióxido de azufre como concentración anual será de 31 ppbv (80 ug/m3N).

Se considerará sobrepasada la norma primaria de calidad de aire para dióxido de azufre como concentración anual, cuando el promedio aritmético de los valores de concentración anual de tres años calendarios sucesivos, en cualquier estación monitora EMRPG, fuere mayor o igual al nivel indicado en el inciso precedente.

Si el periodo de medición en una estación monitora EMRPG no comenzare el 1° de enero, se considerarán los tres primeros periodos de 12 meses a partir del mes de inicio de las mediciones hasta disponer de tres años calendarios sucesivos de mediciones.

Se considerará sobrepasada la norma primaria de calidad de aire para dióxido de azufre como concentración anual, si en el primer o segundo periodo de 12 meses a partir del mes de inicio de las mediciones y, al reemplazar la concentración anual para los periodos faltantes por cero, el promedio aritmético de los tres periodos resultare mayor o igual al nivel de la norma.

Artículo 4.- La norma primaria de calidad de aire para dióxido de azufre como concentración de 24 horas será de 96 ppbv (250 ug/m3N).

Se considerará sobrepasada la norma primaria de calidad de aire para dióxido de azufre como concentración de 24 horas, cuando el promedio aritmético de tres años sucesivos, del percentil 99 de las concentraciones de 24 horas registradas durante un año calendario, en cualquier estación monitora EMRPG, fuere mayor o igual al nivel indicado en el inciso precedente.

Si el periodo de medición en una estación monitora EMRPG no comenzare el 1° de enero, se considerarán los tres primeros periodos de 12 meses a partir del mes de inicio de las mediciones hasta disponer de tres años calendarios sucesivos de mediciones.

Se considerará sobrepasada la norma primaria de calidad de aire para dióxido de azufre como concentración de 24 horas, si en el primer o segundo periodo de 12 meses a partir del mes de inicio de las mediciones y, al reemplazar el percentil 99 de las concentraciones de 24 horas para los periodos faltantes por cero, el promedio aritmético de los tres periodos resultare mayor o igual al nivel de la norma.

Artículo 5.- Los siguientes niveles originarán situaciones de emergencia ambiental para dióxido de azufre, en concentración de una hora:

Nivel 1: 750 - 999 ppbv	(1.962 - 2.615 ug/m3N)
Nivel 2: 1.000 – 1.499 ppbv	(2.616 - 3.923 ug/m3N)
Nivel 3: 1.500 ppbv o superior	(3.924 ug/m3N o superior)

Los niveles que originan situaciones de emergencia ambiental para dióxido de azufre podrán ser obtenidos mediante la aplicación de una metodología de pronóstico de calidad de aire aprobada por el Servicio de Salud respectivo, mediante resolución fundada, o por medio de la constatación ~~de las~~ concentraciones ~~del~~ contaminante a partir de alguna de las estaciones monitoras de calidad de aire EMRPG.

Para los efectos de lo señalado anteriormente, se entenderá por metodología de pronóstico de calidad de aire a aquella que:

a. Entregue un procedimiento mediante el cual ~~es~~ sea posible estimar predecir de manera anticipada la verificación ocurrencia de alguno de los niveles de concentración de calidad de aire señalados anteriormente.

b. Entregue el grado de confiabilidad de la metodología de pronóstico~~, es decir, la probabilidad de acierto de la misma~~.

c. Considere, además, los siguientes elementos:

- ~~La~~ capacidad predictiva de la metodología, es decir con cuanto tiempo de anticipo es posible aplicar la metodología de pronóstico según la confiabilidad de la misma. o/i pronóstico.
- La zona geofráfica de aplicación, y
- La validación de la metodología de pronóstico.

d. Considere, según la situación especial en la cual va a ser aplicada, entre otras, las siguientes variables:

- Emisiones de dióxido de azufre,
- Condiciones meteorológicas,
- Condiciones topográficas,
- Procesos de acumulación y remoción de contaminantes

~~La aplicación para un caso particular de la metodología, podrá ser modificada en consideración a nuevos antecedentes que involucren mejoras, por ejemplo en la capacidad de predicción o en la extensión geográfica involucrada. Dichas modificaciones deberán verificarse de acuerdo con lo señalado en este artículo.~~

Se podrá omitir o dejar sin efecto una situación de emergencia ambiental si se detectare un cambio en las condiciones meteorológicas en forma posterior a la hora de comunicación del pronóstico o a la constatación de la superación de los niveles de calidad de aire, y siempre que dicho cambio asegure una mejoría tal en las condiciones de calidad de aire que invalide los resultados entregados por el pronóstico o que asegure la reducción de los niveles de concentración de calidad de aire por debajo de aquellos que originan situaciones de emergencia ambiental.

Artículo 6.- Para efectos de evaluar el cumplimiento de la norma y los valores que originan situaciones de emergencia ambiental se utilizarán los valores de concentración expresados en ppbv.

Artículo 7.- Cuando el dióxido de azufre fuese precursor de otro contaminante normado, los planes de descontaminación o prevención que se establezcan para el control de este contaminante, podrán incluir medidas de reducción de emisiones del contaminante dióxido de azufre, independientemente del cumplimiento de las normas de calidad de aire que esta norma establece.

TITULO III

Metodología de Medición de la Norma

Artículo 8.- La medición de la concentración de dióxido de azufre en el aire se realizará mediante uno cualesquiera de los siguientes métodos de medición:

a. Fluorescencia ultravioleta;
b. Espectrometría de absorción diferencial con calibración in – situ y,
c. Un método de medición de referencia o equivalente designado o aprobado por la Agencia de Protección Ambiental de los Estados Unidos o por las Directivas de la Comunidad Europea.

El monitoreo de calidad de aire deberá realizarse con instrumentos que cumplen con los métodos de medición señalados en el inciso anterior y que hayan sido reconocidos, aprobados o certificados por la Agencia de Protección Ambiental de los Estados Unidos o por las Directivas de la Comunidad Europea.

Artículo 9.- Para efectos de cumplir con lo establecido en el artículo 13, podrán utilizarse técnicas de medición alternativas a las señaladas en el artículo precedente, las que deberán ser aprobadas por el Servicio de Salud respectivo. Para el monitoreo mediante estas técnicas se deberá considerar lo establecido en la letra (h) del artículo 2 del presente decreto.

TITULO IV

Validación de la Información de Monitoreo de Calidad de Aire

Artículo 10.- Se considerará válida la concentración anual, si para cada uno de los trimestres de un año, se dispusiere de a lo menos un 75% de los datos de concentración de 24 horas para ese periodo.

Se considerará válido el percentil 99 de las concentraciones de 24 horas registradas en un año , si, a lo menos, el 75% de los datos de concentración de 24 horas para el periodo de un año, se encontraren disponibles y dan cuenta de la variación de los datos a lo largo de un año (ciclo estacional).

Se considerará válida la concentración de 24 horas, si, a lo menos, el 75% de los datos de concentración de 1 hora para un periodo de 24 horas, se encontraren disponibles y dan cuenta de la variación de los datos a lo largo de un día (ciclo diario).

En el evento de que se dispusiere de menos del 75% de los datos de concentración de 1 hora, la concentración de 24 horas será considerada, sólo para efectos de verificar el cumplimiento de la norma primaria de calidad de aire como concentración de 24 horas y como concentración anual, si, al reemplazar por cero los datos que faltaren para completar el 75% requerido, la concentración de 24 horas fuere mayor o igual al valor de la norma primaria de calidad de aire como concentración de 24 horas.

Si se dispusiere de datos de concentración de 1 hora para 18, 19, 20, 21, 22 o 23 horas, la concentración de 24 horas se calculará como el promedio aritmético de los datos de concentración de 1 hora disponibles, utilizando como divisor 18, 19, 20, 21, 22 o 23, según corresponda.

Se considerará válida la concentración de 1 hora, si, a lo menos, se dispusiere de 30 minutos sucesivos de medición.

TITULO V

Fiscalización de la Norma

Artículo 11.- Corresponderá a los Servicios de Salud del país y, en la Región Metropolitana al Servicio de Salud Metropolitano del Ambiente, fiscalizar el cumplimiento de las disposiciones de la presente norma.

TITULO VI

Implementación de la Norma

Artículo 12.-Los Servicios de Salud respectivos deberán dentro del plazo de seis meses, contados desde la publicación del presente decreto en el Diario Oficial, determinar mediante resolución fundada aquellas estaciones monitoras que se considerarán como EMRPG.

Artículo 13.- Los Servicios de Salud respectivos deberán dentro del plazo de tres años, contados desde la publicación del presente decreto en el Diario Oficial, realizar un diagnóstico de la calidad de aire para dióxido de azufre según sus competencias territoriales.

Dicho diagnóstico deberá considerar la información de calidad de aire disponible así como la que se genere a partir de organismos públicos y privados.

Los Servicios de Salud respectivos deberán dentro del plazo de dos años, contados desde que se disponga del diagnóstico, elaborar e implementar un programa priorizado de monitoreo para el seguimiento de la norma primaria de calidad de aire para dióxido de azufre.

Dicho programa deberá ser revisado periódicamente en función de los nuevos antecedentes de calidad de aire de que se disponga, los cuales deberán incorporar la información tanto pública como privada.

Artículo 14.- El monitoreo de la calidad de aire según los métodos de medición señalados en los artículos octavo y noveno del presente decreto, deberá realizarse de acuerdo a las disposiciones establecidas por el Servicio de Salud respectivo, el que deberá considerar, cuando se encuentre disponible, lo que señale el manual de aplicación de la norma.

El manual de aplicación de la norma deberá ser elaborado por la Comisión Nacional del Medio Ambiente.

Artículo 15.- Los Servicios de Salud respectivos deberán tener a disposición de la ciudadanía, los datos de los niveles de concentración de calidad de aire para dióxido de azufre correspondientes a la presente norma, los que serán públicos.

TITULO VII

Generación de Antecedentes para la Regulación de Efectos Agudos

Artículo 16.- Los Servicios de Salud respectivos deberán en forma sistemática recopilar la siguiente información:

- Niveles de concentración de calidad de aire para dióxido de azufre como concentración de 5 minutos y una hora, a partir del monitoreo de la calidad de aire de dióxido de azufre.

- Incidencia y prevalencia de asma, en especial en aquellas localidades en las que existe población expuesta a altos niveles de concentración de dióxido de azufre en periodos cortos de exposición.

TITULO VIII

Entrada en Vigencia

Artículo 17.- La presente norma de calidad ambiental entrará en vigencia a partir del día primero del mes siguiente al de su publicación en el Diario Oficial, quedando desde esa fecha sin efecto las normas primarias de calidad de aire para dióxido de azufre o anhídrido sulfuroso vigentes a esa fecha.

Artículos Transitorios

Artículo primero transitorio.- En el periodo comprendido desde la entrada en vigencia de la norma y hasta disponer de tres años sucesivos de mediciones, la norma primaria de calidad de aire para dióxido de azufre como concentración anual o de 24 horas se considerará sobrepasada, si en el primer o segundo periodo de 12 meses y, al reemplazar la concentración anual o el percentil 99 de las concentraciones de 24 horas para los periodos faltantes por cero, el promedio aritmético de los tres periodos resultare mayor o igual al nivel de la norma correspondiente.

Artículo segundo transitorio.- Las disposiciones contenidas en la presente norma serán incorporadas, en lo que corresponda, en los planes de prevención o de descontaminación por dióxido de azufre que se encuentren vigentes o en trámite a la fecha de su entrada en vigencia, adelantando para estos efectos los plazos de revisión de dichos planes si fuere necesario.

Las áreas del territorio de la República que hayan sido declaradas zona latente o saturada en virtud de la norma de calidad de aire para dióxido de azufre contemplada en la Resolución 1215 de 1978, del Delegado del Gobierno en el Servicio Nacional de Salud y el Decreto Supremo N° 185de 1991 del Ministerio de Salud, mantendrán su vigencia mientras no se cuente con las mediciones efectuadas en la forma y periodos señalados en el presente decreto y en tanto se mantengan las condiciones que las hacen procedentes. Una vez que se cuente con las mediciones efectuadas conforme al presente decreto, se revisarán las declaraciones de latencia y saturación mencionadas, de manera que se adecuen a la norma de calidad para dióxido de azufre, que se establece en el presente decreto."

ANÓTESE, TÓMESE RAZÓN Y PUBLÍQUESE.

RICARDO LAGOS ESCOBAR
Presidente de la República

ALVARO GARCÍA HURTADO
Ministro
Secretario General de la Presidencia

MICHELLE BACHELET JERIA
Ministra de Salud