Report on Recommended Ambient Air Quality Guidelines for Toxic Air Contaminants

by

Air Management Services
and
The Ad Hoc Advisory Committee for Toxic Air Contaminants

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I. Introduction

In recent years, the lack of knowledge concerning toxic air contaminants in Philadelphia has become a widespread concern among various sectors of the community. Environmentalists, through the numerous environmental groups active in the Delaware Valley, have taken up the cause of verifying the extent of toxic air contamination in the city and its associated hazard. Industry has an interest in determining if hazards do exist in order to ascertain whether additional controls are, in fact, necessary. And the citizens at risk, through both community and environmental groups have demanded the right to know the toxic substances to which they are being exposed and their potential health consequences. In Philadelphia these diverse groups have begun to cooperate in the complex process of developing an approach to achieve ambient air quality free of toxic air contaminant hazards. The first major step in this process of cooperation was the formation of a working committee, representing all sectors of the community, whose purpose was to draft a regulation controlling toxic air contaminants.

II. Air Management Regulation VI

On February 5, 1981, the Air Management Code, the ordinance under which Air Management Services functions, was amended to include a right-to-know provision. The amendment outlines notice and public access requirements regarding toxic air contaminant emissions and directed the Air Pollution Control Board (empowered to promulgate air pollution regulations) to issue, within six months of the amendment date, a regulation listing substances to be considered toxic air contaminants as well as any other provisions required for implementation of the amendment.

Air Management Regulation VI, Control of Emissions of Toxic Air Contaminants, became effective August 7, 1981. The Regulation specifies emission notification and source registration, review, and approval requirements. In addition, it contains two appendices of toxic air contaminants. Schedule "A" lists ninety-nine substances or classes of substances for which emission reporting is required. Schedule "B" lists five criteria pollutants, acknowledges them as toxic air contaminants as defined by the Environmental Protection Agency, but exempts them from Regulation VI reporting requirements since adequate emission reporting procedures are already in place.

The Schedule "A" list was developed with an eye toward chronic low-level exposure in the community. That is, any acute high-level exposure would most likely be a result of an emergency situation to which Air Management Services would directly respond in an attempt to reduce emissions and limit exposure. The concern, rather, is about continual long-term exposure and the associated health effects. And the most serious long-term effect is, of course, cancer. Thus, the list is heavily weighted toward substances which are known or suspected human carcinogens.

In addition to other provisions the regulation requires that the Department "shall establish or approve procedures, guidelines, and methods to be used in the review and evaluation of toxic air contaminant emissions," and that "approval of an installation permit or operating license for any facility to emit or discharge into the atmosphere any toxic air contaminant listed in the appendix to this Regulation shall be granted only upon a determination by the Department that such emission or discharge will not pose a health hazard."

III. Ad Hoc Advisory Committee for Toxic Air Contaminants

In order to accurately assess the health hazard potential to the community of an emission of a toxic air contaminant, it is necessary to determine both its toxicity to humans and the concentration of the contaminant in the ambient atmosphere so that the degree of exposure may be ascertained. The concentration may be obtained by a combination of ambient monitoring and computer-generated dispersion modeling.

To assist Air Management Services in evaluating the relevant toxicologic data extant for the 99 substances on the Regulation VI, Schedule "A" list, the Health Commissioner appointed an Ad Hoc Advisory Committee for Toxic Air Contaminants. The Committee consists of health professionals from academia, industry, and public interest groups in the fields of toxicology, occupational medicine, and industrial hygiene who gratuitously volunteered their time and expertise. Committee meetings were held every 2-4 weeks over a 2 year period with the Assistant Health Commissioner for Air Management Services presiding and Air Management Services staff participating both technically and administratively (e.g., providing minutes of the meetings and copies of all pertinent information.)

It was decided initially that the major objective would be to recommend ambient air quality guidelines for each of the 99 toxic air contaminants rather than air quality standards (since Air Management does not possess the resources to perform that exhaustive process for even one substance). The guidelines would represent "acceptable risk" ambient air levels to be used by Air Management Services in evaluating the health hazard potential to the community from emissions of Regulation VI pollutants through comparison of actual or predicted ambient air levels with guideline levels. In this manner, problem pollutants and emission sources may be pinpointed and regulations mandating emission control enacted as required.

The limitations to this approach are: (1) the entire toxicologic data base had to be adapted for the Committee's purpose which often meant utilizing data not intended for the development of ambient air quality guidelines (e.g., occupational exposure standard); (2) lack of adequate toxicity data for several of the substances made it infeasible to set guidelines which represent "safe" levels of exposure if "safe" levels do, in fact, exist; (3) the variability of human susceptibility to chemical exposure means that it is difficult to design guidelines for the entire population although by factoring in a sufficient margin of safety it is possible to approach minimal risk levels for even the most susceptible; (4) due to the nature of toxicity testing (exposure to only one substance) there are essentially no data on physiological responses produced by simultaneous multiple exposures as is the typical case in the ambient atmosphere (this situation may also be handled by factoring in an additional margin of safety where needed); (5) the type and amount of emissions vary with time. Any short-term, high level emission situation that posed an immediate danger to the community would be handled independently by Air Management Services directly.

A guideline-setting methodology was designed to assign a priority ranking to the toxicologic data and to outline the mathematical adjustments necessary to derive ambient air quality guidelines from these data.

Air Management Services and the Committee jointly agreed that, since the listed toxic substances generally pose more serious health hazards from chronic (long-term) exposure than from acute(short-term) exposure, the guidelines should be annual averages. That is, the guidelines should represent average levels to which the community can be exposed for long periods of time continuously. Excepting emergencies, situations of exposures greatly exceeding guideline levels for short periods of time (e.g., an uncontrolled release, leak or fire, a situation handled directly by Air Management Services by other means), daily fluctuations in exposures will be "smoothed out" over the course of a year.

The methodology itself outlines a series of priority rankings and data adjustments. First, each of the 99 toxics was classified as either a criteria pollutant, a carcinogen, or a non-carcinogen. A criteria pollutant is one for which there is a National Ambient Air Quality Standard (NAAQS) or is listed by the Environmental Protection Agency (EPA) under NESHAP (National Emission Standard for Hazardous Air Pollutants). To be considered a carcinogen, a toxic must be on at least one of the following lists: the American Conference of Governmental Industrial Hygienists (ACGIH), A1a (human carcinogen with an assigned Threshold Limit Value[TLV]) A1b (human carcinogen without an assigned TLV) or A2 (industrial substances suspect of carcinogenic potential for man) lists, or the National Toxicology Program (NTP) list. All other toxics are non-carcinogens. For criteria pollutants the NAAQS or NESHAP standard (if expressed an an equivalent ambient standard) was adopted as the guideline. For carcinogens and non-carcinogens, toxicologic data had to be adjusted to derive guidelines. This leads to the next priority ranking. Human data superseded animal data in all cases since the guidelines are for human exposures. The last priority ranking concerns the route of exposure. Inhalation data always superseded data based on ingestion or other exposure routes since inhalation is the dominant exposure route for ambient air contaminants. Certain mathematical adjustments were necessary once a suitable response or no-response base-line level had been selected. If the test data were not based on continuous exposure, a time-scale adjustment was applied. In most cases the base-line level was divided by 4.2. This factor is derived by dividing the usual work shift of 40 hours (8 hours/day, 5 days/week) by 168 hours (continuous exposure) and was used whenever the base-line level represented or simulated occupational exposure. In addition, multiple safety factors of 10 were applied as required in each of the following cases: when the toxic is a carcinogen, when utilizing animal data (to allow for species differences between animals and humans), and when considering differences in human susceptibility.

Base-line levels may be abstracted from any scientifically valid source (as per the priority rankings noted above) and include lowest effect or no-effect levels (in humans or animals) which elicit a physiological response (e.g., tumor, kidney or liver damage), the

TLV or Occupational Safety and Health Administration (OSHA) permissible exposure limit (PEL) (acceptable occupational exposure level), or acceptable daily intake (ADI) (acceptable daily ingestion level of a pesticide in humans). In those cases where ingestion data (e.g., an ADI) were used, the ingestion doses were translated into inhalation doses for a 70 kg (154 lb) man breathing 20 M^3 air per day. Lastly, additional safety factors were added where justified. An outline of the methodology follows.

Guideline-setting Methodology

I. Criteria Pollutants (as defined by EPA),

National Ambient Air Quality Standard (NAAQS)

National Emission Standard for Hazardous Air Pollutant (NESHAP), as ambient standard

II. Carcinogens (as listed by ACGIH [Ala, Alb, or A2] or by the National Toxicology Program [NTP]).

A. Human no observed effect level (NOEL) or lowest observed effect level (LOEL), inhalation, divided by 420

B. Threshold limit value (TLV) or OSHA permissible exposure limit (PEL), preferably in existence 5 years or more, divided by 420

C. Animal NOEL or LOEL, inhalation, divided by 4200 or 1000 depending on study

D. Acceptable Daily Intake (ADI), as inhalation dose, divided by 10

III. Non-carcinogens

A. Human NOEL or LOEL, inhalation, divided by 42

B. TLV or OSHA PEL, divided by 42

C. Animal NOEL or LOEL, inhalation, divided by 420 or 100 depending on study

D. ADI, as inhalation dose, divided by 10

IV. Additonal safety factor added where justified

IV. Evaluation of Health Hazard Potential

Under the notice requirements of Air Management Services Regulation VI anyone emitting a toxic air contaminant must report certain information to Air Management Services. Once the emissions of toxic air contaminants have been accurately documented, the resulting ambient air quality levels must be determined in order to ascertain exposure in the community. A judicious comparison between actual ambient levels and air quality guideline values (i.e. one in which other appropriate factors are considered) will then provide an estimate of the degree of hazard or non-hazard to the exposed population, and indicate whether emission reductions are necessary.

There are two methods to determine ambient air quality levels, air monitoring and dispersion modeling. Air monitoring consists of sample collection and laboratory analysis. Sample collection involves trapping contaminants contained in an ambient air sample drawn through some type of collecting medium such as activated carbon or a porous polymer. Laboratory analysis includes removal of the contaminants from the adsorbent, preparation of the sample, and qualitative/quantitative analysis by an analytical instrument such as a gas chromatograph/mass spectrometer (GC/MS). The GC/MS phase also includes analysis of samples of known composition (standards) which are necessary if accurate qualitative/quantitative measurements are to be made. It would obviously be an expensive time-consuming task to measure annual average ground level concentrations for ninety-nine substances citywide. However, dispersion modeling can be applied to actual emissions in order to generate estimates of ground level concentrations. While perhaps not as accurate as direct air monitoring, this method is much simpler, faster, and cheaper. It also is the only method for estimating ambient concentrations of substances that are present below the level of detection of the most sensitive analytical test, but which may have a toxic effect at very low ambient levels. An Environmental Protection Agency supplemental 105 grant has enabled Air Management Services to develop and test a dispersion model suitable for this purpose.

The final step in analyzing the health hazard potential from emissions of toxic air contaminants is to compare measured or estimated ground level concentrations to "acceptable risk," levels as represented by ambient air quality guideline values. However, as previously stated, this must be done carefully. Since the guidelines were developed solely on the basis of existing health effects data for that substance, other considerations must be factored into their application. For example, several of the guidelines for toxic air contaminants which are particulates are well in excess of the 75 ug/m^3 national ambient air quality standard for total suspended particulate (guidelines up to 3500 ug/m^3). This seeming contradiction is explained by the fact that the total suspended particulate standard is based on acute or chronic general respiratory dysfunction, while the guidelines are based primarily on non-reversible major organ damage, possibly leading to carcinogenesis. Another interpretation of guideline values above 75 ug/m^3 annual average is that such substances have no special toxicity and should be removed from the list of toxic air contaminants.

Air Management Services' primary objective has been and will continue to be attainment of national ambient air quality standards for criteria pollutants. Furthermore, for an emission source to produce, even on a local scale, an air quality level of 3500 ug/m^3 annual average, the emission rate from the facility would have to be orders of magnitude in excess of an allowable rate. In the opinion of Air Management Services no single facility can be permitted to cause receptor air quality which might jeopardize the attainment or maintenance of any local, state, or national air quality standard. Another consideration is the fact that guidelines are based on chronic exposure to low levels, but some of these substances may have acute adverse health effects at moderate concentrations. The typical emissions source in Philadelphia will cause a maximum 8-hour ground level concentration 20 to 50 times higher than the maximum annual concentration. This means that annual guidelines based on 1/42nd of the occupational standard might allow occasional occurrences of short term exposure levels close to occupational standards. This may be unacceptable for the general population, and an additional safety margin may be imposed by Air Management Services depending on the substance involved and other pertinent factors.

Finally, since guidelines are based on the best available toxicologic data, as the data change so will the guidelines and, possibly, the list of toxic air contaminants. The process is, therefore, open-ended and must be continually reviewed as new information becomes available. In order to conserve agency resources, new information reviews on Regulation VI listed chemicals will be limited to those substances which are known to be emitted in Philadelphia, and for which the new information may change the status of guideline compliance for any emitter. Any person may submit to Air Management Services toxicologic, epidemological, or other scientific data which is consistent with the committee protocol, and which they believe meets the above parameters. Air Management Services reserves the right under Regulation VI to be the final arbiter of all information to be used in the evaluation of the health hazard potential of toxic air contaminants.

PREFACE TO AMBIENT AIR QUALITY GUIDELINE DOCUMENTATION

Contained herein are ambient air quality guidelines for the ninety-nine toxic air contaminants listed in Air Management Regulation VI, Control of Emissions of Toxic Air Contaminants, with accompanying documentation. Guidelines are acceptable ambient air concentrations for these substances and were developed for use only by Air Management Services to evaluate the impact in the community from air emissions. Development of guidelines is necessitated by the lack of national air quality standards. Guidelines are recommended (or no guideline if available data are insufficient) solely on the basis of available relevant toxicologic data. The Ad Hoc Adivsory Committee for Toxic Air Contaminants recognizes that AMS will use the guidelines as it sees fit given the working restraints and considerations under which it functions. All guidelines are subject to future change as further toxicologic data become available.

GLOSSARY

ACGIH - American Conference of Governmental Industrial Hygienists
ADI - acceptable daily intake
AMS - Air Management Services
bw_3 - body weight
cm^3 or cc - cubic centimeter(s)
d or D - day(s)
EPA - Environmental Protection Agency
FAO/WHO - Food and Agricultural Organization/World Health Organization
g or G - grams(s)
hr - hour(s)
IARC - International Agency for Research on Cancer
kg - kilogram(s)
l or L - liter(s)
LOEL - lowest observed effect level
M^3 - cubic meter(s)
mg - milligram(s)
min - minute(s)
ml - milliliter(s)
NAAQS - national ambient air quality standard
NESHAP - national emission standard for hazardous air pollutant
ng - nanogram(s)
NIOSH - National Institute for Occupational Safety and Health
NOEL - no observed effect level
NTP - National Toxicology Program
OSHA - Occupational Safety and Health Administration
PEL - permissible exposure limit
ppb - parts per billion [by volume]
ppm - parts per million [by volume]
ppt - parts per trillion [by volume]
STEL - short-term exposure limit
TLV - threshold limit value
TWA - time-weighted average
ug - Microgram(s)
um - micrometer(s)
wk - week(s)

Summary of Recommended Ambient Air Quality Guidelines

Schedule "A"	Ambient Air Quality Guideline (Annual Average Unless Otherwise Noted) With Protocol Reference
Acrylonitrile	5 ppb, TLV/420 (II.B.)
Aldrin	0.035 ug/M^3, ADI/10 (III.D.)
4-Aminodiphenyl	0.8 ug/M^3, LEL/4200 (II.C.)
3-Amino-1,2,4-triazole	1.8 ug/M^3, LEL/1000 (II.C.)
Antimony and compounds	1.2 ug/M^3, TLV/420 (II.B.)
Arsenic and compounds	0.024 ug/M^3, PEL/420 (II.B.)
Asbestos	(0.005 fibers> 5 um/cc), TLV/420 (II.B.)
Benzene	24 ppb, TLV/420 (II.B.)
Benzidine	30 ug/M^3, LEL/1000 (II.C.)
Benzo(a)pyrene	0.0007 ug/M^3, LEL/100 (II.A.)
Beryllium and compounds	0.01 ug/M^3, (I.)
BHC	1.2 ug/M^3, TLV/420 (II.B.)
Lindane and isomers	1.2 ug/M^3, TLV/420 (II.B.)
Bis(2-chloroethyl)ether	120 ppb, TLV/42 (III.B.)
Bis(chloromethyl)ether	0.0024 ppb, TLV/420 (II.B.)
Bis(2-hydroxyethyl)-dithiocarbamic acid, potassium salt	No guideline due to insufficient scientific evidence
Cadmium and compounds	0.12 ug/M^3, TLV/420 (II.B.)
Captan	35 ug/M^3, ADI/10 (III.D.)
Carbaryl	3.5 ug/M^3, ADI/10 (III.D.)
Carbon tetrachloride	12 ppb, TLV/420 (II.B.)
Chloramben	1333 ug/M^3, LEL/4200 (II.C.)
Chlordane	0.35 ug/M^3, ADI/10 (III.D.)
Chlorobenzilate	7 ug/M^3, ADI/10 (III.D.)
Chloroform	24 ppb, TLV/420 (II.B.)
Chloromethyl methyl ether	0.02 ppb, NOEL/4200 (II.C.)
Chromium and compounds (hexavalent)	0.12 ug/M^3, TLV/420 (II.B.)
DDT/DDD	1.8 ug/M^3, ADI/10 (III.D.)
1,2-Dibromo-3-chloropropane	0.1 ppb, NOEL/1000 (II.C.)
3,3'-Dichlorobenzidine	No guideline due to insufficient scientific evidence; noted to be carcinogenic
2,4-Dichlorophenoxy acetic acid	105 ug/M^3, ADI/10 (III.D.)

Schedule "A"	Ambient Air Quality Guideline (Annual Average Unless Otherwise Noted) With Protocol Reference
Dieldrin	0.035 ug/M^3, ADI/10 (III.D.)
Di(2-ethyl hexyl)phthalate	120 ug/M^3, TLV/42 (III.B.)
Dimethylcarbamyl chloride	0.24 ppb, LEL/4200 (II.C.)
1,1-Dimethyl hydrazine	1.2 ppb, TLV/420 (II.B.)
Dimethyl sulfate	2.4 ppb, NOEL/420 (II.A.)
Dioxane	24 ppb, NOEL/4200 (II.C.)
Endosulfan	2.4 ug/M^3, TLV/42 (III.B.)
Endrin	0.07 ug/M^3, ADI/10 (III.D.)
Ethylenebisdithiocarbamic acid salts	18 ug/M^3, ADI/10 (III.D.)
Ethylene dibromide	2.4 ppb, LEL/4200 (II.C.)
Ethylene dichloride	37 ppb, LEL/1000 (II.C.)
Ethylene oxide	2.4 ppb, LEL/4200 (II.C.)
Ethylene thiourea	0.7 ug/M^3, ADI/10 (III.D.)
Epichlorohydrin	2.4 ppb, NOEL/4200 (II.C.)
Formaldehyde	4.8 ppb, TLV/420 (II.B.)
Heptachlor	0.18 ug/M^3, ADI/10 (III.D.)
Hexachlorobenzene	0.48 ppb, NOEL/4200 (II.C.)
Hexachlorobutadiene	0.06 ppb, NOEL/1000 (II.C.)
Hexamethyl phosphoramide	0.0024 ppb, NOEL/4200 (II.C.)
Hydrazine	0.24 ppb, TLV/420 (II.B.)
Kelthane	8.8 ug/M^3, ADI/10 (III.D.)
Kepone	0.88 ug/M^3, LEL/1000 (II.C.)
Lead and compounds	1.5 ug/M^3, (I.)
Manganese and compounds	24 ug/M^3, TLV/42 (III.B.)
Mercury and compounds	0.24 ug/M^3, TLV/42 (III.B.)
Methoxychlor	35 ug/M^3, ADI/10 (III.D.)
Methyl bromide	120 ppb, TLV/42 (III.B.)
Methyl chloride	1200 ppb, TLV/42 (III.B.)
4,4'-Methylene bis(2-chloroaniline)	0.05 ppb, TLV/420 (II.B.)
Methylene chloride	2400 ppb, TLV/42 (III.B.)
Methyl iodide	5 ppb, TLV/420 (II.B.)
Mirex	0.88 ug/M^3, LEL/1000 (II.C.)
Monomethyl hydrazine	0.5 ppb, TLV/420 (II.B.)
β-Naphthylamine	19 ug/M^3, LEL/1000 (II.C.)
Nickel and compounds	0.24 ug/M^3, TLV/420 (II.B.)
4-Nitrodiphenyl	2.7 ug/M^3, NOEL/1000 (II.C.)

Schedule "A"	Ambient Air Quality Guideline (Annual Average Unless Otherwise Noted) With Protocol Reference
Nitrofen	0.75 ug/M^3, 24-hr TWA, NOEL/1000 considering teratogenicity, (II.C.)
2-Nitropropane	6 ppb, NOEL/4200 (II.C.)
N-Nitrosodimethylamine	0.0004 ppb, NOEL/4200 (II.C.)
Parathion	1.8 ug/M^3, ADI/10 (III.D.)
Particulate polycyclic aromatic hydrocarbons	0.48 ug/M^3, TLV/420 (II.B.)
Pentachlorophenol	12 ug/M^3, TLV/42 (III.B.)
Perchloroethylene	1200 ppb, TLV/42 (III.B.)
Phenol	120 ppb, TLV/42 (III.B.)
N-Phenyl-β-Naphthylamine	45 ug/M^3, NOEL/4200 (II.C.)
Polybrominated biphenyls	No guideline due to insufficient scientific evidence
Polychlorinated biphenyls	0.18 ug/M^3, NOEL/4200 (II.C.)
Propane sultone	No guideline due to insufficient scientific evidence; noted to be highly carcinogenic
β-Propiolactone	No guideline due to insufficient scientific evidence; noted to be carcinogenic
Propylene Imine	4.8 ppb, TLV/420 (II.B.)
Propylene Oxide	250 ppb, NOEL/420 (III.C.)
Quintozene	2.4 ug/M^3, ADI/10 (III.D.)
Strobane	7.7 ug/M^3, LEL/1000 (II.C.)
2-(p-tert-Butylphenoxy)-isopropyl-2-chloroethyl sulfite	18 ug/M^3, LEL/1000 (II.C.)
Tetrachlorinated dibenzo-p-dioxins	0.000035 ug/M^3, NOEL/1000 (II.C.)
Tetrachloroethane	24 ppb, TLV/42 (III.B.)
Tetrachlorvinphos	3360 ug/M^3, LEL/1000 (II.C.)
Thallium and compounds	2.4 ug/M^3, TLV/42 (III.B.)
o-Tolidine	No guideline due to insufficient scientific evidence
Trichloroethylene	1200 ppb, TLV/42 (III.B.)
Trichlorophenol isomers	3500 ug/M^3, NOEL/100 (III.C.)
2,4,5-Trichlorophenoxy acetic acid	1 ug/M^3, ADI/10 (III.D.)
Trifluralin	1150 ug/M^3, LEL/1000 (II.C.)
Toxaphene	1.2 ug/M^3, TLV/420 (II.B.)
Vinyl bromide	12 ppb, NOEL/4200 (II.C.)
Vinyl chloride	2.4 ppb, PEL/420 (II.B.)

Schedule "A"	Ambient Air Quality Guideline (Annual Average Unless Otherwise Noted) With Protocol Reference
Vinyl cyclohexene dioxide	24 ppb, TLV/420 (II.B.)
Vinylidene chloride	6 ppb, LEL/4200 (II.C.)
Vinyl trichloride	240 ppb, TLV/42 (III.B.)

NOTICE OF TOXIC AIR CONTAMINANT EMISSIONS

CITY OF PHILADELPHIA
DEPARTMENT OF PUBLIC HEALTH
AIR MANAGEMENT SERVICES

AME OF COMPANY

DDRESS OF COMPANY

OURCE ADDRESS

NAME OF TOXIC AIR CONTAMINANT (From Schedule A)	DESCRIPTION OF EMISSION SOURCE(S)	ESTIMATED MAXIMUM EMISSION RATES			DATE EMISSION BEGAN
		LBS/HR.	LBS/DAY	LBS/YR.	

DDITIONAL COMMENTS

COMPANY OFFICIAL COMPLETING THIS REPORT:	NAME	DATE
	TITLE	
	SIGNATURE	

AM-3331