AIR TOXICS INFORMATION CLEARINGHOUSE

EPA Office of Air Quality Planning and Standards
Research Triangle Park, North Carolina 27711

STAPPA / ALAPCO State and Territorial Air Pollution Program Administrators
Association of Local Air Pollution Control Officials

Rationale for Air Toxics Control in Seven State and Local Agencies

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AIR TOXICS INFORMATION CLEARINGHOUSE: RATIONALE FOR AIR TOXICS CONTROL IN SEVEN STATE AND LOCAL AGENCIES

FINAL REPORT

Prepared for:

John Vandenberg
Project Officer
Pollutant Assessment Branch
Strategies and Air Standards Division
Office of Air Quality Planning and Standards
U.S. Environmental Protection Agency
Research Triangle Park, North Carolina 27711

Prepared by:

Alice S. Pelland and Patricia A. Cruse
Radian Corporation
3200 East Chapel Hill Road/Progress Center
Post Office Box 13000
Research Triangle Park, North Carolina 27709

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PREFACE

EPA, in the past, has focused most of its efforts in the control of air toxics on the Clean Air Act §112 programs (National Emission Standards for Hazardous Air Pollutants). The amount of time involved for § 112 listing and eventual emission control is extensive. The public is concerned over continuing exposure to potentially toxic air pollutants. The resultant public pressure has had an impact such that many State and local agencies have developed or are now actively developing air toxics regulatory programs apart from Federal activities.

In response to State and local agency requests for assistance in information exchange, EPA has formed an information dissemination center, known as the Air Toxics Information Clearinghouse. It is being implemented in close coordination with the State and Territorial Air Pollution Program Administrators (STAPPA) and the Association of Local Air Pollution Control Officials (ALAPCO).

The purpose of this report, published by the Air Toxics Information Clearinghouse, is to provide State and local agencies with descriptive information on the approaches used by some of these agencies for determining acceptable ambient concentrations and emissions limits for toxic air pollutants. The report includes a chapter on each of four State and three local agencies, as well as an Executive Summary which contrasts the various programs and presents a summary table of various guidelines for ambient concentrations used by the agencies. These seven agencies were chosen because they represent several different approaches to air toxics control and different levels of program development. Information presented here was compiled in June 1985.

This report is one of several publications prepared by the Air Toxics Information Clearinghouse. Clearinghouse and other related EPA publications include:

- Study of Selected State and Local Air Toxics Control Strategies - EPA 450/5-82-006, October 1982.

- Air Toxics Information Clearinghouse: Selected Bibliography of Health Effects and Risk Assessment Information - July 1984.

- Air Toxics Information Clearinghouse: Interim Report of Selected Information on State and Local Agency Air Toxics Activities - September 1984.

- Air Toxics Information Clearinghouse: Bibliography of Selected EPA Reports and Federal Register Notices - January 1985.

- Air Toxics Information Clearinghouse: Second Interim Report of Selected Information on State and Local Agency Air Toxics Activities - March 1985.

- Air Toxics Information Clearinghouse: Ongoing Research and Regulatory Development Projects - March 1985.

- Air Toxics Information Clearinghouse Newsletter, Vol. 1, No. 1-5, Vol. 2, No. 1-3 - December 1983, February 1984, April 1984, July 1984, September 1984, December 1984, February 1985, and May 1985.

ABSTRACT

An Air Toxics Information Clearinghouse has been established by EPA's Office of Air Quality Planning and Standards for the purpose of facilitating information transfer among State, local, and Federal air quality management agencies. This document has been published as part of that effort.

This report describes the approach used by four State and three local agencies for determining acceptable ambient concentrations and, if applicable, emission limits for noncriteria air pollutants. The agencies included are located in: Chattanooga/Hamilton County (Tennessee), Connecticut, Maine, Mississippi, Nevada, Philadelphia (Pennsylvania), and Sacramento County (California).

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF ABBREVIATIONS

1. ACGIH - American Conference of Governmental Industrial Hygienists
2. ADI - acceptable daily intake
3. ALAPCO - Association of Local Air Pollution Officials
4. BACT - Best Available Control Technology
5. C - ceiling (TLV-C)
6. CAG - Carcinogen Assessment Group (EPA)
7. DNA - deoxyribonucleic acid
8. EPA - Environmental Protection Agency
9. IARC - International Agency for Research on Cancer
10. ISC - Industrial Source Complex Model
11. LOEL - lowest observed effects level
12. NAAQS - National Ambient Air Quality Standards
13. NAS - National Academy of Sciences
14. NCI - National Cancer Institute
15. NESHAP - National Emission Standard for Hazardous Air Pollutants
16. NIOSH - National Institute of Occupational Safety and Health
17. NLM - National Library of Medicine
18. NOEL - no observed effects level
19. NTP - National Toxicology Program
20. OSHA - Occupational Safety and Health Administration
21. PEL - permissible exposure level (OSHA)
22. RTECS - Registry of Toxic Effects of Chemical Substances
23. STAPPA - State and Territorial Air Pollution Program Administrators
24. STEL - short-term exposure level (TLV-STEL)
25. TLV - threshold limit value (ACGIH)
26. TWA - time weighted average (TLV-TWA)
27. WHO - World Health Organization
28. UNAMAP - User's Network for Applied Modeling of Air Pollution

PART I - EXECUTIVE SUMMARY

INTRODUCTION

PURPOSE

The Air Toxics Information Clearinghouse has been established by EPA's Office of Air Quality Planning and Standards for the purpose of facilitating information transfer among State, local, and Federal air quality management agencies. This document has been published as part of that effort.

This report is the result of a study of the rational used by State and local agencies in selecting acceptable ambient concentrations and, if applicable, emission limits for toxic air pollutants. The study was undertaken by the EPA's Office of Air Quality Planning and Standards as part of the Air Toxics Information Clearinghouse. For various reasons, several State and local agencies have established their own programs to control emissions of toxic air pollutants. Furthermore, other agencies are in the process of developing such programs and have requested guidance from EPA. This report is designed, in part, to serve as a resource for agencies that wish to develop their own approach to air toxics controls.

METHODOLOGY

Information on all seven agencies was collected in telephone conversations with one or more agency staff members. In some cases, printed material describing a particular facet of an agency's program was reviewed. The chapters summarizing rationale for the various approaches were reviewed by the respective agencies and revised according to their comments.

Agencies selected for this report have been active in the Air Toxics Information Clearinghouse by submitting information in several air toxics program areas. An effort was made to present approaches used by both State and local agencies, to present some varied methods for selecting acceptable ambient levels for air toxics and to cover agencies at different program

development stages. The methods used for selecting acceptable ambient levels include application of safety factors to occupational levels, risk assessment, and requirements for best available control technology. States covered extensively in earlier EPA air toxics reports were not included since this report is intendes to supplement previous publications. Specifically, in October 1982, EPA published "Study of Selected State and Local Air Toxics Control Strategies" (EPA 450/5-82-006), which describes air toxics programs for seven State and one local air agencies.

ORGANIZATION

This report is divided into two parts. Part 1, the Executive Summary, compares and contrasts the programs and includes a table comparing the acceptable ambient levels of the agencies for 49 toxic air pollutants. Part 2 consists of a description of the rationale for acceptable ambient levels for each agency studied.

Each of the descriptions addresses the same general topics: general program aspects, basis for acceptable ambient limits and emission limits, risk assessment and risk management, and air toxics program application and enforcement. The sections on general program aspects give a brief overview of the agencies' approach to selecting acceptable limits and notes whether the requirements apply to only new sources or new and existing sources. The sections on basis for acceptable ambient limits and emission limits cover the health effects addressed, how acceptable ambient limits are determined, the averaging period, the relationship between ambient limits and emission limits, dispersion models used, and public participation in the development of air toxics requirements. The sections on risk assessment and risk management address how the agencies use these techniques, the steps each agency follows in risk assessment, exposure estimates, and the use of computer modeling. The sections on application and enforcement discuss how ambient limits/emission limits are applied, any regulatory distinctions between new and existing sources, whether sources are allowed to develop

alternatives to the agencies' limits, requirements for monitoring and stack testing, uses of emission inventories, review and appeal procedures and noncompliance penalties.

The level of detail available concerning each of the programs was not consistent among the seven agencies. There are two major reasons for this. First, three of the programs discussed are in the planning stage and these agencies have not been confronted with several issues pertaining to implementation. Second, agencies in less industrialized areas have not been faced with several of the issues associated with large numbers of sources. Some of the areas represented are more heavily industrialized than others and agencies in these areas have handled more source permit applications.

SUMMARY

This section summarizes the seven State and local agency air toxics programs included in this report, comparing and contrasting the agencies contacted. The summary is organized to address the same four general topics included in the discussion for each agency: general program aspects, basis for acceptable ambient limits and emission limits, risk assessment and risk management, and application and enforcement of the air toxics policies.

General Program Aspects

Table 1 compares the seven programs in terms of the status, the scope, and the general approach.

Basis for Acceptable Ambient Guidelines/Emission Limits

All seven agencies use or are considering using some type of acceptable ambient concentration. Table 2 summarizes the basis for establishing acceptable ambient concentrations and the safety factors applied, and the averaging times. Tables 3A and 3B summarize some of the acceptable ambient concentrations used by Connecticut, Nevada, Philadelphia, Sacramento and Maine. Table 4 compares acceptable concentrations for asbestos. The pollutants listed have been studied, are currently being studied, or are scheduled for study by EPA's Pollutant Assessment Branch. Chattanooga was not included because a technology-based approached is used there. Mississippi uses a median value of several occupational health concentration levels on a case-specific basis and was not included since acceptable concentrations may change as newer research emerges.

TABLE 1. COMPARISON OF SEVEN AIR TOXICS PROGRAMS: GENERAL PROGRAM ASPECTS

Agency	Status	Scope	General Approach
Chattanooga/ Hamilton County	Planned, not in effect	99 pollutants, policies will apply to new and modified sources	BACT, may use ambient guidelines in some cases based on safety factor applied to TLV
Connecticut	Planned, not in effect	853 pollutants, policies will apply to new and existing sources	Ambient guidelines based on safety factor applied to an occupational guideline
Maine	Planned, not in effect	Interim guidelines: No specific list of pollutants, policies will apply to new sources. Risk assessment when complete: 58 substances, policies will apply to new and possibly existing sources	Interim ambient guidelines; based on safety factor applied to TLV, NOEL, or LOEL; while risk assessments are being developed
Mississippi	In place	Not limited to a list of pollutants, policies apply to new sources	Guidelines, acceptable ambient concentrations for noncarcinogens based on safety factor applied to median of several occupational guideline, risk assessment for carcinogens

TABLE 1. COMPARISON OF SEVEN AIR TOXICS PROGRAMS: GENERAL PROGRAM ASPECTS (Continued)

Agency	Status	Scope	General Approach
Nevada	In place	Not limited to a list of pollutants, policies apply to new and existing sources	Regulations requiring BACT and attainment of acceptable ambient concentrations based on safety factor applied to TLV
Philadelphia	In place	99 pollutants, policies apply to new and existing sources	Ambient guidelines based on safety factor applied to occupational guideline, NOEL, or LOEL
Sacramento	In place	List of carcinogens, policies apply to new and modified sources	Ambient guidelines based on risk assessment

TABLE 2. COMPARISON OF SEVEN AIR TOXICS PROGRAMS: BASES FOR ACCEPTABLE AMBIENT CONCENTRATIONS

Agency	Basis for Acceptable Concentration	Safety Factor	Averaging Time
Chattanooga/ Hamilton County[1]	ACGIH TLV	1/420	Averaging time has not yet been set
Connecticut	ACGIH TLV, OSHA PEL, NIOSH Recommended Standards	Human carcinogens: 1/200; Suspect carcinogens, mutagens or teratogens: 1/100; Noncarcinogens: 1/50	30 minutes and 8 hours
Maine	ACGIH TLVs or NOEL or LOEL	Range from 1/1000 to 1/4, depending on health effects	Range from instantaneous to 1 week, depending on health effects
Mississippi	Median value of several occupational guidelines (ACGIH, NIOSH, OSHA and standards from Europe and the USSR) for noncarcinogens	1/100	24 hours
Nevada	ACGIH TLV plus BACT	1/42	24 hours
Philadelphia		Carcinogens / Noncarcinogens	
	ACGIH TLV	1/420 / 1/42	Annual (sometimes 24 hours, depending on health effects)
	OSHA PEL	1/420 / 1/42	
	NOEL or LOEL (animal inhalation)	1/4200 or 1/1000[2] / 1/420 or 1/100[2]	
	ADI	1/10 / 1/10	
Sacramento	Ambient concentration may not exceed 1×10^{-6} risk level	Not applicable	Annual

[1] Chattanooga is considering the use of ambient guidelines in some cases.

[2] Safety factor is 1/4200 or 1/1000 for carcinogens and 1/420 or 1/100 for noncarcinogens depending on the animal inhalation study.

TABLE 3A. COMPARISON OF ACCEPTABLE AMBIENT CONCENTRATIONS OF ORGANIC COMPOUNDS[a]

Pollutant	TLV-TWA[b] ppm	Connecticut ppm	Nevada ppm	Philadelphia[c] ppm	Sacramento[c,d] ppm	Maine[c] ppm
Acetaldehyde	100.0	2.0	2.381			
Acrolein	0.1	0.002	0.00238			
Acrylonitrile	2.0[e]	0.01	0.0476	0.005		
Ammonia	25.0	0.5	0.595			
Benzene	10.0		0.238	0.024	5.9×10^{-6}	
1,3-Butadiene	(1000.0)	20.0	(23.8)			
Carbon tetrachloride	5.0[e]	0.05	0.119	0.012		
Chlorine	1.0	0.02	0.0238			
Chlorobenzenes						
Monochlorobenzene	75.0	1.5	1.79			
o-Dichlorobenzene		1.0				
p-Dichlorobenzene	75.0	0.75	1.79			
1,2,4-Trichlorobenzene		0.1				
Chloroform	10.0	0.05	0.238	0.024	0.004	
Chloroprene[f]	10.0[e]	0.2				
Epichlorohydrin	2.0[e]	0.006	0.0476	0.0024		
Ethylene dichloride	10.0	0.02	0.238	0.037	$11.4 - 18.9 \times 10^{-6}$	
Ethylene oxide	1.0	0.01	0.0238	0.0024	Footnote d	
Freon 113 (1,1,2-trichloro-1,2,2-trifluoroethane)	1000.0	20.0	23.8			
Gasoline vapors	300.0	6.0	7.14			
Hexachlorocyclopentadiene	0.01	0.0002	0.000238			
Hydrogen chloride		0.10				
Hydrogen sulfide	10.0	0.2	0.238			
Methyl chloroform	350.0	7.0	8.33			

TABLE 3A. Continued

Pollutant	TLV-TWA[b] ppm	Connecticut ppm	Nevada ppm	Philadelphia[c] ppm	Sacramento[c,d] ppm	Maine[c] ppm
Naphthalene	10.0	0.2	0.238			
Perchloroethylene	50.0	0.25	1.190	1.2	0.05	
Phenol	5.0[e]	0.1	0.119	0.12		
Phosgene	0.1	0.002	0.00238			
Propylene oxide	20.0	0.4	0.476	0.25		
Styrene, monomer	50.0	1.0	1.19			
Toluene (toluol)	100.0	2.0	2.38			1.7 (7 day) 15.4 (15 min)
Toluene diisocyanate	0.005	0.0001	0.000119			
Trichloroethylene	50.0	0.25	1.19	1.2	0.087	
Vinyl chloride	5.0	0.025	0.119	0.0024		0.013
Vinylidene chloride	5.0	0.1	0.119			

TABLE 3B. COMPARISON OF ACCEPTABLE AMBIENT CONCENTRATIONS OF INORGANIC AND OTHER COMPOUNDS[a]

Pollutant	TLV-TWA[b] ug/m^3	Connecticut ug/m^3	Nevada ug/m^3	Philadelphia[c] ug/m^3	Sacramento[c,d] ug/m^3	Maine[c] ug/m^3
Arsenic[g,h,i]	200.0	0.05	4.76	0.024		
Asbestos - See Table 4						
Beryllium[h]	2.0	0.010	0.0476	0.01		
Cadmium[h,j]	50.0	0.5	1.19	0.12		
Chromium metal	500.0					
Chromium (II)	500.0	10.0	11.9			
Chromium (III)[k]	500.0	10.0	11.9			
Chromium (VI)[k]		Footnote m			3.3×10^{-4} 1.08×10^{-6}	
water soluble	50.0		1.19	0.12		
certain water insoluble	50.0		1.19	0.12		
Coke oven emissions (coal tar pitch volatiles)	200.0	1.0				
Copper						
Fume	200.0	2.0	4.76			
Dusts and Mists, as Cu	1000.0	20.0	23.8			
Managanese, as Mn						
Dust and compounds		100.0		24.0		
Fume	1000.0	20.0	23.8			
Mercury, as Hg						
Alkyl compounds	10.0[e]	2.0	0.238	0.24		
All forms except alkyl						
Vapor	50.0	1.0	1.19			
Aryl and inorganic compounds	100.0	2.0	2.38	0.24		
Nickel						
Metal	1000.0	5.0	23.8	0.24		
Soluble compounds, as Ni	100.0	Footnote n	2.38	0.24		
Zinc chloride fume	1000.0	20.0	23.8			
Zinc chromate as Cr	50.0	0.5	1.19			

TABLE 3B. Continued

Pollutant	TLV-TWA[b] ug/m^3	Connecticut ug/m^3	Nevada ug/m^3	Philadelphia[c] ug/m^3	Sacramento[c,d] ug/m^3	Maine[c] ug/m^3
Zinc oxide						
Fume	5000.0	100.0	119.0			
Dust[l]	5000.0					

[a]The authors of this document performed conversions of units to make values comparable. See Table 2 for averaging time.

[b]ACGIH Threshold Limit Value - 8 hour averaging time. Parentheses indicate a change in the TLV has been proposed by ACGIH.

[c]Blank spaces in the tables indicate that acceptable ambient concentrations have not been established by the agency.

[d]Sacramento County addresses risk in terms of annual dosage (mg/yr) and in terms of unit risk. The annual dosage reflects the dosage associated with a 1×10^{-6} risk level for a 70 kg human breathing 20 m^3 per day. Annual risk associated with ethylene oxide is 3.9×10^{-2}, if exposed to 2.01 mg/m^3 for 4 hours/day, 5 days/week.

[e]For TLV, skin.

[f]β-chloroprene.

[g]For TLV, soluble compounds, as As.

[h]For Philadelphia, "and compounds".

[i]For Connecticut, "and compounds".

[j]Dust and salts, as Cd.

[k]Compounds, as Cr.

[l]Nuisance particulate.

[m]Carcinogenic Cr (VI): 0.005; noncarcinogenic Cr (VI); 0.5.

[n]Carcinogens - 0.075; noncarcinogens - 0.3.

TABLE 4. COMPARISONS OF ACCEPTABLE ASBESTOS CONCENTRATIONS

	ACGIH TLV-TWA	Connecticut[1]	Nevada	Philadelphia
	fibers >5 um/cc	fibers >5 um/cc	fibers >5 um/cc (24-hour averaging time)	fibers >5 um/cc (annual averaging time)
ASBESTOS				0.005
Amosite	0.5	0.0005	0.00119	
Chrysotile	2.0	0.0005	0.0476	
Crocidolite	0.2	0.0005	0.00476	
Other forms	2.0		0.0476	

[1]Numbers shown are for 8-hour averaging time. Conversion from fibers/m^3 to fibers >5 um/cc was made by authors to make values comparable. To obtain 30-minute standards, multiply by 5. Pertains to fibers >5 um in length. The 8-hour concentrations for tremolite and fibrous talc are 500 fibers/m^3. The 30-minute standards are 25,000 fiber/m^3 for both.

Risk Assessment/Risk Management

Of the seven agencies surveyed, four use some type of risk analysis. Using the EPA risk assessment guidelines, Maine is presently working on risk assessments for the 58 pollutants of primary concern there. The results of these assessments will be used to establish pollutant or source specific guidelines or standards.

Mississippi calculates carcinogenic risk by multiplying the CAG unit risk factor by the modeled average annual concentration. If no CAG unit risk factor is available, estimates of risk from other groups are consulted. If the calculated risk is less than 10^{-6}, then the risk is termed insignificant. If above 10^{-4}, the risk is considered significant. Between these two values, risk management decisions would be made on a case-by-case basis.

Sacramento also uses 10^{-6} as a guideline for acceptable risk. The California Department of Health Services determines what ambient concentration is associated with a 10^{-6} risk level, and then the Sacramento Air Pollution Control District sets stack emission limits such that the 10^{-6} risk level will not be exceeded.

Nevada's program is not primarily risk based, but the agency does conduct informal exposure assessments of predicted ambient concentrations and numbers of people exposed.

Application, Enforcement, and Public Review and Appeal

The seven agencies described here are at various stages of implementation of their air toxics programs. The agencies have jurisdiction over areas that vary in degree of industrial development. Thus, the experiences with application and enforcement have been varied, making comparisons of provisions among programs difficult.

Almost all of the agencies reported that the public participated in development of the air toxics program and/or in public hearings concerning a specific source.

Six of the seven agencies currently or plan to require ambient monitoring and/or stack testing as a permit condition for some air toxic sources. Only one agency reported that it had no plans for an air toxics inventory. All but one agency reported that they had provisions for appealing the Agency's air toxics requirements. Most of these provisions allowed for suggesting an alternative to the acceptable ambient concentration.

PART II - DESCRIPTIONS OF SELECTED PROGRAM RATIONALE

SACRAMENTO COUNTY AIR POLLUTION CONTROL DISTRICT

General Program Aspects

The Sacramento County Air Pollution Control District (SCAPCD or the District) uses informal guidelines as a basis for regulating carcinogens or suspected carcinogens in the ambient air. The guidelines are based on a risk assessment approach and are applied to new sources as the sources apply for permits or permit modifications. Formal airborne toxic control measures are being developed on a substance-by-substance basis at the State level. The SCAPCD expects to adopt these measures, where applicable, as they are developed.

District authority for regulating air toxics is found in District Rule 402 and an identical State regulation concerning public nuisance (Health and Safety Code Section 41700).

Basis for Acceptable Ambient Limits/Emission Limits

A stack emission limit is specified in each permit issued. The limit is calculated based on the source's stack parameters such that the source's contribution above the ambient concentration of the particular pollutant will not exceed a level corresponding to a carcinogenic risk of 10^{-6}. This risk level is used by the District because it is the action level suggested by the California Department of Health Services (CDHS). The ambient levels corresponding to a carcinogenic risk of 10^{-6} used to date, have been developed upon the District's request by CDHS. CDHS considers primarily animal bioassay data, noting the number of cancers at a given dose level and establishing a dose/response curve. CDHS uses the linear low dose extrapolation assumption and a conservative approach in converting animal dosage to human dosage.

In the future, the District anticipates using CAG unit risk factors to screen permit applications with review after screening by the CDHS. If there is no CAG unit risk factor, nor any CDHS unit risk factor, the District would ask CDHS to develop a risk factor for the pollutant in question, or require the permit applicant to develop the risk factor. If the permit applicant supplies the risk factor, it would be reviewed by the CDHS.

The District currently limits its guidelines to carcinogens because the District staff feels there is no satisfactory mechanism for establishing safe guidelines for noncarcinogens, and because there is considerable disagreement on what factors (e.g., occupational standards divided by safety factors) should be used to define a safe ambient level for noncarcinogens.

Fugitive emissions have not been a major problem at the sources the District has considered thus far. Sources are required to give calculations on fugitive losses (e.g., chemical plant breathing vents), but to date, these sources have not been required to control fugitives.

In estimating dispersion, the permit applicant is required to estimate daily emissions from the stack and then to model concentrations at various receptor sites. Receptor sites are chosen to correspond with the location of human population. The maximum distance from the source varies, and depends on the strength of the source and how far downwind a significant concentration would likely be found. To date, the maximum distance modeled from a source has been approximately 3 miles downwind.

The District has not settled on a particular model so different dispersion models are used depending on the nature of a particular project. When a source recently applied for a permit to perform air stripping to remove solvent from ground water, the project proponent suggested EPA's Industrial Source Complex (ISC) model and the District concurred. PTMAX and ISC are two models used by the District to date.

Public participation has not been a formal step in the development of the SCAPCD guidelines for controlling carcinogens. However, public hearings have been held when there has clearly been public interest in a proposed project. In addition, District regulations contain a provision where any person may petition the APCD Hearing Board to reverse the Air Pollution

Control Officer's decision to authorize construction. Some informal review takes place during the permit application process when the risk assessment is reviewed by the California Air Resources Board (CARB), CDHS, and the District; CARB, CDHS, and the applicant discuss the particular source.

Risk Assessment/Risk Management

As mentioned above, risk assessment is the primary thrust of the SCAPCD effort to control carcinogenic air pollutants. The District regulates any suspected carcinogen based on the "pollutants having evidence of carcinogenicity," as listed in EPA's 1984 study of the air toxics problem in the United States[1] (Table 5), and based on the CARB list of compounds under consideration as toxic air contaminants.

The steps in the District's risk assessment process are:

- o estimation of daily emissions by the permit applicant;
- o modelling by the permit applicant of concentrations at receptor sites;
- o comparison with the ambient concentration (or range of concentrations) associated with a cancer risk of 1 in 1 million; and
- o estimation of cancer burden (i.e., the number of cancer cases in an uniformly exposed population, which is considered to be the exposed population, over a lifetime of 70 years).

If the modelled concentrations are below the concentration associated with the 10^{-6} risk, then the permit application would be approved. If not, the District would work with the applicant to consider achieving emission reduction by means such as additional control or limiting the hours of operation or limiting the process rate. In some cases, the District would consider the life of the proposed project and might permit a fairly short-lived project to exceed the acceptable ambient concentration. The ambient concentration associated with the 10^{-6} risk is based on lifetime (70 years) exposure to the concentration and the District acknowledges that

TABLE 5. POLLUTANTS HAVING SOME EVIDENCE OF CARCINOGENICITY[1*]: SACRAMENTO COUNTY

Acrylamide	Formaldehyde
Acrylonitrile	Gasoline vapors
Allyl chloride	Gasoline marketing
Arsenic	4,4 150 Propylidene diphenol
Asbestos	Melamine
Benzene	Methyl chloride
Benzo-a-pyrene	Methylene chloride
Benzyl chloride	4,4-Methylene dianiline
Beryllium	Nickel (subsulfide)
1,3-Butadiene	Nitrobenzene
Cadmium	Nitrosomorpholine
Carbon tetrachloride	Pentachlorphenol
Chloroform	Perchloroethylene
Chromium	Products of incomplete combustion
Coke oven emissions	PCBs
Diethanolamine	Propylene dichloride
Dimethylnitrosamine	Propylene oxide
Dioctyl phthalate	Radionuclides
Epichlorohydrin	Styrene
Ethyl acrylate	Terephthalic acid
Ethylene	Titanium dioxide
Ethylene dibromide	Trichloroethylene
Ethylene dichloride	Vinyl chloride
Ethylene oxide	Vinylidene chloride

*The weight of evidence of carcinogenicity for the compounds listed varies greatly, from very limited to very substantial. Further, the extent of evaluation and health review performed varies considerably among compounds. However, for the purposes of Reference 1, a conservative scenario (i.e., that all compounds examined could be human carcinogens) was assumed.

this would not be the case for a short-term project. Such was the case at an organic chemical manufacturing plant which was slated to operate for only two years. The ambient monitoring network around the plant indicated periodic unexplained exceedances of the guideline. The District staff has no formal maximum allowable exceedance, but was not concerned in this case since the ambient levels decreased, and the plant was due to close after two years.

Exposure assessment (i.e., determining the number of people exposed to various ambient concentrations of the pollutant) has not been a factor so far in the District's analysis. Since the population of metropolitan Sacramento is about 1 million people, a risk of 1×10^{-6} would present a maximum cancer burden of 1 if the entire population were exposed. Because the action level of 1×10^{-6} cancer risk reflects exposure to a population equivalent to the entire metropolitan area, cancer burden has not played a significant role in the District's program.

The District is anticipating the completion of a risk assessment manual being prepared for use by Air Pollution Control Districts Statewide. The manual is being prepared under a grant and supervision from EPA Region IX, with review by CARB, CDHS, and representatives from various Districts. When completed, the manual will include guidance on carcinogenic risk assessment and possibly on risk assessment for noncarcinogens. SCAPCD would then have a mechanism for regulating noncarcinogenic air toxics based on the manual's guidance.

Application and Enforcement

The District's guidelines for regulating carcinogens are applied by the District to new and modified sources. Eight applications involving two industries have been handled thus far. Once a permit is issued, if permit conditions are met, the permit is renewed annually without additional requirements being placed on the source. State law precludes the imposition of new requirements on an existing permit. If additional health effects data should cause a unit risk factor to be lowered, the District would not

be able to impose stricter requirements in an existing permit. In such a case, the District might ask the source to comply with the more stringent guideline in the interest of public health.

Some sources are required in the permit to perform ambient monitoring and to track equivalent human dose. There is no formal policy about when a source would be required to conduct ambient monitoring, but the District makes decisions on monitoring based on the level of public concern, the availability of monitoring sites, and the source strength. Monitoring would more likely be required of a large source than a small source.

In tracking equivalent human dose, the source must determine the average concentration in ug/m^3 for each 3-month period, and then convert this to the equivalent human dose based on assumptions of the amount of air inhaled. Based on the District's conservative assumption of 100 percent retention of the pollutant, the dose for each quarter is reported. Doses for each 3-month period are added together. Should the quarterly reports project that the annual dose specified in the permit will be exceeded prior to the end of the calendar year, the source would be required to shut down for the remainder of the year or vent emissions to a control device. The 3-month period was selected on an informal basis to reduce the burden on industry of more frequent reporting, yet to give a reasonable amount of notice if the annual dose was likely to be exceeded.

The District has provisions for review and appeal of permit decisions, but no decisions regarding air toxics have been appealed. The provisions for appeal allow the permit applicant to appear before the APCD Hearing Board, which is appointed by the Air Pollution Control Board.

Violators of the District's requirement are subject to criminal penalties consisting of a fine of $1,000 per day (i.e., per violation), or six months in prison, or civil penalties of $1,000 per violation.

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PHILADELPHIA AIR MANAGEMENT SERVICES

General Program Aspects

Philadelphia Air Management Services (AMS) is the process of implementing a program to limit emissions of 99 toxic air pollutants (Table 6). The air toxics provisions are aimed at new and existing sources and are based on acceptable ambient guidelines.

Basis for Acceptable Ambient Limits/Emission Limits

The Philadelphia air toxics guidelines are aimed at 99 substances or classes of substances listed in an ordinance (Air Management Regulation VI) that was signed and became effective in 1981. The list of 99 substances was compiled by reference to other lists to address concerns about chronic low-level exposure in the community, and the associated health effects. The principal reference was the ACGIH carcinogen list.[1,2] Cancer is a primary concern, but the list of pollutants also reflects concern over other chronic effects such as liver and kidney damage (e.g., mercury). Another selection criterion was the likelihood of the pollutant being found in Philadelphia. The AMS believes that any acute, high concentration exposure would be the result of an emergency situation to which AMS would respond directly.

As part of the process of determining the health hazard potential of each of the 99 pollutants, AMS examined the toxicity of each pollutant to humans. To assist AMS in evaluating toxicologic data, an ad hoc advisory committee was appointed by the Health Commissioner. The seven member committee consisted of health professionals from academic, industry, and public interest groups in the fields of toxicology, occupational medicine, and industrial hygiene.

The Committee's objective was to recommend ambient air quality guidelines for the 99 pollutants. It was felt that the AMS did not have the staff and financial resources to perform the exhaustive process necessary

TABLE 6. TOXIC AIR CONTAMINANTS AND AMBIENT AIR QUALITY GUIDELINES LISTED BY AIR MANAGEMENT SERVICES, CITY OF PHILADELPHIA[3]

	Pollutant	Ambient Air Guideline (Annual Average Unless Otherwise Noted)
1.	Acrylonitrile	5 ppb
2.	Aldrin	0.035 ug/m^3
3.	4-Aminodiphenyl	0.8 ug/m^3
4.	3-Amino-1,2,4-triazole	1.8 ug/m^3
5.	Antimony and compounds	1.2 ug/m^3
6.	Arsenic and compounds	0.024 ug/m^3
7.	Asbestos	0.005 fibers > 5 um/cc
8.	Benzene	24 ppb
9.	Benzidine	30 ug/m^3
10.	Benzo(a)pyrene	0.0007 ug/m^3
11.	Beryllium and compounds	0.01 ug/m^3
12.	BHC	1.2 ug/m^3
13.	Lindane and isomers	1.2 ug/m^3
14.	Bis(2-chloroethyl)ether	120 ppb
15.	Bis(chloromethyl)ether	0.0024 ppb
16.	Bis(2-hydroxyethyl)-dithiocarbamic acid, potassium salt	No Guideline[a]
17.	Cadmium and compounds	0.12 ug/m^3
18.	Captan	35 ug/m^3
19.	Carbaryl	3.5 ug/m^3
20.	Carbon tetrachloride	12 ppb
21.	Chloramben	1333 ug/m^3
22.	Chlordane	0.35 ug/m^3
23.	Chlorobenzilate	7 ug/m^3
24.	Chloroform	24 ppb
25.	Chloromethyl methyl ether	0.02 ppb
26.	Chromium and compounds (hexavalent)	0.12 ug/m^3

TABLE 6. TOXIC AIR CONTAMINANTS AND AMBIENT AIR QUALITY GUIDELINES LISTED BY AIR MANAGEMENT SERVICES, CITY OF PHILADELPHIA[3]
(Continued)

	Pollutant	Ambient Air Guideline (Annual Average Unless Otherwise Noted)
27.	DDT/DDD	1.8 ug/m^3
28.	1,2-Dibromo-3-chloropropane	0.1 ppb
29.	3,3-Dichlorobenzidine	No Guideline[a,b]
30.	2,4-Dichlorophenoxy acetic acid	105 ug/m^3
31.	Dieldrin	0.035 ug/m^3
32.	Di(2-ethyl hexyl)phthalate	120 ug/m^3
33.	Dimethylcarbamyl chloride	0.24 ppb
34.	1,1-Dimethyl hydrazine	1.2 ppb
35.	Dimethyl sulfate	2.4 ppb
36.	Dioxane	24 ppb
37.	Endosulfan	2.4 ug/m^3
38.	Endrin	0.07 ug/m^3
39.	Ethylenebisdithiocarbamic acid salts	18 ug/m^3
40.	Ethylene dibromide	2.4 ppb
41.	Ethylene dichloride	37 ppb
42.	Ethylene oxide	2.4 ppb
43.	Ethylene thiourea	0.7 ug/m^3
44.	Epichlorohydrin	2.4 ppb
45.	Formaldehyde	4.8 ppb
46.	Heptachlor	0.18 ug/m^3
47.	Hexachlorobenzene	0.48 ppb
48.	Hexachlorobutadiene	0.06 ppb
49.	Hexamethyl phosphoramide	0.0024 ppb
50.	Hydrazine	0.24 ppb
51.	Kelthane	8.8 ug/^{3}
52.	Kepone	0.88 ug/m^3
53.	Lead and compounds	1.5 ug/m^3
54.	Manganese and compounds	24 ug/m^3

TABLE 6. TOXIC AIR CONTAMINANTS AND AMBIENT AIR QUALITY GUIDELINES LISTED BY AIR MANAGEMENT SERVICES, CITY OF PHILADELPHIA[3]
(Continued)

Pollutant	Ambient Air Guideline (Annual Average Unless Otherwise Noted)
55. Mercury and compounds	0.24 ug/m^3
56. Methoxychlor	35 ug/m^3
57. Methyl bromide	120 ppb
58. Methyl chloride	1200 ppb
59. 4,4-Methylene bis(2-chloroaniline)	0.05 ppb
60. Methylene chloride	2400 ppb
61. Methyl iodide	5 ppb
62. Mirex	0.88 ug/m^3
63. Monomethyl hydrazine	0.5 ppb
64. B-Naphthylamine	19 ug/m^3
65. Nickel and compounds	0.24 ug/m^3
66. 4-Nitrodiphenyl	2.7 ug/m^3
67. Nitrofen	0.75 ug/m^{3d}
68. 2-Nitropropane	6 ppb
69. N-nitrosodimethylamine	0.0004 ppb
70. Parathion	1.8 ug/m^3
71. Particulate polycyclic aromatic hydrocarbons	0.48 ug/m^3
72. Pentachlorophenol	12 ug/m^3
73. Perchloroethylene	1200 ppb
74. Phenol	120 ppb
75. N-phenyl-B-naphthylamine	45 ug/m^3
76. Polybrominated biphenyls	No Guideline[a]
77. Polychlorinated biphenyls	0.18 ug/m^3
78. Propane sultone	No Guideline[a,c]
79. B-Propiolactone	No Guideline[a,b]
80. Propylene imine	4.8 ppb
81. Propylene oxide	250 ppb

TABLE 6. TOXIC AIR CONTAMINANTS AND AMBIENT AIR QUALITY GUIDELINES LISTED BY AIR MANAGEMENT SERVICES, CITY OF PHILADELPHIA[3]
(Continued)

	Pollutant	Ambient Air Guideline (Annual Average Unless Otherwise Noted)
82.	Quintozene	2.4 ug/m^3
83.	Strobane	7.7 ug/m^3
84.	2-(p-tert-Butylphenoxy)-isopropyl-2-chloroethyl sulfite	18 ug/m^3
85.	Tetrachlorinated dibenzo-p-dioxins	0.000035 ug/m^3
86.	Tetrachloroethane	24 ppb
87.	Tetrachlorvinphos	3360 ug/m^3
88.	Thallium and compounds	2.4 ug/m^3
89.	o-Tolidine	No Guideline[a]
90.	Trichloroethylene	1200 ppb
91.	Trichlorophenol isomers	3500 ug/m^3
92.	2,4,5-Trichlorophenoxy acetic acid	1 ug/m^3
93.	Trifluralin	1150 ug/m^3
94.	Toxaphene	1.2 ug/m^3
95.	Vinyl bromide	12 ppb
96.	Vinyl chloride	2.4 ppb
97.	Vinyl cyclohexene dioxide	24 ppb
98.	Vinylidene chloride	6 ppb
99.	Vinyl trichloride	240 ppb

[a]No guideline due to insufficient scientific evidence.
[b]Noted to be carcinogenic.
[c]Noted to be highly carcinogenic.
[d]24-hour averaging period.

for air quality standards. By using guidelines to evaluate the health hazard potential from these pollutants, problem pollutants and emission sources are identified for regulation.

AMS has listed some limitations to this approach: 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 standards); 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.[3]

The Committee designed a guideline-setting methodology 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. The methodology is outlined in Table 7.

As Table 7 illustrates, each of the 99 substances was first classified as either a criteria pollutant, a carcinogen or a noncarcinogen. Criteria pollutants are those for which there are National Ambient Air Quality Standards. AMS also included in this group pollutants which have been listed as hazardous air pollutants by EPA under Section 112 of the Clean Air Act (National Emission Standards for Hazardous Air Pollutants (NESHAP). To be considered a carcinogen, the pollutant had to be on at least one of the following lists: the American Conference of Governmental Industrial Hygienists list of human carcinogens (A1a and A1b) or industrial substances

TABLE 7. PHILADELPHIA AIR MANAGEMENT SERVICES AMBIENT AIR QUALITY GUIDELINE - SETTING METHODOLOGY FOR TOXIC AIR CONTAMINANTS

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 [A1a, A1b, 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 4,200 or 1,000 depending on study

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

III. Noncarcinogens

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. Additional safety factor added where justified

suspect of carcinogenic potential for man (A2) or the carcinogen list of the National Toxicology Program (NTP). All other toxics were considered noncarcinogens.[3]

For the criteria pollutant category, the NAAQS or NESHAP standard (if expressed as an equivalent ambient standard) was adopted as the guideline. For carcinogens and noncarcinogens, toxicologic data had to be adjusted to derive guidelines. This leads to the toxicity data priority ranking. Human data superseded animal data in all cases since the guidelines were for human exposures. This is reflected in Table 7. 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.[3]

Base-line levels were abstracted from any scientifically valid source (as per the priority rankings noted above) and included 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 pound) man breathing 20 M^3 air per day. Lastly, provisions were made for using additional safety factors where justified.[3]

The guidelines were based on annual averages per agreement by AMS and the Committee since the 99 listed substances generally pose more serious health hazards from chronic (long-term) exposure than from acute (short-term) exposure. The guidelines represent annual average levels to which the community can be exposed continuously for long periods of time. There is one exception to the annual averaging period. The guideline for nitrofen is based on a 24-hour averaging period due to possible teratogenic effects.

In comparing a source's contribution to the ambient concentration to the ambient guideline, AMS uses emission estimates from the source and a computer dispersion model to determine the source's annual contribution to the ambient concentration. If the modelling indicates that the ambient contribution from the source (i.e., the maximum ground level concentration in an impacted area) is less than one-third of the guideline then a permit would be granted. If the ambient contribution exceeds three times the guideline then the source would be required to achieve additional emission control. For ambient concentrations greater than one-third but less than three times the guideline, AMS would review the data used in establishing the guideline, possibly conduct ambient monitoring, and work with the source to ensure that existing controls are being used effectively. The lower limit of one-third and the upper limit of three times the guideline were based on ambient monitoring study results compared to dispersion modelling output. This comparison showed the model concentration could vary from the measured concentration by a factor of three.

For dispersion modelling AMS is currently using EPA UNAMAP approved models. (UNAMAP is EPA's User Network for Applied Modeling of Air Pollution.) Under an EPA grant, AMS has been working to develop its own, more refined dispersion model that will better represent Philadelphia's dispersion conditions. These special conditions include building wake effects, unusually shaped vents (e.g., goosenecks), refrigerated vents, and ambient exposure close to the source.

Risk Assessment/Risk Management

Philadelphia does not use a risk assessment/risk management approach.

Application and Enforcement

The Philadelphia program is in the process of being implemented in a phased approach. The four phases[1] are:

Phase I - Control of Health Hazardous due to Toxic Air Contaminant (TAC) Point Sources

A. Determine TAC emissions from each facility

B. Determine "worst case" receptor air quality

C. Evaluate hazard and negotiate settlement

Phase II - Complete TAC Emission Inventory and Determine Air Quality

A. Conduct engineering studies, source sampling, and source-oriented monitoring to evaluate emissions from area sources and "exempt sources".

B. Develop and employ ambient air monitoring methods.

Phase III - Develop Strategies, Plans, and Regulations for TAC Problem Areas Determined in Phase II

Phase IV - Implement Phase III Plans and Regulations, and establish a Maintenance Program

AMS staff members report that work is currently ongoing in all four phases.

The program is being implemented through the permitting system for new and existing sources. New sources include newly constructed facilities as well as existing facilities that have just begun to emit a listed pollutant. There is no minimum emission level under which sources would be exempt. However, the regulation specifically exempts combustion sources only using commercial fuel, retail dry cleaners, retail and noncommercial handling of motor fuels, incineration of waste materials other than industrial wastes, and minor sources such as laboratory-scale operations.

Air Management Regulation VI does not specify when sources must comply with the guidelines. AMS uses the guidelines for evaluating sources rather than for setting a specific emission restriction. AMS would work with a permit applicant on scheduling necessary emission reduction measures.

The regulation pertaining to toxic air contaminants has a provision for sources to present data that would lead AMS to revise the guideline pertaining to a certain pollutant. This provision has not been used by any sources to date since none have greatly exceeded the guideline.

AMS has the authority to require sources to conduct ambient monitoring and/or stack testing for enforcement purposes. To date, no sources have been required to conduct such tests since these would be required in a questionable situation and such situations have been very rare. The AMS staff feels such monitoring or stack testing, if required, would be done on a joint basis with AMS.

Although no sources have challenged any of the air toxics guidelines, AMS has guidelines for review and appeal of any permit decision. If AMS and the permit applicant could not reach an agreement on emission reduction and the permit was denied, the applicant would have recourse to the Licenses and Inspection Review Board.

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CHATTANOOGA-HAMILTON COUNTY
AIR POLLUTION CONTROL BUREAU

General Program Aspects

Chattanooga-Hamilton County's air toxics program was proposed by the staff of the Chattanooga-Hamilton County Air Pollution Control Bureau in 1982. The Bureau is the professional staff of, and operates under the direction of, a 10-member independent Board. The rules of the air toxics program have not yet been adopted by the Board, the Chattanooga City Commission, or the Hamilton County Commission. The basis of the program is two rules, one of which defines a specific list of 99 toxic compounds. A general rule concerning control of toxic air pollutants is also included as part of the air toxics program. Best available control technology (BACT) is often used in Chattanooga-Hamilton County's program, which applies only to new and modified sources.

Basis for Acceptable Emission Limits

The Chattanooga-Hamilton County Air Pollution Control Bureau would establish acceptable emission limits as a function of BACT.

The Bureau proposed that the initial program be directed toward new and modified sources because a program addressing existing sources might be too ambitious. Another reason for directing the program to new and modified sources was that the Bureau realized that many chemical companies (where one might find emissions of toxic substances) modify processes or add new compounds to their product lines. Thus, over a period of time, the Bureau would be regulating many of the larger sources of toxic emissions in Chattanooga-Hamilton County by regulating new sources.

Before a permit is issued, the source must demonstrate that emissions of toxic pollutants would not result in unreasonable risk to human health, plant and animal life, or property. The Bureau may require best available

control technology (BACT) as a condition of the permit. Sources may appeal to the Board for relief, providing that the source demonstrates the change would not create an unreasonable risk.

Unreasonable risk will be determined on a case-by-case basis. Sources will be asked to submit scientific analyses of the worst case condition concentration of toxic air contaminants, including such studies necessary to provide a demonstration of unreasonable risk. The studies may include independent research and tests and literature reviews. As part of the permitting process, the Bureau would also consider as a factor (but not the only factor) whether or not the worst case concentration would exceed a fraction of the TLV. The Bureau has speculated that the fraction of 1/420 may be used in some cases, but has not yet determined when.

A list of 99 substances has been prepared by the Bureau, identifying materials considered as toxic air contaminants subject to the rule discussed above (Table 8). Toxic air contaminants are defined as those materials which, because of their toxic, teratogenic, mutagenic, and/or carcinogenic effects, may pose a potential threat to human health (acute and chronic effects), and animal or plant life. The list of 99 substances was developed by first reviewing other lists of suspected toxic substances from several sources. Included among these lists were the list of chemicals regulated by the Resource Recovery and Conservation Act and the Occupational Safety and Health Administration. Substances were ranked according to the frequency with which they appeared on the lists reviewed and a master list was prepared. The master list was condensed, based on recommendations from a consultant from a local university. Only those substances known or suspected to be present in the Chattanooga environment and/or known or suspected to be toxic, carcinogenic, mutagenic or teratogenic were retained on the list.

Unreasonable risk to animal and plant life are included because damage (defoliation) has been noted in a large area of southern Chattanooga. Emissions from a local chemical facility were thought to be responsible. The Bureau also realized that the public is concerned about damage to plant and animal life in the area.

TABLE 8. LIST OF 99 POLLUTANTS DEVELOPED BY CHATTANOOGA-HAMILTON COUNTY AIR POLLUTION CONTROL BUREAU

1. Acrolein
2. Acrylamide
3. Acrylonitrile
4. Alderlin
5. Aldrin
6. 4-Aminodiphenyl
7. 3-Amino-1,2,4-triazole
8. Antimony
9. Antimony hydride
10. Antimony trifluoride
11. Antimony trioxide
12. Arsenic
13. Arsenic pentoxide
14. Arsenic sulfide
15. Arsenic trioxide
16. Arsine
17. Banvel
18. Barium
19. Benzene
20. Benzidine
21. Benzo(a)pyrene
22. Benzotrichloride
23. Benzyl chloride
24. Beryllium oxide
25. Beryllium sulfate
26. Cadmium
27. Cadmium chloride
28. Cadmium fluoride
29. Cadmium oxide
30. Cadmium sulfate
31. Carbon tetrachloride
32. Chlordane
33. Chlorinated diphenyl
34. Chloromethyl methyl ether
35. Chromium
36. Cyanogen
37. Diborane
38. Dichloro diphenyl trichloroethane
39. Dieldrin
40. Dimethyl mercury
41. Dimethyl sulfate
42. Dinitrobenzene
43. Dioxin
44. Diphenyl
45. Endrin
46. Ethylene chlorohydrin
47. Ethylene dibromide
48. Ethylene oxide
49. Ethylenimine
50. Formaldehyde
51. Heptachlor
52. Hexachlorocyclopentadiene
53. Hydrazine
54. Hydrofluoric acid
55. Hydrogen cyanide
56. Hydrogen sulfide
57. Kepone
58. Lead acetate
59. Lead arsenate
60. Lead chromate
61. Lead oxide
62. Lead tetraethyl
63. Lindane
64. Malathion
65. Manganese
66. Manganese arsenate
67. Mercuric bichloride
68. Mercuric acetate
69. Mercuric cyanide
70. Mercuric nitrate
71. Mercuric oxide
72. Mercurous nitrate
73. Methyl isocyanate
74. Methyl iodide
75. Methyl mercury
76. Mirex
77. beta-Naphthylamine
78. alpha-Naphthylthiourea
79. Nickel
80. Nickel carbonyl
81. Nickel cyanide
82. Nickel fluoride
83. p-Nitrochlorobenzene
84. 4-Nitrodiphenyl
85. Osmium tetroxide
86. Paraquat
87. Parathion
88. Phenol
89. Phenyl mercaptan
90. Phosgene
91. Phosphine
92. Rotenone
93. Selenium oxychloride
94. Sodium arsenite
95. Sodium selenide
96. Strychnine
97. o-Tolidine
98. 2,4,5-Trichlorophenoxy-acetic acid
99. Vinyl bromide

The list of 99 substances may be revised by the Board (after the program is adopted) based on the following considerations:

1. Risk of immediate acute or substantial harm to human health, at concentrations likely to be encountered in the community;
2. Proven or suspected carcinogenicity as shown through epidemiological or other scientific studies in either human or animal populations or in laboratory studies of animals and other experimental media;
3. Mutagenicity and teratogenicity as proven through human, animal, or other experimental media (Ames tests);
4. Chronic adverse health effects or bioaccumulative effects in human and other living members of the environment;
5. Findings of the U.S. Environmental Protection Agency (EPA), the Occupational Safety and Health Administration (OSHA), or other such agencies regarding toxicity;
6. Extent to which the substance is likely to be found in the Chattanooga environment; and
7. Other factors necessary to protect the public health and welfare.

The Board, the City Commission and Hamilton County Commission will be able to delete substances from the list with the Bureau recommending or proposing such changes. In evaluating health effects studies, the primary emphasis is on scientific validity rather than human evidence versus animal evidence.

The second proposed rule addresses general provisions for toxic air pollutants and is based on use of BACT in permitting. The rule states that no release of a toxic air contaminant in excess of any emission limitation imposed by the Director of the Bureau is allowed. A new or modified source emitting a toxic air contaminant must obtain an installation permit. To get a permit, the permit applicant must demonstrate that emissions from the source will not result in an unreasonable risk to human health and safety, plant life, animal life, or property. The Director may require BACT as a permit condition.

In the permitting process, the Bureau provides a determination of the emission limitation which must be met by the source. A BACT determination for a toxic pollutant would be made as for a criteria pollutant. The Bureau would review data for control techniques successfully applied at facilities similar to that of the permit applicant. Although the type of controls would not be specified in the permit, the Bureau would define the emission limit and operating parameters which must be met.

A series of public hearings have been held at which the proposed air toxics program was discussed, both with the public and with industry.

Risk Assessment/Risk Management

The Chattanooga-Hamilton County Air Pollution Control Bureau is not required by the proposed rules to perform risk assessments; however, they may be conducted in certain instances. The source must provide demonstration that emissions will not result in unreasonable risk.

Application and Enforcement

Stack testing and/or ambient monitoring can be required by the Air Pollution Control Bureau. Generally, stack testing of any new source of toxic or criteria pollutants will be required. Ambient monitoring may be required when sufficient concern about emissions from a new facility exists.

A toxics emissions inventory has been developed in conjunction with the air toxics program. A relatively complete criteria pollutant inventory has already been developed, and Hamilton County is refining that existing inventory and adding information on emissions of air toxics.

MAINE BUREAU OF AIR QUALITY CONTROL

General Program Aspects

In 1984, the Maine legislature mandated the Bureau of Air Quality Control to complete a toxic air pollutant inventory. The legislature felt that it was necessary to first determine what toxic pollutants were being emitted and in what quantities, prior to accepting a regulatory program. The inventory has been completed and the 58 hazardous air pollutants found to be emitted in Maine have been prioritized, based on toxicity and the quantity emitted into the ambient air. The prioritized list is being used by the Maine Bureau of Health in assessing public health risks.

The Bureau of Health and the Bureau of Air Quality Control will soon begin using interim exposure guidelines for regulating new sources until risk assessments are completed. As a first approximation in setting guidelines, the ACGIH TLVs were modified to account for differences in exposure duration between occupational and community environments and sensitive target populations.

Basis for Acceptable Ambient Limits/Emission Limits

Maine's Bureau of Health has developed an approach to derive interim exposure guidelines for potentially hazardous air pollutants. The Bureau's approach has undergone peer review and approval by the State's Scientific Advisory Panel. Under this approach, two categories of substances were established; substances shown not to have carcinogenic, mutagenic, teratogenic, or adverse reproductive effects and substances shown to have the above effects. Under each category, four classes were identified. The categories, classes, and interim guidelines (IG) are summarized below.

Category A: Substances not shown to be carcinogenic, mutagenic, teratogenic, or to have adverse reproductive effects by the NTP, NIOSH, IARC, ACGIH, or in the GENE-TOX data base.

Class 1: Substances with ACGIH TLV-TWAs
IG_{A1} = TLV-TWA/60

Class 2: Substances with ACGIH TLV-TWAs and STELs
IG_{A2a} = TLV-TWA/60, IG_{A2b} = TLV-STEL/10

Class 3: Substances with ACGIH Ceiling Limits
IG_{A3} = TLV-C/10

Class 4: Substances without ACGIH TLVs or substances whose TLVs are shown to be inadequate based on new information
IG_{A4} = NOEL (LOEL) x 0.625 to 0.00625

Category B: Substances shown to be carcinogenic, mutagenic, teratogenic, or to have adverse reproductive effects by the NTP, NIOSH, IARC, ACGIH, or GENE-TOX

Class 1: Substances with ACGIH TLV-TWAs
IG_{B1} = TLV-TWA/300

Class 2: Substances with ACGIH TLV-TWAs and STELs
IG_{B2} = STEL/10

Class 3: Substances with ACGIH Ceiling Limits
IG_{B3} = TLV-C/10

Class 4: Substances without ACGIH TLVs or substances whose TLVs are shown to be inadequate based on new information
IG_{B4a} = NOEL (LOEL) x weight factor x 1/1000
IG_{B4b} = NOEL (LOEL)/400, IG_{B4c} = NOEL (LOEL)/3.3, 33.3, or 333

The Bureau of Health noted that there is general agreement that TLVs should not be used as a basis for air quality standards without comprehensive risk assessment on the pollutants. However, the Bureau feels that TLVs must be considered as the preferred source for developing interim exposure guidelines after considering the sensitivity differences between workers and the general population. In this respect, the Bureau of Health views the use of TLVs as a first approximation for protecting the general population. Completion of risk assessments can only ascertain the adequacy of the modified TLV.

As an immediate source, the Bureau of Health notes that the ACGIH-TLV should be used in the development of a guideline because the TLVs represent a body of accessible information, the ACGIH has made available the

documentation for the TLVs, and the values are updated periodically, based on review of new health information. Each TLV, however, must be evaluated to determine if the basis of the TLV contains data which can be used directly to derive a guideline. In addition, the history of each TLV must be examined to assess the extent to which it has assured worker safety. Information obtained from NTP, NIOSH, IARC, and data bases available from the National Library of Medicine (Toxicology Data Bank and Toxline) will augment the review of each TLV documentation before deriving guidelines.

In the absence of adequate risk assessments, populations at risk would not be identified. It is for this reason that a 10 kg infant is chosen as the basis for guideline development. By protecting the infant, a large segment of the sensitive population would be protected, including infants, and possibly, the developing fetus.

Rarely are TLVs based on teratogenic effects. For this reason, for chemicals shown to be teratogenic but void of carcinogenic/mutagenic effects, the NLM data base shall be consulted to obtain adequate no-observed-effect-levels (NOELs) or lowest-observed-effect-levels (LOELs) for teratogenic effects for deriving exposure guidelines based on a 60 kg standard female.

For both technical and practical reasons, the TLV safety factors have been pegged to the concentration in an inverse manner. As the magnitude of the TLV increases, a correspondingly decreased range of fluctuation is permitted. This is based on the premise that "not to decrease the factor for TLVs of increasing magnitude would permit exposures to large absolute quantities, an undesirable condition, and a condition that is minimized at low TLVs. Moreover, larger factors at lower TLVs are consistent with difficulties in analyzing and controlling trace quantities."[1]

The following paragraphs summarize the derivation of interim guidelines for Maine's two categories of hazardous air pollutants.[1]

Category A: Substances not shown to have carcinogenic, mutagenic, teratogenic, or reproductive effects.

Class 1: Substances with TLV-TWAs

1. Conversion from working exposure to continuous exposure:

$$\text{TLV-TWA} \times \frac{\text{8 hrs per work day}}{\text{24 hrs}} \times \frac{\text{5 days per work week}}{\text{7 days}} = \frac{\text{TLV-TWA}}{4.2}$$

2. Population diversity (i.e., conversion to account for the greater sensitivity of some segments of the population:

$$\frac{\text{TLV-TWA}}{4.2} \times 1/10$$

3. Expression of body dosage:

Maine's Bureau of Health notes that for metabolizable, lipophilic chemicals, the data suggest that dose between species is related to body weight to the exponent "b" with "b" having a value other than the 2/3, which is commonly used as the reference base for relating body weight to surface area. The value for "b" varies considerably for different animals and for different metabolic processes involved, ranging from 0.6 to 0.81 and higher. Assuming that the majority of the State's hazardous air pollutants are lipophilic, a conservative approach to intraspecies dose extrapolation is used, setting the value of the exponent "b" to 1.0, thereby permitting a linear dose extrapolation on a body weight basis.

The Bureau of Health feels that inter- and intraspecies linear dose extrapolation on a body weight basis can also be justified by pharmacokinetic and pharmacodynamic behavior of xenobiotics at low doses. Under these conditions, it is expected that metabolism and elimination would effectively remove most of the absorbed dose from circulation, thus ensuring that a) uptake by inhalation never reaches steady-state, and b) uptake would be linear with time. Assuming this to be the case, the absorbed dose would not be a function of surface area but a function of alveolar ventilation rate, cardiac output and blood/gas partition coefficient.

4. Adult inhalation rate to infant inhalation rate:

Adjusting airborne concentrations to reflect inhalation rate differences between adults and infants can be accomplished by two approaches, each using empirically derived data.

The first allometric approach assumes an inhalation rate of 20 m^3/day for a 70 kg adult and an inhalation rate of 4 m^3/day for a 10 kg infant. Incorporating the factors for continuous exposure and population diversity, the equation becomes:

TLV-TWA x (40 hrs per work week/168 hrs) x 1/10 x 20 m^3 adult inhalation rate/4m^3 infant inhalation rate x 10 kg infant/70 kg adult = TLV-TWA x 0.017 or TLV-TWA/59

The second allometric approach is rather complex, compared to the first approach. This approach relies on modeling equations which were based on experimental data from animals and humans. The equations relate parameters that affect uptake by inhalation at low concentrations. Specifically, the parameters addressed are alveolar ventilation, cardiac output, and the blood/gas partition coefficient.

Using the first and second approaches, the final form for the interim guideline (IG) for substances in Category A, Class 1 is:

IG_{A1} = TLV-TWA/60

Class 2: Substances with TLV-TWA and STELs.

Substances with TLV-TWA and STELs have two interim guideline values; a chronic guideline based on the TLV-TWA with an averaging time of one week, developed as in IG_{A1}, and a short-term guideline based on the STEL divided by a safety factor:

IG_{A2a} = TLV-TWA/60 and IG_{A2b} = TLV-STEL x 1/10

The time limit for the TLV-STEL guideline may range from 5 to 30 minutes, depending on the data base.

Class 3: Substances with TLV ceiling limits.

Given the basis for developing TLV-C, the Bureau of Health feels a safety factor is the only consideration necessary for deriving interim guidelines. Thus:

IG_{A3} = TLV-C x 1/10, not to be exceeded

Class 4: Substances without TLVs or substances whose TLVs are shown to be inadequate based on new information.

The selected data base shall be consulted to obtain adequate human or animal NOELs or LOELs (human data takes precedent over animal data) for chronic effects (unrelated to those listed for Category B substances) for deriving exposure guidelines based on a 10 kg, 1 year-old child. Thus:

IG_{A4} = NOEL (LOEL) x 1/uncertainty factor x 10 kg x 1/4 m^3

where:

10 kg = body weight of a 1 year-old child
4 m^3 = assumed daily inhalation rate
Uncertainty factor = ranges from 10 to 1000, depending on origin and adequacy of data base

therefore:

NOEL or LOEL may be divided by 4, 40, or 400

The selected exposure guideline shall thus be the NOEL/LOEL divided by one of the above values.

General guidelines for uncertainty factors were provided by the NAS Safe Drinking Water Committee. These factors are:

10 = is used when extrapolating from valid results from studies on prolonged exposure by humans. Factor is intended to protect the sensitive members of human population.
100 = is used when experimental results of studies of human inhalation are not available or when extrapolating from valid results of long-term studies on experimental animals when results of studies of human are not available or are scanty.
1000 = is used when extrapolating from less than chronic results on experimental animals or humans when there are no useful long-term data.

Category B: Substances shown to be carcinogenic, mutagenic, teratogenic, or to have adverse reproductive effects by the NTP, NIOSH, IARC, ACGIH, or the GENE-TOX data base.

Class 1: Substances with TLV-TWA

IG_{B1} = TLV-TWA/300

The value of 300 is based on the approach adopted by the State of New York Departments of Health and Conservation for their air toxic program which has been in place for about 20 years. Maine's Bureau of Health feels this denominator is arbitrary and certainly less protective than basing a value on a risk level of 1 in 1,000,000 or 1 in 100,000. However, to be confident of the latter approach an indepth risk assessment would be necessary. Given the emissions of other potentially hazardous pollutants and the need to prioritize chemicals for risk assessment based on toxicity and exposure, the Bureau of Health and the Scientific Advisory Panel believe that the above approach is appropriate for addressing chemical carcinogens as an interim guideline.

If ACGIH did not consider carcinogenicity or teratogenicity in establishing the TWA, the Bureau of Health would use the NOEL in setting the guideline (see IG_{B4}).

Class 2: Substances with TLV-TWA and STELs

This class of substances had been assigned two interim guidelines. One guideline is based on protection against short-term exposures using the following approach:

IG_{B2} = STEL/10; time limit may range from 5 to 30 minutes, depending on data base.

The second guideline value is based on protection against carcinogenic, teratogenic, or adverse reproductive effects of these substances using Class 4 approach described below or on TWA/60, whichever is smaller. The second guideline value for substances shown only to have mutagenic properties will be based on systemic effects or on in vivo mutagenic data using Class 4 approach or TWA/60, whichever is smaller.

Class 3: Substances with ceiling limits

Substances shown to be carcinogenic, mutagenic, teratogenic, and to have reproductive effects by the NTP, NIOSH, IARC, GENE-TOX, or the ACGIH, and whose ACGIH ceiling limits are based on effects other than those listed in this section shall be assigned two interim guideline values. One guideline will be based on protection against instantaneous exposures using the following approach:

IG_{B3} = Ceiling limit/10; not to be exceeded instantaneously

The second guideline value will be based on protection against carcinogenic, teratogenic, or adverse reproductive effects of these substances using the Class 4 approach described below. The second guideline value for substances shown only to have mutagenic properties will be based on systemic effects or in vivo mutagenic data using the Class 4 approach.

Class 4: Substances without TLVs and/or meeting criteria described in Classes 2 and 3 of Category B substances or substances whose TLVs are shown to be inadequate based on new information.

A. Carcinogenic Substances

The Bureau of Health will utilize threshold levels for the purposes of deriving interim guidelines for carcinogens. The data base (i.e., NLM, NTP, NIOSH, IARC, ACGIH) shall be consulted to obtain adequate human or animal NOELs or LOELs values (human data takes precedent over animal data). It is assumed that the surface area rule applies for dose extrapolation because of the direct interaction with DNA as suggested by the EPA's CAG and the NAS. (The surface area rule is used to estimate equivalent dose between species. When dose is measured in milligram per m^2 body surface per day, it is assumed body weight to the 2/3 power is equivalent to surface area.)

Due to the carcinogenic endpoint, a safety factor of 1,000 is employed. Thus:

$$IG_{B4a} = \text{NOEL (LOEL)} \times (\text{animal body weight/adult human male body weight})^{1/3} \times 70 \text{ kg} \times 1/1000 \times 1/20 \text{ m}^3$$

where:

animal body weight = in kg and depends on test species
adult human male body weight = standard 70 kg
20 m^3 = assumed daily inhalation rate

B. Substances Shown to be Mutagenic Only

For the purposes of deriving interim guidelines, the data base (i.e., NLM, NTP, NIOSH, IARC, ACGIH) shall be consulted to obtain adequate NOELs or LOELs values for systemic effects. Where available, adequate human or animal NOELs or LOELs (human data takes precedent over animal data) for in vivo mutagenic effects will be used in place of systemic effects. Thus:

For systemic effects, the guideline will be based on a 10 kg child, thereby retaining consistency with Category A approach. Due to the mutagenic concern, a safety factor of 1000 is employed. Thus:

$$IG_{B4b} = \text{NOEL (LOEL)} \times 1/1000 \times 10 \text{ kg} \times 1/4 \text{ m}^3$$

therefore:

$$IG_{B4b} = \text{NOEL (LOEL)}/400$$

For in vivo mutagenic effects, it is assumed that the surface area rule applies for dose extrapolation as with carcinogens because of the direct interaction with the DNA as suggested by the EPA's CAG and the NAS. Due to the mutagenic end point, a safety factor of 1000 is employed. Thus:

$$IG_{B4b} = \text{NOEL (LOEL)} \times (\text{animal body weight/adult human male body weight})^{1/3} \times 70 \text{ kg} \times 1/1000 \times 1/20 \text{ m}^3$$

C. Chemicals with Teratogenic or Adverse Reproductive Activity

For the purposes of deriving interim guidelines, the data base (i.e., NLM, NTP, NIOSH, IARC, ACGIH) shall be consulted to obtain adequate human or animal NOELs or LOELs values (human data takes precedent over animal data) for deriving guidelines based on a 60 kg adult female. Thus:

$$IG_{B4c} = \text{NOEL (LOEL)} \times 1/\text{uncertainty factor} \times 60 \text{ kg} \times 1/20 \text{ m}^3$$

where:

Uncertainty factor = ranges from 10 to 1000, depending on adequacy of data base as described in Category A.

or: NOEL or LOEL/3.3, 33.3, or 333

The interim guidelines developed by the Bureau of Health have been recently approved by the State's Scientific Advisory Panel. The Bureau of Air will have the responsibility of implementing the guidelines for new sources through the source licensing process. (Existing sources will be required to apply best practical treatment as determined on a case-by-case basis.) Although the guidelines have not yet been used, the Bureau of Air Quality Control anticipates that dispersion modeling estimates of a source's contribution to the ambient concentration will be compared to the guideline. Sources that approach or exceed the interim guideline will trigger more discussion among the permit applicant and the Bureau of Air Quality Control and Health. No decision has been made as to how ambient guidelines will be related to emission limits applied to the source.

Risk Assessment/Risk Management

Maine's Bureau of Health has recently begun conducting risk assessments for the 58 hazardous air pollutants identified in the legislatively mandated inventory. The Bureau plans to follow EPA risk assessment guidelines. The results of these risk assessments will be available to the Department of Environmental Protection to establish pollutant or source-specific standards. It is anticipated that a guideline approach may be chosen instead of standards.

The risk assessment process, recently begun for toluene, is made up of the following steps:

- review of secondary literature sources; such as EPA (air and water), NAS, NIOSH, WHO, and computerized literature search of NLM data bases;

- o examination of pertinent effects of concentrations expected at ambient levels and determination if a carcinogenic threshold exists; and
- o recommendation based on existing evidence.

The State's recent inventory and the scheme used to prioritize pollutants for future risk assessments are key steps in the risk assessment process. The legislation that required the State's inventory required that the following information be gathered for sources emitting any substance that may be a potential hazardous air pollutant:

- number of sources,
- location of each source or category of source,
- the quantity emitted by each source or category of sources,
- the total emissions, and
- the percentage of total emissions generated by sources with existing air licenses.

The inventory was conducted via a detailed questionnaire, which was sent to approximately 700 sources, including process sources; incineration sources; storage facilities; and loading, unloading, and transfer operations. The scope of the inventory was limited to 199 substances identified as potentially hazardous by the Bureaus of Air Quality Control and Health. No reporting was required for a use rate below 2000 pounds per year. (The 2000 pounds reporting cutoff was selected by the Bureau of Air Quality Control after consultation with an industry committee who reviewed the inventory questionnaire.) The inventory indicated 58 of the 199 substances were emitted in Maine.[2]

The next step after completion of the inventory was to prioritize the 58 pollutants identified for future risk assessment. Two components were addressed in the ranking system: toxicity and exposure. The Bureau of Health noted that combining these two components is necessary for a balanced perception of actual public health risk.

The ranking measured all the pollutants against a standardized set of criteria, and assigned numerical scores based on these criteria. The Bureau of Health feels that although the ranking system is not directly translatable into a measure of public health risk, it provides a relative index of the pollutants' potential health threats.

Four main criteria were used in the toxicity component ranking system, developed to be a general scheme that could be completed quickly for a large number of pollutants. The toxicity criteria addressed are: carcinogenicity, mutagenicity, reproductive effects, and acute effects. Scoring for the toxicity component was based on studies cited in the NIOSH publication, Registry of Toxic Effects of Chemical Substances (RTECS). Values were assigned for the four toxicity criteria based on the weight of evidence found in RTECS. Values for each of the criteria range from zero to four, except for acute toxicity, which ranges from one to four. Scores for all four health related criteria are added for the total toxicity component score.

The Bureau of Health noted that there are several difficulties involved with the derivation of a general toxicity value for a wide variety of pollutants. For instance, some scores may be underestimated due to inadequate data. To compensate for this, the standard deviation of the four health effects scores was added to the sum of the scores of the four toxicity criteria.

For the exposure component of the ranking scheme, emission estimates for all 58 hazardous air pollutants identified in the inventory were provided by the Bureau of Air Quality Control. The estimates were in the form of Statewide summations in pounds per year from industrial, commercial, residential, and mobile sources.

To rank the 58 pollutants, the Bureau of Health listed the pollutants in order of decreasing toxicity and emissions. The rankings in each list were added together to produce a total score, such that pollutants decreased in priority as their total scores increased. The toxicity and exposure components were not weighted due to the uncertainties involved with the weighting process. The 58 pollutants are listed in order of priority in Table 9.

TABLE 9. PRIORITY RANKING FOR MAINE'S HAZARDOUS AIR POLLUTANTS[2]

Pollutant	Toxicity Rank	Emission Rank	Total
1. Toluene	18	1	19
2. Tetrachloroethylene	15	6	21
3. Formaldehyde	2	21	23
4. Benzene	2	24	26
5. Epoxypropane	10	19	29
6. Chlorine	27	3	30
7. Methylene chloride	18	13	31
8. 1,1,1-Trichloroethane	30	2	32
9. Lead	18	16	34
10. Styrene	2	32	34
11. Trichloroethylene	15	20	35
12. Benzo-a-pyrene	7	30	37
13. Xylene	34	4	38
14. Methyl mercaptan	31	9	40
15. 1,2-Dichloroethane	15	28	43
16. Methyl cellosolve	36	7	43
17. Methyl methacrylate	28	15	43
18. Hydrogen chloride	18	26	44
19. Bis 2-ethylhexyl phthalate	11	34	45
20. Chlorine dioxide	36	10	46
21. Ethylene glycol ethyl ether	36	11	47
22. Naphthalene	18	33	51
23. Acetone	46	5	51
24. Methyl ethyl ketone	43	8	51
25. Arsenic	1	50	51
26. Hydrogen sulfide	41	12	53
27. Hydrazine	7	49	56
28. Ethylene oxide	11	45	56
29. Formic acid	31	25	56

TABLE 9. Continued

Pollutant	Toxicity Rank	Emission Rank	Total
30. Chromium	2	54	56
31. Methyl chloride	28	29	57
32. Zinc	11	47	58
33. Cadmium	7	52	59
34. Epichlorhydrin	2	58	60
35. Phenol	24	37	61
36. n-Butyl acetate	49	14	63
37. Diethyl sulfate	26	38	64
38. Butanol	49	17	66
39. Copper	11	55	66
40. Diphenyl methyl 4,4-diisocyanate	51	18	69
41. Manganese	35	35	70
42. Turpentine	51	22	73
43. Nitric acid	47	27	74
44. Ethyl acetate	51	23	74
45. Ethyl benzene	18	56	74
46. Furfural	40	36	76
47. Barium	36	44	80
48. Mercury	24	57	81
49. Biphenyl	43	40	83
50. Cyanide	41	42	83
51. p-Nitrophenol	31	53	84
52. Methyl isobutyl ketone	57	31	88
53. Ethanolamine	51	41	92
54. 1,2-dichlorobenzene	51	43	94
55. Tetrahydrofuran	43	51	94
56. Oxalic acid	47	48	95
57. Titanium oxide	57	39	96
58. Acetic anhydride	51	46	97

Application and Enforcement

As mentioned above, the Bureau of Air Quality Control plans to implement the interim ambient air guidelines for new sources, while individual risk assessments are being developed for the 58 hazardous pollutants. Existing sources will be required to use best practical technology until risk assessments are completed. Since the interim guidelines have not been implemented yet, many of the questions associated with application have not been addressed. The interim guidelines will be applied for all toxic pollutants emitted from new sources and implemented through the existing licensing process. The State does not currently issue permits to area sources such as dry cleaners and degreasers. Such sources will be controlled by source-specific regulations.

REFERENCES

1. Shehata, T., Derivation of Interim Exposure Guidelines for the Hazardous Air Pollutant Program. Second Draft. State of Maine, Department of Human Services. Augusta, Maine. March 27, 1985. 21 pp.

2. Bureau of Air Quality Control, Bureau of Health. Hazardous Air Pollutants in Maine: Emissions Inventory and Ranking System. Department of Environmental Protection, State of Maine. Augusta, Maine. March 1985. 76 pp.

MISSISSIPPI BUREAU OF POLLUTION CONTROL

General Program Aspects

Mississippi's air toxics program is based on informal guidelines and staff policy. The program has not been presented at public hearings and does not involve regulations or standards. The program's emphasis is placed on new sources. During review of the permit application, the agency investigates the potential for emissions of toxic pollutants. The pollutants considered are not limited to a specific list. The decision on which noncarcinogenic pollutants to address is officially made by the permit board, with substantial input from the Bureau of Pollution Control. All known and suspect carcinogens are addressed in the program.

Emissions of air toxics from existing sources are addressed through the NESHAP process. If a large number of complaints are received by the agency concerning an existing source, the agency evaluates those sources on a case-by-case basis. An opportunity to use the case-by-case approach has not yet been encountered by the agency.

Basis for Acceptable Ambient Concentrations

The Mississippi Bureau of Pollution Control separates toxic air pollutants into categories of known or suspected carcinogens and non-carcinogens. At this time, carcinogens are defined based on guidance from EPA. For noncarcinogens, a guideline for acceptable ambient concentrations is determined based on occupational health standards. If several occupational health standards are available (i.e., NIOSH recommended standards, OSHA PEL's, ACGIH TLV (TWA), health standards from Europe or the Soviet Union), the median of the available values is calculated. The median of various occupational health standards is used because the occupational data can not be directly extrapolated to ambient environmental conditions. Using a median value also helps smooth extremes of data. One percent of

that median value is used as the acceptable ambient concentration guideline for that chemical. The fact that 1 percent has been used by several other states in air toxics work was heavily considered in selecting the safety factor. The Bureau of Pollution Control believes that the 1 percent factor is conservative enough to use as a guideline.

Mississippi uses a 24-hour averaging time in their evaluations of non-carcinogens. The 24-hour averaging period was selected to coordinate easily with dispersion modelling work. The agency believes that the 24-hour averaging time is also conservative enough to use in developing guidelines. Models such as PTMAX or PTPLU are used to estimate ambient concentrations.

The guidelines are applied during the permitting process. The Bureau uses permit application data and other references to help determine the likelihood of a chemicals use or presence in a given process. Thus, far in the history of the program, a clear, definitive case having an air toxics problem has not been encountered.

Risk Assessment and Risk Management

For known and suspect carcinogens, the agency uses risk assessment and risk management. EPA CAG unit risk factors are multiplied by predicted (modelled) annual average concentrations to obtain an estimate of risk. Normally the CRSTER model, which predicts annual average concentrations, is used by the agency. EPA health assessment documents are reviewed to obtain specific health effects data. If no CAG risk factor is available for a chemical, the agency attempts to locate risk factors or similar data developed by other agencies or groups. An annual averaging period is used to fit with the unit risk factors which are based on annual exposure.

Results of the risk assessment are presented at a public hearing. If the source disagrees with the agency's risk estimation, they may present their own risk assessment. Mississippi's risk management is based on definition of significant risk. If the calculated risk is less than or equal to 10^{-6}, the risk is considered insignificant. A risk greater than or equal to 10^{-4} is considered significant. If the risk is significant, then the agency works with the source on a case-by-case basis to reduce the risk.

A grey area exists if the risk is estimated to be between 10^{-4} and 10^{-6}. Case-by-case decisions are made in such situations. At this point, no "controversial" cases have been encountered by the state.

Because Mississippi's program is that of informal guidelines, no real public or industry participation was involved in program development. However, the Bureau of Pollution Control routinely involves industry and manufacturing groups in their activities by annually advising those groups of the agency's planned actions for the coming year.

Application and Enforcement

The acceptable ambient concentrations guidelines and risk assessment/risk management processes are used as guidelines by agency personnel during the permitting process for new sources. New and existing sources' emissions of some noncriteria pollutants are addressed via NESHAPS. Both new and existing sources are also reviewed for non-NESHAP toxics.

When an acceptable ambient concentration is determined from the health effects literature, an acceptable emission rate is not generally calculated. Instead, the proposed emission rate of the source is modelled to compare predicted concentrations to the acceptable ambient concentration.

Stack testing has been required by the agency when possible because it is generally considered the best measure of compliance capability. One facility was tested for dioxins and another for acrylonitrile. Thus far, the "worst case" situation to undergo the public hearing process involved a source whose emissions were associated with an estimated risk of 10^{-5}. No objections were noted during the public comment period.

Compliance with permit limits is checked by testing emissions, plant inspections, and/or plant records. Exceedances of limits are addressed through the Bureau's standard enforcement mechanisms which apply to all regulated sources.

NEVADA AIR QUALITY CONTROL

General Program Aspects

The State of Nevada has in place air toxics regulations which cover new and existing sources. The program is based on the application of safety factors to TLVs and on risk assessment that may be performed on a case-by-case basis. The pollutants covered by the program are not limited to a specific list. An emissions inventory is being prepared by the Air Quality Control Division.

Basis for Acceptable Ambient Concentrations

The State of Nevada devised an ambient air program with the intent of ensuring public health and safety, since there are no Federal guidelines established at this time.

Review of other in-place programs (California, Michigan) and a State-by-State air toxics survey prepared by STAPPA/ALAPCO showed that the most common approach throughout the United States was the use of TLVs as established by the ACGIH.

Information provided in the "Documentation of the Threshold Limit Values" prepared by ACGIH was reviewed. The various chemical substances and physical agents listed were evaluated to determine:

- if they could become airborne (i.e., are atmospheric exposures possible);
- if so, the effect they would have on living organisms; and
- the level of exposure considered to be safe.

In terms of health effects, the TLV documentations were reviewed and the substances to be considered as air toxics assigned to the following categories:

Irritant: Those substances which would, upon sufficient exposure, cause an irritation in the test or exposed subject. Substances to which exposure at even high levels (those to which a subject would not normally be exposed) were nonlethal. The effects of the irritation were considered reversible upon removal from exposure or with time.

Warning: A substance which at normal levels of exposure may cause irritation within the test subject. With exposure at high concentration (those not normally encountered) the substance may cause irreparable damage to tissues or systems or be lethal via suffocation, etc.

Toxic: A substance which at even limited levels of exposure may cause irreparable damage to tissues or systems and, upon sufficient exposure, be lethal.

Carcinogen: Those substances which are recognized as being cancer-inducing either by laboratory experimentation or field studies of exposure victims.

Suspected Carcinogens: Substances which evidence suggest may be cancer-inducing agents either by laboratory experimentation or by field studies. (Teratogens and mutagens are not addressed as distinct categories.) The ACGIH lists of carcinogens and suspect carcinogens were used by the staff. Classes of irritant, warning and toxic were developed by the Air Quality Control Division staff, based on data in the documentation of TLV.

The 8-hour ambient air quality standard (AAQS) is derived by the following equation: TLV x (1/10) (40 hours work week)/(168 hours per week) = 1/42 or AAQS = TLV/42. In order to ensure public health and safety but not cause an economic hardship on business, a 10-fold safety factor was applied to the TLV.

The safety factor of 10 was chosen after review of the "Documentation of Threshold Limit Values" and consideration of the fact that TLVs are designed to protect healthy workers. Populations potentially exposed to toxic air pollutants include the very young, elderly and individuals with chronic ailments. After discussions with the public and industry representatives, a safety factor of 10 was chosen to ensure no

suspected or possible health hazard would arise. The factor is applied to the time weighted average TLV, but ceiling limits and short-term exposure levels (STELs) are reviewed by the State as well to obtain additional information on potential toxicities of chemical substances.

An averaging time of 24 hours is used by Nevada in conjunction with the factored TLV. The 24-hour period was chosen because it represents total daily exposure.

Formal exposure assessments are not conducted by Nevada. However, the state does attempt to estimate the number of persons that may be exposed by location. Also, the regulations address urban and non-urban exposure scenarios. That is, in urban areas the concentration of a given pollutant at the sources property line is compared to 1/42 of the TLV. In non-urban areas, the expected concentration at the closest residence or public use area is compared to 1/42 of the TLV.

BACT review is required for any source emitting 1/4 pound of a pollutant per 8-hour period. Air Quality Control models the impact on the area surrounding the source, identifying the concentration at the property line or closest residence/public use area. Models used thus far include the Valley and PTMAX models. If the ambient concentration (1/42 of the TLV) is exceeded, then BACT is required to the extent that the source will be below the standard. This procedure is followed for pollutants in the toxic, carcinogen or suspected carcinogen categories described previously. If the pollutant is considered to be in the "warning" category, and predicted concentrations exceed 1/42 of the TLV, the source may appeal BACT decision. The procedure requires that the source provide documentation that even after BACT, the concentration of a "warning" category pollutant will exceed the allowable ambient concentration. The 1/42 of the TLV rule may be relaxed for that source. Emissions of substances classified as "irritant" are subject to BACT review if greater than 1/4 pound is emitted in a 8-hour period. BACT determinations for emissions of toxics are made the same way as for criteria pollutants, using concepts of the Clean Air Act.

During the development of the program, a series of meetings and public hearings were held to allow industry and public participation. A hearing was held when the program was proposed (May 1984), and a second public

hearing was held (July - August 1984). Between the hearings, meetings were held with mining associations, utilities and others. When the program was presented before the Commission, State Air Quality Control staff members report that the State and industry groups were in good agreement over program aspects.

Risk Assessment/Risk Management

A formal risk assessment/risk management process is not included in Nevada's air toxics program. The State does determine the expected concentration of a given pollutant by modeling and reviewing the number of people in the area impacted. The State also determines the types of populations potentially exposed, whether they include businesses or residential areas and the suspected length of time the population would be exposed. A general assessment of the number of cases of cancer expected during the lifetime of the plant may be performed by the source for relief or variance of regulations. Lifetime of the plant is reported by the source. This measure of exposure time was thought to be more representative than a total lifetime exposure.

Application and Enforcement

The State of Nevada administers the air toxics program through the permitting process. New sources are brought into the program as they apply for permits. Existing sources are reviewed when their current permits expire. Sources which are not currently permitted, but are thought to be emitting greater than 1/4 pound of a pollutant per 8-hour period, will be investigated by the Division.

Nevada's permitting process consists of two phases. In the first phase, a source is granted a construction permit, with emissions information based on engineering estimates. Then within 180 days after construction is complete, the source must demonstrate that it meets permit conditions. Stack testing data are usually the method of demonstration. The source is then issued a final 5 year operating permit.

The State has calculated emission limits for sources, usually when the efficiency of the control device is uncertain. When the final permit is issued to the source, the emission rate is measured.

Monitoring has been performed at some sources in cases when predicted ambient concentrations were close to (90 percent of) the standard. Frequency of monitoring depends heavily on the availability of a monitoring method for the specific pollutant.

Penalties for noncompliance with air toxics regulations in Nevada are the same as for criteria pollutants. The fine is $5,000 per day per violation.

An appeal procedure is available to sources that disagree with the air toxics standards. For pollutants in the "warning" category, the source may appeal to Air Quality Control. For pollutants in the toxic, carcinogen, or suspected carcinogen, the source may appeal to the Commission. No source has made an appeal to either group at this time.

CONNECTICUT AIR COMPLIANCE UNIT
DEPARTMENT OF ENVIRONMENTAL PROTECTION

General Program Aspects

Connecticut's air toxics program is based on standards for maximum allowable ambient concentrations derived from safety factors applied to occupational standards. Different safety factors are used for the three pollutant classifications developed by the Department of Environmental Protection. Emphasis is placed on assuring that new sources are included in the program, but existing sources are also covered. The program is anticipated to be in effect by the end of 1985.

Basis for Acceptable Ambient Concentrations/Emissions Limits

The Connecticut Department of Environmental Protection (DEP) plans to develop maximum allowable ambient concentrations (MAACs) based on occupational limits of ACGIH, OSHA, NIOSH, and any other recognized standard setting agency. Each organizations' limits are reviewed and the most restrictive value is used in developing the MAAC. The Connecticut DEP includes as hazardous air pollutants:

- The 47 substances identified in Substitute House Bill 7204 (1983).
- Substances identified as carcinogens or suspected carcinogens by IARC, ACGIH, NCI, and NTP or the United States Public Health Service.
- Substances for which maximum allowable workplace exposures have been established by principal compilers of such listings such as ACGIH, NIOSH and OSHA.

All pollutants considered are divided into three classes or groups (Table 10). Group I includes proven human carcinogens, defined as chemicals on NTP List A, IARC Groups 1 and 2A, and ACGIH List A1. In addition, a list of 16 chemicals of concern have been developed in conjunction with Connecticut's drinking water regulations. Group I also includes carcinogens identified on a list developed by the State (Connecticut General Statutes, Section 19a-329). Presently, 71 substances are in this group.

Group II chemicals include suspect carcinogens, mutagens, and teratogens. Specifically, this group includes chemicals contained in NTP List B, IARC Group 2B, and ACGIH List A-2. NIOSH data, usually from the Registery of Toxic Effects of Chemical Substances or RTECS, is used to define mutagens and teratogens. One hundred forty-seven substances are now classed in Group II.

Connecticut DEP Group III consists of all noncarcinogenic substances of concern; there will be 635 substances in Group III.

To resolve possible differences concerning identification of carcinogens and review MAAC(s), the Connecticut air toxics program will include a seven member Hazardous Air Pollutant Review Panel of health scientists appointed by the Governor and other political leaders. The panel will consist of a toxicologist, an epidemiologist, and a physician specializing in environmental or occupational medicine. The other members will have experience in related fields such as air pollution, biochemistry, or biostatistics.

The standards for air toxics or MAACs will be determined by dividing an 8-hour TLV or other occupational standard by a safety factor. The safety factor differs for each of the three groups of pollutants, as shown in the table below:

Pollutant Group	Safety Factor
1	200
2	100
3	50

TABLE 10. SUMMARY OF CLASSIFICATION SCHEMES FOR KNOWN AND SUSPECTED CARCINOGENS USED BY CONNECTICUT DEPARTMENT OF ENVIRONMENTAL PROTECTION

Group I:	NTP List A	- Known carcinogens
	IARC Group 1	- Sufficent evidence in epidemiological studies, causally associated with cancer in humans
	IARC Group 2A	- Limited evidence in humans, probably carcinogenic to humans
	ACGIH List A1	- Human carcinogens
Group II:	NTP List B	- Reasonably anticipated to be carcinogenic
	IARC Group 2B	- Sufficient evidence in animals, inadequate data in humans; probably carcinogenic in humans
	ACGIH List A-2	- Industrial substances suspect of carcinogenic potential to humans

The lowest or most restrictive occupational limit on a standard is selected for each chemical from values obtained from ACGIH, NIOSH, and OSHA. When occupational standards are not available for a given chemical, the Hazardous Air Pollutant Review Panel will review MAACs proposed by the Department of Health Services. The DEP will make the final determination of a MAAC.

MAACs are calculated for two averaging periods, an 8-hour and a 30 minute period. The 8-hour MAAC is obtained by dividing the TLV or occupational standard by the appropriate safety factor (shown above), depending on group classification of a given chemical. The 30 minute MAAC is obtained by multiplying the 8-hour MAAC by a maximum allowable excursion factor of 5. The factor of 5 was chosen because ACGIH sets excursion limits using a maximum factor of 5. An 8-hour averaging time was selected because it reflects the averaging time of occupational standards and it conforms to a working day.

For chemicals which are criteria pollutants, and have a national ambient air quality standard, the MAAC will be set equal to the NAAQS. For the criteria pollutants particulates and hydrocarbons, the specific chemical species of each pollutant will have a MAAC.

The pollutants to be covered in Connecticut DEP's air toxics program, along with the MAAC are shown in Table 11 at the end of this chapter. MAAC may be changed and additional chemicals may be added to the list. The public or industry may request that the DEP change a MAAC or add a chemical to the list. The DEP would forward the request by submitting a proposal to the Department of Health Services (DHS). The DHS would then respond to the DEP proposal and, together, the agencies would present the request to the Hazardous Air Pollutant Review Panel. The panel would then accept, reject, or modify the proposal. A public hearing may be requested by industry or the public as part of this process.

Emission rate limits are not calculated by the DEP. Instead, sources must meet maximum allowable concentrations of pollutants in the stack, along with the 8-hour MAAC (beyond the source property lines). A model was developed by DEP which calculates allowable stack concentrations based on each chemical's MAAC. The model calculates pollutant concentrations at

receptor heights of 20 meters above ground to better identify potential exposures for elevated receptors. The source must then demonstrate attainment of the MAAC and the allowable stack concentration.

Risk Assessment/Risk Management

Connecticut DEP does not plan to use risk assessment or risk management in their air toxics program.

Application and Enforcement

The air toxics program in Connecticut will apply to new and existing sources with special effort aimed at bringing new sources into the program. The type of pollutant emitted (Groups 1, 2, or 3) also plays a part in applicability. For Group 1 substances, the program will apply to all sources. For Group 2 and 3 substances, at first only new sources will be covered. Existing sources emitting Group 2 and 3 pollutants must meet program requirements at a later date. If an existing source is thought to be violating either the 30 minute or 8-hour MAAC for Group 2 or 3 pollutants, that source will be monitored. If the source is in violation of a MAAC, corrective action would be required.

If a source does not meet stack concentration limits, a compliance schedule will be worked out with the DEP on a case-by-case basis.

Compliance testing will be performed by DEP staff for stack or vent emissions from new and existing sources. Testing will be performed for all chemicals likely to be present, based on process chemistry and physics, and raw materials used. Existing major sources emitting Group 1 pollutants will be tested in the beginning of the program. New sources emitting 15 tons per year VOC will be tested as part of the permitting process.

Sources may apply to the Commissioner for a variance or partial variance of one or more provisions of the regulations. No variance is approved unless the applicant provides information to show that discharges occurring as part of the variance would not constitute a danger to public

health or safety. The applicant may also provide information showing that compliance would produce practical difficulties or hardship without equal or greater benefits to the public.

The Connecticut DEP plans to purchase appropriate equipment for ambient monitoring. At first, monitoring will be conducted primarily to identify potential problem areas, not to assess compliance. The DEP has taken this approach because ambient sampling is not likely to detect "worst case" conditions unless monitoring is performed continuously at many locations around a source.

Monitoring may be conducted when a violation of a MAAC is suspected. If a violation of the 30 minute MAAC is found, DEP will begin a more extensive monitoring survey to check for compliance with the 8-hour MAAC.

Enforcement of the new program will take two separate approaches, including source specific ambient monitoring and source inspections. Inspections for compliance with air toxic standards will be added to the existing inspection efforts for criteria pollutants.

Currently, DEP requires a source to complete a pre-inspection questionnaire. Information on potential air toxics will be derived from completed questionnaires. If a source is determined to be in violation of the MAAC or stack concentration limits, corrective actions will be required. These include material substitution, installing controls, curtailment or shutdown of part or all of the process, or raising the stack and diluting stack exhaust.

Civil and criminal penalties may be brought about for violation of the air toxics standards in the same manner as with criteria pollutants.

TABLE 11. MAXIMUM ALLOWABLE AMBIENT CONCENTRATIONS PROPOSED BY CONNECTICUT DEPARTMENT OF ENVIRONMENTAL PROTECTION

HAZARDOUS SUBSTANCE	LOWEST THRESHOLD LIMIT VALUE (TLV) (8-Hour Averaging Time) ppm	mg/m3	CAS NUMBER	TOXICITY GROUP*	CT MAAC (8-hour) (ug/m3)	(volumetric units***)	ODOR THRESHOLD (ppm)
Acetaldehyde	100	180	75-07-0	3	3,600	2.0	.21
Acetic acid	10	25	69-19-7	3	500	0.2	1.00
Acetic anhydride	5	20	108-24-7	3	400	0.1	1.0
Acetone	246	590	67-64-1	3	11,800	5.0	
Acetone cyanohydrin	---	---	75-86-5	3		---	
Acetonitrile	19.4	34	75-05-8	3	680	0.39	100.0
● 2-Acetylamino fluorene			53-96-3	1			
Acetylene	---	---	74-86-2	3			
Acetylene dichloride	200	790	540-59-0	3	15,800	4.0	
Acetylene tetrabromide	1	14	79-27-6	3	280	0.02	
Acetylsalicylic acid	---	5	50-78-2	3	100	---	
★ Acrolein	0.1	0.25	107-02-8	3	5	2 ppbv	0.21
Acrylamide	---	0.3	79-06-1	3	6	---	
Acrylic acid	10	30	79-10-7	3	600	0.2	
★ Acrylonitrile	2.0	4.4	107-13-1	1	22	0.01	21.4
Actinomycin D	---	---	1402-38-6	2		0.08	
Adiponitrile	4	18		3	360		
Adriamycin	---	---	23214-92-8	2			
Aflatoxins	---	---	83219-44-7	1			
			83219-45-8				
★ Aldicarb	---	---	116-06-3	2			
Aldrin	---	0.15	309-00-2	2	1.5	---	
Allyl alcohol	2	5	107-18-6	3	100	0.04	1.40
Allyl chloride	1	3	107-05-1	3	60	0.02	0.47
Allyl glycidyl ether	5	22	106-92-3	2	220	0.05	
Allyl propyl disulfide	2	12	2179-59-1	3	240	0.04	
Aluminum metal and oxide	---	10	7429-90-5	3	200	---	
Aluminum pyro powders	---	5		3	100	---	
Aluminum welding fumes	---	5		3	100	---	

* Group 1: Substances on IARC Lists 1 and 2A, on ACGIH list A1, in NCI Classes 1-5, in 19a-329 of the CGS, and on NTP list A.
Group 2: Substances on IARC List 2B in NCI Classes 6-9, on ACGIH list A2, on NTP list B; also substances identified as teratogens or mutagens by NIOSH.
Group 3: Other substances.

** na - not available

*** volumetric concentrations are in parts per million per volume (ppmv) unless shown as parts per billion by volume or as parts per trillion by volume (pptv).

★ Connecticut's "List of 47"

● Carcinogenic substance (Statute 19a - 329)

TABLE 11. Continued

HAZARDOUS SUBSTANCE	LOWEST THRESHOLD LIMIT VALUE (TLV) (8-Hour Averaging Time) ppm	mg/m3	CAS NUMBER	TOXICITY GROUP*	CT MAAC (8-hour) (ug/m3)	(volumetric units***)	ODOR THRESHOLD (ppm)
Aluminum soluble salts	---	2		3	40		
Aluminum alkyls (not otherwise classified)	---	2		3	40		
2-Aminoanthroquinone				2			
1-Amino-2-methylanthraquinone				2			
● ★ Aminodiphenyl	---	---	92-67-1	1	---		
2-Aminoethanol	2	6	141-43-5	3	120	0.04	
2-Aminopyridine	0.5	2	509-29-0	3	40	0.01	
3-Amino 1,2,4-triazole (amitrole)	---	---	61-82-5	2			
Ammonia	25	18	7664-41-7	3	360	0.5	46.8
Ammonium chloride-fume	---	10	12125-02-9	3	200	---	
Ammonium sulfamate	---	10	7773-06-0	3	200	---	
iso-Amyl acetate	100	525	123-91-2	3	10,500	2.0	
1-Amyl acetate	100	525	628-63-7	3	10,500	2.0	
sec-Amyl acetate	125	650	626-38-0	3	13,000	2.5	
tert-Amyl acetate			628-63-7	3	---		
Aniline	2	10	62-53-3	3	200	0.04	1.00
o-Anisidine	0.1	0.5	29191-52-4	2	5	1.0 ppbv	
p-Anisidine	0.1	0.5	29191-52-4	3	10	2.0 ppbv	
Antimony & compounds (as Sb)	---	0.5		3	10	---	
Antimony trioxide, handling & use (as Sb)	---	0.5	1309-64-4	2	5	---	
Antimony trioxide production (as Sb)	---	0.5	1309-64-4	2	5	---	
ANTU (-Naphthyl thiourea)	---	0.3	86-88-4	3	6	---	
Aramite				2			
● ★ Arsenic & compounds (as As)	---	0.01*	7440-38-2	1	0.05	---	
★ Arsenic pentoxide	---	---	1303-28-2	1	---		
★ Arsenic trioxide production (as As)	---	.05	1327-53-3	1	0.25	---	
Arsine	0.05	0.2	7784-42-1	1	1.0	0.25 ppbv	
● ★ Asbestos (see Table 4)			1332-21-4	1			
Asphalt (petroleum) fumes	---	5	8052-42-4	3	100		
Atrazine	---	5	1912-24-9	3	200		
★ Auramine	---	---	2465-27-2	1	---		
Azathioprine	---	---	446-86-6	1			
Azinphos-methyl	---	0.2	86-50-0	3	4		
Barium (soluble compounds), as Ba	---	0.5	7440-39-3	3	10		
Baygon (propoxur)	---	0.5	114-26-1	3	10		
Baytex	---	0.1	55-38-9	3	2		
Benomyl	---	10	17804-35-2	3	200		
Benzal chloride	---	---	98-87-3	3			

* Inorganic
** var - variable

★ Connecticut's "List of 47"

TABLE 11. Continued

HAZARDOUS SUBSTANCE	LOWEST THRESHOLD LIMIT VALUE (TLV) (8-Hour Averaging Time) ppm	mg/m3	CAS NUMBER	TOXICITY GROUP*	CT MAAC (8-hour) (ug/m3)	(volumetric units***)	ODOR THRESHOLD (ppm)
Benz(a)anthracene				2			
● ☆ Benzene	10	30	71-43-2	1	150	0.05	46.8
Benzenethiol	---	---		3			
● ☆ Benzidine	---	---	92-87-5	1	---		
Benzo(b)fluoranthene				2			
Benzo(r,s,t) pentaphene				2			
p-Benzoquinone	0.1	0.4	106-51-4	3	8	2.0 ppbv	
Benzotrichloride	---	---	98-07-7	2			
Benzoyl chloride	---	---		3			
Benzoyl peroxide	---	5	94-36-0	3	100	0.02	
Benz(a)pyrene	---	---		2	---	---	
(see polycyclic aromatic hydrocarbons)			50-32-8				
Benzyl chloride	1	5	100-44-7	3	100	0.02	0.047
Beryllium	---	0.002	7440-41-7	1	.010	---	
☆ Beryllium oxide	---	---	1304-56-9	1	---		
☆ Beryllium sulfate	---	---	13510-49-1	1	---		
Biphenyl	0.2	1.5	92-52-4	3	30	4.0 ppbv	.06-.29
Bismuth telluride	---	10	1304-82-1	3	200	---	
Bismuth telluride, Se-doped	---	5		3	100	---	
Bleomycins	---	---		3			
Borates, tetra, sodium salts - anhydrous	---	1	1303-96-4	3	20	---	
- decahydrate	---	5	1303-96-4	3	100	---	
- pentahydrate	---	1	1303-96-4	3	20	---	
Boron oxide	---	10	1303-86-2	3	200	---	
Boron tribromide	1	10	10294-33-4	3	200	0.02	
Boron trifluoride	1	3	7637-07-2	3	60	0.02	
Bromacil	1	10	314-40-9	3	200	0.02	
Brominated biphenyls				2			
Bromine	0.1	0.7	7726-95-6	3	14	2.0 ppbv	0.047
Bromine pentafluoride	0.1	0.7	7789-30-2	3	14	2.0 ppbv	
Bromochloromethane/chlorobromomethane	200	1,050	74-97-5	3	21,000	4.0	
Bromoform	0.5	5	75-25-2	3	100	0.01	
Butadiene (1,3-butadiene)	1,000	2,200	106-99-0	3	44,000	20.0	
Butane	800	1,900	106-97-8	3	38,000	16.0	
1-Butanethiol	0.5	1.5	109-79-5	3	30	0.01	
2-Butanethiol	0.5	1.5	513-53-1	3	30	0.01	
2-Butanone	200	590	78-93-3	3	11,800	4.0	
2-Butoxyethanol	25	120	111-76-2	3	2,400	0.5	
n-butyl acetate	150	710	123-86-4	3	14,200	3.0	
sec-Butyl acetate	200	950	105-46-4	3	19,000	4.0	
tert-Butyl acetate	200	950	540-88-5	3	19,000	4.0	
Butyl acrylate	10	55	140-32-2	3	1,100	0.2	

☆ Connecticut's "List of 47"

● Carcinogenic substance (Statute 19a - 329)

TABLE 11. Continued

HAZARDOUS SUBSTANCE	LOWEST THRESHOLD LIMIT VALUE (TLV) (8-Hour Averaging Time) ppm	mg/m3	CAS NUMBER	TOXICITY GROUP*	CT MAAC (8-hour) (ug/m3)	(volumetric units***)	ODOR THRESHOLD (ppm)
n-Butyl alcohol	50	150	71-36-3	3	3,000	1.0	
sec-Butyl alcohol	100	305	78-92-2	3	6,100	2.0	
tert-Butyl alcohol	100	300	75-65-1	3	6,000	2.0	
Butylamine	5	15	109-73-9	3	300	0.1	
tert-Butyl chromate (as CrO3)	---	0.1	1189-85-1	3	2	---	
n-Butyl glycidyl ether (BGE)	25	135	2426-08-6	2	1,350	0.25	
n-Butyl lactate	5	25	138-22-7	3	500	0.1	
Butyl mercaptan	0.5	1.5	109-79-5	3	30	0.01	.001 to .048
o-sec Butylphenol	5	30	89-72-5	3	600	0.1	
p-tert-Butyltoluene	10	60	98-51-1	3	1,200	0.2	
n-butyronitrile	8	22		3	440	0.16	
Cadmium	---	---	7440-43-9	2	---		
☆ Cadmium dust & salts (as Cd)	---	0.05	7440-43-9	2	0.5	---	
☆ Cadmium oxide fume (as Cd)	---	0.05	1306-19-0	2	0.5	---	
Cadmium oxide production	---	0.05	1306-19-0	2	0.5	---	
☆ Cadmium sulfate	---	---	10124-36-4	2	---		
Calcium arsenate (as As)	---	---		2	---		
Calcium cyanamide	---	0.5	156-62-7	3	10		
Calcium hydroxide	---	5	1305-62-0	3	100	---	
Calcium oxide	---	2	1305-78-8	3	40	---	
Camphor, synthetic	2	12	76-22-2	3	240	0.04	
Caprolactam dust	---	1	105-60-2	3	20	---	
Caprolactam vapor	5	20	105-60-2	3	400	0.01	
Captafol (difolatan)	---	0.1	2425-06-1	3	2	---	
Captan	---	5	113-06-2	3	100	---	
Carbaryl (Sevin)	---	5*	63-25-2	3	100	---	
Carbofuran (Furadan)	---	0.1	1563-66-2	3	2	---	
Carbon black	---	3.5*	1333-86-4	3	70	---	
Carbon disulfide	1	3	75-15-0	3	60	0.02	0.21
Carbon monoxide	36	40	630-08-0	3	800**	0.72	
☆ Carbon tetrabromide	0.1	1.4	558-13-4	3	28	2.0 ppbv	
Carbon tetrachloride	5	30	50-23-5	2	300	0.05	21.4-100
Carbonyl chloride (Phosgene)	0.1	0.4	75-44-5	3	8	2.0 ppbv	
Carbonyl fluoride	2	5	353-50-4	3	100	0.04	

** The national ambient air quality standards are 10 mg/m3, 8-hour average and 40 mg/m3, 1-hour average. The NAAQS will take precedence. The value shown is entered for comparative purposes only.

☆ Connecticut's "List of 47"

● Carcinogenic substance (Statute 19a - 329)

TABLE 11. Continued

HAZARDOUS SUBSTANCE	LOWEST THRESHOLD LIMIT VALUE (TLV) (8-Hour Averaging Time) ppm	mg/m3	CAS NUMBER	TOXICITY GROUP*	CT MAAC (8-hour) (ug/m3)	(volumetric units***)	ODOR THRESHOLD (ppm)
Catechol	5	20	120-80-9	3	400	0.1	
Cesium hydroxide	---	2	21351-79-1	3	40	na	
Chlorambucil	---	---	305-03-3	1			
Chloramphenicol	---	---	56-75-7	2			
2-Chloraniline	.0005	.003	106-47-8	3	.06	0.01 ppbv	
Chlordane	---	0.5	12789-03-6	1	2.5	---	
Chlorinated camphene	---	0.5	8001-35-2	1	2.5	---	
Chlorinated diphenyl oxide	---	0.5	55720-99-5	3	10	---0	0.314
Chlorine	1	3	7782-50-5	3	60	0.02	0.314
Chlorine dioxide	0.1	0.3	10049-04-4	3	6	2.0 ppbv	
Chlorine trifluoride	0.1	0.4	7790-91-2	3	8	2.0 ppbv	3.5
Chlormadinone acetate	---	---		3			
Chlornaphthazine	---	---	494-03-1	1			
Chloroacetaldehyde	1	3	107-20-0	3	60	0.02	
- Chloroacetophenone (Phenacyl chloride)	0.05	0.3	532-27-4	3	6	1.0 ppbv	0.016
Chloroacetyl chloride	0.05	0.2	79-04-0	3	4	1.0 ppbv	
Chlorobenzene	75	350	108-90-7	3	7,000	1.5	
Chlorobenzilate	---	---	510-15-4	1			
o-Chlorobenzylidene malonitrile	0.05	0.4	2698-41-1	3	8	1.0 ppbv	
Chlorobromomethane/bromochloromethane	200	1,050	74-79-5	3	21,000	4.0	
2-Chloro-1,3-butadiene	10	45	126-99-8	3	900	0.2	
Chlorodifluoromethane	1,000	3,500	75-45-6	3	70,000	20.0	
Chlorodiphenyl (42% Chlorine)	---	1	53449-21-9	3	20	---	
Chlorodiphenyl (54% Chlorine)	---	0.5	53449-21-9	3	10	---	
1-Chloro,2,3-epoxy-propane	2	10	106-89-8	3	200	0.04	
2-Chloroethanol	1	3	107-07-3	3	60	0.02	
bis-Chloroethyl nitrosourea (BCNU)	---	---	108-60-1	2			
1-(2-Chloroethyl)-3-cyclohexyl-1-nitrosourea (CCNU)	---	---	13909-09-6	2			

☆ Connecticut's "List of 47"

● Carcinogenic substance (Statute 19a - 329)

TABLE 11. Continued

HAZARDOUS SUBSTANCE	LOWEST THRESHOLD LIMIT VALUE (TLV) (8-Hour Averaging Time) ppm	mg/m3	CAS NUMBER	TOXICITY GROUP*	CT MAAC (8-hour) (ug/m3)	(volumetric units***)	ODOR THRESHOLD (ppm)
Chloroform	10	50	67-66-3	1	250	0.05	
Chloromadinone acetate				3			
● ★ bis-Chloromethyl ether	0.001	.003	542-88-1	1	0.015	5.0 pptv	
● Chloromethyl methyl ether			107-30-2	1			
Chloropentafluoroethane	1,000	6,320	76-15-3	3	126,400	20.0	
1-Chloro-1-nitro-propane	2	10	600-25-9	3	200	0.04	
Chloropicrin	0.1	0.7	76-06-2	3	14	2.0 ppbv	
- Chloroprene	10	45	126-99-3	3	900	0.2	
o-Chlorostyrene	50	285	1331-28-8	3	5,700	1.0	
o-Chlorotoluene	50	250	95-49-8	3	5,000	1.0	
2-Chloro-6-trichloromethyl	---	10.		3	200	---	
Chloropyrifos (Dursban)	---	0.2	2921-88-2	3	4	---	
Chromic acid and chromates (as Cr)	---	0.05		1	0.25	---	
Chromite ore processing (chromate), as Cr	---	0.05		1	0.25	---	
Chromium, metal		0.5	7440-47-3	1	2.5	---	
Chromium (II) compounds, as Cr		0.5		3	10	---	
Chromium (III) compounds, as Cr		0.5		3	10	---	
Chromium (VI) compounds, as Cr		*		**	***	---	
Chromyl chloride	0.025	0.15	14977-61-8	3	3	0.5 ppbv	
Chrysene			218-01-9	2			
Cisplatin	---	---	15663-27-1	2			
Clofibrate	---	---	637-07-1	3			
Clomiprene	---	---	911-45-5	3			
Clopidol	---	10	2971-90-6	3	200	---	
Coal tar pitch volatiles	---	0.2		1	1	---	
Coal tar products (see polycyclic aromatic hydrocarbons)				2			
Cobalt metal, dust & fume (as Co)	---	0.1****	7440-48-4	3	2	---	
Cobalt carbonyl, as Co		0.1	00000-00-0	3	2	---	
Cobalt hydrocarbonyl, as Co		0.1	16842-03-8	3	2	---	
Coke oven emissions				1			
Copper - dusts & mists (as Cu)	---	1	7440-50-8	3	20	---	
Copper fume	---	0.1	7440-50-8	3	2	---	
Cotton dust, raw	---	0.2		3	4	---	
Crag herbicide	---	15	556-22-9	3	300	---	
p-Cresidine				2			

* Carcinogenic Cr(VI): .001; noncarcinogenic Cr(VI): .025

*** Carcinogenic Cr(VI): .005; noncarcinogenic Cr(VI): 0.5

**** Proposed for revision

★ Connecticut's "List of 47"

● Carcinogenic substance (Statute 19a - 329)

TABLE 11. Continued

HAZARDOUS SUBSTANCE	LOWEST THRESHOLD LIMIT VALUE (TLV) (8-Hour Averaging Time) ppm	mg/m3	CAS NUMBER	TOXICITY GROUP*	CT MAAC (8-hour) (ug/m3)	(volumetric units***)	ODOR THRESHOLD (ppm)
Cresol	2.4	10	1319-77-3	3	200	0.048	0.001
Crotonaldehyde	2	6	123-73-9	3	120	0.04	0.2
Crufomate	---	5	229-86-5	3	100	---	
Cumene	50	245	98-82-8	3	4,900	1.0	
Cupferron				2			
Cyanamide	---	2	420-04-2	3	40	---	
Cyanide, as CN	---	5	51-50-8	3	100	---	
			143-33-9				
Cyanogen	10	20	460-19-5	3	400	0.2	
Cyanogen chloride	0.3	0.6	506-77-4	3	12	6.0 ppbv	
Cycasin				2			
Cyclamates	---	---	100-88-9	3		---	
Cyclohexane	2300	1,050	110-82-7	3	21,000	46.0	
Cyclohexanethiol	---	---	1569-69-3	3	---	---	
Cyclohexanol	50	200	108-93-0	3	4,000	1.0	
Cyclohexanone	25	100	108-94-1	3	2,000	0.5	
Cyclohexene	300	1,015	110-83-8	3	20,300	6.0	
Cyclohexylamine	10	40	108-91-8	3	800	0.2	
Cyclonite		1.5	121-82-4	3	30		
Cyclohexylmethane 4,4'-diisocyanate	---	0.55		3	1.1	1.5	
Cyclopentadiene	75	200	542-92-7	3	4,000	6.0	
Cyclopentane	300	850	287-92-3	3	17,000		
Cyclophosphamide	---	---	50-18-0	1			
Cyhexatin			13121-70-5	3			
Dacarbazene	---	---	4342-03-4	2			
Dalapon	1	6	75-99-0	3	120	0.02	
Dapsone	---	---	80-08-0	3			
Decaborane	0.05	0.3	17702-41-9	3	6	1.0 ppbv	
Decanethiol	---	---	143-10-2	3	---		
Demeton	0.01	0.1	8065-48-3	3	2	0.2 ppbv	
DDT (Dichlorodiphenyl-trichloroethane)	---	0.5	50-29-3	2	5	---	
Diacetone alcohol	50	240	123-42-2	3	4,800	1.0	
2,4-Diaminoanisole sulfate				2			
2,4-Diaminotoluene				2			
1,2-Diaminoethane	10	25	107-15-3	3	500	0.2	
o-Dianisidine	---	---	119-90-4	2		---	
Diazinon	---	0.1	333-41-5	3	2	---	
Diazomethane	0.2	0.4	334-88-3	3	8	4.0 ppbv	
Dibenz(a,h) acridine				2			
Dibenz(a,j) acridine				2			
Dibenz(a,h) anthracene				2			

✯ Connecticut's "List of 47"

● Carcinogenic substance (Statute 19a - 329)

TABLE 11. Continued

HAZARDOUS SUBSTANCE	LOWEST THRESHOLD LIMIT VALUE (TLV) (8-Hour Averaging Time) ppm	mg/m3	CAS NUMBER	TOXICITY GROUP*	CT MAAC (8-hour) (ug/m3)	(volumetric units***)	ODOR THRESHOLD (ppm)
7H-Dibenzo(c,g) carbazole				2			
Dibenzo(a,h) pyrene				2			
Dibenzo(a,i) pyrene				2			
Diborane	0.1	0.1	19287-45-7	3	2	2.0 ppbv	
Dibrom	---	3	300-76-5	3	0.04	---	
Dibromochloropropane	---	.01	96-12-8	1	0.02	---	
★ 1,2 Dibromoethane	20	155	106-93-4	1	775	0.1	25
2-n-Dibutylaminoethanol	2	14	102-81-8	3	280	0.04	
Dibutyl phosphate	1	5		3	100	0.02	
Dibutyl phthalate	---	5	84-74-2	3	50	---	
Dichloracetylene	0.1	0.4	7572-29-4	3	8	2.0 ppbv	
o-Dichlorobenzene	50	300	95-50-1	3	6,000	1.0	
★ p-Dichlorobenzene	75	450	106-46-7	2	4,500	0.75	
● 3,3'-Dichlorobenzidine	---	---	91-94-1	1			
Dichlorodifluoromethane	1,000	4,950	75-71-8	3	99,000	20.0	
1,3-Dichloro-5,5-dimethyl hydantoin	---	0.2	118-52-5	3	4	---	
1,1-Dichloroethane	100	400	75-34-3	3	8,000	2.0	
1,2-Dichloroethane	10	40	107-06-2	1	200	0.05	
Dichloroethylene	200	790	540-59-0	3	15,800	4.0	
Dichloroethyl ether	5	30	111-44-4	3	600	0.1	
Dichloromethane	100	350	75-09-2	3	7,000	2.0	
Dichloromonofluoromethane	10	40	75-43-4	3	800	0.2	
1,1-Dichloro-1-nitroethane	2	10	594-72-9	3	200	0.04	
2,4-D (2,4-Dichlorophenoxyacetic acid)	---	10	74-75-9	2	100	---	
Dichloropropene	1	5	542-75-6	3	100	0.02	
Dichloropropionic acid	1	6	75-99-0	3	120	0.02	
Dichlorotetrafluoroethane	1,000	7,000	76-14-2	3	140,000	20.0	
Dichlorvos (DDVP)	0.1	1	62-73-7	3	20	2.0 ppbv	
Dicrotophos (Bidrin)	---	0.25	141-66-2	3	5	---	
Dicyclohexyl methane 4,4'diisocyanate	---	.055		3	1.1	---	
Dicyclopentadiene	5	30	77-73-6	3	600	0.1	
Dicyclopentadienyl iron	---	10	102-54-5	3	200	---	
Dieldrin	---	0.25	60-57-1	3	5	---	
Dienestrol	---	---	84-17-3	2			
Diepoxybutane				2			
Di-2,3-epoxypropyl ether	---	---		2			
Diethanol amine	3	15	111-42-2	3	300	0.06	
Diethyl ether	400	1,200	60-29-7	3	24,000	8.0	

★ Connecticut's "List of 47"

● Carcinogenic substance (Statute 19a - 329)

TABLE 11. Continued

HAZARDOUS SUBSTANCE	LOWEST THRESHOLD LIMIT VALUE (TLV) (8-Hour Averaging Time) ppm	mg/m3	CAS NUMBER	TOXICITY GROUP*	CT MAAC (8-hour) (ug/m3)	(volumetric units***)	ODOR THRESHOLD (ppm)
Di(2-ethylhexyl)phthalate				2			
Diethyl ketone	200	705	96-22-0	3	14,100	4.0	
Diethyl phthalate	---	5	84-66-2	3	100	---	
Diethylamine	10	30	109-89-7	3	600	0.2	0.047
Diethylaminoethanol	10	50	100-37-8	3	1,000	0.2	
Diethyl hexyl phthalate				3			
Diethylene triamine	1	4	111-40-0	3	80	0.02	
Diethylstilboestriol	---	---	39011-86-4	1			
Diethyl sulfate	---	---	64-67-5	1			
Difluorodibromomethane	100	860	75-61-6	3	17,200	2.0	
Diglycidal ether (DGE)	0.1	0.5	2238-07-5	3	10	2.0 ppbv	
Diisobutyl ketone	23	140	108-83-8	3	2,800	0.46	
Diisocyanates, not listed	.005	---		3	---	0.1 ppb	
Diisopropylamine	5	20	108-18-9	3	400	0.1	
Dimethisterone	---	---	79-64-1	3			
3-3'-Dimethoxybenzidine				2			
Dimethoxymethane	1,000	3,100	109-87-5	3	31,000	20.0	
Dimethyl acetamide	10	35	127-19-5	3	700	0.2	46.80
Dimethylamine	10	18	124-40-3	3	50	0.2	.047
● 4-Dimethylaminoazobenzene				2			
4-Dimethylaminobenzene	2	10	1300-73-8	1	50	0.01	
Dimethylaniline	5	25	121-69-7	3	500	0.1	
3,3'-Dimethylbenzidine				2			
Dimethyl carbamyl chloride	---	---	79-44-7	2	---	na	
Dimethylformamide	10	30	68-12-2	3	600	0.2	100
1,1-Dimethylhydrazine	0.5	1	57-14-7	2	10	5.0 ppbv	
3,3'-Dimethyloxybenzidine	---	---	119-90-4	2	---		
Dimethylphthalate	---	5	131-11-3	3	100	---	
☆ Dimethyl sulfate	0.1	0.5	77-78-1	1	2.5	0.5 ppbv	0.001
Dinitolmide	---	5	148-01-6	3	100		
Dinitrobenzene	0.15	1	528-29-0	3	20	3 ppbv	
Dinitro-o-cresol	---	0.2	534-52-1	3	4	---	
3,5-Dinitro-o-toluamide (Dinitolmide)	---	5	148-01-6	3	100	---	
Dinitrotoluene	---	1.5	121-14-2	2	15	---	
Dioxane, Tech. Grade	25	90	123-91-1	1	450	0.125	
Dioxathion (Delnav)	---	0.2	78-34-2	3	4	---	
2,4-D (2,4-Dichlorophenoxyacetic acid)	---	10	74-75-9	3	200	---	
Diphenyl	---	1	92-52-4	3	20	---	
Diphenylamine	---	10	122-39-4	3	200	---	
☆ Diphenylmethane diisocyanate	---	.05	101-68-8	3	1	---	
Diphenylphthalate				3			
Dipropylene glycol methyl ether	100	600	34590-94-8	3	12,000	2.0	

☆ Connecticut's "List of 47"

● Carcinogenic substance (Statute 19a - 329)

TABLE 11. Continued

HAZARDOUS SUBSTANCE	LOWEST THRESHOLD LIMIT VALUE (TLV) (8-Hour Averaging Time) ppm	mg/m3	CAS NUMBER	TOXICITY GROUP*	CT MAAC (8-hour) (ug/m3)	(volumetric units***)	ODOR THRESHOLD (ppm)
Dipropyl ketone			123-19-3	3			
Diquat	---	0.5	85-00-7	3	10	---	
Direct Black 38	---	---	1937-37-7	2			
Direct Blue 6	---	---	2610-05-1	2			
Direct Brown 95	---	---	10300-74-0	2			
Di-sec octyl phthalate	---	5	117-81-7	3	100	----	
Disulfiram	---	2	97-77-8	3	40	---	
Disulfoton		0.1	298-04-4	3	2	---	
Disyston	---	0.1	298-04-4	3	2	---	
2,6-Ditert butyl-p-cresol	---	10	128-37-0	3	200	---	
Diuron	---	10	330-54-1	3	200	---	
Divinyl benzene	10	50	108-57-6	3	1,000	0.2	
Dodecanethiol	---	---		3	---		
Dyfonate	---	0.1	944-22-9	3	2	---	
Endosulfan	---	0.1	115-29-7	3	2	---	
Endrin	---	0.1	72-20-8	3	2	---	
Epichlorhydrin	0.6	2	106-89-8	2	20	6.0 ppbv	
EPN	---	0.5	2104-64-5	3	10	---	
Estrogens				1			
Ethane	---	---	74-84-0	3	---		
Ethanol	1,000	1,900	64-17-5	3	38,000	20.0	10.00
Ethanolamine	3	8	141-43-5	3	160	0.06	
Ethinylestridiol	---	---	57-63-6	2			
Ethion	---	0.4	563-12-2	3	8	---	
2-Ethoxyethanol	5	9	110-80-5	3	180	0.1	
2-Ethoxyethyl acetate	5	27	111-15-9	3	540	0.1	
Ethyl acetate	400	1,400	141-78-6	3	28,000	8.0	
Ethyl acrylate	5	20	140-88-5	3	400	0.1	0.00047
Ethylamine	10	18	75-04-7	3	360	0.2	
Ethyl sec-amyl ketone	25	130	41-85-5	3	2,600	0.6	
Ethyl benzene	100	435	100-41-4	3	8,700	2.0	
Ethyl bromide	200	890	74-96-4	3	17,800	4.0	
Ethylbutyl ketone	50	230	106-35-4	3	4,600	1.0	
Ethyl chloride	1,000	2,600	75-00-3	3	52,000	20.0	
Ethyl ether	400	1,200	60-29-7	3	24,000	8.0	
Ethyl formate	100	300	109-94-4	3	6,000	2.0	
Ethyl mercaptan	0.5	1	75-08-1	3	20	0.01	0.001
Ethyl silicate	10	85	78-10-4	3	1,700	0.2	

☆ Connecticut's "List of 47"

● Carcinogenic substance (Statute 19a - 329)

TABLE 11. Continued

HAZARDOUS SUBSTANCE	LOWEST THRESHOLD LIMIT VALUE (TLV) (8-Hour Averaging Time) ppm	mg/m3	CAS NUMBER	TOXICITY GROUP*	CT MAAC (8-hour) (ug/m3)	(volumetric units***)	ODOR THRESHOLD (ppm)
Ethylene	---	---	74-85-1	3	---	---	
☆ Ethylenediamine	10	25	107-15-9	3	500	0.2	
Ethylene chlorohydrin	1	3	107-07-3	3	60	0.02	
☆ Ethylene dibromide	20	155	106-93-4	1	775	0.1	
Ethylene dichloride	1	4	107-06-2	3	80	0.02	
Ethylene glycol (vapor)	50	125	107-21-1	3	2,500	1.0	
Ethylene glycol dinitrate	0.05*	0.3*	628-96-6	3	6	1.0 ppbv	
Ethylene glycol monomethyl ether acetate	25	120	110-49-6	3	2,400	0.5	
Ethylene glycol, particulate	---	10*	107-21-1	3	200	---	
☆ Ethylene oxide	1	2	75-21-8	2	20	0.01	
Ethylene thiourea	---	---	96-45-7	2			
☆ Ethylenimine	0.5	1	151-56-4	3	20	0.01	
Ethylidene norbornene	5	25	16219-75-3	3	500	0.1	
n-Ethylmorpholine	5	23	100-74-3	3	460	0.1	
Ethynodiol acetate	---	---		3			
Fensulfothion (Dasanit)	---	0.1	115-90-2	3	2	---	
Fenthion	---	0.2	55-38-9	3	4	---	
Ferbam	---	10	14484-64-1	3	200	---	
Ferrovanadium dust	---	1	12604-58-9	3	20	---	
Fibrous glass (see Table 2A)							
Fluorides (as F)	---	2.5		3	50	---	
Fluorine	0.1	0.2	7782-41-1	3	4	2.0 ppbv	
Fluorocarbon polymer decomposition products							
Fluorotrichloromethane	1,000	5,600	75-69-4	3	112,000	20.0	
5-Fluorouracil	---	---		2			
Fonofos	---	0.1	944-22-9	3	2		
Formaldehyde	1	1.2	50-00-0	2	12	0.01	.10-1.0
Formamide	20	30	75-12-7	3	600	0.4	
Formic acid	5	9	64-18-6	3	180	0.1	
Furfural	2	8	98-01-1	3	160	0.04	
Furfuryl alcohol	10	40	98-00-0	3	800	0.2	
Gasoline	300	900	8006-61-9	3	18,000	6.0	
Germanium tetrahydride	0.2	0.6	7782-65-2	3	12	4.0 ppbv	
Glutaraldehyde, activated or unactivated	0.2	0.7	111-30-8	3	14	4.0 ppbv	
Glycerin mist	---	---	56-81-5	3	---		
Glycidol	25	75	556-52-5	3	1,500	0.5	
Glyconitrile	---	---		3	---		
Guthion (Azinphos-Methyl)	---	0.2	86-50-0	3	4	---	
Hafnium	---	0.5	7440-58-6	3	10	---	
Hematite				3			

* Proposed for revision

☆ Connecticut's "List of 47"

● Carcinogenic substance (Statute 19a - 329)

TABLE 11. Continued

HAZARDOUS SUBSTANCE	LOWEST THRESHOLD LIMIT VALUE (TLV) (8-Hour Averaging Time) ppm	mg/m3	CAS NUMBER	TOXICITY GROUP*	CT MAAC (8-hour) (ug/m3)	(volumetric units***)	ODOR THRESHOLD (ppm)
Heptachlor	---	0.5	76-44-8	1	2.5	---	
Heptane (n-Heptane)	87.5	350	142-82-5	3	7,000	1.75	
Heptanethiol	---	---	1639-09-4	3	---	---	
Hexachlorobenzene				2			
Hexachlorobutadiene	0.02	0.24	76-68-3	2	2.4	0.2 ppbv	
Hexachlorocyclohexane	---	---	319-85-7	3			
Hexachlorocyclopentadiene	0.01	0.1	77-47-4	3	2	0.2 ppbv	
Hexachloroethane	1	10	67-72-1	1	50	5.0 ppbv	
Hexachloronaphthalene	---	0.2	1335-87-1	3	4	---	
Hexadecanethiol	---	---		3	---		
Hexafluoroacetone	0.1	0.7	684-16-2	3	14	2.0 ppbv	
Hexamethylene diisocyanate	---	.035		3	0.7	---	
Hexamethylphosphoramide	---	---	680-31-9	2			
Hexane (n-hexane)	50	180	110-54-3	3	3,600	1.0	
Hexane, other isomers	500	1,800	110-54-3	3	36,000	10.0	
Hexanethiol	---	---	111-31-9	3	---	---	
2-Hexanone	5	20	25683-00-5	3	400	0.1	
Hexone	50	205	108-10-1	3	4,100	1.0	
sec-Hexyl acetate	50	300	142-92-7	3	6,000	1.0	
Hexylene glycol	25	125	107-41-5	3	2,500	0.5	
Hydralazine	---	---	86-54-4	3			
★Hydrazine	0.1	0.1	302-01-2	2	1	1.0 ppbv	
Hydrazine sulfide				2			
Hydrazinobenzene				3			
Hydrazobenzene				2			
Hydrachloride o-anisidine				3			
Hydrogenated terphenyls	0.5	5	92-94-4	3	100	0.01	
Hydrogen bromide	3.*	10.*	10035-10-6	3	200	0.06	
Hydrogen chloride	5	7	7647-01-0	3	140	0.10	10
Hydrogen cyanide	10	11	74-90-8	3	200	0.2	
Hydrogen fluoride	3.*	2.5*	7664-39-3	3	50	0.06	
Hydrogen peroxide	1	1.4	7722-84-1	3	28	0.02	
Hydrogen selenide	0.05	0.2	7783-07-5	3	4	1.0 ppbv	
Hydrogen sulfide	10	14	7783-06-4	3	280	0.2	.00047
Hydroquinone							
17x-Hydroxyprogesterone caproate	---	---		3	---	na	
2-Hydroxypropyl acrylate	0.5	3	999-61-1	3	60	0.01	

* Proposed for revision

★ Connecticut's "List of 47"

● Carcinogenic substance (Statute 19a - 329)

TABLE 11. Continued

HAZARDOUS SUBSTANCE	LOWEST THRESHOLD LIMIT VALUE (TLV) (8-Hour Averaging Time) ppm	mg/m3	CAS NUMBER	TOXICITY GROUP*	CT MAAC (8-hour) (ug/m3)	(volumetric units***)	ODOR THRESHOLD (ppm)
Indene	10	45	95-13-6	3	900	0.2	
Indeno(1,2,3-cd) pyrene				2			
Indium & Compounds (as In)	---	0.1	7440-74-6	3	2		
Iodine	0.1	1	7553-56-2	3	20	2.0 ppbv	
Iodoform	0.6	10	75-47-8	3	200	12.0 ppbv	
Iron dextran complex	---	---		2			
Iron oxide fume	---	5	1309-37-1	3	100	---	
Iron pentacarbonyl	---	0.08	13463-40-6	3	1.6	---	
Iron salts, soluble (as Fe)	---	1		3	20	---	
Isoamyl acetate	100	525	123-92-2	3	10,500	2.0	
Isoamyl alcohol	100	360	123-51-3	3	7,200	2.0	
Isobutyl acetate	150	700	110-19-0	3	14,000	3.0	
Isobutyl alcohol	50	150	78-83-1	3	3,000	1.0	
Isobutyronitrile	8	22		3	440	0.16	
Isooctyl alcohol	50	270	26952-21-6	3	5,400	1.0	
Isonicotinic acid hydrazide	---	---	55-22-1	3			
Isophorone	5	25	78-59-1	3	460	0.1	
Isophorone diisocyanate	.01	.045	4098-71-9	3	0.9	0.2 ppbv	
Isopropoxyethanol	25	105	109-59-1	3	2,100	0.5	
Isopropyl acetate	250	950	108-21-4	3	19,000	5.0	
Isopropyl alcohol	400	980	67-63-0	3	19,600	8.0	
n-Isopropyl aniline	2	10	643-28-7	3	200	0.04	
Isopropylamine	5	12	75-31-0	3	240	0.1	
Isopropyl ether	250	1,050	108-20-3	3	21,000	5.0	
Isopropyl glycidyl ether (IGE)	50	240	4016-14-2	2	2,400	0.5	
Isopropyl oils				3			
Kepone	---	---	143-50-0	1	---		
Kerosene	---	100		3	2,000		
Ketene	0.5	0.9	463-51-4	3	18	0.01	
Lead, inorg., fumes & dusts (as Pb)	---	0.15	7439-92-1	3	3*		
Lead acetate				2			
☆ Lead arsenate (as Pb)	---	0.15	10102-48-4	3	3		
Lead chromate (as Cr)	---	0.05	18454-12-1	2	0.5		
Lead phosphate				2			

* The EPA national ambient air quality standard, 3-month average, is 1.5 ug/m3.

☆ Connecticut's "List of 47"

● Carcinogenic substance (Statute 19a - 329)

TABLE 11. Continued

HAZARDOUS SUBSTANCE	LOWEST THRESHOLD LIMIT VALUE (TLV) (8-Hour Averaging Time) ppm	mg/m3	CAS NUMBER	TOXICITY GROUP*	CT MAAC (8-hour) (ug/m3)	(volumetric units***)	ODOR THRESHOLD (ppm)
Lindane	---	0.5	58-89-9	2	5		
Liquified petroleum gas	1,000	1,800		3	36,000	20	
Lithium hydride	---	0.025	7580-67-8	3	0.5		
Lynoestrenol	---	---	52-76-6	3			
Magenta				3			
Magnesite	---	---	546-90-0	3	---		
Magnesium oxide fume	---	10	1309-48-8	3	200		
Malathion	---	10	121-75-5	3	200		
Maleic anhydride	0.25	1	108-31-6	3	20	5.0 ppbv	
Malonitrile	3	8		3	160		
Manganese dust & compounds (as Mn)	---	5	7489-96-5	3	100	.06	
Manganese cyclopentadienyl tricarbonyl (as Mn)	---	0.1	12079-65-1	3	2		
Manganese fume (as Mn)	---	1	7439-96-5	3	20		
Manganese tetroxide	---	1		3	20		
Medroxyprogesterone acetate	---	---		3			
Megestrol acetate	---	---		3			
Melphalan	---	---	148-82-3	1			
6-Mercaptopurine	---	---	50-44-2	3			
Mercury (alkyl compounds) (as Hg)	0.001	0.01		3	2	0.02 ppbv	
Mercury, (all forms except alkyl) (as Hg) vapor		0.05	7439-97-6	3	1		
aryl and inorganic compounds		0.1		3	2		
Mesityl oxide	10	40	141-79-7	3	800	0.2	
Mestranol	---	---	72-33-3	2			
Methacrylic acid	20	70	79-41-4	3	1,400	0.4	
Methanethiol	0.5	1	74-93-1	3	20	0.01	
Methanol	200	260	67-56-1	3	5,200	4.0	100.00
Methomyl	---	2.5	16752-77-5	3	50		
Methotrexate	---	---	59-05-2	3			
Methoxychlor	---	10	72-43-5	3	100		
2-Methoxyethanol	5	16	109-86-4	3	320	0.1	
2-Methoxyethyl acetate	5	24	110-49-6	3	480	0.1	
4-Methoxyphenol		5	150-76-5	3	100	---	
Methyl acetate	200	610	79-20-9	3	12,200	4.0	
Methyl acetylene	1,000	1,650	74-99-7	3	33,000	20.0	

☆ Connecticut's "List of 47"

● Carcinogenic substance (Statute 19a - 329)

TABLE 11. Continued

HAZARDOUS SUBSTANCE	LOWEST THRESHOLD LIMIT VALUE (TLV) (8-Hour Averaging Time) ppm	mg/m3	CAS NUMBER	TOXICITY GROUP*	CT MAAC (8-hour) (ug/m3)	(volumetric units***)	ODOR THRESHOLD (ppm)
Methyl acetylene-propadiene mixture	1,000	1,800		3	36,000	20.0	
Methyl acrylate	10	35	96-33-3	3	700	0.2	
Methylacrylonitrile	1	3	126-98-7	3	60	0.02	
Methylal	1,000	3,100	109-87-5	3	62,000	20.0	
Methylamine	10	12	74-89-5	3	240	0.2	.021
Methyl n-amyl ketone	50	235	110-43-0	3	4,700	1.0	
n-Methyl aniline	0.5	2	100-61-8	3	40	0.01	
Methyl bromide	15	60	74-83-9	3	1,200	0.3	
Methyl butyl ketone	5	20	591-78-6	3	400	0.1	20.47
Methyl cellosolve	25	80	109-86-4	3	1,600	0.5	
Methyl cellosolve acetate	25	120		3	2,400	0.5	
Methyl chloride	50	105	74-87-3	3	2,100	1.0	10.00
Methyl chloroform	350	1,900	71-55-6	3	38,000	7.0	
Methyl 2-cyanoacrylate	2	8	137-05-3	3	160	0.04	
Methylcyclohexane	400	1,600	108-87-2	3	32,000	8.0	
Methylcyclohexanol	50	235	25639-42-3	3	4,700	1.0	
O-Methylcyclohexanone	50	230	583-60-8	3	4,600	1.0	
Methylcyclopentadienyl manganese tricarbonyl (as Mn)	0.1	0.2	12108-13-3	3	4	2.0 ppbv	
Methylene bisphenyl isocyanate (MDI)	0.02	0.2	101-68-8	3	4	0.4 ppbv	
Methylene bis (4-cyclo-hexylisocyanate)	0.01	0.11	5124-30-1	3	2.2	0.2 ppbv	
● 4,4'-Methylene bis (2-chloraniline)	---	.003	101-14-4	1	.015		
4,4'-methylene bis (N,N-dimethyl)benzenamide				2			
Methylene chloride	100	350	75-09-2	3	7,000	2.0	214.00
4,4-Methylene dianiline	0.1*	0.8*	101-77-9	3	16	2.0 ppbv	
Methyl n-butyl ketone	1.4	4	591-78-6	3	80	28.0 ppbv	
Methyl demeton		0.5	8022-00-2	3	10	---	
Methyl ethyl ketone (MEK)	200	590	78-93-3	3	11,800	4.0	
Methyl ethyl ketone peroxide	0.2	1.5	1338-23-4	3	30	4.0 ppbv	
Methyl formate	100	250	107-31-3	3	5,000	2.0	
Methyl hydrazine	0.2	0.35	60-34-4	2	3.5	2.0 ppbv	
Methyl iodide	5	28	74-88-4	2	280	0.05	
Methyl isoamyl ketone	48	230	110-12-3	3	4,600	0.96	
Methyl isobutyl carbinol	25	100	105-30-6	3	2,000	0.5	
Methyl isobutyl ketone	50	200	108-10-1	3	4,000	1.0	
★ Methyl isocyanate	0.02	0.05	624-83-9	3	1	0.4 ppbv	
Methyl isopropyl ketone	200	705	563-80-4	3	14,100	4.0	
Methyl mercaptan	0.5	1	74-93-1	3	20	0.01	0.0021

* Proposed for revision

★ Connecticut's "List of 47"

● Carcinogenic substance (Statute 19a - 329)

TABLE 11. Continued

HAZARDOUS SUBSTANCE	LOWEST THRESHOLD LIMIT VALUE (TLV) (8-Hour Averaging Time) ppm	mg/m3	CAS NUMBER	TOXICITY GROUP*	CT MAAC (8-hour) (ug/m3)	(volumetric units***)	ODOR THRESHOLD (ppm)
Methyl methacrylate	100	410	80-62-6	3	8,200	2.0	0.21
Methyl parathion	---	0.2	298-00-0	3	4	---	
Methyl n-propyl ketone	200	700	107-87-9	3	10,600	4.0	
Methyl silicate	1	6	681-84-5	3	120	0.02	
Metribuzin	---	5	21087-64-9	3	100	---	
Methyl styrene	50	240	98-83-9	3	4,800	1.0	
Metronidazole	---	---	443-48-1	2		---	
Mevinphos	0.01	0.1	7786-34-7	3	2	2.0 ppbv	
Michler's ketone				2			
Mirex				2			
MOCA	---	---		3	---		
Molybdenum (as Mo) soluble compounds	---	5	7439-98-7	3	100	---	
Molybdenum (insoluble compounds)	---	10	7439-98-7	3	200	---	
Monocrotophos	---	0.25	6923-22-4	3	5	---	
Monomethyl aniline	0.5	2	100-61-8	3	40	2.0 ppbv	
Monomethyl hydrazine	0.2	0.35	60-34-4	2	3.5	2.0 ppbv	
Morpholine	20	70		1	350	0.1	
Mustard gas	---	---	505-60-2	1			
Myleran	---	---	55-98-1	1			
Naled		3	300-76-5	3	60		
Naptha*	100	400		3	8,000	2.0	
☆ Napthalene	10	50	91-20-3	3	1,000	0.2	
Napthalene diisocyanate	---	.04	39394-45-1	3	0.8		
1-Napthylamine	---	---	134-32-7	3			
● ☆ -Napthylamine	---	---	91-59-8	1	---		
☆ Nickel carbonyl, as Ni	.05	.35	13463-39-3	1	1.75	0.25 ppbv	
☆ *Nickel (metal)*	---	1	7440-02-2	1	5		
☆ Nickel, soluble compounds (as Ni)	---	0.015		1,3	**		
☆ Nickel sulfide	---	---	12035-72-2	1	---		
Nickel sulfide roasting, fume and dust (as Ni)	---	1		1	5		
Nicotine	---	0.5	54-11-5	3	10		
Nitrapyrin		10	1929-82-4	3	200		
Nitric acid	2	5	7697-37-2	3	100	0.04	
Nitric oxide	25	30	10102-43-9	3	600	0.5	
Nitrilotriacetic acid				2			
p-Nitroaniline	0.5	3	100-01-6	3	60	0.01	

* See also VM&P Naptha
** Carcinogens - .075, *noncarcinogens* - 0.3.

☆ Connecticut's "List of 47"

● Carcinogenic substance (Statute 19a -329)

TABLE 11. Continued

HAZARDOUS SUBSTANCE	LOWEST THRESHOLD LIMIT VALUE (TLV) (8-Hour Averaging Time) ppm	mg/m3	CAS NUMBER	TOXICITY GROUP*	CT MAAC (8-hour) (ug/m3)	(volumetric units***)	ODOR THRESHOLD (ppm)
5-Nitro-o-anisidine				2			
Nitrobenzene	1	5	98-95-3	3	100	.02	.0047
p-Nitrochlorobenzene	---	1	100-00-5	3	20	---	
● ★ 4-Nitrodiphenyl	---	---	92-93-3	1	---		
Nitroethane	100	310	79-24-3	3	6,200	2.0	
Nitrofen				2			
Nitrogen dioxide	3	6	10102-44-0	3	120*	0.06	
★ Nitrogen mustard	---	---	55-86-7	1	---	---	
Nitrogen trifluoride	10	29	7783-54-2	3	580	0.2	
Nitroglycerin	.05	0.5	55-63-0	3	10	1.0 ppbv	
Nitromethane	100	250	75-52-5	3	5,000	2.0	
1-Nitropropane	25	90	108-03-2	3	1,800	0.5	
2-Nitropropane	25.***	90.***	79-46-9	2	900	0.25	
Nitrosamines	---	---		2	---		
n-Nitrosodi-n-butylamine				2			
● ★ n-Nitrosodimethylamine	---	---	62-75-9	1	---		
n-nitrosodiethanolamine				2			
n-Nitrosodiethylamine				2			
n-Nitrosodiphenylamine				2			
n-Nitroso-N-propylamine				2			
n-Nitroso-N-ethylurea				2			
n-Nitroso-N-methylurea				2			
n-Nitrosomethylvinylamine				2			
n-Nitrosomorpholine				2			
n-Nitrosonornicotine				2			
n-Nitrosopiperidine				2			
n-Nitrosopyrrolidine				2			
n-Nitrososarcosine				2			
Nitrotoluene	2	11	99-08-1	3	220	0.04	
Nitrous oxide	37	67	10024-97-2	3	1,330	0.73	
Nonane	200	1,050	111-84-2	3	21,000	4.0	
Nonanethiol	---	---	1455-21-6	3	---	---	
Norethisterone	---	---	68-22-4	2			
Norethynodrel	---	---	68-23-4	3	---		
Norgestrel	---	---	6533-00-2	3	---		
Octachloronaphthalene	---	0.1	2234-13-1	3	2	---	
Octane	72	350	111-65-9	3	7,000	1.4	
Octanethiol	---	---	111-86-6	3	---		
Octodecanethiol	---	---		3	---		
Oestradiol-17-beta	---	---	2529-64-8	2			

* The national ambient air quality standard (annual arithmetic mean) is 100 ug/m3. The NAAQS will take precedence. The value shown is entered for comparative purposes only.

★ Connecticut's "List of 47"

● Carcinogenic substance (Statute 19a - 329)

TABLE 11. Continued

HAZARDOUS SUBSTANCE	LOWEST THRESHOLD LIMIT VALUE (TLV) (8-Hour Averaging Time) ppm	mg/m3	CAS NUMBER	TOXICITY GROUP*	CT MAAC (8-hour) (ug/m3)	(volumetric units***)	ODOR THRESHOLD (ppm)
Oestrone	---	---	53-16-7	2	---		
Oil mist, mineral	---	5	8012-95-1	3	100		
Osmium tetroxide (as Os)	0.0002	0.002	20816-12-0	3	0.4	4.0 pptv	
Oxalic acid	---	1	144-62-7	3	20	---	
Oxygen difluoride	0.05***	0.1***	7783-41-7	3	2	1.0 ppbv	
Oxymetholone	---	---	434-07-1	1			
Ozone	0.1	0.2	10028-15-6	3	4**	2.0 ppbv	
Paraffin wax fume	---	2	8002-74-2	3	40	---	
Paraquat, respirable sizes	---	0.1	1910-42-5	3	2	---	
★ Parathion	---	0.1	56-38-2	3	2	---	
Pentaborane	0.005	0.01	19624-22-7	3	0.2	0.1 ppbv	
Pentachloronaphthalene	---	0.5	1321-64-8	3	10		
Pentachlorophenol	---	0.5	87-86-5	3	10		
Pentaerythritol	---	15	115-77-5	3	300		
Pentane	200	350	109-66-0	3	7,000	4.0	
Pentanethiol	---	---	110-66-7	3			
2-Pentanone	200	700	107-87-9	3	14,000	4.0	
Perchloroethylene	50	335	127-18-4	1	1,700	0.25	4.68
Perchloromethyl mercaptan	0.1	0.8	594-42-3	3	16	2.0 ppbv	
Perchloryl fluoride	3	13.5	7616-94-6	3	270	0.06	
Phenacetin	---	---	62-44-2	1			
Phenazopyridine	---	---	94-78-0	2			
Phenazopyridine chloride				2			
Phenelzine	---	---	51-71-8	3			
Phenantoin (and sodium salt)				2			
Phenobarbitol				3			
Phenol	5	19	108-95-2	3	380	0.1	.047
Phenothiazine	---	5	92-84-2	3	100		
Phenoxyacetic acid herbicides	---	---		2			
Phenylbutazone	---	---	50-33-9	3			
p-Phenylene diamine	---	0.1	106-50-3	3	2	---	
Phenyl ether (vapor)	1	7	101-84-8	3	140	0.02	
Phenyl ether-Diphenyl mixture (vapor)	1	7		3	140	0.02	
Phenyl glycidyl ether (PGE)	1	6	122-60-1	2	60	0.01	
Phenylhydrazine	5	20	100-63-0	3	400	0.1	
Phenyl mercaptan	0.5	2	108-98-5	3	40	0.01	
Phenyl- -naphthylamine	---	---	135-8806	2			
Phenyl-2-naphthylamine	---	---		3			
Phenylphosphine	0.05	0.25	638-21-1	3	5	1.0 ppbv	

** The national ambient air quality standard (1-hour) is 235 ug/m3. The NAAQS will take precedence. The value shown is entered for comparative purposes only.

*** Proposed for revision

★ Connecticut's "List of 47"

● Carcinogenic substance (Statute 19a - 329)

TABLE 11. Continued

HAZARDOUS SUBSTANCE	LOWEST THRESHOLD LIMIT VALUE (TLV) (8-Hour Averaging Time) ppm	mg/m3	CAS NUMBER	TOXICITY GROUP*	CT MAAC (8-hour) (ug/m3)	(volumetric units***)	ODOR THRESHOLD (ppm)
Phenytoin	---	---	57-41-0	2			
Phorate (Thimet)	---	0.05	298-02-2	3	1	---	
Phosdrin (Mevinphos)	0.01	0.1	7786-34-7	3	2	0.2 ppbv	
Phosgene (carbonyl chloride)	0.1	0.4	75-44-5	3	8	2.0 ppbv	1.0
Phosphine	0.3	0.4	7803-51-2	3	8	6.0 ppbv	
Phosphoric acid	---	1	7664-38-2	3	20		
Phosphorus (yellow)	---	0.1	7723-14-0	3	2		
Phosphorus oxychloride	0.1	0.6	10026-13-8	3	12	2.0 ppbv	
Phosphorus pentachloride	0.1	1	10026-13-8	3	20	2.0 ppbv	
Phosphorus pentasulfide	---	1	1314-80-3	3	20	---	
Phosphorus trichloride	0.2	1.5	7719-12-2	3	30	4.0 ppbv	
Phthalic anhydride	1	6	85-44-9	3	120	0.02	
m-Phthalodinitrile	---	5	626-17-5	3	100	---	
Picloram	---	10	1918-02-1	3	200	---	
Picric acid	---	0.1	88-89-1	3	2	---	
Pindone	---	0.1	83-26-1	3	2	---	
Piperazine dihydrochloride		5	142-64-3	3	100	---	
Pival (2-Pivalyl-1,3-indandione)	---	0.1	83-26-1	3	2	---	
Platinum (metal)		1	7440-06-4	3	20	---	
Platinum (soluble salts) (as Pt)	---	0.002		3	0.4	---	
Polybrominated biphenyls				2			
Polychlorinated biphenyls:							
★ 42% Cl	---	.001	11097-69-1	2	.01	---	
★ 54% Cl	---	.001	11097-69-1	2	.01	---	
★ Polycyclic Aromatic Hydrocarbons (PAH)	---	0.02*	50-32-8	1	0.10*	---	
Polytetrafluoroethylene decomposition products	---	---		3	---		
Potassium hydroxide	---	2	1310-58-3	3	40	---	
Prednisone	---	---	53-03-2	3			
Procarbazine	---	---	671-16-9	2	---		
Procarbazine hydrochloride				2			
Progesterone	---	---	57-83-0	2	---		
Propane	---	---	74-98-6	3	---		
Propane sultone	---	---	1120-71-4	2			
Propanethiol	---	1,800	75-33-2	3	36,000	---	
● -Propiolactone	0.5	1.5	57-57-8	1	---	2.5 ppbv	
Propargyl alcohol	1	2	107-19-7	3	40	0.02	
Propionic acid	10	30	79-09-4	3	600	0.2	

* Benzene-soluble fraction

★ Connecticut's "List of 47"

● Carcinogenic substance (Statute 19a - 329)

TABLE 11. Continued

HAZARDOUS SUBSTANCE	LOWEST THRESHOLD LIMIT VALUE (TLV) (8-Hour Averaging Time) ppm	mg/m3	CAS NUMBER	TOXICITY GROUP*	CT MAAC (8-hour) (ug/m3)	(volumetric units***)	ODOR THRESHOLD (ppm)
Propionitrile	6	14	107-12-0	3	280	0.12	
Propoxur	---	0.5		3	10	---	
n-Propyl acetate	200	840	109-60-4	3	16,800	4.0	
Propyl alcohol	200	500	71-23-8	3	10,000	4.0	
Propylene	---	---	115-07-1	3	---		
Propylene dichloride	75	350	78-87-5	3	7,000	1.5	
Propylene glycol dinitrate	.05	0.3	6423-43-4	3	6	1.0 ppbv	
Propylene glycol monomethyl ether	100	360	107-98-2	3	7,200	2.0	
Propylene imine	2	5	75-55-8	2	100	0.04	
Propylene oxide	20	50	75-56-9	3	1,000	0.4	
n-Propyl nitrate	25	105	627-13-4	3	2,100	0.5	
Propylthiouracil	---	---		2			
Pyrethrum	---	5	8003-34-7	3	100	---	
Pyridine	5	15	110-864-1	3	300	0.1	0.021
Quinone	0.1	0.4	106-51-4	3	8	2.0 ppbv	
RDX	---	1.5	121-82-4	3	30	---	
Reserpine	---	---	50-55-5	2			
Resorcinol	10	45	108-46-3	3	900	0.2	
Rhodium, Metal fume & dusts (as Rh)	---	0.1	7440-16-6	3	2	---	
- insoluble compounds	---	1		3	20	---	
- soluble salts (as Rh)	---	0.01		3	.02	---	
Ronnel	---	10	299-84-3	3	200	---	
Rosin core solder pyrolysis products (as formaldehyde)	---	0.1		3	2	---	
Rotenone	---	5	83-79-4	3	100	2.0 ppbv	
Rouge	---	---	1309-37-1	3	---	<1	
Saccharine	---	---	81-07-2	2			
Safrole				2			
Selenium compounds (as Se)	---	0.2	7782-49-2	3	4	---	
Selenium hexafluoride	0.05	0.2	7783-79-1	3	8	2.0 ppbv	
Selenium sulfide				2			
Sesone		10	136-78-7	3	200		
Silane	5	7	7803-62-5	3	140	0.1	
Silica, amorphous	---	---	60676-86-0	3			
Silicon	---	---	7440-21-3	3	---		
Silicon carbide	---	---	409-21-2	3	---		
Silver, metal	---	0.01	7440-22-4	3	0.2	---	
Silver, soluble compounds		0.01		3	0.2	---	
Sodium azide	0.1	0.3	26628-22-8	3	6	2.0 ppbv	
Sodium bisulfite	---	5	7631-90-5	3	100	---	
Sodium fluoroacetate (1080)	---	0.05	62-74-8	3	1	---	
Sodium hydroxide	---	2	1310-73-2	3	40	---	
Sodium metabisulfite	---	5	7681-57-4	3	100	---	

★ Connecticut's "List of 47"

● Carcinogenic substance (Statute 19a - 329)

TABLE 11. Continued

HAZARDOUS SUBSTANCE	LOWEST THRESHOLD LIMIT VALUE (TLV) (8-Hour Averaging Time) ppm	mg/m3	CAS NUMBER	TOXICITY GROUP*	CT MAAC (8-hour) (ug/m3)	(volumetric units***)	ODOR THRESHOLD (ppm)
Sprionolactone	---	---	52-01-7	3	---		
Stibine	0.1	0.5	7803-52-3	3	10	2.0 ppbv	
Stoddard solvent	61	350*	8052-41-43	3	7,000*	1.22	
Streptozotocin				2			
Strychnine	---	0.15	57-24-9	3	3	---	
Styrene, monomer	50	215	100-42-5	3	4,300	1.0	0.047
Styrene oxide	---	---	96-09-3	3	---		
Subtilisins (proteolytic enzymes as 100% pure crystalline enzyme)	---	0.00006	1395-21-7	3	.0012	---	
Succinonitrile	6	20	110-61-2	3	400	0.12	
Sulfafurazole	---	---	127-69-5	3			
Sulfallate				2			
Sulfamethoxazole	---	---	723-46-6	3	10**		.016
Sulfur dioxide	0.2	0.5	7446-09-5	3	20**	4.0 ppbv	
Sulfur hexafluoride	1,000	6,000	2551-62-4	3	120,000	20.0	
Sulfuric acid	---	1	7664-93-9	3	20	---	
Sulfur monochloride	1.***	6.***	10025-67-9	3	120	0.02	
Sulfur pentafluoride	0.025***	0.25***	5714-22-7	3	5	0.5 ppbv	
Sulfur tetrafluoride	0.1***	0.4***	7783-60-0	3	8	2.0 ppbv	
Sulfuryl fluoride	5	20	2699-79-8	3	400	0.1	
Sulprofos	---	1	35400-43-2	3	20	---	
2,4,5-T	---	10	93-76-5	3	200	---	
Tantalum	---	5	7440-25-7	3	100	---	
TEDP (Sulfotep)	---	0.2	3689-24-5	3	4	---	
Teflon decomposition products	---	---	---	3	---		
Tellerium & compounds (as Te)	---	0.1	13494-80-9	3	2	---	
Tellerium hexafluoride, as Te	0.02	0.2	7783-80-4	3	4	0.4 ppbv	
Temephos	---	10	3383-96-8	3	200	---	
TEPP	0.004	0.05	107-49-3	3	1	0.08 ppbv	
Terphenyls	0.5	5	92-94-4	3	100	0.01	
★ 2,3,7,8-Tetrachlorodibenzofuran	---	---	51207-31-0	3	---		
★ Tetrachlorinated dibenzo-p-dioxins	---	---	1746-01-6	2	---		
1,1,1,2-Tetrachloro-2,2-difluoroethane	500	4,170	76-11-9	3	83,400	10.0	

* Petroleum solvents generally, except kerosene

** The short-term EPA national ambient air quality standards for SO2 are: 1300 ug/m3 (3-hour average) and 365 ug/m3 (24-hour average). The 8-hour equivalent NAAQS would be 860 ug/m3, by logarithmic interpolation. The NAAQS will take precedence. The value shown is entered for comparative purposes only.

*** Proposed for revision

★ Connecticut's "List of 47"

● Carcinogenic substance (Statute 19a - 329)

TABLE 11. Continued

HAZARDOUS SUBSTANCE	LOWEST THRESHOLD LIMIT VALUE (TLV) (8-Hour Averaging Time) ppm	mg/m3	CAS NUMBER	TOXICITY GROUP*	CT MAAC (8-hour) (ug/m3)	(volumetric units***)	ODOR THRESHOLD (ppm)
1,1,2,2-Tetrachloro-1,2-difluoroethane	500	4,170	76-12-0	3	83,400	10.0	
1,1,2,2-Tetrachloroethane	1	6.87	79-34-5	1	34.4	5.0 ppbv	
Tetrachloronaphthalene	---	2	1335-88-2	3	40	---	
Tetraethyl lead (as Pb)	---	0.075	78-00-2	3	1.5	---	
Tetrahydrofuran	200	590	109-99-9	3	11,800	4.0	
Tetramethyl lead (as Pb)	---	0.075	75-74-1	3	1.5	---	
Tetramethyl succinonitrile	0.5	3	3333-52-6	3	60	0.01	
Tetranitromethane	1	8	509-14-8	3	160	0.02	
Tetrasodium pyrophosphate	---	5	7722-88-5	3	100	---	
Tetryl (2,4,6-trinitrophenyl-methylnitramine)	---	1.5	479-45-8	3	30	---	
Thallium, soluble compounds (as Tl)	---	0.1	7440-28-0	3	2	---	
Thioacetamine				2			
4,4'-Thiobis (6-tert butyl-m-cresol)	---	10	96-69-5	3	200	---	
Thioglycolic acid	1	5	68-11-1	3	100	0.02	
Thiotepa	---	---	52-24-4	2			
Thiourea				2			
Thiram	---	5	137-26-8	3	100		
Thorium dioxide				1			
Tin, metal	---	2	7440-31-5	3	40		
Tin, inorganic compounds, except SnH4	---	2		3	40		
Tin, organic compounds (as Sn)	---	0.1		3	2		
Tin, oxide (as Sn)	---	2		3	---		
Titanium dioxide (as Ti)	---	15	13463-67-7	3	300		
o-Tolidine	---	---	119-93-7	2	180	0.04	
Toluene	100	375	108-88-3	3	7,500	2.0	2.14 to 4.68
✯ Toluene-2,4-diisocyanate (TDI)	.005	.04	584-84-9	3	0.8	0.1 ppbv	2.14
o-Toluidine	2	9	95-53-4	2	90	0.05	
o-Toluidine hydrochloride				2			
Toxaphene	---	0.5	8001-35-2	1		---	
Treosulfan	---	---	299-75-2	1			
Triaziquone	---	---	68-76-8	2			
Tributyl phosphate	0.2	5	126-73-8	3	100	4.0 ppbv	
Trichloroacetic acid	1	5	76-03-9	3	20	0.02	

* Proposed for revision

✯ Connecticut's "List of 47"

● Carcinogenic substance (Statute 19a - 329)

TABLE 11. Continued

HAZARDOUS SUBSTANCE	LOWEST THRESHOLD LIMIT VALUE (TLV) (8-Hour Averaging Time) ppm	mg/m3	CAS NUMBER	TOXICITY GROUP*	CT MAAC (8-hour) (ug/m3)	(volumetric units***)	ODOR THRESHOLD (ppm)
1,2,4-Trichlorobenzene	5	40	120-82-1	3	800	0.1	
1,1,1-Trichloroethane	350	1,900	71-55-6	3	38,000	7.0	
1,1,2-Trichloroethane	10	45	79-00-5	1	225	0.05	
Trichloroethylene	50.**	270.**	79-01-6	1	1,350	0.25	21.40
Trichlorofluoromethane	1,000	5,600	75-69-4	3	112,000	20.0	
Trichloronaphthalene	---	5	1321-65-9	3	100	---	
2,4,5-Trichlorophenol	---	---	95-95-4	3			
2,4,6-Trichlorophenol	---	---	88-06-2	1			
1,2,3-Trichloropropane	50	300	96-18-4	3	6,000	1.0	
1,1,2-Trichloro 1,2,2-trifluoroethane	1,000	7,600	76-13-1	3	152,000	20.0	
Tricyclohexyltin hydroxide (plictran)	---	5	13121-70-5	3	100	---	
Triethylamine	10	40	121-44-8	3	800	0.2	
Trifluoromonobomomethane	1,000	6,100	75-63-8	3	122,000	20.0	
Trimetalic anhydride	0.005	0.04	552-30-7	3	0.8	0.1 ppbv	
Trimethyl amine	10	24	75-50-3	3	480	0.2	
Trimethyl benzene	25	125	25551-13-7	3	2,500	0.5	
Trimethyl phosphite	2	10	121-45-9	3	200	0.04	
2,4-6-Trinitrotoluene (TNT)	---	0.5	118-96-7	3	10	---	
Triorthocresyl phosphate	---	0.1	73-30-8	3	2	---	4.83
Triphenyl phosphate	---	3	115-86-6	3	60	---	
Tris(1-aziridinyl)phosphine sulfide				2			
Tris (2,3-dibromopropyl)phosphate				2			
Tungsten & compounds, as W - soluble	---	1	7440-33-7	3	20*	---	
- insoluble	---	5		3	100*		
Turpentine	100	560	8006-64-2	3	11,200	2.0	
Undecanethiol	---	---		3	---		
Uracil mustard	---	---	66-75-1	2			
Uranium (natural) soluble, as U	---	.05	7440-61-1	3	1	---	
insoluble	---	0.20		3	4	---	
Urethane				2			
Valeraldehyde	50	175	110-62-3	3	3,500	1.0	
Vanadium, as Pentoxide, - Dust	---	0.05	1314-62-1	3	10	---	
- (Fume)	---	0.05	1314-62-1	3	1	---	
Vinblastine	---	---	865-21-4	3			
Vincristine	---	---	57-22-7	3			
Vinyl acetate	10	30	108-05-4	3	600	0.2	

* Less when combined with Co and Ni
** Proposed for revision

★ Connecticut's "List of 47"

● Carcinogenic substance (Statute 19a - 329)

TABLE 11. Continued

HAZARDOUS SUBSTANCE	LOWEST THRESHOLD LIMIT VALUE (TLV) (8-Hour Averaging Time) ppm	mg/m3	CAS NUMBER	TOXICITY GROUP*	CT MAAC (8-hour) (ug/m3)	(volumetric units***)	ODOR THRESHOLD (ppm)
Vinyl bromide	1.1	4.4	593-60-2	2	44	11 ppbv	
● ★ Vinyl chloride	5	10	75-01-4	1	50	25.0 ppbv	
Vinyl cyclohexene dioxide	10	60	106-87-6	2	600	0.1	
Vinyl toluene	100	480	25013-15-4	3	9,600	2.0	
★ Vinylidene chloride	5	20	75-35-4	3	400	0.1	
VM & P Naphtha	300	1350	8030-30-6	3	27,000	6.0	
Warfarin	--	0.1	81-81-2	3	2	---	
Welding fumes (NOC)+	---	5		3	100	---	
o-Xylene	100	435	1330-20-7	3	8,680	2.0	0.47
m-Xylene	100	435	1330-20-7	3	8,680	2.0	0.47
p-Xylene	100	435	1330-20-7	3	8,680	2.0	0.47
m-Xylene , '-diamine	---	0.1		3	2	---	
Xylidine	2	10	1330-73-8	3	200	0.04	
Yttrium	---	1	7440-65-5	3	20	---	
Zinc chloride fume	---	1	7646-85-7	3	20	---	
Zinc chromate (as Cr)	---	0.05	13530-65-9	2	0.5	---	
Zinc oxide fume	---	5	1314-13-2	3	100	---	
Zinc stearate	---	---	557-05-1	3	---	---	
Zirconium compounds (as Zr)	---	5	7440-67-2	3	100	---	

★ Connecticut's "List of 47"

● Carcinogenic substance (Statute 19a - 329)