Chapter 2 Clean Air Act Requirements and Programs to Regulate Air Toxics

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2.1 Introduction

In a general sense, an air pollutant is any substance introduced into the air by human activities (currently, approximately 75,000 industrial chemicals are produced or imported into the United States,[a] and science knows many millions more). Some air pollutants may take the form of solid particles, liquid droplets, or gases. Many different types of air pollutants can injure health and/or harm the environment (see Common Air Pollutants box).

Common Air Pollutants

acid aerosols
asbestos
carbon monoxide (CO)
carbonyl compounds
ground level ozone
metals
nitrogen oxides (NO_x)
particulate matter (PM)
propellants
radon
refrigerants
semivolatile organic compounds
sulfur dioxide (SO_2)
volatile organic compounds

In early versions of the Clean Air Act (CAA), Congress identified six criteria air pollutants for regulation. In addition to these pollutants, the1990 CAA Amendments focused EPA's efforts on another group of pollutants, the 188 Hazardous Air Pollutants (**HAPs**).[b] Additionally, EPA has identified 21 mobile source air toxics, 20 of which are also HAPs and the other one is "diesel particulate matter and diesel exhaust organic gases" (see Chapter 4).

The group of six criteria air pollutants occur commonly throughout the U.S. and are derived from numerous and diverse mobile and stationary sources. EPA has set National Ambient Air Quality Standards (NAAQS) for these pollutants based on health and welfare-related criteria (see Section 2.4.1 and http://www.epa.gov/ttn/naaqs/). No such national ambient air quality standards currently exist for HAPs, although regulatory programs are in place to address emissions of HAPs. In addition, air pollutants from indoor sources are of concern (with many of the chemicals emitted indoors overlapping with the criteria and HAP lists). EPA, however does not currently regulate indoor air.

A Note on Terminology

The terms "**air toxics**" and "**toxic air pollutants**" are often used interchangeably with "**hazardous air pollutants**" (which is a Clean Air Act phrase specific to the 188 pollutants that are the focal point of section 112 of the Act – see http://www.epa.gov/ttn/atw/188polls.html). For the purposes of this reference library, however, the term "air toxics" is used in the more general sense to refer generally to any air pollutant (other than criteria pollutants) that has the potential to cause adverse impacts to human health or the environment.

Criteria air pollutants are six common air pollutants determined to be hazardous to human health and for which EPA has established National Ambient Air Quality Standards (NAAQS). The six criteria air pollutants are carbon monoxide, lead, nitrogen dioxide, ozone, sulfur dioxide, and particulate matter.

The CAA is the primary federal law that regulates air emissions of HAPs. The Act applies to a number of different types of sources; these include small and large stationary facilities such as factories and neighborhood dry cleaners, as well as mobile sources such as cars and trucks. The original CAA was passed in 1963 and has been

[a] TSCA Chemical Substance Inventory, http://www.epa.gov/opptintr/newchems/invntory.htm

[b] CAA section 112(b)(1) lists 189 HAPs, but since the original Act, one chemical (caprolactam) has been delisted, leaving 188 HAPs (61 FR 30816, June 18, 1996).

amended since that time on a number of occasions, most recently in 1990. Congress intended the 1990 amendments to resolve unaddressed or insufficiently addressed air pollution problems such as acid rain, ground-level ozone, and stratospheric ozone depletion. The 1990 amendments also dramatically affected how EPA was to approach the issue of air toxics. For example, previous versions of the Act required EPA itself to identify pollutants as HAPs one-by-one and to set health-based standards for each. Given the problems that arose in working to implement this approach, Congress restructured the approach for air toxics in the 1990 amendments. The discussion below describes this current approach.

Specifically, this chapter provides an overview of the CAA requirements that are specific to HAPs, with emphasis on **stationary sources**, **mobile sources**, and **indoor sources** of HAPs. The chapter also provides insight into other aspects of air quality that play a role in understanding the air toxics problem. The chapter concludes with a brief description of some of the important studies EPA was required to perform under the Act to better understand the nature of the air toxics problem. The full text of the Act can be accessed at http://www.epa.gov/oar/caa. EPA has also developed a plain English guide to the Act that can be accessed at http://www.epa.gov/oar/oaqps/peg_caa/pegcaain.html.

2.2 HAPs and their Sources: Stationary, Mobile, and Indoor Sources

2.2.1 Hazardous Air Pollutants (HAPs)

Hazardous air pollutants (HAPs) are those 188 listed pollutants and groups of pollutants[c] that EPA knows or suspects cause cancer or other serious human health effects, such as reproductive effects or birth defects, or adverse environmental effects (Appendix A presents the full list).[1] Examples of HAPs include benzene, which is found in gasoline; perchloroethlyene, which is emitted by most dry cleaning facilities; methylene chloride, which is used as a solvent and paint stripper by a number of industries; dioxin; asbestos; toluene; and compounds of metals such as cadmium, mercury, chromium, and lead. Congress has given EPA the authority to add and subtract chemicals from that list, following established criteria [CAA Section 112(b)(3)]. According to summary data compiled by EPA, an estimated 5.1 million tons of HAPs were released from stationary and mobile sources in the U.S. in 1999.

Major Source – Any source or group of stationary sources located within a contiguous area and under common control that emits or has the potential to emit considering controls, in the aggregate, 10 tons per year (tpy) or more of any hazardous air pollutant or 25 tpy or more of any combination of hazardous air pollutants [CAA section 112(a)(1)].

Area Source – any stationary source of hazardous air pollutants that is not a major source ... not includ[ing] motor vehicles or nonroad vehicles subject to regulation under title II [CAA section 112(a)(2)].

People exposed to HAPs at sufficient concentrations and for a sufficient duration of time may have an increased chance of developing cancer or experiencing other serious health effects. These health effects can include damage to the immune system, as well as neurological,

[c] CAA section 112(b)(1) lists 189 HAPs, but since the original Act, one chemical (caprolactam) has been delisted, leaving 188 HAPs (61 FR 30816, June 18, 1996)

reproductive (e.g., reduced fertility), developmental, respiratory, and other health effects. In addition to exposure from breathing air toxics, some HAPs such as mercury compounds can deposit onto soils or surface waters, where they can be taken up by plants and animals (see Chapter 4). Like humans, ecological systems may experience adverse health problems if exposed to sufficient quantities of HAPs over time (ecological risk assessment is discussed in Part IV of this reference manual).

People may be exposed to HAPs in many ways, including:

- Breathing contaminated air;
- Eating contaminated food products, such as fish from contaminated waters; meat, milk, or eggs from animals that fed on contaminated plants; and fruits and vegetables grown in contaminated soil on which HAPs have been deposited;
- Drinking water contaminated by HAPs;
- Ingesting contaminated soil. Young children are especially vulnerable because they often ingest soil from their hands or from objects they place in their mouths; and
- Touching (making skin contact with) contaminated soil, dust, or water (for example, during recreational use of contaminated water bodies).

Anthropogenic sources of HAPs include stationary sources (e.g., factories, refineries, power plants), mobile sources (e.g., cars, trucks, buses), and indoor sources (e.g., some building materials and cleaning solvents). Some HAPs are also released from natural sources such as volcanoes.

The Urban Air Toxics

In 1999, EPA identified a group of 33 HAPs (the *Urban Air Toxics*) as those most important to health risks in urban areas (see Section 1.1).

acetaldehyde	coke oven emissions	manganese compounds
acrolein	dioxin	mercury compounds
acrylonitrile	1, 2-dibromoethane	methylene chloride[(b)]
arsenic comounds	propylene dichloride	nickel compounds
benzene	1, 3-dichloropropene	polychlorinated biphenyls (PCBs)
beryllium compounds	ethylene dichloride[(a)]	polycyclic organic mater (POM)
1,3-butadiene	ethyene oxide	quinoline
cadmium compounds	formaldehyde	1, 1, 2, 2-tetrachlorethane
carbon tetrachloride	hexachlorobenzene	tetrachloroethylene[(c)]
chloroform	hydrazine	trichloroethylene
chromium compounds	lead compounds	vinyl chloride

[(a)] also represented as 1,2-dichloroethane
[(b)] also represented as dichloromethane
[(c)] also represented as perchloroethylene

2.2.2 Stationary Sources: The Pre-1990 CAA "Risk-Only" Approach

Prior to 1990, the CAA directed EPA to regulate toxic air pollutants from stationary sources based on the risks each pollutant posed to human health. Specifically, the Act directed EPA to:

- Identify all pollutants that caused "serious and irreversible illness or death," and
- Develop standards to reduce emissions of these pollutants to levels that provided an "ample margin of safety" for the public.

In other words, EPA was tasked with identifying the chemicals to be considered HAPs and setting standards for chemical emissions that would not only be "safe," but would be safe with an "ample margin" to the public. (A discussion of what the term "ample margin of safety" means is presented in Chapter 27. A discussion as how to interpret risk levels such as "one in a million" is provided in Chapter 13.) EPA turned to a method called "risk assessment" in performing this task because it provided the tools necessary to evaluate the potential risks posed by hazardous chemicals released to the air.[(d)]

While attempting to understand and control air toxics during the 1970s and 1980s, EPA became involved in many legal, scientific, and policy debates over which pollutants to regulate and how stringently to regulate them. Much of the debate focused on what kinds of risk assessment methods to use, what assumptions in the process were appropriate, the amount of data needed to justify regulation, questions about the costs to industry and benefits to human health and the environment, and decisions about "how safe is safe" (see additional discussion in Chapter 3).

While EPA and the scientific community gained valuable knowledge about risk assessment methods during this time, the chemical-by-chemical regulatory approach – an approach based solely on risk – proved difficult. In fact, between 1970 and 1990 EPA regulated only seven pollutants (asbestos, benzene, beryllium, inorganic arsenic, mercury, radionuclides, and vinyl chloride) in this manner. Standards for sources of HAPs, known as the **National Emissions Standards for Hazardous Air Pollutants** or **NESHAPs**, cut annual air toxics emissions by an estimated 125,000 tons. However, the process did not work quickly enough to address pressing air pollution concerns.

2.2.3 Stationary Sources and the 1990 Clean Air Act Amendments: A "Technology First, Then Risk" Approach

Realizing the shortcomings of the "chemical-by-chemical" risk-based decision framework for stationary sources and acknowledging the gaps in scientific and analytical information, Congress adopted a new strategy in 1990. Specifically, Congress revised section 112 of the Act to mandate a more practical, phased approach to reducing emissions of toxic air pollutants.

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[d]People have been assessing risk in various ways for thousands of years, so in one sense, "risk assessment" is an ancient practice. However, methods to quantitatively assess risk for specific applications are a more recent development. As noted above, the methods necessary to assess the risks posed by air toxics are an even more recent development and are the subject of this discussion.

2.2.3.1 Step 1: The Technology-based Approach

This new approach has two components. In the first phase, EPA identifies categories of stationary sources that emit large amounts of HAPs and then develops pollution reduction regulations – called **Maximum Achievable Control Technology** or **MACT** standard - for those sources.[e] The MACT standards adopted by EPA are *technology-based* (not risk-based), which means EPA requires emission reductions based on an evaluation of the emission reductions that the best-performing similar sources are already achieving.

Specifically, when developing a MACT standard for a particular source category, EPA looks at the level of emissions already being achieved by the best-performing similar sources through clean processes, control devices, work practices, or other methods. The CAA specifies baselines (often referred to as the "MACT floors") for the new standards. At a minimum, a MACT standard must achieve, throughout the industry, a level of emissions control that is at least equivalent to the MACT floor. EPA can establish a more stringent standard after considering cost, non-air quality and environmental impacts, and energy requirements (section 112(d)(2) of the CAA).

The MACT floors specified in the CAA are different for existing sources and new sources. For existing sources, the MACT floor must equal the average emissions limitations achieved by the best-performing 12 percent of sources in that source category, if there are 30 or more existing sources. If there are fewer than 30 existing sources, then the MACT floor must equal the average emissions limitation achieved by the best-performing five sources in the category. For new sources, the MACT floor must equal the level of emissions control achieved in practice by the best-controlled similar source.

EPA has issued MACT standards for a variety of industrial source categories, including chemical plants, oil refineries, aerospace manufacturers, and steel mills, and smaller sources, such as dry cleaners, commercial sterilizers, secondary lead smelters, and chromium electroplating facilities. EPA has also issued standards pursuant to section 129 of the Clean Air Act to control emissions of certain toxic pollutants from solid waste combustion facilities. A comprehensive list of final MACT rules and regulations for the MACT program can be found at http://www.epa.gov/ttn/atw/mactfnl.html. EPA's proposed timetable for finalizing the remaining standards is available at http://www.epa.gov/ttn/atw/mactprop.html. When fully implemented, all of these standards will reduce air toxics emissions by several million tons per year – more than 10 times the reductions achieved prior to 1990.

2.2.3.2 Step 2: The Risk-based Approach

In the second phase of the process, EPA reviews the technology-based MACT standards to ensure that these standards have adequately reduced risk within an "ample margin of safety." In this second assessment, the Agency must adopt additional standards to address any significant risks remaining (also called **residual risks**) after the first phase implementation of the technology-based standards (section 112(f)(2)(A) of the CAA). This time lag between the

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[e] MACT standards are also considered NESHAPs.

technology and risk-based phases allows EPA to evaluate the best way to use risk assessment as a tool for assessing residual risks (see Chapter 3).

Within eight years after promulgation of MACT standards for each category or subcategory of sources, EPA must promulgate standards for such category or subcategory if the MACT standard for the category or subcategory does not protect public health with an ample margin of safety or to prevent, taking into consideration costs, energy, safety, and other relevant factors, an adverse environmental effect (section 112(f)(2)(A)). In 1999, EPA reported to Congress on its residual risk assessment framework and included a discussion of its methods, data, and tools.[2]

EPA has begun to assess residual risk for several source categories, including coke ovens, dry cleaning, gasoline distribution Stage I, commercial ethylene oxide sterilizers, halogenated solvent cleaning, industrial cooling towers, and magnetic tape manufacturing.

2.2.4 Mobile Sources of Air Toxics Rule

Mobile sources is a term used to describe a wide variety of vehicles, engines, and equipment that generate air pollution and that move, or can be moved, from place to place. Mobile sources pollute the air through combustion and fuel evaporation. These emissions contribute greatly to air pollution nationwide and are the primary cause of air pollution in many urban areas. EPA has identified 21 mobile source air toxics (MSATs) (see box below). Twenty of these are also listed as HAPs in CAA section 112(b); the remaining one (diesel particulate matter and diesel exhaust organic gases) is a mixture that includes many HAPs.[3] The two major divisions or types of mobile sources include:

- **On-road** (highway) sources include vehicles used on roads for transportation of passengers or freight. These include passenger cars, light-duty trucks (pickup trucks, minivans, passenger vans, and sport-utility vehicles), heavy-duty vehicles, and motorcycles. On-road vehicles may be fueled with gasoline, diesel fuel, or alternative fuels such as alcohol or natural gas.

- **Nonroad** (off-road) sources include vehicles, engines, and equipment used for construction, agriculture, transportation, recreation, lawn and garden care, and many other purposes. These include equipment and vehicles fueled with diesel fuel, gasoline, propane, or natural gas. Mobile sources include boats, aircraft, and locomotives. Not all mobile sources are "self-propelled." They can include portable generators, air compressors, chainsaws, trimmers, and shredders.

EPA uses an integrated approach (including regulations) to reduce pollution from mobile sources. From better engine design to better transit options, EPA's approach addresses:

- Vehicles, engines, and equipment;
- The fuels they use; and
- The people who operate them.

Mobile Source Air Toxics Listed in 2001 Rule[3]

- acetaldehyde
- acrolein
- arsenic compounds[a]
- benzene
- 1,3-butadiene
- chromium compounds[a]
- diesel particulate matter and diesel exhaust organic gases (DPM + DEOG)
- dioxin/furans[b]
- ethylbenzene
- formaldehyde
- n-hexane
- lead compounds[a]
- manganese compounds[a]
- mercury compounds[a]
- methyl tertiary butyl ether (MTBE)
- naphthalene
- nickel compounds[a]
- polycyclic organic matter (POM)[c]
- styrene
- toluene
- xylene

[a] Although the different metal compounds may differ in their toxicity, the on-road mobile source inventory contains emissions estimates for total metal compounds (i.e., the sum of all forms).
[b] This entry refers to two large groups of chlorinated compounds. In assessing their cancer risks, their quantitative potencies are usually derived from that of the most toxic, 2,3,7,8-tetrachlorodibenzodioxin.
[c] Polycyclic organic matter includes organic compounds with more than one benzene ring, and which have a boiling point greater than or equal to 100 degrees Celsius. A group of seven polynuclear aromatic hydrocarbons, which have been identified by EPA as probable human carcinogens (benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, chrysene, 7,12-dimethylbenz(a)anthracene, and indeno(1,2,3-cd)pyrene) are used here as surrogates for the larger group of POM compounds.

This approach includes national engine and fuel standards, as well as state requirements (e.g., engine maintenance, traffic flow/roadway design) established to enable attainment of the NAAQS for the criteria pollutants. The approach also involves extensive collaboration among EPA, state local and tribal (S/L/T) governments, transportation planners, individual citizens, and vehicle, engine, and fuel manufacturers and has been responsible for greatly reducing mobile source air pollution during the last 30 years.

In addition to achieving air toxics emissions reductions as a result of actions aimed at reductions in criteria pollutants, the 1990 CAA Amendments contain provisions specific to air toxics. These amendments direct EPA to address emissions of air toxics from motor vehicles and their fuels. Specifically, section 202(l) of the Clean Air Act instructs EPA to:

- Study the need for and feasibility of controlling emissions of toxic air pollutants associated with motor vehicles and their fuels. This section identifies benzene, 1,3-butadiene, and formaldehyde for particular consideration. EPA completed this study in 1993 and updated it in 1999.

- Set standards for HAPs from motor vehicles, their fuels, or both. Those standards are to be promulgated under section 202(a) or section 211(c) of the Act and must address at least benzene and formaldehyde. EPA is to base these standards on available technology, taking into account existing standards; costs, noise, energy, and safety factors; and lead time. EPA promulgated a rulemaking in accordance with CAA section 202(l) on March 29, 2001 (66 FR 17230).

The many vehicle and fuel changes in the last 25 years have greatly reduced air toxics emissions from highway vehicles. For example, the removal of lead from gasoline has essentially eliminated on-road mobile source emissions of this highly toxic substance in the United States. In addition, results of recent modeling indicate that current and planned programs will reduce emissions of mobile source air toxics by about one million tons (about 35 percent) between 1996 and 2007; on-highway emissions of benzene, formaldehyde, 1,3-butadiene, and acetaldehyde by 67 to 76 percent between 1990 and 2020; and on-highway diesel particulate matter by 94 percent between 1990 and 2020.[4] New cars using reformulated gasolines are capable of emitting more than 90 percent less air toxics on a per-mile basis than the uncontrolled models of 1970; new trucks and buses are designed to emit less than half the air toxics of their 1970 counterparts. Overall air toxics emissions will continue to decrease as older vehicles leave the fleets and as new regulatory programs take effect. However, the number of vehicles on the road and the number of miles they travel is continuing to grow. Without additional controls, growth in vehicle travel will offset progress in reducing air toxics.

Rulemakings and Voluntary Efforts to Reduce MSATs and other Air Pollutants

- Tier 2 gasoline/sulfur rulemaking (http://www.epa.gov/otaq/tr2home.htm)
- Reducing nonroad diesel emissions (http://www.epa.gov/nonroad/)
- Voluntary diesel retrofit program (http://www.epa.gov/otaq/retrofit)
- Best Workplaces for Commuters (http://www.commuterchoice.gov)
- Clean School Bus USA (http://www.epa.gov/cleanschoolbus.
- It All Adds Up to Cleaner Air (http://www.italladdsup.gov)

2.2.5 Indoor Air and Indoor Air Toxics

Indoor pollution sources that release gases or particles into the air are the primary cause of indoor air quality problems in homes and other buildings. Inadequate ventilation can increase indoor pollutant levels by not bringing in enough outdoor air to dilute emissions from indoor sources and by not carrying indoor air pollutants out of the building. High temperature and humidity levels can also increase concentrations of some pollutants.

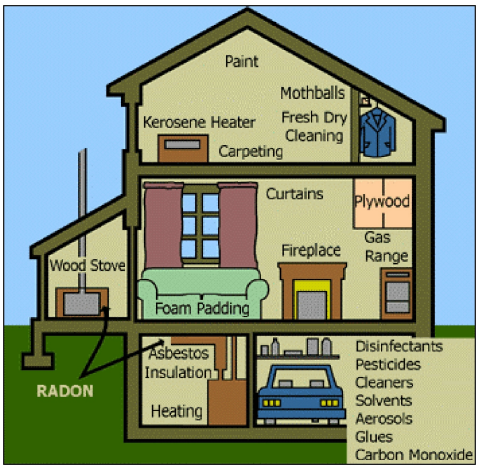
The importance of indoor air exposures to the total risk from air toxics is a relatively new finding. The contribution of indoor sources was not really recognized until the early 1980s when EPA performed the Total Exposure Assessment Methodology (TEAM) studies, which showed that the indoor concentrations of some air toxics can be significantly higher than outdoor concentrations. Since that time, numerous studies have confirmed that finding. In addition, the fact that Americans spend about 90 percent of their times indoors makes these exposures even more important

2.2.5.1 Potential Sources of Indoor Air Toxics

There are many potential sources of indoor air toxics in any home or building. These sources include combustion sources such as oil, gas, kerosene, coal, wood, and tobacco products; building materials and furnishings as diverse as deteriorated, asbestos-containing insulation, and cabinetry or furniture made of certain pressed wood products; products for household cleaning and maintenance (e.g., pesticides), personal care, or hobbies; and outdoor sources such as radon and other air pollution that penetrate into the indoor space.

Sources of Indoor Air Toxics

- Indoor air can become contaminated from numerous sources.
- Indoor air can have significantly higher concentrations of air toxics than outdoor air.
- EPA currently does not regulate indoor sources of air toxics.



The relative importance of any single source depends on how much of a given pollutant it emits and how hazardous those emissions are. In some cases, factors such as the age of the source and whether it is properly maintained are significant. For example, an improperly adjusted gas stove can emit significantly more carbon monoxide than one that is properly adjusted.

Some sources, such as building materials, furnishings, and household products like air fresheners, release pollutants more or less continuously (usually at a decreasing rate with age). Other sources, related to activities carried out in the home, release pollutants intermittently. These include smoking, the use of unvented or malfunctioning stoves, furnaces, or space heaters, the use of solvents in cleaning and hobby activities, the use of paint strippers in redecorating activities, and the use of cleaning products and pesticides in housekeeping. High pollutant concentrations can remain in the air for long periods after some of these activities.

How Does Outdoor Air Enter a House?

Outdoor air enters and leaves a house by: infiltration, natural ventilation, and mechanical ventilation. In a process known as infiltration, outdoor air flows into the house through openings, joints, and cracks in walls, floors, and ceilings, and around windows and doors. In natural ventilation, air moves through opened windows and doors. Air movement associated with infiltration and natural ventilation is caused by air temperature differences between indoors and outdoors and by wind. Finally, there are a number of mechanical ventilation devices, from outdoor-vented fans that intermittently remove air from a single room, such as bathrooms and kitchens, to air handling systems that use fans and duct work to continuously remove indoor air and distribute filtered and conditioned outdoor air to strategic points throughout the house. The rate at which outdoor air replaces indoor air is described as the air exchange rate. When there is little infiltration, natural ventilation, or mechanical ventilation, the air exchange rate is low, and pollutant levels can increase.

2.2.5.2 Indoor Air Toxics

Although EPA does not regulate indoor air pollution levels, it does take a proactive approach. The Agency provides a broad range of information about indoor air-related

risks, as well as the steps to reduce them, through the use of public awareness campaigns, guidance document dissemination, training course delivery, the operation of several linked hotlines and clearinghouses, and other outreach efforts. Useful resources on indoor air quality from the Agency are also available online.[5][6] EPA's activities to reduce exposures to indoor air toxics are many and include publishing guidelines about radon testing and result interpretation; persuading parents and caregivers of young children not to smoke indoors; and providing information to homeowners, school administrators, and office managers on the proper use of products and materials indoors, including appropriate maintenance and ventilation.

In 2001, EPA issued the Healthy Buildings, Healthy People (HBHP) report, a vision for indoor environmental quality in the 21st century.[7] The report covers three general areas: (1) why human health indoors deserves the scrutiny, concern, and action of policy makers; (2) a vision statement of EPA's vision, goals, broad strategies, and guiding principles to address indoor air quality issues; and (3) potential actions that EPA or others may pursue. The report also provides an overview of current indoor environmental program priorities in various offices within EPA and examines the roles of the Agency's partners in indoor environmental protection, including Federal, S/L/T organizations, and stakeholders.

EPA's objective is to realize major human health gains over the next 50 years by upgrading indoor environments. The Agency has set five goals and strategies to accomplish this objective:

- Achieve major health gains and improve professional education;
- Foster a revolution in the design of new and renovated buildings;
- Stimulate nationwide action to enhance health in existing structures;
- Create and use innovative products, materials, and technologies; and
- Promote health-conscious individual behavior and consumer awareness.

In addition to providing information on actions and strategies that can be taken to protect people indoors, EPA's vision acknowledges the important role individuals play in protecting their own health and the health of those around them.

EPA's specific goals to reduce the health risks from indoor air for 2005 include:

- 700,000 homes with high radon levels will be mitigated and 1 million homes with radon-resistant construction techniques will be constructed;
- The proportion of households in which children ages six and under are regularly exposed to smoking will be reduced from 27 percent in 1994 to 15 percent;
- Five percent of office buildings will be managed with indoor air quality practices consistent with EPA's *Building Air Quality* guidance;[8]
- Fifteen percent of the nation's schools will adopt good indoor air quality practices consistent with EPA's *Indoor Air Quality Tools for Schools* guidance;[9]
- One million children with asthma will have reduced exposure to indoor asthma triggers; and
- 200,000 low-income adults with asthma and 2.5 million people with asthma overall, will have reduced exposures to indoor asthma triggers.

Additional information on EPA's indoor air programs can be found EPA's Indoor Air Toxics web site.[5]

2.2.5.3 Health Risks and Indoor Pollutants

The health risks from a few indoor air toxics (e.g., radon, environmental tobacco smoke, benzene, lead, and asbestos) are well known and have been the subject of risk assessments both within and outside EPA. EPA's best estimate of annual lung cancer deaths from radon is currently about 21,000 (with an uncertainty range of 8,000 to 45,000). Environmental tobacco smoke is estimated to cause an additional 3,000 lung cancer deaths in non-smokers each year. EPA estimates that environmental tobacco smoke may also significantly aggravate symptoms of asthma for 200,000 children and may affect as many as 1,000,000 children to some extent. A California report estimates that environmental tobacco smoke causes 9,700 to 18,600 cases of low birth weight in infants each year and 35,000 to 62,000 cardiovascular deaths among non-smokers.[10]

To prioritize activities for other chemicals typically found in indoor air, EPA's Office of Radiation and Indoor Air (ORIA) is sponsoring a screening-level, risk-based analysis, which is currently in draft form and being revised. Some of the chemicals that may be of concern in indoor air, based on the draft ranking, are provided in the box to the right. However, it should be noted that the final results of this analysis may be significantly different. It should also be noted that, because monitoring data were only available for 112 chemicals and only 59 chemicals could be ranked, many chemicals found indoors might rank higher, given more complete information.

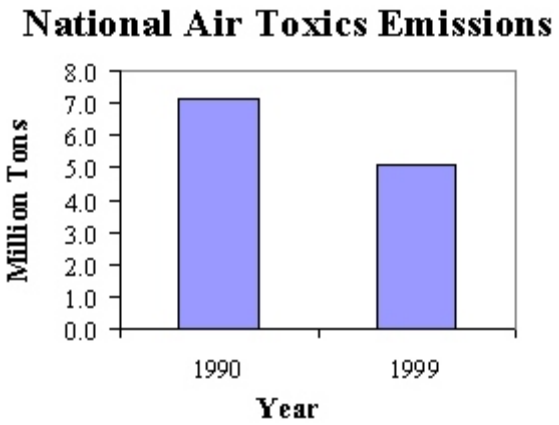
Some Pollutants of Potential Concern Indoors

- Formaldehyde
- Heptachlor
- 1,4-Dichlorobenzene
- Aldrin
- Chloroform
- Dieldrin
- Benzene
- Chlordane
- Tetrachloroethylene
- Acetaldehyde
- Trichloroethylene
- Dichlorvos
- Methylene chloride
- Lindane

Both acute and chronic cancer and noncancer health effects were addressed in the analysis, which focused on inhalation exposure only. Ten monitoring studies provided 213 concentration records for 112 air toxics including metals, aldehydes, volatile organic compounds (VOCs), and semivolatile organic compounds (SVOCs). Studied microenvironments included office buildings, residences, and schools. The general methodology used in the analysis echoed that used by the stationary source program to choose a list of urban HAPs for the Integrated Urban Air Toxics Strategy (64 FR 38706).

The study also estimated the indoor source contribution to indoor concentrations by subtracting associated outdoor concentrations from indoor concentrations. The listed pollutants were found to have large indoor source components. Note, however, that four of the listed pollutants (i.e., heptachlor, aldrin, dieldrin, and chlordane) are pesticides that are no longer in use but may continue to be of concern due to their persistence in the environment and the presence of unused and uncollected stocks.[11]

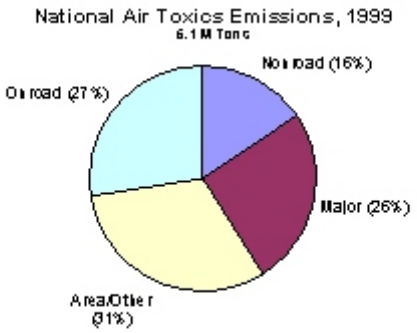
2.3 Progress in Understanding and Reducing Toxic Air Pollution



While monitoring data is critical to understanding and reducing toxic air pollution, EPA and S/L/T governments do not currently maintain as extensive a nationwide monitoring network for outdoor concentrations of air toxics as they do for many of the other pollutants (such as ozone and particulate matter). And, while EPA and S/L/T regulatory agencies do collect monitoring data for a number of toxic air pollutants, both the chemicals monitored and the geographic coverage of the monitors vary among individual S/L/T partners. EPA is working with these regulatory partners to build upon the existing monitoring sites to create a national outdoor monitoring network for a number of toxic air pollutants. The Agency's goal is to improve the scientific and technical competency of existing outdoor air monitoring networks in order to be more responsive to the public and the scientific and health communities; in this way, EPA can accommodate future needs in the face of scarce resources.

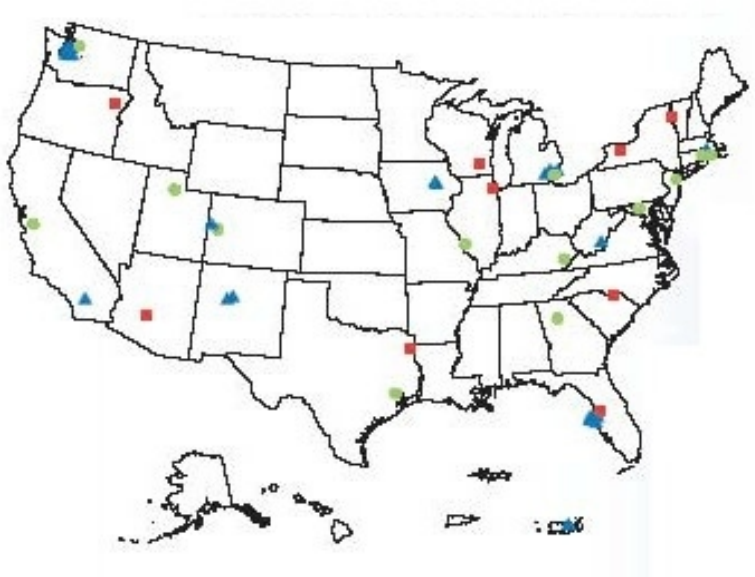
2.3.1 Trends

Monitoring data that are available can help air pollution control agencies track local trends in toxic air pollutants around the country. EPA began a pilot city monitoring project in 2001 with the intention to help answer several important national network design questions (e.g., sampling and analysis precision, sources of variability, and minimum quantitation levels). Based on the results of this year-long study and an analysis of historical monitoring data, the Agency is establishing a network of 22-city National Air Toxics Trends Sites (NATTS) that will help develop national trends for several pollutants of concern. For the latest information on national air toxics monitoring, see www.epa.gov/ttn/amtic/airtxfil.html.

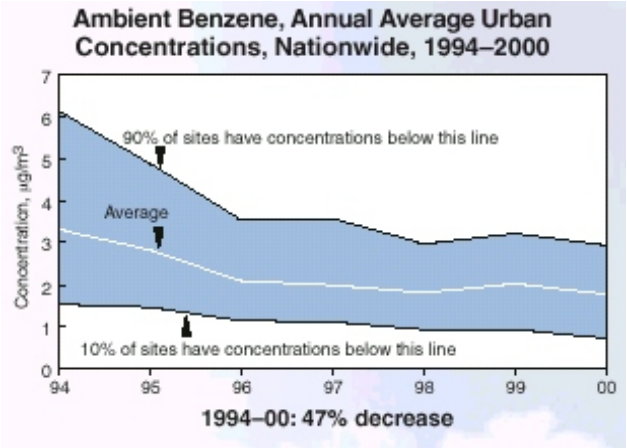


As shown in this pie chart, based on 1999 estimates (the most recent year of available data in the National Emissions Inventory (NEI) for air toxics), the emissions of HAPs are relatively equally divided between four types of sources: on road, non road, major, and area/other sources. However, this distribution varies from city to city.

Based on the data in the NEI, estimates of nationwide outdoor air toxics emissions have dropped approximately 29 percent between baseline (1990-1993) and 1999. Thirty-three of these air toxics (the Urban Air Toxics), which are considered to pose the greatest threat to public health in most urban areas, have similarly dropped 31 percent. Although changes in how EPA compiled the national inventory over time may account for some differences, EPA and S/L/T regulations, as well as voluntary reductions by industry have also achieved large reductions in air toxic emissions.

National Air Toxics Trends Stations (NAATS) Sites		
		
January 2003 Startup ●	**January 2004 Startup** ■	**Pilot Programs** ▲
Providence, RI Roxbury, MA New York, NY Washington, DC Decatur (Atlanta), GA Hazard, KY** Detroit, MI Deer Park (Houston), TX St. Louis, MO Bountiful, UT Grand Junction, CO** San Jose, CA Seattle, WA	Chittenden County, VT** Rochester, NY Tampa, FL Chesterfield, SC** Chicago, IL Mayville, WI Harrison County, TX** Phoenix, AZ La Grande, OR**	Barcelona/San Juan, PR Providence, RI Keeney Knob, WV Tampa, FL Detroit, MI Rio Rancho, NM Cedar Rapids, IA San Jacinto, CA Grand Junction, CO Seattle, WA ** rural site
Source: EPA's *Latest Findings on National Air Quality*[12]		

Trends for individual air toxics vary from pollutant to pollutant. Benzene, the most widely monitored toxic air pollutant, is emitted from cars, trucks, oil refineries, and chemical processes. The graph at right shows measurements of benzene taken from 95 urban monitoring sites around the country. These urban areas generally have higher levels of benzene than other areas of the country. These site measurements show, on average, a 47 percent drop in benzene levels from 1994 to 2000 (see adjacent graph). During this period,



EPA phased in new (so-called "tier 1") car emission standards, implemented the federal reformulated gasoline program in several parts of the country, and required reductions in emissions of benzene and other HAPs from oil refineries and chemical manufacturers. EPA estimates that, nationwide, benzene emissions from all sources dropped 20 percent from 1990 to 1996.

2.3.2 NATA National Scale Assessment

As part of its National Air Toxics Assessment (NATA)[f] activities, EPA has developed a national-scale risk characterization for 33 toxic air pollutants (Exhibit 2-1), based on 1996 emissions data. This set of pollutants is similar to the list of 33 Urban Air Toxics except that diesel particulate matter is included and dioxin is not. EPA used computer modeling of the 1996 NEI air toxics data as the basis for developing health risk estimates. The goal of the national-scale assessment risk characterization is to identify those air toxics which may be of potential concern in terms of contribution to population risk. The results are being used to, among other things, set priorities for the collection of additional air toxics data (e.g., emissions data and ambient monitoring data). EPA plans to update the national scale assessment every three years.

A number of important limitations and uncertainties are associated with the national scale assessment (see Summary of Limitations, Variability, and Uncertainty in the 1996 National-Scale Air Toxics Assessment box). Nonetheless, the results provide important information for priority setting. For example, the following map shows the distribution of relative predicted cancer risk attributed to exposures to outdoor sources of air toxics across the continental United States as estimated by the national-scale assessment. The highest ranking 20 percent of counties in terms of risk (622 counties) contain almost three-fourths of the U.S. population. Three air toxics (chromium, benzene, and formaldehyde) appear to pose the greatest nationwide carcinogenic risk. This map does not include the potential risk from diesel exhaust emissions because the existing health data were not deemed sufficient to develop a numerical estimate of cancer risk for this pollutant. However, exposure to diesel exhaust is widespread, and EPA has concluded that diesel exhaust is a likely human carcinogen and ranks it with the other substances that the national-scale assessment suggests pose the greatest relative risk. One toxic air pollutant, acrolein, is estimated to pose the highest potential nationwide for chronic adverse effects other than cancer. For more information about NATA activities, see www.epa.gov/ttn/atw/nata.

This technical assessment represents an important step toward characterizing air toxics nationwide. It is designed to help identify general patterns in air toxics exposure and risk across the country, but is not recommended as a tool to characterize or compare risk at local levels (e.g., to compare risks from one part of a city to another). More localized assessments, including monitoring and modeling, provide a more appropriate way to accurately characterize local-scale risk.

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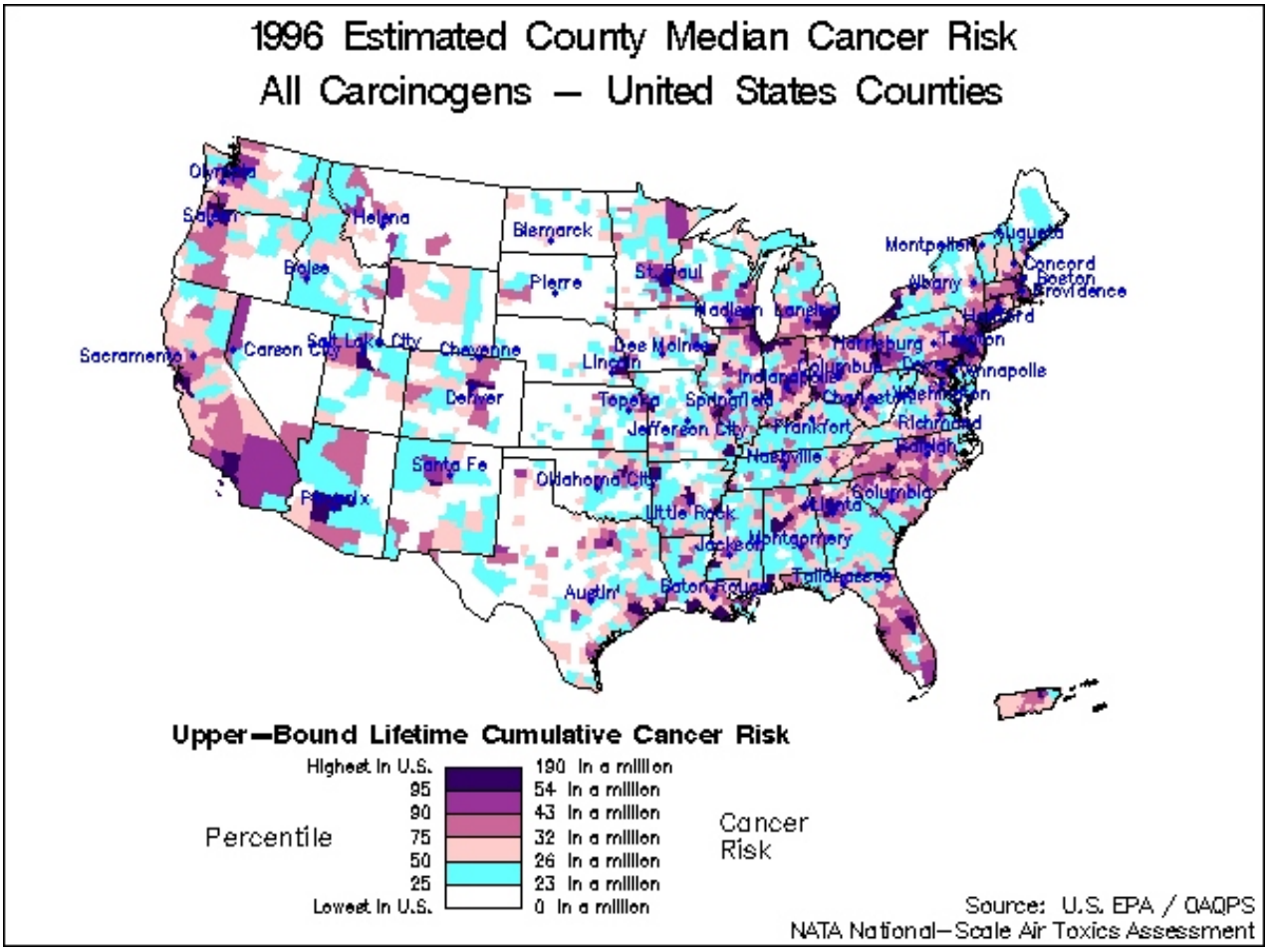
[f] NATA is EPA's ongoing comprehensive evaluation of air toxics in the U.S. These activities include expansion of air toxics monitoring, improving and periodically updating emission inventories, improving national- and local-scale modeling, continuing research on health effects and exposures to both ambient and indoor air, and improving assessment tools (http://www.epa.gov/ttn/atw/nata/index.html).

Exhibit 2-1. The 33 Pollutants Included in the National-Scale Air Toxics Assessment		
acetaldehyde	coke oven emissions	mercury compounds
acrolein	1,3-dichloropropene	methylene chloride
acrylonitrile	diesel particulate matter	nickel compounds
arsenic compounds	ethylene dibromide	perchlorothylene
benzene	ethylene dichloride	polychlorinated biphenyls (PCBs)
beryllium compounds	ethylene oxide	polycyclic organic matter (POM)[a]
1,3-butadiene	formaldehyde	propylene dichloride
cadmium compounds	hexachlorobenzene	quinoline
carbon tetrachloride	hydrazine	1,1,2,2-tetrachloroethane
chloroform	lead compounds	trichloroethylene
chromium compounds	manganese compounds	vinyl chloride

[a]Also represented as 7-PAH
EPA plans eventually to include all 188 HAPs in the NATA national-scale assessment
Source: http://www.epa.gov/ttn/atw/nata/34poll.html



Summary of Limitations, Variability, and Uncertainty in the 1996 National-Scale Air Toxics Assessment[a]

- **Limitations**. The NATA results provide macro-level data on emissions, ambient air concentrations, exposures, and risks across broad geographic areas (such as counties, states and the nation) at a moment in time. As such, they help the EPA identify specific air toxics compounds, and specific source sectors such as stationary sources or mobile sources, which generally produce the highest exposures and risks in the country. But the results are also based on assumptions and methods that limit the range of questions that can be answered reliably. The data cannot be used to identify exposures and risks for specific individuals, or even to identify exposures and risks in small geographic regions such as a specific census tract. Also, these data are not appropriate for determining impacts close to particular facilities. These limitations, or caveats, must always be kept in mind when interpreting the results, and the results should be used only to address questions for which the assessment methods are suited.

- **Variability**. Emissions, air concentrations, exposures and risks are not the same throughout the U.S., and are not the same for every person. Some geographic areas have higher concentrations than others; there are some periods of time when the concentration is higher at a given location than at other times. Some individuals have an exposure and/or risk below the national average, while others have an exposure and/or risk above the national average. It is necessary, therefore, to have some idea of how the ambient air toxics concentrations, exposures, and risks vary throughout the U.S. Such a process is called a variability analysis.

- **Uncertainty**. EPA seeks to protect health with reasonable confidence. Scientific estimates of air concentrations, exposures, and risks, however, always involve simplifying assumptions that make the assessment possible given available information and resources. These assumptions introduce uncertainties into the results, since there is never complete confidence that the assumptions are entirely correct. It is necessary to understand the size of these uncertainties, the level of confidence that can be placed in any statement related to the assessment, and how this confidence affects the ability to make reasoned decisions. Such a process is called an uncertainty analysis.

[a]More detailed discussion of specific limitations, variability, and uncertainty associated with the 1996 national-scale assessment is provided in three individual pages accessed by links from http://www.epa.gov/ttn/atw/nata/natsalim2.html.

2.4 Other Air Pollutants of Potential Concern

As previously noted, there are many other air pollutants that may be harmful to public health and the environment and, for some of these chemicals, other programs may already be in place to help control them. This section discusses several groups of air pollutants, some of which overlap with the list of 188 HAPs.

2.4.1 Criteria Air Pollutants

Pursuant to the CAA, EPA has set standards, also known as **National Ambient Air Quality Standards (NAAQS)**, for six **criteria pollutants** (Exhibit 2-2). The Clean Air Act requires these standards to be set at levels that protect public health with an adequate margin of safety and without consideration of cost. These standards serve two important purposes: first, they provide information to the public about whether the air in their community is healthful; and second, they

present state and local governments with the targets they must meet to achieve clean air. EPA requires that each state containing areas that do not attain the standards develop a written plan for cleaning the air in those areas. The plans developed are called state implementation plans (SIPs). Through these plans, the states outline efforts that they will make to try to correct the levels of air pollution and bring their areas back into attainment.

Exhibit 2-2. National Ambient Air Quality Standards (NAAQS)

Pollutant	Standard Value*		Standard Type
Carbon Monoxide (CO)			
8-hour Average	9 ppm	(10 mg/m^3)	Primary
1-hour Average	35 ppm	(40 mg/m^3)	Primary
Nitrogen Dioxide (NO_2)			
Annual Arithmetic Mean	0.053 ppm	(100 µg/m^3)	Primary & Secondary
Ozone (O_3)			
1-hour Average	0.12 ppm	(235 µg/m^3)	Primary & Secondary
8-hour Average	0.08 ppm	(157 µg/m^3)	Primary & Secondary
Lead (Pb)			
Quarterly Average	1.5 µg/m^3		Primary & Secondary
Particulate (PM_{10}) *Particles with diameters of 10 micrometers or less*			
Annual Arithmetic Mean	50 µg/m^3		Primary & Secondary
24-hour Average	150 µg/m^3		Primary & Secondary
Particulate ($PM_{2.5}$) *Particles with diameters of 2.5 micrometers or less*			
Annual Arithmetic Mean	15 µg/m^3		Primary & Secondary
24-hour Average	65 µg/m^3		Primary & Secondary
Sulfur Dioxide (SO_2)			
Annual Arithmetic Mean	0.030 ppm	(80 µg/m^3)	Primary
24-hour Average	0.140 ppm	(365 µg/m^3)	Primary
3-hour Average	0.500 ppm	(1300 µg/m^3)	Secondary

* Parenthetical value is an approximately equivalent concentration

Four of these pollutants (CO, Pb, NO_2, and SO_2) result primarily through direct emissions from a variety of sources. PM results from direct emissions, but is also commonly formed from emissions of nitrogen oxides (NO_x), sulfur oxides (SO_x), ammonia, organic compounds, and other gases in the atmosphere. Sources of fine particles ($PM_{2.5}$) include many types of combustion activities (e.g., motor vehicles, power plants, wood burning) and certain industrial processes. Ozone is not directly emitted from sources, but is formed when NO_x and VOCs react in the presence of sunlight.

Exposure to the criteria pollutants is associated with numerous effects on human health, including increased respiratory symptoms, hospitalization for heart or lung diseases, and even premature death. The CAA established two types of NAAQS for the criteria pollutants:

- **Primary standards** are designed to establish limits to protect public health, including the health of sensitive populations such as asthmatics, children, and the elderly.

- **Secondary standards** set limits to protect public welfare, including protection against visibility impairment and adverse effects on crops, vegetation, and building materials.

Many of the health effects associated with the criteria pollutants can happen within a few hours or days after breathing polluted air. Thus, EPA has developed an index, called the Air Quality Index or AQI, for reporting daily air quality. The AQI can be thought of as a yardstick that runs from 0 to 500. The higher the AQI value, the greater the level of air pollution and the greater the health danger. For example, an AQI value of 50 represents good air quality and little potential to affect public health, while an AQI value over 300 represents hazardous air quality. Most States now provide this information to their citizens on either their own website or through the EPA's AirNow website (http://www.epa.gov/airnow/where/).

Air Quality Index

Air Quality Index (AQI) Values	Levels of Health Concern	Colors
0 to 50	Good	Green
51 to 100	Moderate	Yellow
101 to 150	Unhealthy for sensitive groups	Orange
151 to 200	Unhealthy	Red
201 to 300	Very Unhealthy	Purple
301 to 500	Hazardous	Maroon

Despite the progress made in the last 30 years, millions of people live in counties in which monitoring data show unhealthy air for one or more of the six criteria pollutants. EPA's most recent evaluation of air pollution trends for these six pollutants can be found at http://www.epa.gov/airtrends/. General information on the criteria pollutants can be found at http://www.epa.gov/air/urbanair/6poll.html.

2.4.2 Chemicals on the Toxics Release Inventory

In 1984, a cloud of methyl isocyanate released from an accident at a pesticide plant in Bhopal, India, killed thousands of people. Shortly thereafter, there was a serious chemical release at a sister plant in West Virginia. These incidents underscored the needs of industrial workers and communities for more complete information on hazardous materials. Public interest and environmental organizations around the country increased demands for information on toxic chemicals being released "beyond the fence line" – outside of the facility. In response, Congress enacted the Emergency Planning and Community Right-to-Know Act (EPCRA) in 1986. Shortly thereafter, the CAA Amendments of 1990 required EPA to publish regulations and guidance for chemical accident prevention at facilities using extremely hazardous substances (see box below).

Risk Management Planning: Accidental Release Prevention

The CAA Amendments of 1990 required EPA to publish regulations and guidance for chemical accident prevention at facilities using extremely hazardous substances. The Risk Management Program Rule was written to implement section 112(r) of these amendments. The rule, which built upon existing industry codes and standards, requires companies of all sizes that use certain flammable and toxic substances to develop a Risk Management Program, which includes a(n):

- Hazard assessment that details the potential effects of an accidental release, an accident history of the last five years, and an evaluation of worst-case and alternative accidental releases;
- Prevention program that includes safety precautions and maintenance, monitoring, and employee training measures; and
- Emergency response program that spells out emergency health care, employee training measures, and procedures for informing the public and response agencies (e.g., the fire department) should an accident occur.

A summary of each facility's risk management program (known as a "Risk Management Plan" or "RMP") was to be submitted to EPA by 1999 and must be revised and resubmitted every five years.

The List of Regulated Substances under section 112(r) of the Clean Air Act is found in 40 CFR Part 68 and lists the regulated substances, including their synonyms, and threshold quantities (in pounds) to help facilities assess if they are subject to the RMP rule or the general duty clause (see http://www.access.gpo.gov/nara/cfr/cfrhtml_00/Title_40/40cfr68_00.html). Note that pursuant to section 112(r), threshold quantities for RMPs, are of *amounts stored on site* and not emissions. Additional information on the Risk Management Program can be found at: http://yosemite.epa.gov/oswer/ceppoweb.nsf/content/RMPS.htm

EPCRA's primary purpose is to inform communities and citizens of chemical hazards in their areas. Sections 311 and 312 of EPCRA require businesses to report the locations and quantities of chemicals stored on-site as a means of helping communities prepare for chemical spills and similar emergencies. EPCRA section 313 requires EPA and the states to annually collect data on releases and transfers of listed toxic chemicals from certain industrial facilities, and make the data available to the public in the Toxics Release Inventory (TRI). In 1990, Congress passed the Pollution Prevention Act which required that additional data on waste management and source reduction activities also be reported in the TRI. One of the goals of the TRI is to empower citizens, through information, to hold companies and local governments accountable for the management of toxic chemicals.

The TRI program has expanded significantly since its inception in 1987. The Agency has issued rules to roughly double the number of chemicals that the TRI includes to over 650. The TRI has added seven new industry sectors, expanding coverage significantly beyond manufacturing industries. Most recently, the Agency has reduced the reporting thresholds for certain persistent, bioaccumulative, and toxic (PBT) chemicals (discussed in Chapter 4) in order to provide additional information to the public on these chemicals. A full list of the TRI chemicals, along with information on accessing the database and health and environmental effects information, can be found at http://www.epa.gov/tri/.

2.4.3 Toxic Chemicals that Persist and Which Also May Bioaccumulate

Toxic chemicals that persist and which also may bioaccumulate are compounds that can build up in the food chain to levels that are harmful to human and ecosystem health. Such chemicals, commonly called PBT chemicals, may be associated with a range of adverse human health effects, including effects on the nervous system, reproductive and developmental problems, cancer, and genetic impacts. EPA's challenge in reducing risks from these chemicals stems from the pollutant's ability to transfer easily between air, water, and land; to linger for generations in people and the environment; and in some cases to travel long distances. A number of "lists" of these chemicals have been developed through international and EPA efforts (see Chapter 4).

Over the years, much work has been done to reduce the risk associated with these chemicals. However, the nation still finds PBT chemicals in the air, water, land, and, as a result, food. For example, the total number of advisories for eating contaminated fish in the United States increased by 93 percent from 1993 to 2002.[13] Although there are advisories for a total of 39 chemical contaminants, most advisories involve five primary contaminants: mercury, PCBs, dioxins, DDT, and chlordane. Almost 75 percent of the advisories have been issued at least in part because of mercury contamination. The 2,800 advisories issued in 2002 represent approximately 33 percent of the nation's total lake acreage and over 15 percent of the nation's total river miles.

Until the late 1990s, EPA actions to reduce emissions of toxic chemicals that persist and which also may bioaccumulate have been separate regulatory activities aimed at pollutant releases to individual environmental media (air, water, or land). In 1998, EPA developed a **PBT Strategy** to better coordinate these actions and to assure, for example, that regulations removing a pollutant from the air do not inadvertently result in transferring it to the land or water (http://www.epa.gov/opptintr/pbt/). The main goals of the strategy are to:

- Develop and implement national action plans to reduce priority PBT pollutants, utilizing the full range of EPA tools;
- Continue to screen and select more priority PBT pollutants for action;
- Prevent new PBTs from entering the marketplace; and
- Measure progress of these actions against the Government Performance and Results Act (GPRA) goals and national commitments.

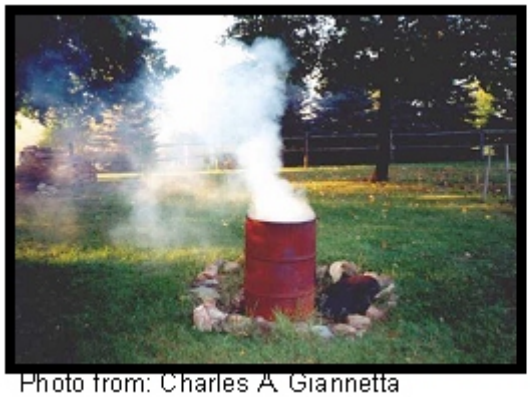
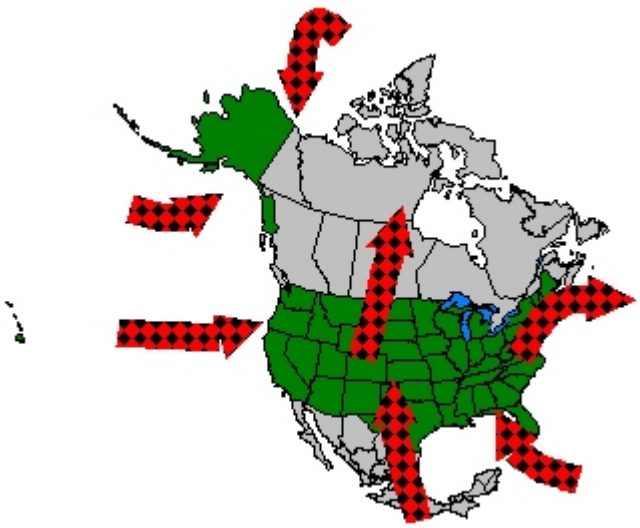


Photo from: Charles A. Giannetta

The Agency-wide strategy enables EPA to harness all of its tools – voluntary, regulatory, international, enforcement, compliance, and research – and direct them at a set of priority pollutants of common concern to all EPA program offices. Implementing the strategy will require time and the coordination of many EPA offices as well as other stakeholders, such as industry, other governmental groups, and the international community.

International Transport of Air Pollutants

There is the potential for toxic chemicals that persist and which also may bioaccumulate to be transported from long distances to contaminate distant regions of the globe. An investigation by EPA Region 5 has shown the possibility of long-range transport of certain of these chemicals (identified in an international treaty as "persistent organic pollutants," or POPs – see Chapter 4) which were used in Central America prior to the 1980s to impact the Great Lakes. This is due to several phenomena. The semi-volatility of many POPs, allows them to be volatilized from warmer regions of the globe and redeposited in cooler regions in higher latitudes. Additionally, meteorological patterns during certain times of year can transport air masses and pollutants from the Central American region though the central U.S. into the northern states. Air masses from Central America have an unobstructed path to the Great Lakes (e.g. no physical barriers such as mountain ranges). Satellite photos show the transport of smoke from Central American fires in May of 1998 up through the Great Lakes Region.



This figure illustrates the mean wind flow at 1500 meters of altitude during the months of June, July and August from 1985 to 1996. Although these patterns can be disrupted by climatological events such as El Niño, it is clear that POPs released in the southern areas of this hemisphere can impact areas of the U.S. Studies have shown that long range transport from many regions of the globe is a significant source of POP chemicals to the Great Lakes and that mitigation efforts are going to be needed both in the U.S. and globally to address potential sources. The study of Central American sources has shown that this region is a potential contributor to POPs contamination in the Great Lakes, due to the fact that these chemicals degrade very slowly, and there still exist areas of high contamination and stockpiles of these chemicals that are no longer in use in Cental America.

For more information on International Issues & U.S. Air Quality, see EPA's Air Trends website at http://www.epa.gov/airtrends/international.html

2.4.4 Overlaps and Differences Between Chemical "Lists"

The various lists of chemicals discussed above (e.g., HAPs, criteria air pollutants, TRI chemicals) do not always treat groups of chemicals (or chemical precursors/reaction products) in the same manner. Some examples of the ways in which these lists overlap or differ include:

- "Glycol ethers" are defined differently for the TRI and as HAPs (see box below);
- Ozone is formed by the interaction of NO_X, VOCs, and sunlight. Some of the HAPs are VOCs that may contribute to ozone formation;
- "Particulate matter" that is regulated as a criteria pollutant can be comprised of any number of individual chemicals and may contain various HAPs.

Glycol Ethers in the TRI and as HAPs

The TRI includes certain glycol ethers R-(OCH2CH2)n -OR' where:
n = 1, 2, or 3
R = alkyl C7 or less; phenyl or alkyl substituted phenyl
R' = H, or alkyl C7 or less
OR' consisting of carboxylic acid ester, sulfate, phosphate, nitrate, or sulfonate.

The list of HAPs includes mono- and di- ethers of ethylene glycol, diethylene glycol, and triethylene glycol R-(OCH2CH2)n -OR' where:
n = 1, 2, or 3
R = alkyl or aryl groups
R' = R, H, or groups which, when removed, yield glycol ethers with the structure: R-(OCH2CH)n-OH.
Polymers (surfactant alcohol ethoxylates and their derivatives)are excluded from the glycol category.

It is important to keep these overlaps and differences in mind since they can have important legal, policy, and other practical implications when studying air toxics impact or developing risk reduction alternatives for a particular location. The reader should also remember that the differences among chemical "lists" are based mostly on legal and regulatory considerations, not necessarily on toxicologic properties.

2.5 Reports to Congress on Air Toxics Issues

The CAA requires EPA to study and produce reports on several specific topics relevant to our understanding of air toxics and the risks they pose to human health. These studies have been critical to our understanding of important air toxics sources and how certain chemicals move through and impact our environment. A synopsis of several of these studies is presented below. Links to all of the various reports can be found at http://www.epa.gov/ttn/oarpg/t3rc.html.

2.5.1 Air Toxics Deposition to the Great Waters

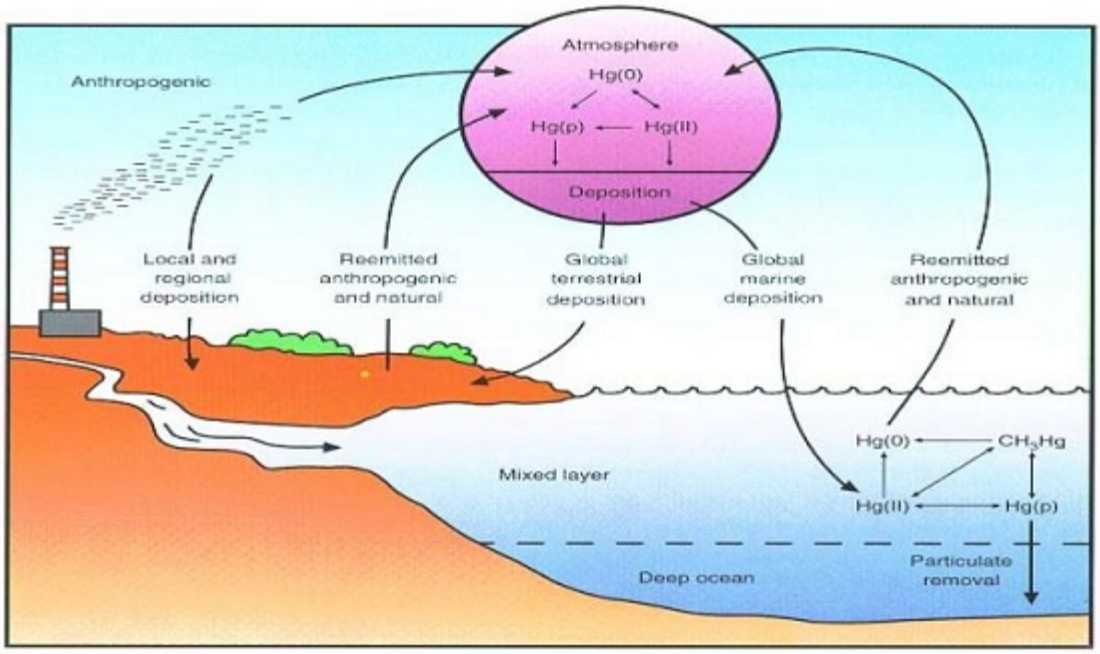
Pursuant to section 112(m) of the CAA, EPA, in conjunction with the National Oceanic and Atmospheric Administration (NOAA), has issued three reports to Congress on the deposition of air toxics and the resulting effects on the Great Lakes, Chesapeake Bay, Lake Champlain, and certain other coastal waters, collectively known as the **Great Waters**. In addition to EPA and NOAA, other international, national, regional, and local organizations also contribute to the body of science relevant to the Great Waters program and are engaged in activities that seek to reduce sources and quantities of pollution to the Great Waters. These activities focus on 15 **pollutants of concern**, including certain pesticides, metal compounds, chlorinated organic compounds, and nitrogen compounds. These pollutants enter the air in a variety of ways, including direct emission from industries and natural sources, and "re-emission" from soil and water. The Agency selected pollutants of concern due to their persistence, potential to bioaccumulate, and/or potential for adverse impacts to the Great Waters. Some of these pollutants are also likely **endocrine disruptors**, meaning they may interfere with the action of hormones in wildlife and humans. EPA will work to increase public awareness of risks of exposure to Great Waters pollutants as well as continue to support the development of modeling tools that address the transport and fate of pollutants in ecosystems and characterize risk, including research to clarify mechanisms of mercury methylation so as to better predict and manage ecosystems at risk. The most recent Great Waters Report to Congress is available at http://www.epa.gov/airprogm/oar/oaqps/gr8water/.

2.5.2 Mercury Study Report to Congress

Mercury compounds are one of the 188 HAPs. They are of concern because they persist in the environment, and bioaccumulate in food, and are associated with serious health and environmental effects, including neurological impacts in infants. Coal-fired electric utility plants are the largest air emission sources of mercury in the U.S. (responsible for approximately 40 percent of 1999 emissions). Resultant mercury concentrations in air are usually low and of little direct concern. However, when mercury enters surface waters, biological processes transform it to a highly toxic form that accumulates in fish, which can result in large exposures to fish consumers (including people). (See following graphic.)

EPA prepared the 1997 Mercury Study as a Report to Congress pursuant to the requirements of section 112(n)(1)(B) of the CAA to provide an assessment of the magnitude of U.S. mercury emissions by source, the health and environmental implications of those emissions, and the availability and cost of control technologies. As the state-of-the-science for mercury is continuously and rapidly evolving, this Report represents a "snapshot" of our understanding of mercury. This Report does not quantify the risk from mercury exposure because of scientific uncertainty in a number of important areas. The Report identifies areas where further research is needed to provide a quantitative risk assessment. The full Report can be accessed at http://www.epa.gov/ttn/atw/112nmerc/mercury.html.

Mercury Cycling in the Environment



2.5.3 Utility Report to Congress

Section 112(n)(1)(A) of the 1990 CAA Amendments required EPA to conduct a study of the public health impacts of emissions of air toxics from electric utilities that burn fossil fuel. Utility emissions include 67 HAPs, including arsenic compounds, nickel compounds, chromium compounds, radionuclides, and mercury compounds. EPA has presented the results of these studies in two key documents, a 1998 Report to Congress and a 1999 analysis of emissions reduction options. The key findings of the report to Congress include:

- **Air Toxics Emissions of Concern**. The report indicates that, although uncertainties in the analysis exist, on balance, mercury from coal-fired utilities is the hazardous air pollutant of greatest potential public health concern. Three other air toxics are identified, for which there are some potential concerns and uncertainties that may need further study: dioxins, arsenic, and nickel.

- **Risk Assessment of Exposure Pathways Other Than Inhalation**. The assessment determined that exposures due to non-inhalation routes (i.e., dermal, ingestion) are by far the most important routes of exposure for mercury and dioxins. For arsenic and radionuclides, both inhalation and ingestion appear to be important exposure routes. However, there are uncertainties and limitations in the data that indicate a need for further evaluation to more fully characterize the public health impacts of these pollutant emissions from utilities.

- **Inhalation Exposure Assessment**. The modeling assessment suggests that a substantial fraction of the utility emissions are dispersed well beyond the local area due to the nature of the emissions (mostly fine particulate substances) and the height of the tall stacks. Assessment of inhalation exposure for the 67 air toxics emitted by utilities indicate that the cancer risk from inhalation exposure is estimated to be less than one in a million for the majority of utility plants, with a few plants perhaps with slightly greater risks. Further research and evaluation may be needed to more comprehensively assess the inhalation cancer risks.

- **Mercury**. The results of the investigation indicate that mercury from coal-fired utilities is the air pollutant of greatest potential concern to public health from utilities. Coal-fired utilities are estimated to emit about one-third (52 tons) of U.S. anthropogenic (manmade) mercury emissions per year. The risk assessment indicates that ingestion of contaminated fish is the most important route of exposure to mercury. The modeling assessment, in conjunction with available scientific data, provides evidence for a plausible link between emissions of mercury from utilities and the methylmercury found in soil, water, air, and fish. Consequently, mercury emissions from coal-fired utilities may contribute to the potential exposures to mercury through consumption of contaminated fish. However, there remain uncertainties about the extent of impacts directly attributable to mercury emissions from utilities.

- **Alternative Control Strategies**. There are numerous potential alternative control technologies and strategies for air toxics control, although the feasibility and effectiveness of potential control technologies vary.

2.5.4 Residual Risk Report to Congress

The Residual Risk Report to Congress responds to section 112(f)(1) of the Clean Air Act, which requires EPA to investigate and report to Congress on a variety of topics pertaining to the assessment of residual risks associated with air toxics emissions from stationary sources remaining after the implementation of technology based standards per section 112(d) (i.e., MACT standards).[(g)]

While the main purpose of the Report is to describe the methods and the framework that EPA will use to make residual risk determinations, the Report also discusses, in general terms, the available methods of reducing residual risks - including pollution prevention, add-on controls, and voluntary approaches - and factors relevant to costs of these methods; the current state of knowledge regarding health effects of air toxics on humans; and EPA's current methods for collecting and assessing health effects data.

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[g]As touched on in Section 2.2.3.2, section 112(f) of the CAA requires the Agency to consider the need for additional standards following regulation under section 112(d) to protect public health and the environment. Section 112(f) of the CAA specifies that such residual risk standards "provide an ample margin of safety to protect public health." Section 112(f) also requires EPA to determine whether residual risk standards are necessary to prevent "an adverse environmental effect" taking into consideration "costs, energy, safety, and other relevant factors" in deciding what level is protective.

While developed in response to Clean Air Act provisions particular to "residual risk," the report describes methodologies intended for EPA's use more broadly in assessing risk from toxic air pollutants. The Report does not specify a particular method for conducting risk assessments, stressing that EPA has the flexibility to use current techniques along with new methods as they are developed. The full report is available at http://www.epa.gov/ttncaaa1/t3/reports/risk_rep.pdf.

Specifically, the *Residual Risk Report to Congress*[2] identifies two objectives for residual risk activities:

- Assess any risks remaining after MACT standard compliance; and
- Set standards for the identified source categories, if additional HAP emission reductions are necessary to provide an ample margin of safety to protect public health or, taking into account cost, energy, safety, and other relevant factors, to prevent an adverse environmental effect.

2.5.5 Integrated Urban Strategy Report to Congress

The Strategy addresses the need to reduce emissions of air toxics in urban areas and looks collectively at large and small industrial and commercial operations, as well as mobile sources of pollution. The Strategy also includes plans for improving current understanding of the health risks posed by toxics in urban areas. This Report to Congress provides the following: a more detailed examination of the methodologies used for selecting the 33 initial urban air toxics identified in the Strategy; a summary of recent risk assessments conducted in several urban areas; and a detailed discussion of research needs to achieve the goals outlined in the Strategy. These needs were identified in the following areas: exposure assessment, health effects, dose-response assessment, risk assessment, risk characterization, and risk management. The report is available at http://www.epa.gov/ttnatw01/urban/natprpt.pdf.

2.5.6 Other Reports

Finally, EPA prepared two other reports that were called for in the Clean Air Act (http://www.epa.gov/ttn/atw/112npg.html).

First, section 112(n)(5) of the CAA required EPA to assess the public health hazards associated with emissions of hydrogen sulfide from oil and gas extraction. This report, *Hydrogen Sulfide Air Emissions Associated with the Extraction of Oil and Natural Gas* (EPA-453/R-93-045), is available from the National Technical Information Services (NTIS) as publication number PB94-131224.

Second, section 112(n)(6) of the CAA required EPA to assess the public health hazards associated with emissions of hydrofluoric acid in areas that do not have comprehensive health and safety regulations addressing hydrofluoric acid. The *Hydrogen Fluoride Study: Report to Congress* (EPA 550-R-93-001) was published in September 1993 and is available from NTIS as publication number PB 94-121308.

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