



# Federal Register

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**Wednesday,  
March 29, 2006**

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**Part II**

## **Environmental Protection Agency**

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**40 CFR Parts 59, 80, 85 and 86  
Control of Hazardous Air Pollutants From  
Mobile Sources; Proposed Rule**

**ENVIRONMENTAL PROTECTION AGENCY****40 CFR Parts 59, 80, 85 and 86**

[EPA-HQ-OAR-2005-0036; FRL-8041-2]

RIN 2060-AK70

**Control of Hazardous Air Pollutants From Mobile Sources****AGENCY:** Environmental Protection Agency (EPA).**ACTION:** Proposed rule.

**SUMMARY:** Today EPA is proposing controls on gasoline, passenger vehicles, and portable gasoline containers (gas cans) that would significantly reduce emissions of benzene and other hazardous air pollutants ("mobile source air toxics"). Benzene is a known human carcinogen, and mobile sources are responsible for the majority of benzene emissions. The other mobile source air toxics are known or suspected to cause cancer or other serious health effects.

We are proposing to limit the benzene content of gasoline to an annual average of 0.62% by volume, beginning in 2011. We are also proposing to limit exhaust emissions of hydrocarbons from passenger vehicles when they are operated at cold temperatures. This standard would be phased in from 2010 to 2015. For passenger vehicles we also propose evaporative emissions standards that are equivalent to those in California. Finally, we are proposing a hydrocarbon emissions standard for gas cans beginning in 2009, which would reduce evaporation and spillage of gasoline from these containers.

These controls would significantly reduce emissions of benzene and other mobile source air toxics such as 1,3-butadiene, formaldehyde, acetaldehyde, acrolein, and naphthalene. This proposal would result in additional substantial benefits to public health and welfare by significantly reducing emissions of particulate matter from passenger vehicles.

We project annual nationwide benzene reductions of 35,000 tons in 2015, increasing to 65,000 tons by 2030. Total reductions in mobile source air toxics would be 147,000 tons in 2015 and over 350,000 tons in 2030. Passenger vehicles in 2030 would emit 45% less benzene. Gas cans meeting the new standards would emit almost 80% less benzene. Gasoline would have 37% less benzene overall. We estimate that these reductions would have an average cost of less than 1 cent per gallon of gasoline and less than \$1 per vehicle. The average cost for gas cans would be

less than \$2 per can. The reduced evaporation from gas cans would result in significant fuel savings, which would more than offset the increased cost for the gas can.

**DATES:** Comments must be received on or before May 30, 2006. Under the Paperwork Reduction Act, comments on the information collection provisions must be received by OMB on or before April 28, 2006.

**Hearing:** We will hold a public hearing on April 12, 2006. The hearing will start at 10 a.m. local time and continue until everyone has had a chance to speak. If you want to testify at the hearing, notify the contact person listed under **FOR FURTHER INFORMATION CONTACT** by April 3, 2006.

**ADDRESSES:** Submit your comments, identified by Docket ID No. EPA-HQ-OAR-2005-0036, by one of the following methods:

- <http://www.regulations.gov>: Follow the on-line instructions for submitting comments.

- Fax your comments to: (202) 566-1741.

- Mail: Air Docket, Environmental Protection Agency, Mailcode: 6102T, 1200 Pennsylvania Ave., NW., Washington, DC 20460. In addition, please mail a copy of your comments on the information collection provisions to the Office of Information and Regulatory Affairs, Office of Management and Budget (OMB), Attn: Desk Officer for EPA, 725 17th St. NW., Washington, DC 20503.

- Hand Delivery: EPA Docket Center, (EPA/DC) EPA West, Room B102, 1301 Constitution Ave., NW., Washington, DC 20004. Such deliveries are only accepted during the Docket's normal hours of operation, and special arrangements should be made for deliveries of boxed information.

**Instructions:** Direct your comments to Docket ID No. EPA-HQ-OAR-2005-0036. EPA's policy is that all comments received will be included in the public docket without change and may be made available online at [www.regulations.gov](http://www.regulations.gov), including any personal information provided, unless the comment includes information claimed to be Confidential Business Information (CBI) or other information whose disclosure is restricted by statute. Do not submit information that you consider to be CBI or otherwise protected through [www.regulations.gov](http://www.regulations.gov) or e-mail. The [www.regulations.gov](http://www.regulations.gov) website is an "anonymous access" system, which means EPA will not know your identity or contact information unless you provide it in the body of your comment. If you send an

e-mail comment directly to EPA without going through [www.regulations.gov](http://www.regulations.gov) your e-mail address will be automatically captured and included as part of the comment that is placed in the public docket and made available on the Internet. If you submit an electronic comment, EPA recommends that you include your name and other contact information in the body of your comment and with any disk or CD-ROM you submit. If EPA cannot read your comment due to technical difficulties and cannot contact you for clarification, EPA may not be able to consider your comment. Electronic files should avoid the use of special characters, any form of encryption, and be free of any defects or viruses. For additional information about EPA's public docket visit the EPA Docket Center homepage at <http://www.epa.gov/epahome/dockets.htm>. For additional instructions on submitting comments, go to section XI, Public Participation, of the **SUPPLEMENTARY INFORMATION** section of this document.

**Docket:** All documents in the docket are listed in the [www.regulations.gov](http://www.regulations.gov) index. Although listed in the index, some information is not publicly available, e.g., CBI or other information whose disclosure is restricted by statute. Certain other material, such as copyrighted material, will be publicly available only in hard copy. Publicly available docket materials are available either electronically in [www.regulations.gov](http://www.regulations.gov) or in hard copy at the Air Docket, EPA/DC, EPA West, Room B102, 1301 Constitution Ave., NW., Washington, DC. The Public Reading Room is open from 8:30 a.m. to 4:30 p.m., Monday through Friday, excluding legal holidays. The telephone number for the Public Reading Room is (202) 566-1744, and the telephone number for the Air Docket is (202) 566-1742.

**Hearing:** The public hearing will be held at Sheraton Crystal City Hotel, 1800 Jefferson Davis Highway, Arlington, Virginia 22202, Telephone: (703) 486-1111. See section XI, Public Participation, for more information about public hearings.

**FOR FURTHER INFORMATION CONTACT:** Mr. Chris Lieske, U.S. EPA, Office of Transportation and Air Quality, Assessment and Standards Division (ASD), Environmental Protection Agency, 2000 Traverwood Drive, Ann Arbor, MI 48105; telephone number: (734) 214-4584; fax number: (734) 214-4816; email address: [lieske.christopher@epa.gov](mailto:lieske.christopher@epa.gov), or Assessment and Standards Division

Hotline; telephone number: (734) 214-4636; e-mail address: *asdin@epa.gov*.

**SUPPLEMENTARY INFORMATION:**

**General Information**

*A. Does this Action Apply to Me?*

Entities potentially affected by this action are those that produce new motor vehicles, alter individual imported motor vehicles to address U.S.

regulation, or convert motor vehicles to use alternative fuels. It would also affect you if you produce gasoline motor fuel or manufacture portable gasoline containers. Regulated categories include:

Category	NAICS codes <sup>a</sup>	SIC codes <sup>b</sup>	Examples of potentially affected entities
Industry .....	336111	3711	Motor vehicle manufacturers.
Industry .....	335312	3621	Alternative fuel vehicle converters.
	424720	5172	
	811198	7539	
		7549	
Industry .....	811111	7538	Independent commercial importers.
	811112	7533	
	811198	7549	
Industry .....	324110	2911	Gasoline fuel refiners.
Industry .....	326199	3089	Portable fuel container manufacturers.
	332431	3411	

<sup>a</sup> North American Industry Classification System (NAICS).

<sup>b</sup> Standard Industrial Classification (SIC) system code.

This table is not intended to be exhaustive, but rather provides a guide for readers regarding entities likely to be regulated by this action. This table lists the types of entities that EPA is now aware could potentially be regulated by this action. Other types of entities not listed in the table could also be regulated. To determine whether your activities are regulated by this action, you should carefully examine the applicability criteria in 40 CFR parts 59, 80, 85, and 86. If you have any questions regarding the applicability of this action to a particular entity, consult the person listed in the preceding **FOR FURTHER INFORMATION CONTACT** section.

*B. What Should I Consider as I Prepare My Comments for EPA?*

1. Submitting CBI

Do not submit this information to EPA through *www.regulations.gov* or e-mail. Clearly mark the part or all of the information that you claim to be confidential business information (CBI). For CBI information in a disk or CD ROM that you mail to EPA, mark the outside of the disk or CD ROM as CBI and then identify electronically within the disk or CD ROM the specific information that is claimed as CBI. In addition to one complete version of the comment that includes information claimed as CBI, a copy of the comment that does not contain the information claimed as CBI must be submitted for inclusion in the public docket. Information so marked will not be disclosed except in accordance with procedures set forth in 40 CFR part 2.

2. Tips for Preparing Your Comments

When submitting comments, remember to:

- Explain your views as clearly as possible.
- Describe any assumptions that you used.
- Provide any technical information and/or data you used that support your views.
- If you estimate potential burden or costs, explain how you arrived at your estimate.
- Provide specific examples to illustrate your concerns.
- Offer alternatives.
- Make sure to submit your comments by the comment period deadline identified.
- To ensure proper receipt by EPA, identify the appropriate docket identification number in the subject line on the first page of your response. It would also be helpful if you provided the name, date, and **Federal Register** citation related to your comments.

**Outline of This Preamble**

- I. Introduction
  - A. Summary
  - B. What Background Information is Helpful to Understand this Proposal?
    - 1. What Are Air Toxics and Related Health Effects?
    - 2. What is the Statutory Authority for Today's Proposal?
      - a. Clean Air Act Section 202(l)
      - b. Clean Air Act Section 183(e)
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    - 3. What Other Actions Has EPA Taken Under Clean Air Act Section 202(l)?
      - a. 2001 Mobile Source Air Toxics Rule
      - b. Technical Analysis Plan
- II. Overview of Proposal
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    - 1. National Cancer Risk from Air Toxics

- 2. Noncancer Health Effects
- 3. Exposure Near Roads and From Attached Garages
- 4. Ozone and Particulate Matter
- B. What Is EPA Proposing?
  - 1. Light-Duty Vehicle Emission Standards
  - 2. Gasoline Fuel Standards
  - 3. Portable Gasoline Container (Gas Can) Controls
- III. What Are Mobile Source Air Toxics (MSATs) and Their Health Effects?
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  - C. Which Mobile Source Emissions Pose the Greatest Health Risk at Current Levels?
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    - 1. Overview of Potential Cancer and Noncancer Health Effects
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      - c. Formaldehyde
      - d. Acetaldehyde
      - e. Acrolein
      - f. Polycyclic Organic Matter (POM)
      - g. Naphthalene
      - h. Diesel Particulate Matter and Diesel Exhaust Organic Gases
  - E. Gasoline PM
  - F. Near-Roadway Health Effects
  - G. How Would This Proposal Reduce Emissions of MSATs?
- IV. What Are the Air Quality and Health Impacts of Air Toxics, and How do Mobile Sources Contribute?
  - A. What Is the Health Risk to the U.S. Population from Inhalation Exposure to Ambient Sources of Air Toxics, and How Would It be Reduced by the Proposed Controls?

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    - d. Occupational Exposure
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  4. What Are the Implications for Distribution of Individual Risk?
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  2. Health Effects of Ozone
  3. Current and Projected 8-hour Ozone Levels
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  2. Health Effects of PM
  3. Current and Projected PM<sub>2.5</sub> Levels
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- E. Other Environmental Effects
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    - b. Current Visibility Impairment
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- V. What Are Mobile Source Emissions Over Time and How Would This Proposal Reduce Emissions, Exposure and Associated Health Effects?
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  - B. VOC Emissions from Mobile Sources
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- XIII. Statutory Provisions and Legal Authority

## I. Introduction

### A. Summary

Mobile sources emit air toxics that can cause cancer and other serious health effects. Section III of this preamble and Chapter 1 of the

Regulatory Impact Analysis (RIA) for this rule describe these compounds and their health effects. Mobile sources contribute significantly to the nationwide risk from breathing outdoor sources of air toxics. Mobile sources were responsible for about 44% of outdoor toxic emissions, almost 50% of the cancer risk, and 74% of the noncancer risk according to EPA's National-Scale Air Toxics Assessment (NATA) for 1999. In addition, people who live or work near major roads or live in homes with attached garages are likely to have higher exposures and risk, which are not reflected in NATA. Sections II.A and IV of this preamble and Chapter 3 of the RIA provide more detail about NATA, as well as our analysis of exposures near roadways.

According to NATA for 1999, there are a few mobile source air toxics that pose the greatest risk based on current information about ambient levels and exposure. These include benzene, 1,3-butadiene, formaldehyde, acrolein, naphthalene, and polycyclic organic matter (POM). All of these compounds are hydrocarbons except POM. Benzene is the most significant contributor to cancer risk from all outdoor air toxics, according to NATA for 1999. NATA does not include a quantitative estimate of cancer risk for diesel exhaust, but it concludes that diesel exhaust (specifically, diesel particulate matter and diesel exhaust organic gases) is one of the pollutants that pose the greatest relative cancer risk. Although we expect significant reductions in mobile source air toxics in the future, cancer and noncancer health risks will remain a public health concern, and exposure to benzene will remain the largest contributor to this risk.

As discussed in detail in Section V of this preamble and Chapter 2 of the RIA, this proposal would significantly reduce emissions of the many air toxics that are hydrocarbons, including benzene, 1,3-butadiene, formaldehyde, acetaldehyde, acrolein, and naphthalene. The proposed fuel benzene standard and hydrocarbon standards for vehicles and gas cans would together reduce total emissions of mobile source air toxics by 350,000 tons in 2030, including 65,000 tons of benzene. Mobile sources were responsible for 68% of benzene emissions in 1999. As a result of this proposal, in 2030 passenger vehicles would emit 45% less benzene, gas cans would emit 78% less benzene, and the gasoline would have 37% less benzene overall.

In addition, EPA has already taken significant steps to reduce diesel emissions from mobile sources, which will result in a 70% reduction between

1999 and 2020. We have adopted stringent standards for diesel trucks and buses, and nonroad diesel engines (engines used, for example, in construction, agricultural, and industrial applications). We also have additional programs underway to reduce diesel emissions, including voluntary programs and a proposal that is being developed to reduce emissions from diesel locomotives and marine engines.

The proposed reductions in mobile source air toxics emissions would reduce exposure and predicted risk of cancer and noncancer health effects, including in environments where exposure and risk may be highest, such as near roads, in vehicles, and in homes with attached garages. In addition, the hydrocarbon reductions from the vehicle and gas can standards would reduce VOC emissions (which are a precursor to ozone and PM<sub>2.5</sub>) by over 1 million tons in 2030. The proposed vehicle standards would reduce direct PM<sub>2.5</sub> emissions by 20,000 tons in 2030 and would also reduce secondary formation of PM<sub>2.5</sub>. Although ozone and PM<sub>2.5</sub> are considered criteria pollutants rather than "air toxics," reductions in ozone and PM<sub>2.5</sub> are important co-benefits of this proposal. More details on emissions, cancer risks, and adverse health and welfare effects associated with ozone and PM are found in sections II.A, IV and V of this preamble and Chapters 2 and 3 of the RIA.

Section II.B of this preamble provides an overview of the regulatory program that EPA is proposing for passenger vehicles, gasoline, and gas cans. We are proposing standards to limit the exhaust hydrocarbons from passenger vehicles during cold temperature operation. We are also proposing evaporative hydrocarbon emissions standards for passenger vehicles. We are proposing to limit the average annual benzene content of gasoline. Finally, we are proposing hydrocarbon emissions standards for gas cans that would reduce evaporation, permeation, and spillage from these containers. Detailed discussion of each of these programs is in sections VI, VII, and VIII of the preamble and Chapters 5, 6, and 7 of the RIA.

We estimate that the benefits of this proposal would be about \$6 billion in 2030, based on the direct PM<sub>2.5</sub> reductions from the vehicle standards, plus unquantified benefits from reductions in mobile source air toxics and VOC. We estimate that the annual net social costs of this proposal would be about \$200 million in 2030 (expressed in 2003 dollars). These net social costs include the value of fuel

savings from the proposed gas can standards, which would be worth \$82 million in 2030.

The proposed reductions would have an average cost of 0.13 cents per gallon of gasoline, less than \$1 per vehicle, and less than \$2 per gas can. The reduced evaporation from gas cans would result in fuel savings that would more than offset the increased cost for the gas can. In 2030, the long-term cost per ton of the proposed standards (in combination, and including fuel savings) would be \$450 per ton of total mobile source air toxics reduced; \$2,400 per ton of benzene reduced; and no cost for the hydrocarbon and PM reductions (because the vehicle standards would have no cost in 2020 and beyond). Section IX of the preamble and Chapters 8–13 of the RIA provide more details on the costs, benefits, and economic impacts of the proposed standards. The impacts on small entities and the flexibilities we are proposing are discussed in section XII.C of this preamble and Chapter 14 of the RIA.

#### *B. What Background Information is Helpful to Understand this Proposal?*

##### **1. What Are Air Toxics and Related Health Effects?**

Air toxics, which are also known in the Clean Air Act as "hazardous air pollutants," are those pollutants known or suspected to cause cancer or other serious health or environmental effects. For example, some of these pollutants are known to have negative effects on people's respiratory, cardiovascular, neurological, immune, reproductive, or other organ systems, and they may also have developmental effects. They may pose particular hazards to more susceptible and sensitive populations, such as children, the elderly, or people with pre-existing illnesses.

Mobile source air toxics (MSATs) are those toxics emitted by motor vehicles, nonroad engines (such as lawn and garden equipment, farming and construction equipment, aircraft, locomotives, and ships), and their fuels. Toxics are also emitted by stationary sources such as power plants, factories, oil refineries, dry cleaners, gas stations, and small manufacturers. They can also be produced by combustion of wood and other organic materials. There are also indoor sources of air toxics, such as solvent evaporation and outgassing from furniture and building materials.

Some MSATs of particular concern include benzene, 1,3-butadiene, formaldehyde, acrolein, naphthalene, and diesel particulate matter and diesel exhaust organic gases. Benzene and 1,3-butadiene are both known human

carcinogens. Section III of this preamble provides more detail on the health effects of each of these pollutants.

MSATs are emitted as a result of various processes. Some MSATs are present in fuel or fuel additives and are emitted to the air when the fuel evaporates or passes through the engine. Some MSATs are formed through engine combustion processes. Some compounds, like formaldehyde and acetaldehyde, are also formed through a secondary process when other mobile source pollutants undergo chemical reactions in the atmosphere. Finally, some air toxics, such as metals, result from engine wear or from impurities in oil or fuel.

## 2. What is the Statutory Authority for Today's Proposal?

### a. Clean Air Act Section 202(l)

Section 202(l)(2) of the Clean Air Act requires EPA to set standards to control hazardous air pollutants from motor vehicles, motor vehicle fuels, or both. These standards must reflect the greatest degree of emission reduction achievable through the application of technology which will be available, taking into consideration the motor vehicle standards established under section 202(a) of the Act, the availability and cost of the technology, and noise, energy and safety factors, and lead time. The standards are to be set under Clean Air Act sections 202(a)(1) or 211(c)(1), and they are to apply, at a minimum, to benzene and formaldehyde emissions.

Section 202(a)(1) of the Clean Air Act directs EPA to set standards for new motor vehicles or new motor vehicle engines which EPA judges to cause or contribute to air pollution which may reasonably be anticipated to endanger public health or welfare. We are proposing a cold-temperature hydrocarbon emission standard for passenger vehicles under this authority.

Section 211(c)(1)(A) of the Clean Air Act authorizes EPA (among other things) to control the manufacture of fuel if any emission product of such fuel causes or contributes to air pollution which may reasonably be anticipated to endanger public health or welfare. We are proposing a benzene standard for gasoline under this authority.

Clean Air Act section 202(l)(2) requires EPA to "from time to time revise" its regulations controlling hazardous air pollutants from motor vehicles and fuels. As described in more detail in section I.F. below, EPA has previously set standards under section 202(l), and we committed in that rule to engage in further rulemaking to

implement section 202(l). This proposal fulfills that commitment.

### b. Clean Air Act Section 183(e)

Clean Air Act section 183(e)(3) requires EPA to list categories of consumer or commercial products that the Administrator determines, based on an EPA study of VOC emissions from such products, contribute at least 80 percent of the VOC emissions from such products in areas violating the national ambient air quality standard for ozone. EPA promulgated this list at 60 FR 15264 (March 23, 1995). EPA plans to publish a **Federal Register** notice announcing that EPA has added portable gasoline containers to the list of consumer products to be regulated. This action must be taken by EPA prior to issuing a final rule for gas cans. EPA is required to develop rules reflecting "best available controls" to reduce VOC emissions from the listed products. "Best available controls" are defined in section 183(e)(1)(A) as follows:

The term "best available controls" means the degree of emissions reduction that the Administrator determines, on the basis of technological and economic feasibility, health, environmental, and energy impacts, is achievable through the application of the most effective equipment, measures, processes, methods, systems, or techniques, including chemical reformulation, product or feedstock substitution, repackaging, and directions for use, consumption, storage, or disposal."

Section 183(e)(4) also allows these standards to be implemented by means of "any system or systems of regulation as the Administrator may deem appropriate, including requirements for registration and labeling, self-monitoring and reporting \* \* \* concerning the manufacture, processing, distribution, use, consumption, or disposal of the product." We are proposing a hydrocarbon standard for gas cans under the authority of section 183(e).

### c. Energy Policy Act

Section 1504(b) of the Energy Policy Act of 2005 requires EPA to adjust the toxics emissions baselines for reformulated gasoline to reflect 2001–2002 fuel qualities. However, the Act provides that this action becomes unnecessary if EPA takes action which results in greater overall reductions of toxics emissions from vehicles in areas with reformulated gasoline. As described in section VII of this preamble, we believe today's proposed action would in fact result in greater reductions than would be achieved by adjusting the baselines under the Energy Policy Act. Accordingly, under the

provisions of the Energy Policy Act, this proposed action would obviate the need for readjusting emissions baselines for reformulated gasoline.

## 3. What Other Actions Has EPA Taken Under Clean Air Act Section 202(l)?

### a. 2001 Mobile Source Air Toxics Rule

EPA published a final rule under Clean Air Act section 202(l) on March 29, 2001, entitled, "Control of Emissions of Hazardous Air Pollutants from Mobile Sources" (66 FR 17230). This rule established toxics emissions performance standards for gasoline refiners. These standards were designed to ensure that the over compliance to the standard seen in the in-use fuels produced in the years of 1998–2000 would continue in the future.

EPA adopted this anti-backsliding requirement as a near-term control that could be implemented and take effect within a year or two. We did not adopt long-term controls, those controls that require a longer lead time to implement, because we lacked information to address the costs and benefits of potential fuel controls in the context of the fuel sulfur controls that we had finalized in February 2000. However, the March 2001 rule did commit to additional rulemaking that would evaluate the need for and feasibility of additional controls.<sup>1</sup> Today's proposal fulfills that commitment, and represents the second step of the two-step approach originally envisioned in the 2001 rule.

The 2001 rule did not set additional air toxics controls for motor vehicles, because the technology-forcing Tier 2 light-duty vehicle standards and 2007 heavy-duty engine and vehicle standards had just been promulgated. We found that those standards represented the greatest degree of toxics control achievable at that time under section 202(l).<sup>2</sup>

### b. Technical Analysis Plan

The 2001 rulemaking also included a Technical Analysis Plan that described toxics-related research and activities that would inform our future rulemaking to evaluate the need for and appropriateness of additional mobile source air toxic controls. Specifically, we identified four critical areas where there were data gaps requiring long-term efforts:

- Developing better air toxics emission factors for nonroad sources;
- Improving estimation of air toxics exposures in microenvironments;

<sup>1</sup> See *Sierra Club v. EPA*, 325 F. 3d 374, 380 (D.C. Cir. 2003), which upholds this approach.

<sup>2</sup> 66 FR 17241–17245 (March 29, 2001).

- Improving consideration of the range of total public exposures to air toxics; and
- Increasing our understanding of the effectiveness and costs of vehicle, fuel and nonroad controls for air toxics.

EPA and other outside researchers have conducted significant research in these areas since 2001. The findings of this research are described in more detail in other sections of this preamble and in the regulatory impact analysis for this proposal. Following are some highlights of our activities.

*Nonroad emissions testing.* EPA has tested emissions of nonroad diesel engines for a comprehensive suite of hydrocarbons and inorganic compounds. These emissions tests employed steady-state as well as transient test cycles, using typical nonroad diesel fuel and low-sulfur nonroad diesel fuel. In addition, EPA tested small gasoline-powered engines such as lawnmowers, leaf blowers, chainsaws and string trimmers.

Improved estimation of exposures in microenvironments and consideration of the range of public exposures. EPA and other researchers have conducted a substantial amount of research and analysis in these areas, which is discussed in section IV of this preamble and in the regulatory impact analysis. This research has involved monitoring as well as the development and application of enhanced modeling tools. For example, personal exposure monitoring and ambient monitoring has been conducted at homes and schools near roadways; in vehicles; in homes with attached garages; and in occupational settings involving both diesel and gasoline nonroad equipment. We have also applied dispersion modeling techniques with greater spatial refinement to estimate gradients of toxic pollutants near roadways. A variety of improvements to our emissions, dispersion, and exposure modeling tools are improving our ability to consider the range of exposure people experience. These include the MOBILE6 emissions model, improved spatial and temporal allocation of emissions, development of the Community Multiscale Air Quality (CMAQ) model, and updates to the HAPEM exposure model. Many of these improvements were applied in EPA's National-Scale Air Toxics Assessment for 1999 and other analyses EPA performed to support this proposal. In fact, EPA developed a modification of the HAPEM exposure model to account for higher pollutant concentrations near major roads.

Research in these areas is continuing both inside and outside EPA, including

work under the auspices of the Health Effects Institute and the Mickey Leland National Urban Air Toxics Research Center.

Costs and effectiveness of vehicle, fuel, and nonroad controls for air toxics. EPA's analysis of the costs and effectiveness of vehicle and fuel controls is described in section IX of this preamble and in the regulatory impact analysis. In addition, as described in section V, EPA is currently developing rules that will examine controls of small gasoline engines and diesel locomotive and marine engines.

## II. Overview of Proposal

### A. Why Is EPA Making This Proposal?

People experience elevated risk of cancer and other noncancer health effects from exposure to air toxics. Mobile sources are responsible for a significant portion of this risk. For example, benzene is the most significant contributor to cancer risk from all outdoor air toxics,<sup>3</sup> and most of the nation's benzene emissions come from mobile sources. These risks vary depending on where people live and work and the kinds of activities in which they engage. People who live or work near major roads, or people that spend a large amount of time in vehicles, are likely to have higher exposures and higher risks. Although we expect significant reductions in mobile source air toxics in the future, predicted cancer and noncancer health risks will remain a public health concern. Benzene will remain the largest contributor to this risk. In addition, some mobile source air toxics contribute to the formation of ozone and PM<sub>2.5</sub>, which contribute to serious public health problems, which are discussed further in section II.A.4.

Sections II.A.1–3 discuss the risks posed by outdoor toxics now and in the future, based on national-scale estimates such as EPA's National-Scale Air Toxics Assessment (NATA). EPA's NATA for 1999 provides some perspective on the average risk of cancer and noncancer health effects resulting from breathing air toxics from outdoor sources, and the contribution of mobile sources to these risks.<sup>4,5</sup> This assessment did not include indoor sources of air toxics. Also, it estimates average concentrations within

<sup>3</sup> Based on quantitative estimates of risk, which do not include diesel particulate matter and diesel exhaust organic gases.

<sup>4</sup> [http://www.epa.gov/ttn/atw/nata\\_1999](http://www.epa.gov/ttn/atw/nata_1999).

<sup>5</sup> NATA does not include a quantitative estimate of cancer risk for diesel particulate matter and diesel exhaust organic gases. EPA has concluded that while diesel exhaust is likely to be a human carcinogen, available data are not sufficient to develop a confidential estimate of cancer unit risk.

a census tract, and therefore does not reflect elevated concentrations and exposures near roadways within a census tract. Nevertheless, its findings are useful in providing a perspective on the magnitude of risks posed by outdoor sources of air toxics generally, and in identifying what pollutants and sources are important contributors to these health risks.

EPA also performed a national-scale assessment for future years, using the same modeling tools and approach as the 1999 NATA. Finally, we also performed national-scale exposure modeling that accounts for the higher toxics concentrations near roads. This latter modeling provides a perspective on the mobile source contribution to risk from air toxics that is not reflected in our other national-scale assessments.

### 1. National Cancer Risk from Air Toxics

According to NATA, the average national cancer risk in 1999 from all outdoor sources of air toxics was 42 in a million. That is, 42 out of one million people would be expected to contract cancer from a lifetime of breathing air toxics at 1999 levels. Mobile sources were responsible for 44% of outdoor toxic emissions and almost 50% of the cancer risk. Considering only the subset of compounds emitted by mobile sources (see Table IV.C–2), the national average cancer risk in 1999, including the stationary source contribution to these pollutants, was 23 in a million.

Benzene is the largest contributor to cancer risk of all 133 pollutants quantitatively assessed in the 1999 NATA. The national average cancer risk from benzene alone was 11 in a million. Over 120 million people in 1999 were exposed to a risk level above 10 in a million due to chronic inhalation exposure to benzene. Mobile sources were responsible for 68% of benzene emissions in 1999.

Although air toxics emissions are projected to decline in the future as a result of standards EPA has previously adopted, cancer risk will continue to be a public health concern. The predicted national average cancer risk from MSATs in 2030 will be 18 in a million, according to EPA analysis (described in more detail in section IV of this preamble and Chapter 3 of the Regulatory Impact Analysis). In fact, in 2030 there will be more people exposed to the highest levels of risk. The number of Americans above the 10 in a million cancer risk level from exposure to MSATs is projected to increase from 214 million in 1999 to 240 million in 2030. Mobile sources will continue to be a significant contributor to risk in the future, accounting for 22% of total air



toxic emissions in 2020, and 44% of benzene emissions.

## 2. Noncancer Health Effects

According to the NATA for 1999, nearly the entire U.S. population was exposed to an average level of air toxics that has the potential for adverse respiratory health effects (noncancer).<sup>6</sup> This will continue to be the case in 2030, even though toxics levels will be lower.

Mobile sources were responsible for 74% of the noncancer (respiratory) risk from outdoor air toxics in 1999. The majority of this risk was from acrolein, and formaldehyde also contributed to the risk of respiratory health effects. Mobile sources will continue to be responsible for the majority of noncancer risk from outdoor air toxics in 2030.

Although not included in NATA's estimates of noncancer risk, PM from gasoline and diesel mobile sources contribute significantly to the health effects associated with ambient PM, for which EPA has established a National Ambient Air Quality Standard. There is extensive human data showing a wide spectrum of adverse health effects associated with exposure to ambient PM.

## 3. Exposure Near Roads and From Attached Garages

The national-scale risks described above do not account for higher exposures experienced by people who live near major roadways, or people who live in homes with attached garages. A substantial number of studies show elevated concentrations of multiple MSATs in close proximity to major roads. We also conducted an exposure modeling study for three geographically distinct states (Colorado, New York, and Georgia) and found that when the elevated concentrations near roadways are accounted for, the distribution of benzene exposure is broader, with a larger fraction of the population exposed to higher concentrations. The largest effect on personal exposure occurs for the population living near major roads. A U.S. Census survey of housing found that in 2003 12.6% of U.S. housing units were within 300 feet of a major transportation source.<sup>7</sup> The potential population exposed to elevated concentrations near major roadways is

therefore large. In addition, our analysis indicates that benzene exposure experienced by people living in homes with attached garages may be twice the national average benzene exposure estimated by NATA for 1999. More details on exposure near roads and from attached garages can be found in section IV of this preamble.

## 4. Ozone and Particulate Matter

Many MSATs are part of a larger category of mobile source emissions known as volatile organic compounds (VOC), which contribute to the formation of ozone and particulate matter (PM). In addition, some MSATs are emitted directly as PM rather than being formed through secondary processes. Thus, MSATs contribute to adverse health effects both as individual pollutants, and as precursors to ozone and PM. Mobile sources contribute significantly to national emissions of VOC and PM. In addition, gas cans are a source of both VOC and benzene emissions.

Both ozone and PM contribute to serious public health problems, including premature mortality, aggravation of respiratory and cardiovascular disease (as indicated by increased hospital admissions and emergency room visits, school absences, work loss days, and restricted activity days), changes in lung function and increased respiratory symptoms, changes to lung tissues and structures, altered respiratory defense mechanisms, chronic bronchitis, and decreased lung function.

In addition, ozone and PM cause significant harm to public welfare. Specifically, ozone causes damage to vegetation, which leads to crop and forestry economic losses, as well as harm to national parks, wilderness areas, and other natural systems. PM contributes to the substantial impairment of visibility in many parts of the U.S., including national parks and wilderness areas. The deposition of airborne particles can also reduce the aesthetic appeal of buildings and culturally important articles through soiling, and can contribute directly (or in conjunction with other pollutants) to structural damage by means of corrosion or erosion.

Finally, atmospheric deposition and runoff of polycyclic organic matter (POM), metals, and other mobile-source-related compounds contribute to the contamination of water bodies such as the Great Lakes and coastal waters (e.g., the Chesapeake Bay).

## B. What Is EPA Proposing?

### 1. Light-Duty Vehicle Emission Standards

As described in more detail in section VI, we are proposing new standards for both exhaust and evaporative emissions from passenger vehicles. The new exhaust emissions standards would significantly reduce non-methane hydrocarbon (NMHC) emissions from passenger vehicles at cold temperatures. These hydrocarbons include many mobile source air toxics (including benzene), as well as VOC.

Current vehicle emission standards require that the certification testing of NMHC is performed at 75 °F. Recent research and analysis indicates that these standards are not resulting in robust control of NMHC at lower temperatures. We believe that cold temperature NMHC control can be substantially improved using the same technological approaches that are generally already being used in the Tier 2 vehicle fleet to meet the stringent standards at 75 °F. These cold-temperature NMHC controls would also result in lower direct PM emissions at cold temperatures.

Accordingly, we are proposing that light-duty vehicles, light-duty trucks, and medium-duty passenger vehicles would be subject to a new non-methane hydrocarbon (NMHC) exhaust emissions standard at 20 °F. Vehicles at or below 6,000 pounds gross vehicle weight rating (GVWR) would be subject to a sales-weighted fleet average NMHC level of 0.3 grams/mile. Vehicles between 6,000 and 8,500 pounds GVWR and medium-duty passenger vehicles would be subject to a sales-weighted fleet average NMHC level of 0.5 grams/mile. For lighter vehicles, the standard would phase in between 2010 and 2013. For heavier vehicles, the new standards would phase in between 2012 and 2015. We are also proposing a credit program and other provisions designed to provide flexibility to manufacturers, especially during the phase-in periods. These provisions are designed to allow the earliest possible phase-in of standards and help minimize costs and ease the transition to new standards.

We are also proposing a set of nominally more stringent evaporative emission standards for all light-duty vehicles, light-duty trucks, and medium-duty passenger vehicles. The proposed standards are equivalent to California's Low Emission Vehicle II (LEV II) standards, and they reflect the evaporative emissions levels that are already being achieved nationwide. The standards we are proposing today would codify the approach that most

<sup>6</sup> That is, the respiratory hazard index exceeded 1. See section III.D of this preamble for more information.

<sup>7</sup> United States Census Bureau. (2004) American Housing Survey web page. [Online at <http://www.census.gov/hhes/www/housing/ahs/ahs03/ahs03.html>] Table IA-6.

manufacturers are already taking for 50-state evaporative systems, and the standards would thus prevent backsliding in the future. We are proposing to implement the evaporative emission standards in 2009 for lighter vehicles and in 2010 for the heavier vehicles.

Section VI provides details on the proposed exhaust and evaporative standards and their implementation, and our rationale for proposing them.

## 2. Gasoline Fuel Standards

As described in more detail in section VII, we are proposing to limit the benzene content of all gasoline, both reformulated and conventional. We propose that beginning January 1, 2011, refiners would meet an average gasoline benzene content standard of 0.62% by volume on all their gasoline. We are not proposing a standard for California, however, because it is already covered by a similar state program.

This proposed fuel standard would result in air toxics emissions reductions that are greater than required under all existing gasoline toxics programs. As a result, EPA is proposing that upon full implementation in 2011, the regulatory provisions for the benzene control program would become the single regulatory mechanism used to implement the RFG and Anti-dumping annual average toxics requirements. The current RFG and Anti-dumping annual average provisions thus would be replaced by the proposed benzene control program. The MSAT2 benzene control program would also replace the MSAT1 requirements. In addition, the program would satisfy certain fuel MSAT conditions of the Energy Policy Act of 2005 and obviate the need to revise toxics baselines for reformulated gasoline otherwise required by the Energy Policy Act. In all of these ways, we would significantly consolidate and simplify the existing national fuel-related MSAT regulatory program.

We also propose that refiners could generate benzene credits and use or transfer them as a part of a nationwide averaging, banking, and trading (ABT) program. From 2007–2010 refiners could generate benzene credits by taking early steps to reduce gasoline benzene levels. Beginning in 2011 and continuing indefinitely, refiners could generate credits by producing gasoline with benzene levels below the 0.62% average standard. Refiners could apply the credits towards company compliance, “bank” the credits for later use, or transfer (“trade”) them to other refiners nationwide (outside of California) under the proposed program. Under this program, refiners could use

credits to achieve compliance with the benzene content standard.

This proposed ABT program would allow us to set a more stringent benzene standard than would otherwise be possible, and it would allow implementation to occur earlier. Under this proposed benzene content standard and ABT program, gasoline in all areas of the country would have lower benzene levels than they have today. Overall benzene levels would be 37% lower. This would reduce benzene emissions and exposure nationwide.

Finally, we propose hardship provisions. Refiners approved as “small refiners” would be eligible for certain temporary relief provisions. In addition, any refiner facing extreme unforeseen circumstances or extreme hardship circumstances could apply for similar temporary relief.

Section VII of this preamble provides a detailed explanation and rationale for the proposed fuel program and its implementation. It also discusses and seeks comment on a variety of alternatives that we considered.

## 3. Portable Gasoline Container (Gas Can) Controls

Portable gasoline containers, or gas cans, are consumer products used to refuel a wide variety of gasoline-powered equipment, including lawn and garden equipment, recreational equipment, and passenger vehicles that have run out of gas. As described in section VIII, we are proposing standards that would reduce hydrocarbon emissions from evaporation, permeation, and spillage. These standards would significantly reduce benzene and other toxics, as well as VOC more generally. VOC is an ozone precursor.

We propose a performance-based standard of 0.3 grams per gallon per day of hydrocarbons, based on the emissions from the can over a diurnal test cycle. The standard would apply to gas cans manufactured on or after January 1, 2009. We also propose test procedures and a certification and compliance program, in order to ensure that gas cans would meet the emission standard over a range of in-use conditions. The proposed standards would result in the use of best available control technologies, such as durable permeation barriers, automatically closing spouts, and cans that are well-sealed.

California implemented an emissions control program for gas cans in 2001, and since then, several other states have adopted the program. Last year, California adopted a revised program, which will take effect July 1, 2007. The

revised California program is very similar to the program we are proposing. Although a few aspects of the program we are proposing are different, we believe manufacturers would be able to meet both EPA and California requirements with the same gas can designs.

## III. What Are Mobile Source Air Toxics (MSATs) and Their Health Effects?

### A. What Are MSATs?

Section 202(l) refers to “hazardous air pollutants from motor vehicles and motor vehicle fuels.” We use the term “mobile source air toxics (MSATs)” to refer to compounds that are emitted by mobile sources and have the potential for serious adverse health effects. There are a variety of ways in which to identify compounds that have the potential for serious adverse health effects. For example, EPA’s Integrated Risk Information System (IRIS) is EPA’s database containing information on human health effects that may result from exposure to various chemicals in the environment. In addition, Clean Air Act section 112(b) contains a list of hazardous air pollutants that EPA is required to control through regulatory standards; other agencies or programs such as the Agency for Toxic Substances and Disease Registry and the California EPA have developed health benchmark values for various compounds; and the International Agency for Research on Cancer and the National Toxicology Program have assembled evidence of substances that cause cancer in humans and issue judgments on the strength of the evidence. Each source of information has its own strengths and limitations. For example, there are inherent limitations on the number of compounds that have been investigated sufficiently for EPA to conduct an IRIS assessment. There are some compounds that are not listed in IRIS but are considered to be hazardous air pollutants under Clean Air Act section 112(b) and are regulated by the Agency (e.g., propionaldehyde, 2,2,4-trimethylpentane).

### B. Compounds Emitted by Mobile Sources and Identified in IRIS

In its 2001 MSAT rule, EPA identified a list of 21 MSATs. We listed a compound as an MSAT if it was emitted from mobile sources, and if the Agency had concluded in IRIS that the compound posed a potential cancer hazard and/or if IRIS contained an inhalation reference concentration or ingestion reference dose for the compound. Since 2001, EPA has conducted an extensive review of the

literature to produce a list of the compounds identified in the exhaust or evaporative emissions from onroad and nonroad equipment, using baseline as well as alternative fuels (e.g., biodiesel, compressed natural gas). This list, the Master List of Compounds Emitted by Mobile Sources (“Master List”), currently includes approximately 1,000 compounds. It is available in the public docket for this rule and on the web (www.epa.gov/otaq/toxics.htm). Table III.B–1 lists those compounds from the Master List that currently meet those 2001 MSAT criteria, based on the current IRIS.

Table III.B–1 identifies all of the compounds from the Master List that are present in IRIS with (a) a cancer hazard

identification of known, probable, or possible human carcinogens (under the 1986 EPA cancer guidelines) or carcinogenic to humans, likely to be carcinogenic to humans, or suggestive evidence of carcinogenic potential (under the 2005 EPA cancer guidelines); and/or (b) an inhalation reference concentration or an ingestion reference dose. Although all these compounds have been detected in emissions from mobile sources, many are emitted in trace amounts and data are not adequate to develop an inventory. Those compounds for which we have developed an emissions inventory are summarized in Table IV.C–2. There are several compounds for which IRIS assessments are underway and therefore

are not included in Table III.B–1. These compounds are: Cerium, copper, ethanol, ethyl tertiary butyl ether (ETBE), platinum, propionaldehyde, and 2,2,4-trimethylpentane.

The fact that a compound is listed in Table III.B–1 does not imply a risk to public health or welfare at current levels, or that it is appropriate to adopt controls to limit the emissions of such a compound from motor vehicles or their fuels. In conducting any such further evaluation, pursuant to sections 202(a) or 211(c) of the Act, EPA would consider whether emissions of the compound from motor vehicles cause or contribute to air pollution which may reasonably be anticipated to endanger public health or welfare.

TABLE III.B–1.—COMPOUNDS EMITTED BY MOBILE SOURCES THAT ARE LISTED IN IRIS\*

1,1,1,2-Tetrafluoroethane .....	Cadmium .....	Manganese.
1,1,1-Trichloroethane .....	Carbon disulfide .....	Mercury, elemental.
1,1-Biphenyl .....	Carbon tetrachloride .....	Methanol.
1,2-Dibromoethane .....	Chlorine .....	Methyl chloride.
1,2-Dichlorobenzene .....	Chlorobenzene .....	Methyl ethyl ketone (MEK).
1,3-Butadiene .....	Chloroform .....	Methyl isobutyl ketone (MIBK).
2,4-Dinitrophenol .....	Chromium III .....	Methyl tert-butyl ether (MTBE).
2-Methylnaphthalene .....	Chromium VI .....	Molybdenum.
2-Methylphenol .....	Chrysene .....	Naphthalene.
4-Methylphenol .....	Crotonaldehyde .....	Nickel.
Acenaphthene .....	Cumene (isopropyl benzene) .....	Nitrate.
Acetaldehyde .....	Cyclohexane .....	N-Nitrosodiethylamine.
Acetone .....	Cyclohexanone .....	N-Nitrosodimethylamine.
Acetophenone .....	Di(2-ethylhexyl)phthalate .....	N-Nitroso-di-n-butylamine.
Acrolein (2-propenal) .....	Dibenz[a,h]anthracene .....	N-Nitrosodi-N-propylamine.
Ammonia .....	Dibutyl phthalate .....	N-Nitrosopyrrolidine.
Anthracene .....	Dichloromethane .....	Pentachlorophenol.
Antimony .....	Diesel PM and Diesel exhaust organic gases	Phenol.
Arsenic, inorganic .....	Diethyl phthalate .....	Phosphorus.
Barium and compounds .....	Ethylbenzene .....	Phthalic anhydride.
Benz[a]anthracene .....	Ethylene glycol monobutyl ether .....	Pyrene.
Benzaldehyde .....	Fluoranthene .....	Selenium and compounds.
Benzene .....	Fluorene .....	Silver.
Benzo[a]pyrene (BaP) .....	Formaldehyde .....	Strontium.
Benzo[b]fluoranthene .....	Furfural .....	Styrene.
Benzo[k]fluoranthene .....	Hexachlorodibenzo-p-dioxin, mixture (dioxin/ furans).	Tetrachloroethylene.
Benzoic acid .....	n-Hexane .....	Toluene.
Beryllium and compounds .....	Hydrogen cyanide .....	Trichlorofluoromethane.
Boron (Boron and Borates only) .....	Hydrogen sulfide .....	Vanadium.
Bromomethane .....	Indeno[1,2,3-cd]pyrene .....	Xylenes.
Butyl benzyl phthalate .....	Lead and compounds (inorganic) .....	Zinc and compounds.

\* Compounds listed in IRIS as known, probable, or possible human carcinogens and/or pollutants for which the Agency has calculated a reference concentration or reference dose.

C. Which Mobile Source Emissions Pose the Greatest Health Risk at Current Levels?

The 1999 National-Scale Air Toxics Assessment (NATA) provides some perspective on which mobile source emissions pose the greatest risk at current estimated ambient levels.<sup>8</sup> We

<sup>8</sup> It is, of course, not necessary for EPA to show that a compound is a national or regional risk driver to show that its emission from motor vehicles may reasonably cause or contribute to endangerment of public health or welfare. A showing that motor

also conducted a national-scale assessment for future years, which is discussed more fully in section IV of this preamble and Chapters 2 and 3 of the RIA. Our understanding of what emissions pose the greatest risk will evolve over time, based on our understanding of the ambient levels and

vehicles contribute some non-trivial percentage of the inventory of a compound known to be associated with adverse health effects would normally be sufficient. Cf. *Bluewater Network v. EPA*, 370 F. 3d 1, 15 (D.C. Cir. 2004).

health effects associated with the compounds.<sup>9</sup>

1. National and Regional Risk Drivers in 1999 National-Scale Air Toxics Assessment

The 1999 NATA evaluates 177 hazardous air pollutants currently listed under CAA section 112(b), as well as

<sup>9</sup> The discussion here considers risks other than those attributed to ambient levels of criteria pollutants.

diesel PM.<sup>10</sup> NATA is described in greater detail in Chapters 2 and 3 of the Regulatory Impact Analysis for this proposed rule. Additional information can also be obtained from the NATA website (<http://www.epa.gov/ttn/atw/nata1999>). Based on the assessment of inhalation exposures associated with outdoor sources of these hazardous air pollutants, NATA has identified cancer and noncancer risk drivers on a national and regional scale (Table III.C-1). A cancer risk driver on a national scale is a hazardous air pollutant for which at least 25 million people are exposed to risk greater than ten in one million. Benzene is the only compound identified in the 1999 NATA as a national cancer risk driver. A cancer risk driver on a regional scale is a hazardous air pollutant for which at least one million people are exposed to risk greater than ten in one million or at least 10,000 people are exposed to risk greater than 100 in one million. Twelve compounds (or groups of compounds in the case of POM) were identified as regional cancer risk drivers. The 1999 NATA concludes that diesel particulate matter is among the substances that pose the greatest relative risk, although the cancer risk cannot be quantified.

A noncancer risk driver at the national scale is a hazardous air pollutant for which at least 25 million people are exposed at a concentration greater than the inhalation reference concentration. The RfC is an estimate (with uncertainty spanning perhaps an

order of magnitude) of a daily exposure to the human population (including sensitive subgroups) that is likely to be without appreciable risk of deleterious effects during a lifetime. Acrolein is the only compound identified in the 1999 NATA as a national noncancer risk driver. A noncancer risk driver on a regional scale is defined as a hazardous air pollutant for which at least 10,000 people are exposed to an ambient concentration greater than the inhalation reference concentration. Sixteen regional-scale noncancer risk drivers were identified in the 1999 NATA (see Table III.C-1.).

TABLE III.C-1.—NATIONAL AND REGIONAL CANCER AND NONCANCER RISK DRIVERS IN 1999 NATA

Cancer <sup>1</sup>	Noncancer
National drivers <sup>2</sup> .....	National drivers <sup>4</sup>
Benzene .....	Acrolein
Regional drivers <sup>3</sup> .....	Regional drivers <sup>5</sup>
Arsenic compounds ..	Antimony
Benzidine .....	Arsenic compounds
1,3-Butadiene .....	1,3-Butadiene
Cadmium compounds	Cadmium compounds
Carbon tetrachloride	Chlorine
Chromium VI .....	Chromium VI
Coke oven .....	Diesel PM
Ethylene oxide .....	Formaldehyde
Hydrazine .....	Hexamethylene 1-6-diisocyanate
Naphthalene .....	Hydrazine
Perchloroethylene .....	Hydrochloric acid
Polycyclic organic matter.	Maleic anhydride
	Manganese compounds

TABLE III.C-1.—NATIONAL AND REGIONAL CANCER AND NONCANCER RISK DRIVERS IN 1999 NATA—Continued

Cancer <sup>1</sup>	Noncancer
	Nickel compounds
	2,4-Toluene diisocyanate
	Triethylamine

<sup>1</sup> The list of cancer risk drivers does not include diesel particulate matter. However, the 1999 NATA concluded that it was one of the pollutants that posed the greatest relative cancer risk.

<sup>2</sup> At least 25 million people exposed to risk >10 in 1 million.

<sup>3</sup> At least 1 million people exposed to risk >10 in 1 million or at least 10,000 people exposed to risk >100 in 1 million.

<sup>4</sup> At least 25 million people exposed to a hazard quotient > 1.0.

<sup>5</sup> At least 10,000 people exposed to a hazard quotient > 1.

2. 1999 NATA Risk Drivers with Significant Mobile Source Contribution

Among the national and regional-scale cancer and noncancer risk drivers identified in the 1999 NATA, seven compounds have significant contributions from mobile sources: benzene, 1,3-butadiene, formaldehyde, acrolein, polycyclic organic matter (POM), naphthalene, and diesel particulate matter and diesel exhaust organic gases (Table III.C-2.). For example, mobile sources contribute 68% of the national benzene inventory, with 49% from on-road sources and 19% from nonroad sources.

TABLE III.C-2.—MOBILE SOURCE CONTRIBUTION TO 1999 NATA RISK DRIVERS

1999 NATA risk drivers	Percent contribution from all mobile sources (percent)	Percent contribution from on-road mobile sources (percent)
Benzene .....	68	49
1,3-Butadiene .....	58	41
Formaldehyde .....	47	27
Acrolein .....	25	14
Polycyclic organic matter* .....	6	3
Naphthalene .....	27	21
Diesel PM and Diesel exhaust organic gases .....	100	38

\*This POM inventory includes the 15 POM compounds: benzo[b]fluoranthene, benz[a]anthracene, indeno(1,2,3-c,d)pyrene, benzo[k]fluoranthene, chrysene, benzo[a]pyrene, dibenz(a,h)anthracene, anthracene, pyrene, benzo(g,h,i)perylene, fluoranthene, acenaphthylene, phenanthrene, fluorene, and acenaphthene.

<sup>10</sup>NATA does not include a quantitative estimate of cancer risk for diesel particulate matter and diesel exhaust organic gases.

### D. What Are the Health Effects of Air Toxics?

#### 1. Overview of Potential Cancer and Noncancer Health Effects

Air toxics can cause a variety of cancer and noncancer health effects. A number of the mobile source air toxic pollutants described in section III are known or likely to pose a cancer hazard in humans. Many of these compounds also cause adverse noncancer health effects resulting from chronic,<sup>11</sup> subchronic,<sup>12</sup> or acute<sup>13</sup> inhalation exposures. These include neurological, cardiovascular, liver, kidney, and respiratory effects as well as effects on the immune and reproductive systems. Section III.D.2 discusses the health effects of air toxic compounds listed in Table III.C-2, as well as acetaldehyde. The compounds in Table III.C-2 were all identified as national and regional-scale cancer and noncancer risk drivers in the 1999 National-Scale Air Toxics Assessment (NATA), and have significant inventory contributions from mobile sources. Acetaldehyde is included because it is a likely human carcinogen, has a significant inventory contribution from mobile sources, and was identified as a risk driver in the 1996 NATA. We are also including diesel particulate matter and diesel exhaust organic gases in this discussion. Although 1999 NATA did not quantify cancer risks associated with exposure to this pollutant, EPA has concluded that diesel exhaust ranks with the other substances that the national-scale assessment suggests pose the greatest relative risk.<sup>14</sup>

Inhalation cancer risks are usually estimated by EPA as "unit risks," which represent the excess lifetime cancer risk estimated to result from continuous exposure to an agent at a concentration of 1 µg/m<sup>3</sup> in air. Some air toxics are known to be carcinogenic in animals but lack data in humans. These have been assumed to be human carcinogens. Also, relationships between exposure and probability of cancer are assumed to be linear. In addition, these unit risks are typically upper bound estimates. Upper bound estimates are more likely to

overestimate than underestimate risk. Where there are strong epidemiological data, a maximum likelihood (MLE) estimate may be developed. An MLE is a best scientific estimate of risk. The benzene unit risk is an MLE. A discussion of the confidence in a quantitative cancer risk estimate is provided in the IRIS file for each compound. The discussion of the confidence in the cancer risk estimate includes an assessment of the source of the data (human or animal), uncertainties in dose estimates, choice of the model used to fit the exposure and response data and how uncertainties and potential confounders are handled.

Potential noncancer chronic inhalation health risks are quantified using reference concentrations (RfCs) and noncancer chronic ingestion health risks are quantified using reference doses (RfDs). The RfC is an estimate (with uncertainty spanning perhaps an order of magnitude) of a daily exposure to the human population (including sensitive subgroups) that is likely to be without appreciable risk of deleterious effects during a lifetime. Sources of uncertainty in the development of the RfCs and RfDs include intraspecies extrapolation (animal to human) and interspecies extrapolation (average human to sensitive human). Additional sources of uncertainty can be using a lowest observed adverse effect level in place of a no observed adverse effect level, and other data deficiencies. A statement regarding the confidence in the RfC and/or RfD is developed to reflect the confidence in the principal study or studies on which the RfC or RfD are based and the confidence in the underlying database. Factors that affect the confidence in the principal study include how well the study was designed, conducted and reported. Factors that affect the confidence in the database include an assessment of the availability of information regarding identification of the critical effect, potentially susceptible populations and exposure scenarios relevant to assessment of risk.

The RfC may be used to estimate a hazard quotient, which is the environmental exposure to a substance divided by its RfC. A hazard quotient greater than one indicates adverse health effects are possible. The hazard quotient cannot be translated to a probability that adverse health effects will occur, and is unlikely to be proportional to risk. It is especially important to note that a hazard quotient exceeding one does not necessarily mean that adverse effects will occur. In NATA, hazard quotients for different

respiratory irritants were also combined into a hazard index (HI). A hazard index is the sum of hazard quotients for substances that affect the same target organ or organ system. Because different pollutants may cause similar adverse health effects, it is often appropriate to combine hazard quotients associated with different substances. However, the HI is only an approximation of a combined effect because substances may affect a target organ in different ways.

#### 2. Health Effects of Key MSATs

##### a. Benzene

The EPA's IRIS database lists benzene, an aromatic hydrocarbon, as a known human carcinogen (causing leukemia) by all routes of exposure.<sup>15</sup> A number of adverse noncancer health effects including blood disorders and immunotoxicity have also been associated with long-term occupational exposure to benzene.

Inhalation is the major source of human exposure to benzene in the occupational and non-occupational setting. Long-term inhalation occupational exposure to benzene has been shown to cause cancer of the hematopoietic (blood cell) system in adults. Among these are acute nonlymphocytic leukemia<sup>16</sup> and chronic lymphocytic leukemia.<sup>17 18</sup>

<sup>15</sup> U.S. EPA (2000). Integrated Risk Information System File for Benzene. This material is available electronically at <http://www.epa.gov/iris/subst/0276.htm>.

<sup>16</sup> Leukemia is a blood disease in which the white blood cells are abnormal in type or number. Leukemia may be divided into nonlymphocytic (granulocytic) leukemias and lymphocytic leukemias. Nonlymphocytic leukemias generally involves the types of white blood cells (leukocytes) that are involved in engulfing, killing, and digesting bacteria and other parasites (phagocytosis) as well as releasing chemicals involved in allergic and immune responses. This type of leukemia may also involve erythroblastic cell types (immature red blood cells). Lymphocytic leukemia involves the lymphocyte type of white blood cells that are responsible for the immune responses. Both nonlymphocytic and lymphocytic leukemia may, in turn, be separated into acute (rapid and fatal) and chronic (lingering, lasting) forms. For example; in acute myeloid leukemia there is diminished production of normal red blood cells (erythrocytes), granulocytes, and platelets (control clotting), which leads to death by anemia, infection, or hemorrhage. These events can be rapid. In chronic myeloid leukemia (CML) the leukemic cells retain the ability to differentiate (*i.e.*, be responsive to stimulatory factors) and perform function; later there is a loss of the ability to respond.

<sup>17</sup> U.S. EPA (1985) Environmental Protection Agency, Interim quantitative cancer unit risk estimates due to inhalation of benzene, prepared by the Office of Health and Environmental Assessment, Carcinogen Assessment Group, Washington, DC, for the Office of Air Quality Planning and Standards, Washington, DC, 1985.

<sup>18</sup> U.S. EPA. (1993). Motor Vehicle-Related Air Toxics Study. Office of Mobile Sources, Ann Arbor, MI. [http://www.epa.gov/otaq/regs/toxics/tox\\_archive.htm](http://www.epa.gov/otaq/regs/toxics/tox_archive.htm).

<sup>11</sup> Chronic exposure is defined in the glossary of the Integrated Risk Information (IRIS) database ([www.epa.gov/iris](http://www.epa.gov/iris)) as repeated exposure by the oral, dermal, or inhalation route for more than approximately 10 of the life span in humans (more than approximately 90 days to 2 years in typically used laboratory animal species).

<sup>12</sup> Defined in the IRIS database as exposure to a substance spanning approximately 10 of the lifetime of an organism.

<sup>13</sup> Defined in the IRIS database as exposure by the oral, dermal, or inhalation route for 24 hours or less.

<sup>14</sup> <http://www.epa.gov/ttn/atw/nata1999>.

Leukemias, lymphomas, and other tumor types have been observed in experimental animals exposed to benzene by inhalation or oral administration. Exposure to benzene and/or its metabolites has also been linked with chromosomal changes in humans and animals<sup>19 20</sup> and increased proliferation of mouse bone marrow cells.<sup>21 22</sup>

The latest assessment by EPA places the excess risk of developing acute nonlymphocytic leukemia from inhalation exposure to benzene at  $2.2 \times 10^{-6}$  to  $7.8 \times 10^{-6}$  per  $\mu\text{g}/\text{m}^3$ . In other words, there is a risk of about two to eight excess leukemia cases in one million people exposed to  $1 \mu\text{g}/\text{m}^3$  of benzene over a lifetime.<sup>23</sup> This range of unit risks are the MLEs calculated from different exposure assumptions and dose-response models that are linear at low doses. At present, the true cancer risk from exposure to benzene cannot be ascertained, even though dose-response data are used in the quantitative cancer risk analysis, because of uncertainties in the low-dose exposure scenarios and lack of clear understanding of the mode of action. A range of estimates of risk is recommended, each having equal scientific plausibility. There are confidence intervals associated with the MLE range that reflect random variation of the observed data. For the upper end of the MLE range, the 5th and 95th percentile values are about a factor of 5 lower and higher than the best fit value. The upper end of the MLE range was used in NATA.

It should be noted that not enough information is known to determine the

slope of the dose-response curve at environmental levels of exposure and to provide a sound scientific basis to choose any particular extrapolation/exposure model to estimate human cancer risk at low doses. EPA risk assessment guidelines suggest using an assumption of linearity of dose response when (1) there is an absence of sufficient information on modes of action or (2) the mode of action information indicates that the dose-response curve at low dose is or is expected to be linear.<sup>24</sup> Since the mode of action for benzene carcinogenicity is unknown, the current cancer unit risk estimate assumes linearity of the low-dose response. Data that were considered by EPA in its carcinogenic update suggested that the dose-response relationship at doses below those examined in the studies reviewed in EPA's most recent benzene assessment may be supralinear. They support the inference that cancer risks are as high or are higher than the estimates provided in the existing EPA assessment.<sup>25</sup> Data discussed in the EPA IRIS assessment suggest that genetic abnormalities occur at low exposure in humans, and the formation of toxic metabolites plateaus above 25 ppm (80,000  $\mu\text{g}/\text{m}^3$ ).<sup>26</sup> More recent data on benzene adducts in humans, published after the most recent IRIS assessment, suggest that the enzymes involved in benzene metabolism start to saturate at exposure levels as low as 1 ppm.<sup>27</sup> Because there is a transition from linear to saturable metabolism below 1 ppm, the assumption of low-dose linearity extrapolated from much higher exposures could lead to substantial underestimation of leukemia risks. This is consistent with recent epidemiological data which also suggest a supralinear exposure-response relationship and which "[extend] evidence for hematopoietic cancer risks to levels substantially lower than had previously been established."<sup>28 29</sup> These

data are from the largest cohort study done to date with individual worker exposure estimates. However, these data have not yet been formally evaluated by EPA as part of the IRIS review process, and it is not clear whether these data provide sufficient evidence to reject a linear dose-response curve. A better understanding of the biological mechanism of benzene-induced leukemia is needed.

Children may represent a subpopulation at increased risk from benzene exposure, due to factors that could increase their susceptibility. Children may have a higher unit body weight exposure because of their heightened activity patterns which can increase their exposures, as well as different ventilation tidal volumes and frequencies, factors that influence uptake. This could entail a greater risk of leukemia and other toxic effects to children if they are exposed to benzene at similar levels as adults. There is limited information from two studies regarding an increased risk to children whose parents have been occupationally exposed to benzene.<sup>30 31</sup> Data from animal studies have shown benzene exposures result in damage to the hematopoietic (blood cell formation) system during development.<sup>32 33 34</sup> Also, key changes related to the development of childhood leukemia occur in the developing fetus.<sup>35</sup> Several studies have reported that genetic changes related to eventual leukemia development occur before birth. For example, there is one study of genetic changes in twins who developed T cell leukemia at 9 years of

the dose-related incidence of hematologic neoplasms in China. *J. Nat. Cancer Inst.* 89:1065-1071.

<sup>29</sup> Hayes, R.B.; Songnian, Y.; Dosemeci, M.; and Linet, M. (2001) Benzene and lymphohematopoietic malignancies in humans. *Am. J. Indust. Med.* 40:117-126.

<sup>30</sup> Shu, X.O.; Gao, Y.T.; Brinton, L.A.; *et al.* (1988) A population-based case-control study of childhood leukemia in Shanghai. *Cancer* 62:635-644.

<sup>31</sup> McKinney, P.A.; Alexander, F.E.; Cartwright, R.A.; *et al.* (1991) Parental occupations of children with leukemia in west Cumbria, north Humberside, and Gateshead, Br. *Med. J.* 302:681-686.

<sup>32</sup> Keller, KA; Snyder, CA. (1986) Mice exposed in utero to low concentrations of benzene exhibit enduring changes in their colony forming hematopoietic cells. *Toxicology* 42:171-181.

<sup>33</sup> Keller, KA; Snyder, CA. (1988) Mice exposed in utero to 20 ppm benzene exhibit altered numbers of recognizable hematopoietic cells up to seven weeks after exposure. *Fundam. Appl. Toxicol.* 10:224-232.

<sup>34</sup> Corti, M; Snyder, CA. (1996) Influences of gender, development, pregnancy and ethanol consumption on the hematotoxicity of inhaled 10 ppm benzene. *Arch. Toxicol.* 70:209-217.

<sup>35</sup> U.S. EPA. (2002). Toxicological Review of Benzene (Noncancer Effects). National Center for Environmental Assessment, Washington, DC. Report No. EPA/635/R-02/001F. [http://www.epa.gov/iris/toxreviews/0276-tr\[1\].pdf](http://www.epa.gov/iris/toxreviews/0276-tr[1].pdf).

<sup>19</sup> International Agency for Research on Cancer (IARC) (1982) IARC monographs on the evaluation of carcinogenic risk of chemicals to humans, Volume 29, Some industrial chemicals and dyestuffs, International Agency for Research on Cancer, World Health Organization, Lyon, France, p. 345-389.

<sup>20</sup> U.S. EPA (1998) Environmental Protection Agency, Carcinogenic Effects of Benzene: An Update, National Center for Environmental Assessment, Washington, DC. EPA600-P-97-001F. <http://www.epa.gov/ncepihom/Catalog/EPA600P97001F.html>.

<sup>21</sup> Irons, R.D., W.S. Stillman, D.B. Colagiovanni, and V.A. Henry (1992) Synergistic action of the benzene metabolite hydroquinone on myelopoietic stimulating activity of granulocyte/macrophage colony-stimulating factor in vitro. *Proc. Natl. Acad. Sci.* 89:3691-3695.

<sup>22</sup> U.S. EPA (1998) Environmental Protection Agency, Carcinogenic Effects of Benzene: An Update, National Center for Environmental Assessment, Washington, DC. EPA600-P-97-001F. <http://www.epa.gov/ncepihom/Catalog/EPA600P97001F.html>.

<sup>23</sup> U.S. EPA (1998). Environmental Protection Agency, Carcinogenic Effects of Benzene: An Update, National Center for Environmental Assessment, Washington, DC. EPA600-P-97-001F. <http://www.epa.gov/ncepihom/Catalog/EPA600P97001F.html>.

<sup>24</sup> U.S. EPA (2005) Guidelines for Carcinogen Risk Assessment. Report No. EPA/630/P-03/001F. <http://cfpub.epa.gov/ncea/raf/recordisplay.cfm?deid=116283>.

<sup>25</sup> U.S. EPA (1998) Carcinogenic Effects of Benzene: An Update. EPA/600/P-97/001F.

<sup>26</sup> Rothman, N; Li, GL; Dosemeci, M; *et al.* (1996) Hematotoxicity among Chinese workers heavily exposed to benzene. *Am. J. Indust. Med.* 29:236-246.

<sup>27</sup> Rappaport, S.M.; Waidyanatha, S.; Qu, Q.; Shore, R.; Jin, X.; Cohen, B.; Chen, L.; Melikian, A.; Li, G.; Yin, S.; Yan, H.; Xu, B.; Mu, R.; Li, Y.; Zhang, X.; and Li, K. (2002) Albumin adducts of benzene oxide and 1,4-benzoquinone as measures of human benzene metabolism. *Cancer Research* 62:1330-1337.

<sup>28</sup> Hayes, R.B.; Yin, S.; Dosemeci, M.; Li, G.; Wacholder, S.; Travis, L.B.; Li, C.; Rothman, N.; Hoover, R.N.; and Linet, M.S. (1997) Benzene and

age.<sup>36</sup> An association between traffic volume, residential proximity to busy roads and occurrence of childhood leukemia has also been identified in some studies, although some studies show no association.

A number of adverse noncancer health effects, including blood disorders such as preleukemia and aplastic anemia, have also been associated with long-term exposure to benzene.<sup>37, 38</sup> People with long-term occupational exposure to benzene have experienced harmful effects on the blood-forming tissues, especially in bone marrow. These effects can disrupt normal blood production and suppress the production of important blood components, such as red and white blood cells and blood platelets, leading to anemia (a reduction in the number of red blood cells), leukopenia (a reduction in the number of white blood cells), or thrombocytopenia (a reduction in the number of blood platelets, thus reducing the ability of blood to clot). Chronic inhalation exposure to benzene in humans and animals results in pancytopenia,<sup>39</sup> a condition characterized by decreased numbers of circulating erythrocytes (red blood cells), leukocytes (white blood cells), and thrombocytes (blood platelets).<sup>40, 41</sup> Individuals that develop pancytopenia and have continued exposure to benzene may develop aplastic anemia, whereas others exhibit both pancytopenia and bone marrow hyperplasia (excessive cell formation), a condition that may indicate a

preleukemic state.<sup>42, 43</sup> The most sensitive noncancer effect observed in humans, based on current data, is the depression of the absolute lymphocyte count in blood.<sup>44, 45</sup>

EPA's inhalation reference concentration (RfC) for benzene is 30  $\mu\text{g}/\text{m}^3$ , based on suppressed absolute lymphocyte counts as seen in humans under occupational exposure conditions. The overall confidence in this RfC is medium. Since development of this RfC, there have appeared human reports of benzene's hematotoxic effects in the literature that provides data suggesting a wide range of hematological endpoints that are affected at occupational exposures of less than 5 ppm (about 16  $\text{mg}/\text{m}^3$ )<sup>46</sup> and even at air levels of 1 ppm (about 3  $\text{mg}/\text{m}^3$ ) or less among genetically susceptible populations.<sup>47</sup> One recent study found benzene metabolites in mouse liver and bone marrow at environmental doses, indicating that even concentrations in urban air can elicit a biochemical response in rodents that indicates toxicity.<sup>48</sup> EPA has not formally evaluated these recent studies as part of the IRIS review process to determine whether or not they will lead to a change in the current RfC. EPA does not currently have an acute reference concentration for benzene. The Agency for Toxic Substances and Disease Registry Minimal Risk Level for acute exposure to benzene is 160  $\mu\text{g}/\text{m}^3$  for 1–14 days exposure.

#### b. 1,3-Butadiene

EPA has characterized 1,3-butadiene, a hydrocarbon, as a leukemogen,

carcinogenic to humans by inhalation.<sup>49, 50</sup> The specific mechanisms of 1,3-butadiene-induced carcinogenesis are unknown; however, it is virtually certain that the carcinogenic effects are mediated by genotoxic metabolites of 1,3-butadiene. Animal data suggest that females may be more sensitive than males for cancer effects; nevertheless, there are insufficient data from which to draw any conclusions on potentially sensitive subpopulations. The upper bound cancer unit risk estimate is 0.08 per ppm or  $3 \times 10^{-5}$  per  $\mu\text{g}/\text{m}^3$  (based primarily on linear modeling and extrapolation of human data). In other words, it is estimated that approximately 30 persons in one million exposed to 1  $\mu\text{g}/\text{m}^3$  of 1,3-butadiene continuously for their lifetime would develop cancer as a result of this exposure. The human incremental lifetime unit cancer risk estimate is based on extrapolation from leukemias observed in an occupational epidemiologic study.<sup>51</sup> This estimate includes a two-fold adjustment to the epidemiologic-based unit cancer risk applied to reflect evidence from the rodent bioassays suggesting that the epidemiologic-based estimate (from males) may underestimate total cancer risk from 1,3-butadiene exposure in the general population, particularly for breast cancer in females. Confidence in the excess cancer risk estimate of 0.08 per ppm is moderate.

1,3-Butadiene also causes a variety of reproductive and developmental effects in mice; no human data on these effects are available. The most sensitive effect was ovarian atrophy observed in a lifetime bioassay of female mice.<sup>52</sup> Based on this critical effect and the benchmark concentration methodology, an RfC was calculated. This RfC for chronic health effects is 0.9 ppb, or about 2  $\mu\text{g}/\text{m}^3$ . Confidence in the inhalation RfC is medium.

#### c. Formaldehyde

Since 1987, EPA has classified formaldehyde, a hydrocarbon, as a

<sup>36</sup> Ford, AM; Pombo-de-Oliveira, MS; McCarthy, KP; MacLean, JM; Carrico, KC; Vincent, RF; Greaves, M. (1997) Monoclonal origin of concordant T-cell malignancy in identical twins. *Blood* 89:281–285.

<sup>37</sup> Aksoy, M. (1989) Hematotoxicity and carcinogenicity of benzene. *Environ. Health Perspect.* 82:193–197.

<sup>38</sup> Goldstein, B.D. (1988) Benzene toxicity. *Occupational medicine. State of the Art Reviews* 3: 541–554.

<sup>39</sup> Pancytopenia is the reduction in the number of all three major types of blood cells (erythrocytes, or red blood cells, thrombocytes, or platelets, and leukocytes, or white blood cells). In adults, all three major types of blood cells are produced in the bone marrow of the vertebra, sternum, ribs, and pelvis. The bone marrow contains immature cells, known as multipotent myeloid stem cells, that later differentiate into the various mature blood cells. Pancytopenia results from a reduction in the ability of the red bone marrow to produce adequate numbers of these mature blood cells.

<sup>40</sup> Aksoy, M. (1991) Hematotoxicity, leukemogenicity and carcinogenicity of chronic exposure to benzene. In: Arinc, E.; Schenkman, J.B.; Hodgson, E., Eds. *Molecular Aspects of Monooxygenases and Bioactivation of Toxic Compounds*. New York: Plenum Press, pp. 415–434.

<sup>41</sup> Goldstein, B.D. (1988) Benzene toxicity. *Occupational medicine. State of the Art Reviews* 3: 541–554.

<sup>42</sup> Aksoy, M., S. Erdem, and G. Dincol. (1974) Leukemia in shoe-workers exposed chronically to benzene. *Blood* 44:837.

<sup>43</sup> Aksoy, M. and K. Erdem. (1978) A follow-up study on the mortality and the development of leukemia in 44 pancytopenic patients associated with long-term exposure to benzene. *Blood* 52: 285–292.

<sup>44</sup> Rothman, N., G.L. Li, M. Dosemeci, W.E. Bechtold, G.E. Marti, Y.Z. Wang, M. Linet, L.Q. Xi, W. Lu, M.T. Smith, N. Titenko-Holland, L.P. Zhang, W. Blot, S.N. Yin, and R.B. Hayes (1996) Hematotoxicity among Chinese workers heavily exposed to benzene. *Am. J. Ind. Med.* 29: 236–246.

<sup>45</sup> EPA 2005 “Full IRIS Summary for Benzene (CASRN 71–43–2)” Environmental Protection Agency, Integrated Risk Information System (IRIS), Office of Health and Environmental Assessment, Environmental Criteria and Assessment Office, Cincinnati, OH <http://www.epa.gov/iris/subst/0276.htm>.

<sup>46</sup> Qu, Q., R. Shore, G. Li, X. Jin, L.C. Chen, B. Cohen, *et al.* (2002). Hematological changes among Chinese workers with a broad range of benzene exposures. *Am. J. Industr. Med.* 42: 275–285.

<sup>47</sup> Lan, Qing, Zhang, L., Li, G., Vermeulen, R., *et al.* (2004). Hematotoxicity in Workers Exposed to Low Levels of Benzene. *Science* 306: 1774–1776.

<sup>48</sup> Turteltaub, K.W. and Mani, C. (2003). Benzene metabolism in rodents at doses relevant to human exposure from Urban Air. *Res Rep Health Effect Inst* 113.

<sup>49</sup> U.S. EPA. (2002). Health Assessment of 1,3-Butadiene. Office of Research and Development, National Center for Environmental Assessment, Washington Office, Washington, DC. Report No. EPA600–P–98–001F. <http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=54499>.

<sup>50</sup> U.S. EPA (1998). A Science Advisory Board Report: Review of the Health Risk Assessment of 1,3-Butadiene. EPA–SAB–EHC–98.

<sup>51</sup> Delzell, E. N. Sathikumar, M. Macaluso, *et al.* (1995). A follow-up study of synthetic rubber workers. Submitted to the International Institute of Synthetic Rubber Producers. University of Alabama at Birmingham. October 2, 1995.

<sup>52</sup> Bevan, C.; Stadler, J.C.; Elliot, G.S.; *et al.* (1996) Subchronic toxicity of 4-vinylcyclohexene in rats and mice by inhalation. *Fundam. Appl. Toxicol.* 32:1–10.

probable human carcinogen based on evidence in humans and in rats, mice, hamsters, and monkeys.<sup>53</sup> Recently released research conducted by the National Cancer Institute (NCI) found an increased risk of nasopharyngeal cancer among workers exposed to formaldehyde.<sup>54 55</sup> A recent National Institute of Occupational Safety and Health (NIOSH) study of garment workers also found increased risk of death due to leukemia among workers exposed to formaldehyde.<sup>56</sup> In 2004, the working group of the International Agency for Research on Cancer concluded that formaldehyde is carcinogenic to humans (Group 1 classification), on the basis of sufficient evidence in humans and sufficient evidence in experimental animals—a higher classification than previous IARC evaluations. In addition, the National Institute of Environmental Health Sciences recently nominated formaldehyde for reconsideration as a known human carcinogen under the National Toxicology Program. Since 1981 it has been listed as a “reasonably anticipated human carcinogen.”

In the past 15 years there has been substantial research on the inhalation dosimetry for formaldehyde in rodents and primates by the CIIT Centers for Health Research, with a focus on use of rodent data for refinement of the quantitative cancer dose-response assessment.<sup>57 58 59</sup> CIIT's risk assessment of formaldehyde incorporated mechanistic and dosimetric information on formaldehyde. The risk assessment analyzed carcinogenic risk from inhaled

formaldehyde using approaches that are consistent with EPA's draft guidelines for carcinogenic risk assessment. In 2001, Environment Canada relied on this cancer dose-response assessment in their assessment of formaldehyde.<sup>60</sup> In 2004, EPA also relied on this cancer unit risk estimate during the development of the plywood and composite wood products national emissions standards for hazardous air pollutants (NESHAPs).<sup>61</sup> In these rules, EPA concluded that the CIIT work represented the best available application of the available mechanistic and dosimetric science on the dose-response for portal of entry cancers due to formaldehyde exposures. EPA is reviewing the recent work cited above from the NCI and NIOSH, as well as the analysis by the CIIT Centers for Health Research and other studies, as part of a reassessment of the human hazard and dose-response associated with formaldehyde.

Noncancer effects of formaldehyde have been observed in humans and several animal species and include irritation to eye, nose and throat tissues in conjunction with increased mucous secretions.

#### d. Acetaldehyde

Acetaldehyde, a hydrocarbon, is classified in EPA's IRIS database as a probable human carcinogen and is considered moderately toxic by inhalation.<sup>62</sup> Based on nasal tumors in rodents, the upper confidence limit estimate of a lifetime extra cancer risk from continuous acetaldehyde exposure is about  $2.2 \times 10^{-6}$  per  $\mu\text{g}/\text{m}^3$ . In other words, it is estimated that about 2 persons in one million exposed to  $1 \mu\text{g}/\text{m}^3$  acetaldehyde continuously for their lifetime (70 years) would develop cancer as a result of their exposure, although the risk could be as low as zero. In short-term (4 week) rat studies, compound-related histopathological changes were observed only in the respiratory system at various concentration levels of exposure.<sup>63 64</sup>

<sup>60</sup> Health Canada. 2001. Priority Substances List Assessment Report. Formaldehyde. Environment Canada, Health Canada, February 2001.

<sup>61</sup> U.S. EPA. 2004. National Emission Standards for Hazardous Air Pollutants for Plywood and Composite Wood Products Manufacture: Final Rule. (69 FR 45943, 7/30/04).

<sup>62</sup> U.S. EPA. 1988. Integrated Risk Information System File of Acetaldehyde. This material is available electronically at <http://www.epa.gov/iris/subst/0290.htm>.

<sup>63</sup> Appleman, L. M., R. A. Woutersen, V. J. Feron, R. N. Hooftman, and W. R. F. Notten. (1986). Effects of the variable versus fixed exposure levels on the toxicity of acetaldehyde in rats. *J. Appl. Toxicol.* 6: 331–336.

<sup>64</sup> Appleman, L.M., R.A. Woutersen, and V.J. Feron. (1982). Inhalation toxicity of acetaldehyde in

Data from these studies showing degeneration of the olfactory epithelium were found to be sufficient for EPA to develop an RfC for acetaldehyde of  $9 \mu\text{g}/\text{m}^3$ . Confidence in the principal study is medium and confidence in the database is low, due to the lack of chronic data establishing a no observed adverse effect level and due to the lack of reproductive and developmental toxicity data. Therefore, there is low confidence in the RfC. The agency is currently conducting a reassessment of risk from inhalation exposure to acetaldehyde.

The primary acute effect of exposure to acetaldehyde vapors is irritation of the eyes, skin, and respiratory tract.<sup>65</sup> Some asthmatics have been shown to be a sensitive subpopulation to decrements in functional expiratory volume (FEV1 test) and bronchoconstriction upon acetaldehyde inhalation.<sup>66</sup>

#### e. Acrolein

Acrolein, a hydrocarbon, is intensely irritating to humans when inhaled, with acute exposure resulting in upper respiratory tract irritation and congestion. The Agency has developed an RfC for acrolein of  $0.02 \mu\text{g}/\text{m}^3$ .<sup>67</sup> The overall confidence in the RfC assessment is judged to be medium. The Agency is also currently in the process of conducting an assessment of acute health effects for acrolein. EPA determined in 2003 using the 1999 draft cancer guidelines that the human carcinogenic potential of acrolein could not be determined because the available data were inadequate. No information was available on the carcinogenic effects of acrolein in humans and the animal data provided inadequate evidence of carcinogenicity.

#### f. Polycyclic Organic Matter (POM)

POM is generally defined as a large class of organic compounds which have multiple benzene rings and a boiling point greater than 100 degrees Celsius. Many of the compounds included in the class of compounds known as POM are classified by EPA as probable human carcinogens based on animal data. One

rats. I. Acute and subacute studies. *Toxicology.* 23: 293–297.

<sup>65</sup> U.S. EPA (1988). Integrated Risk Information System File of Acetaldehyde. This material is available electronically at <http://www.epa.gov/iris/subst/0290.htm>.

<sup>66</sup> Myou, S.; Fujimura, M.; Nishi K.; Ohka, T.; and Matsuda, T. (1993) Aerosolized acetaldehyde induces histamine-mediated bronchoconstriction in asthmatics. *Am. Rev. Respir. Dis.* 148(4 Pt 1): 940–3.

<sup>67</sup> U.S. Environmental Protection Agency (2003) Integrated Risk Information System (IRIS) on Acrolein. National Center for Environmental Assessment, Office of Research and Development, Washington, D.C. 2003. This material is available electronically at <http://www.epa.gov/iris/subst/0364.htm>.

<sup>53</sup> U.S. EPA (1987). Assessment of Health Risks to Garment Workers and Certain Home Residents from Exposure to Formaldehyde. Office of Pesticides and Toxic Substances, April 1987.

<sup>54</sup> Hauptmann, M.; Lubin, J. H.; Stewart, P. A.; Hayes, R. B.; Blair, A. 2003. Mortality from lymphohematopoietic malignancies among workers in formaldehyde industries. *Journal of the National Cancer Institute* 95: 1615–1623.

<sup>55</sup> Hauptmann, M.; Lubin, J. H.; Stewart, P. A.; Hayes, R. B.; Blair, A. 2004. Mortality from solid cancers among workers in formaldehyde industries. *American Journal of Epidemiology* 159: 1117–1130.

<sup>56</sup> Pinkerton, L. E. 2004. Mortality among a cohort of garment workers exposed to formaldehyde: an update. *Occup. Environ. Med.* 61: 193–200.

<sup>57</sup> Conolly, RB, JS Kimbell, D Janszen, PM Schlosser, D Kalisak, J Preston, and FJ Miller. 2003. Biologically motivated computational modeling of formaldehyde carcinogenicity in the F344 rat. *Tox. Sci.* 75: 432–447.

<sup>58</sup> Conolly, RB, JS Kimbell, D Janszen, PM Schlosser, D Kalisak, J Preston, and FJ Miller. 2004. Human respiratory tract cancer risks of inhaled formaldehyde: Dose-response predictions derived from biologically-motivated computational modeling of a combined rodent and human dataset. *Tox. Sci.* 82: 279–296.

<sup>59</sup> Chemical Industry Institute of Toxicology (CIIT). 1999. Formaldehyde: Hazard characterization and dose-response assessment for carcinogenicity by the route of inhalation. CIIT, September 28, 1999. Research Triangle Park, NC.



of these compounds, naphthalene, is discussed separately below.

Polycyclic aromatic hydrocarbons (PAHs) are a chemical subset of POM. In particular, EPA frequently obtains data on 16 of these POM compounds. Recent studies have found that maternal exposures to PAHs in a population of pregnant women were associated with several adverse birth outcomes, including low birth weight and reduced length at birth.<sup>68</sup> These studies are discussed in the Regulatory Impact Analysis.

#### g. Naphthalene

Naphthalene is a PAH compound consisting of two benzene rings fused together with two adjacent carbon atoms common to both rings. In 2004, EPA released an external review draft (External Review Draft, IRIS Reassessment of the Inhalation Carcinogenicity of Naphthalene, U.S. EPA. <http://www.epa.gov/iris>) of a reassessment of the inhalation carcinogenicity of naphthalene.<sup>69</sup> The draft reassessment completed external peer review in 2004 by Oak Ridge Institute for Science and Education.<sup>70</sup> Based on external comments, additional analyses are being considered. California EPA has also released a new risk assessment for naphthalene with a cancer unit risk estimate of  $3 \times 10^{-5}$  per  $\mu\text{g}/\text{m}^3$ .<sup>71</sup> The California EPA value was used in the 1999 NATA and in the analyses done for this rule. In addition, IARC has reevaluated naphthalene and re-classified it as Group 2B: possibly carcinogenic to humans.<sup>72</sup> The cancer data form the basis of an inhalation RfC of  $3 \mu\text{g}/\text{m}^3$ .<sup>73</sup> A low to medium confidence rating was given to this RfC, in part because it cannot be said with

certainty that this RfC will be protective for hemolytic anemia and cataracts, the more well-known human effects from naphthalene exposure.

#### h. Diesel Particulate Matter and Diesel Exhaust Organic Gases

In EPA's Diesel Health Assessment Document (HAD),<sup>74</sup> diesel exhaust was classified as likely to be carcinogenic to humans by inhalation at environmental exposures, in accordance with the revised draft 1996/1999 EPA cancer guidelines. A number of other agencies (National Institute for Occupational Safety and Health, the International Agency for Research on Cancer, the World Health Organization, California EPA, and the U.S. Department of Health and Human Services) have made similar classifications. EPA concluded in the Diesel HAD that it is not possible currently to calculate a cancer unit risk for diesel exhaust due to a variety of factors that limit the current studies, such as limited quantitative exposure histories in occupational groups investigated for lung cancer.

However, in the absence of a cancer unit risk, the EPA Diesel HAD sought to provide additional insight into the significance of the cancer hazard by estimating possible ranges of risk that might be present in the population. The possible risk range analysis was developed by comparing a typical environmental exposure level for highway diesel sources to a selected range of occupational exposure levels. The occupationally observed risks were then proportionally scaled according to the exposure ratios to obtain an estimate of the possible environmental risk. A number of calculations are needed to accomplish this, and these can be seen in the EPA Diesel HAD. The outcome was that environmental risks from diesel exhaust exposure could range from a low of  $10^{-4}$  to  $10^{-5}$  to as high as  $10^{-3}$ , reflecting the range of occupational exposures that could be associated with the relative and absolute risk levels observed in the occupational studies. Because of uncertainties, the analysis acknowledged that the risks could be lower than  $10^{-4}$  or  $10^{-5}$ , and a zero risk from diesel exhaust exposure was not ruled out.

The acute and chronic exposure-related effects of diesel exhaust emissions are also of concern to the Agency. EPA derived an RfC from consideration of four well-conducted

chronic rat inhalation studies showing adverse pulmonary effects.<sup>75 76 77 78</sup> The RfC is  $5 \mu\text{g}/\text{m}^3$  for diesel exhaust as measured by diesel PM. This RfC does not consider allergenic effects such as those associated with asthma or immunologic effects. There is growing evidence, discussed in the Diesel HAD, that diesel exhaust can exacerbate these effects, but the exposure-response data are presently lacking to derive an RfC.

The Diesel HAD also briefly summarizes health effects associated with ambient PM and the EPA's annual National Ambient Air Quality Standard (NAAQS) of  $15 \mu\text{g}/\text{m}^3$ . There is a much more extensive body of human data showing a wide spectrum of adverse health effects associated with exposure to ambient PM, of which diesel exhaust is an important component. The RfC is not meant to say that  $5 \mu\text{g}/\text{m}^3$  provides adequate public health protection for ambient  $\text{PM}_{2.5}$ . In fact, there may be benefits to reducing diesel PM below  $5 \mu\text{g}/\text{m}^3$  since diesel PM is a major contributor to ambient  $\text{PM}_{2.5}$ .

#### E. Gasoline PM

Beyond the specific areas of quantifiable risk discussed above in section III.C, EPA is also currently investigating gasoline PM. Gasoline exhaust is a complex mixture that has not been evaluated in EPA's IRIS, in contrast to diesel exhaust, which has been evaluated in IRIS. However, there is evidence for the mutagenicity and cytotoxicity of gasoline exhaust and gasoline PM. Seagrave *et al.* investigated the combined particulate and semivolatile organic fractions of gasoline engine emissions.<sup>79</sup> Their results demonstrate that emissions from gasoline engines are mutagenic and can induce inflammation and have cytotoxic effects. Gasoline exhaust is a ubiquitous

<sup>68</sup> Perara, F.P.; Rauh, V.; Tsai, W.-Y.; et al. (2002) Effect of transplacental exposure to environmental pollutants on birth outcomes in a multiethnic population. *Environ Health Perspect.* 111: 201–205.

<sup>69</sup> U.S. EPA. (2004) External Review Draft, IRIS Reassessment of the Inhalation Carcinogenicity of Naphthalene. <http://www.epa.gov/iris>

<sup>70</sup> Oak Ridge Institute for Science and Education. (2004) External Peer Review for the IRIS Reassessment of the Inhalation Carcinogenicity of Naphthalene. August 2004. <http://cfpub2.epa.gov/ncea/cfm/recordisplay.cfm?deid=86019>

<sup>71</sup> California EPA. (2004) Long Term Health Effects of Exposure to Naphthalene. Office of Environmental Health Hazard Assessment. [http://www.oehha.ca.gov/air/toxic\\_contaminants/draftnaphth.html](http://www.oehha.ca.gov/air/toxic_contaminants/draftnaphth.html)

<sup>72</sup> International Agency for Research on Cancer (IARC). (2002) Monographs on the Evaluation of the Carcinogenic Risk of Chemicals for Humans. Vol. 82. Lyon, France.

<sup>73</sup> EPA 2005 "Full IRIS Summary for Naphthalene (CASRN 91–20–3)" Environmental Protection Agency, Integrated Risk Information System (IRIS), Office of Health and Environmental Assessment, Environmental Criteria and Assessment Office, Cincinnati, OH <http://www.epa.gov/iris/subst/0436.htm>.

<sup>74</sup> U.S. EPA (2002) Health Assessment Document for Diesel Engine Exhaust. EPA/600/8–90/057F Office of Research and Development, Washington DC. This document is available electronically at <http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=29060>.

<sup>75</sup> Ishinishi, N; Kuwabara, N; Takaki, Y; et al. (1988) Long-term inhalation experiments on diesel exhaust. In: Diesel exhaust and health risks. Results of the HERP studies. Ibaraki, Japan: Research Committee for HERP Studies; pp. 11–84.

<sup>76</sup> Heinrich, U; Fuhst, R; Rittinghausen, S; et al. (1995) Chronic inhalation exposure of Wistar rats and two different strains of mice to diesel engine exhaust, carbon black, and titanium dioxide. *Inhal. Toxicol.* 7:553–556.

<sup>77</sup> Mauderly, J.L; Jones, R.K; Griffith, W.C; et al. (1987) Diesel exhaust is a pulmonary carcinogen in rats exposed chronically by inhalation. *Fundam. Appl. Toxicol.* 9:208–221.

<sup>78</sup> Nikula, K.J; Snipes, M.B; Barr, E.B; et al. (1995) Comparative pulmonary toxicities and carcinogenicities of chronically inhaled diesel exhaust and carbon black in F344 rats. *Fundam. Appl. Toxicol.* 25:80–94.

<sup>79</sup> Seagrave, J.; McDonald, J.D.; Gigliotti, A.P.; Nikula, K.J.; Seilkop, S.K.; Gurevich, M. and Mauderly, J.L. (2002) Mutagenicity and in Vivo Toxicity of Combined Particulate and Semivolatile Organic Fractions of Gasoline and Diesel Engine Emissions. *Toxicological Sciences* 70:212–226.

source of particulate matter, contributing to the health effects observed for ambient PM which is discussed extensively in the EPA Particulate Matter Criteria Document.<sup>80</sup> The PM Criteria Document notes that the PM components of gasoline and diesel engine exhaust are hypothesized, important contributors to the observed increases in lung cancer incidence and mortality associated with ambient PM<sub>2.5</sub>.<sup>81</sup> Gasoline PM is also a component of near-roadway emissions that may be contributing to the health effects observed in people who live near roadways (see section III.F).

EPA is working to improve the understanding of PM emissions from gasoline engines, including the potential range of emissions and factors that influence emissions. EPA led a cooperative test program that recently completed testing approximately 500 randomly procured vehicles in the Kansas City metropolitan area. The purpose of this study was to determine the distribution of gasoline PM emissions from the in-use light-duty fleet. Results from this study are expected to be available in 2006. Some source apportionment studies show gasoline and diesel PM can result in larger contributions to ambient PM than predicted by EPA emission inventories.<sup>82 83</sup> These source apportionment studies were one impetus behind the Kansas City study.

Another issue related to gasoline PM is the effect of gasoline vehicles and engines on ambient PM, especially secondary PM. Ambient PM is composed of primary PM emitted directly into the atmosphere and secondary PM that is formed from chemical reactions in the atmosphere. The issue of secondary organic aerosol formation from aromatic precursors is an important one to which EPA and others are paying significant attention. This is discussed in more detail in Section 1.4.1 of the RIA.

#### F. Near-Roadway Health Effects

Over the years there have been a large number of studies that have examined associations between living near major roads and different adverse health endpoints. These studies generally examine people living near heavily-trafficked roadways, typically within several hundred meters, where fresh emissions from motor vehicles are not yet fully diluted with background air.

Several studies have measured elevated concentrations of pollutants emitted directly by motor vehicles near road as compared to overall urban background levels. These elevated concentrations generally occur within approximately 200 meters of the road, although the distance may vary depending on traffic and environmental conditions. Pollutants measured with elevated concentrations include benzene, polycyclic aromatic hydrocarbons, carbon monoxide, nitrogen dioxide, black carbon, and coarse, fine, and ultrafine particulate matter. In addition, concentrations of road dust, and wear particles from tire and brake use also show concentration increases in proximity of major roadways.

The near-roadway health studies provide stronger evidence for some health endpoints than others. Evidence of adverse responses to traffic-related pollution is strongest for non-allergic respiratory symptoms, cardiovascular effects, premature adult mortality, and adverse birth outcomes, including low birth weight and size. Some evidence for new onset asthma is available, but not all studies have significant correlations. Lastly, among studies of childhood cancer, in particular childhood leukemia, evidence is inconsistent. Several small studies report positive associations, though such effects have not been observed in two larger studies. As described above, benzene and 1,3-butadiene are both known human leukemogens in adults. As previously mentioned, there is evidence of increased risk of leukemia among children whose parents have been occupationally exposed to benzene. Though the near-roadway studies are equivocal, taken together with the laboratory studies and other exposure environments, the data suggest a potentially serious children's health concern could exist. Additional research is needed to determine the significance of this potential concern.

Significant scientific uncertainties remain in our understanding of the relationship between adverse health effects and near-road exposure, including the exposures of greatest

concern, the importance of chronic versus acute exposures, the role of fuel type (e.g. diesel or gasoline) and composition (e.g., % aromatics), relevant traffic patterns, the role of co-stressors including noise and socioeconomic status, and the role of differential susceptibility within the "exposed" populations. For a more detailed discussion, see Chapter 3 of the Regulatory Impact Analysis.

These studies provide qualitative evidence that reducing emissions from on-road mobile sources will provide public health benefits beyond those that can be quantified using currently available information.

#### G. How Would This Proposal Reduce Emissions of MSATs?

The benzene and hydrocarbon standards proposed in this action would reduce benzene, 1,3-butadiene, formaldehyde, acrolein, polycyclic organic matter, and naphthalene, as well as many other hydrocarbon compounds that are emitted by motor vehicles, including those that are listed in Table III.B-1 and discussed in more detail in Chapter 1 of the RIA. The emission reductions expected from today's controls are reported in section V.E of this preamble and Chapter 2 of the RIA.

EPA believes that the emission reductions from the standards proposed today for motor vehicles and their fuels, combined with the standards currently in place, represent the maximum achievable reductions of emissions from motor vehicles through the application of technology that will be available, considering costs and the other factors listed in section 202(l)(2). This conclusion applies whether you consider just the compounds listed in Table III.B-1, or consider all of the compounds on the Master List of emissions, given the breadth of EPA's current and proposed control programs and the broad groups of emissions that many of the control technologies reduce.

EPA has already taken significant steps to reduce diesel emissions from mobile sources. We have adopted stringent standards for on-highway diesel trucks and buses, and nonroad diesel engines (engines used, for example, in construction, agricultural, and industrial applications). We also have additional programs underway to reduce diesel emissions, including voluntary programs and a proposal that is being developed to reduce emissions from diesel locomotives and marine engines.

Emissions from motor vehicles can be chemically categorized as hydrocarbons, trace elements (including metals) and a

<sup>80</sup> U.S. Environmental Protection Agency (2004) Air Quality Criteria for Particulate Matter. Research Triangle Park, NC: National Center for Environmental Assessment—RTP Office; Report No. EPA/600/P-99/002aF (PM Criteria Document).

<sup>81</sup> PM Criteria Document, p. 8-318.

<sup>82</sup> Fujita, E.; Watson, M.J.; Chow, M.C.; *et al.* (1998) Northern Front Range Air Quality Study, Volume C: Source apportionment and simulation methods and evaluation. Prepared for Colorado State University, Cooperative Institute for Research in the Atmosphere, by Desert Research Institute, Reno, NV.

<sup>83</sup> Schauer, J.J.; Rogge, W.F.; Hildemann, L.M.; *et al.* (1996) Source apportionment of airborne particulate matter using organic compounds as tracers. *Atmos. Environ.* 30(22):3837-3855.

few additional compounds containing carbon, nitrogen and/or halogens (e.g., chlorine). For the hydrocarbons, which are the vast majority of these compounds, we believe that with the controls proposed today, we would control the emissions of these compounds from motor vehicles to the maximum amount currently feasible or currently identifiable with available information. Section VI of this preamble provides more details about why the proposed and existing standards represent maximum achievable reduction of hydrocarbons from motor vehicles. There are not motor vehicle controls to reduce individual hydrocarbons selectively; instead, the maximum emission reductions are achieved by controls on hydrocarbons as a group. There are fuel controls that could selectively reduce individual air toxics (e.g., formaldehyde, acetaldehyde, 1,3-butadiene), as well as controls that reduce hydrocarbons more generally. Section VII of this preamble describes why the standards we are proposing today represent the maximum emission reductions achievable through fuel controls, considering the factors required by Clean Air Act section 202(l).

Motor vehicle emissions also contain trace elements, including metals, which originate primarily from engine wear and impurities in engine oil and gasoline or diesel fuel. EPA does not have authority to regulate engine oil, and there are no feasible motor vehicle controls to directly prevent engine wear. Nevertheless, oil consumption and engine wear have decreased over the years, decreasing emission of metals from these sources. Metals associated with particulate matter will be captured in emission control systems employing a particulate matter trap, such as heavy-duty vehicles meeting the 2007 standards. We believe that currently, particulate matter traps, in combination with engine-out control, represent the maximum feasible reduction of both motor vehicle particulate matter and toxic metals present as a component of the particulate matter.

The mobile source contribution to the national inventory for metal compounds is generally small. In fact, the emission rate for most metals from motor vehicles is small enough that quantitative measurement requires state-of-the-art analytical techniques that are only recently being applied to this source category. We have efforts underway to gather information regarding trace metal emissions, including mercury emissions, from motor vehicles (see Chapter 1 of the RIA for more details).

A few metals and other elements are used as fuel additives. These additives

are designed to reduce the emission of regulated pollutants either in combination with or without an emission control device (e.g., a passive particulate matter trap). Clean Air Act section 211 provides EPA with various authorities to regulate fuel additives in order to reduce the risk to public health from exposure to their emissions. It is under this section that EPA requires manufacturers to register additives before their introduction into commerce. Registration involves certain data requirements that enable EPA to identify products whose emissions may pose an unreasonable risk to public health. In addition, section 211 provides EPA with authority to require health effects testing to fill any gaps in the data that would prevent a determination regarding the potential for risk to the public. Clean Air Act section 211(c) provides the primary mechanism by which EPA would take actions necessary to minimize exposure to metals or other additives to diesel and gasoline. It is under section 211 that EPA is currently generating the information needed to update an assessment of the potential human health risks related to having manganese in the national fuel supply.

Existing regulations limit sulfur in gasoline and diesel fuel to the maximum amount feasible and will reduce emissions of all sulfur-containing compounds (e.g., hydrogen sulfide, carbon disulfide) to the greatest degree achievable.<sup>84 85 86</sup> For the remaining compounds (e.g., chlorinated compounds), we currently have very little information regarding emission rates and conditions that impact emissions. This information would be necessary in order to evaluate potential controls under section 202(l). Emissions of hydrocarbons containing chlorine (e.g., dioxins/furans) would likely be reduced with control measures that reduce total hydrocarbons, just as these emissions were reduced with the use of catalytic controls that lowered exhaust hydrocarbons.

#### **IV. What Are the Air Quality and Health Impacts of Air Toxics, and How Do Mobile Sources Contribute?**

##### *A. What Is the Health Risk to the U.S. Population from Inhalation Exposure to Ambient Sources of Air Toxics, and How Would It be Reduced by the Proposed Controls?*

EPA's National-Scale Air Toxics Assessment (NATA) assesses human

health impacts from chronic inhalation exposures to outdoor sources of air toxics. It assesses lifetime risks assuming continuous exposure to levels of air toxics estimated for a particular point in time. The most recent NATA was done for the year 1999.<sup>87</sup>

The NATA modeling framework has a number of limitations, but it remains very useful in identifying air toxic pollutants and sources of greatest concern. Among the significant limitations of the framework, which are discussed in more detail in the regulatory impact analysis, is that it cannot be used to reliably identify "hot spots," such as areas in immediate proximity to major roads, where the air concentration, exposure and/or risk might be significantly higher within a census tract<sup>88</sup> or county. These "hot spots" are discussed in more detail in section IV.B.2. The framework also does not account for risk from sources of air toxics originating indoors, such as stoves, out-gassing from building materials, or evaporative benzene emissions from cars in attached garages. There are also limitations associated with the dose-response values used to quantify risk; these are discussed in Section I of the preamble. Importantly, it should be noted that the 1999 NATA does not include default adjustments for early life exposures recently recommended in the Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens.<sup>89</sup> These adjustments would be applied to compounds which act through a mutagenic mode of action. EPA will determine as part of the IRIS assessment process which substances meet the criteria for making adjustments, and future assessments will reflect them. If warranted, incorporation of such adjustments would lead to higher estimates of risk assuming constant lifetime exposure.

Because of its limitations, EPA notes that the NATA assessment should not be used as the basis for developing risk reduction plans or regulations to control specific sources or pollutants. Additionally, this assessment should not be used for estimating risk at the local level, for quantifying benefits of reduced air toxic emissions, or for identifying localized hotspots. In this

<sup>87</sup> [www.epa.gov/ttn/atw/nata1999](http://www.epa.gov/ttn/atw/nata1999).

<sup>88</sup> A census tract is a subdivision of a county that typically contains roughly 4000 people. In urban areas, these tracts can be very small, on the order of a city block, whereas in rural areas, they can be large.

<sup>89</sup> U. S. EPA. (2005) Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens. Report No. EPA/630/R-03/003F. Available electronically at <http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=116283>.

<sup>84</sup> 65 FR 6697, February 10, 2000.

<sup>85</sup> 66 FR 5001, January 18, 2001.

<sup>86</sup> 69 FR 38958, June 29, 2004.

rule, we have evaluated air quality, exposure, and risk impacts of mobile source air toxics using the 1999 NATA, as well as projections of risk to future years using the same tools as 1999 NATA. In addition, we also evaluate more refined local scale modeling, measured ambient concentrations, personal exposure measurements, and other data. This information is discussed below, as well as in Chapter 3 of the RIA. It serves as a perspective on the possible risk-related implications of the rule.

Overall, the average nationwide lifetime population cancer risk in 1999 NATA was 42 in a million, assuming continuous exposure to 1999 levels. The average noncancer respiratory hazard index was 6.4.<sup>90</sup> Highway vehicles and nonroad equipment account for almost 50% of the average population cancer risk, and 74% of the noncancer risk. These estimates are based on the contribution of sources within 50 kilometers of a given emission point and do not include the contribution to ambient concentrations from transport beyond 50 kilometers. Ambient concentrations from transport beyond 50 kilometers, referred to as “background” in NATA, are responsible for almost 50% of the average cancer risk in NATA.

Section III.C.1 discusses the pollutants that the 1999 National-Scale Air Toxics Assessment identifies as national and regional risk drivers. As summarized in Table III.C-1, benzene is the only pollutant described as a national cancer risk driver. Twenty-four percent of the total cancer risk in the

1999 National-Scale Air Toxics Assessment was due to benzene. In 1999, 68% of nationwide benzene emissions were attributable to mobile sources. 1,3-Butadiene and naphthalene are regional cancer risk drivers that have a large mobile source contribution. As presented in Table III.C-2, 58% of nationwide 1,3-butadiene emissions in 1999 came from mobile sources. Twenty-seven percent of nationwide naphthalene emissions in 1999 came from mobile sources.

One compound, acrolein, was identified as a national risk driver for noncancer health effects, and 25% of primary acrolein emissions were attributable to mobile sources. Over 70% of the average ambient concentration of acrolein is attributable to mobile sources. This is due to the large contribution from mobile source 1,3-butadiene, which is transformed to acrolein in the atmosphere.

Table III.C-2 provides additional information on the mobile source contribution to emissions of national and regional risk drivers. The standards proposed in this rule will reduce emissions of all these pollutants.

In addition to the 1999 NATA, we have estimated future-year risks for those pollutants included in the 1999 NATA whose emissions inventories include a mobile source contribution (see Table IV.B-1). This analysis indicates that cancer and noncancer risk will continue to be a public health concern due to exposure to mobile-source-related pollutants.

Figure IV.A-1 summarizes changes in average population inhalation cancer risk for the MSATs in Table IV.A-1. Despite significant reductions in risk from these pollutants, average inhalation cancer risks are expected to remain well above 1 in 100,000. In addition, because of population growth (using projected populations from the

U.S. Bureau of Census), the number of Americans above the 1 in 100,000 cancer risk level from exposure to these mobile source air toxics is projected to increase from about 214 million in 1999 to 240 million in 2030. Benzene continues to account for a large fraction of the total inhalation cancer risk from mobile source air toxics, decreasing slightly from 45% of the risk in 1999 to 37% in 2030. Similarly, although the average noncancer respiratory hazard index for MSATs decreases from over 6 in 1999 to 3.2 in 2030, the population with a hazard index above one increases from 250 million in 1999 to 273 million in 2030. That is, in 2030 nearly the entire U.S. population will still be exposed to levels of these pollutants that have the potential to cause adverse respiratory health effects (other than cancer).

These projected risks were estimated using the same tools and methods as the 1999 NATA, but with future-year projected inventories. More detailed information on the methods used to do these projections, and associated limitations and uncertainties, can be found in Chapter 3 of the RIA for this rule. Projected risks assumed 1999 “background” levels. For MSATs, “background” accounts for slightly less than 20% of the average cancer risk in 1999, increasing to 24% in 2030. However, background levels should decrease along with emissions. A sensitivity analysis of this assumption is presented in Chapter 3 of the RIA. It should also be noted that the projected inventories used for this modeling do not include some more recent revisions, such as higher emissions of hydrocarbons, including gaseous air toxics, at cold temperatures. These revisions are discussed in section V and increase the overall magnitude of the inventory.

<sup>90</sup> A hazard index above 1 indicates the potential for adverse health effects. It cannot be translated into a probability that an adverse effect will occur, and is not likely to be proportional to risk. A hazard index greater than one can be best described as only indicating that a potential may exist for adverse health effects.

Figure IV.A-1. Trends in Nationwide Average Population Cancer Risk from Inhalation Exposure to Outdoor Sources of Mobile Source Air Toxics, 1999 to 2030

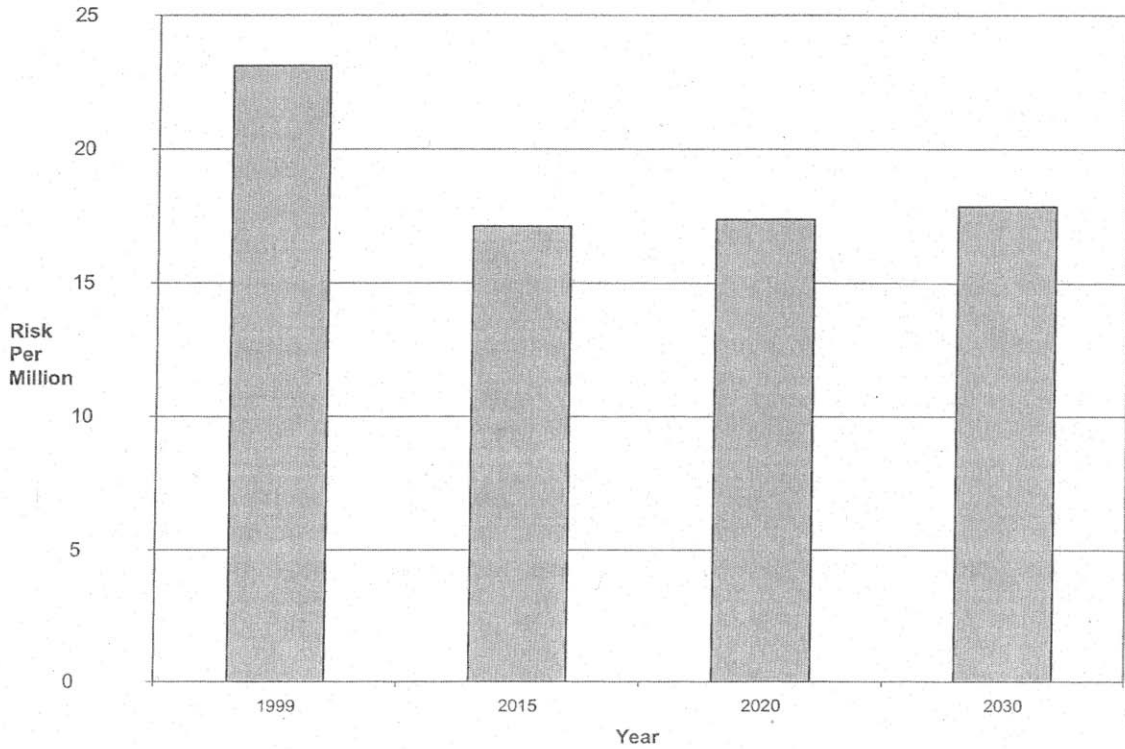


TABLE IV.A-1.—POLLUTANTS INCLUDED IN RISK MODELING FOR PROJECTION YEARS \*

1,3-Butadiene .....	Ethyl Benzene
2,2,4-Trimethylpentane ....	Fluoranthene **
Acenaphthene ** .....	Fluorene **
Acenaphthylene ** .....	Formaldehyde
Acetaldehyde .....	Hexane
Acrolein .....	Indeno(1,2,3,c,d)-pyrene **
Anthracene ** .....	Manganese
Benzene .....	Methyl tert-butyl ether (MTBE)
Benz(a)anthracene ** .....	Naphthalene
Benzo(a)pyrene ** .....	Nickel
Benzo(b)fluoranthene ** ...	Phenanthrene **
Benzo(g,h,i)perylene ** .....	Propionaldehyde
Benzo(k)fluoranthene ** ...	Pyrene **
Chromium (includes Chromium III, Chromium VI, and non-speciated Chromium).	Styrene
Chrysene ** .....	Toluene

TABLE IV.A-1.—POLLUTANTS INCLUDED IN RISK MODELING FOR PROJECTION YEARS \*—Continued

Dibenzo(a,h)anthracene **	Xylenes
* This list includes compounds from the 1999 National-Scale Air Toxics Assessment with a mobile source emissions contribution, for which data were sufficient to develop an emissions inventory.	
** POM compound as discussed in Section III.	
<i>B. What Is the Distribution of Exposure and Risk?</i>	
1. Distribution of National-Scale Estimates of Risk From Air Toxics	
National-scale modeling indicates that 95th percentile average cancer risk from exposure to mobile source air toxics is more than three times higher than median risk. In addition, the 95th percentile cancer risk is more than 10 times higher than the 5th percentile risk. This is true for all years modeled,	

from 1999 to 2030. Table IV.B-1 gives the median and 5th and 95th percentile cancer risk distributions for mobile source air toxics. As previously mentioned, the tools used in this assessment are inadequate for identifying “hot spots” and do not account for significant sources of inhalation exposure, such as benzene emissions within attached garages from vehicles, equipment, and portable fuel containers. If these hot spots and additional sources of exposure were accounted for, a larger percentage of the population would be exposed to higher risk levels. (Sections IV.B.2-4 provides more details on “hot spots” and the implications for distribution of risk.) In addition, the modeling underestimates the contribution of hydrocarbon and particulate matter emissions at cold temperatures. These modeling results are discussed in more detail in Chapter 3 of the RIA.

TABLE IV.B—1.—MEDIAN AND 5TH AND 95TH PERCENTILE LIFETIME INHALATION CANCER RISK DISTRIBUTIONS FOR INHALATION EXPOSURE TO OUTDOOR SOURCES OF MOBILE SOURCE AIR TOXICS

[Based on modeled average census tract risks]

Pollutant	1999			2020		
	5th	Median	95th	5th	Median	95th
All MSATs .....	$4.0 \times 10^{-6}$	$1.9 \times 10^{-5}$	$5.9 \times 10^{-5}$	$3.6 \times 10^{-6}$	$1.3 \times 10^{-5}$	$4.4 \times 10^{-5}$
Benzene .....	$2.4 \times 10^{-6}$	$8.9 \times 10^{-6}$	$2.5 \times 10^{-5}$	$2.1 \times 10^{-6}$	$5.6 \times 10^{-6}$	$1.4 \times 10^{-5}$
1,3-Butadiene .....	$1.6 \times 10^{-7}$	$3.1 \times 10^{-6}$	$1.2 \times 10^{-5}$	$7.5 \times 10^{-8}$	$2.0 \times 10^{-6}$	$7.5 \times 10^{-6}$
Acetaldehyde .....	$1.0 \times 10^{-6}$	$2.5 \times 10^{-6}$	$6.9 \times 10^{-6}$	$9.3 \times 10^{-7}$	$1.6 \times 10^{-6}$	$3.6 \times 10^{-6}$
Naphthalene .....	$1.1 \times 10^{-7}$	$1.4 \times 10^{-6}$	$7.6 \times 10^{-6}$	$1.0 \times 10^{-7}$	$1.4 \times 10^{-6}$	$8.5 \times 10^{-6}$

## 2. Elevated Concentrations and Exposure in Mobile Source-Impacted Areas

Air quality measurements near roads often identify elevated concentrations of air toxic pollutants at these locations. The concentrations of air toxic pollutants near heavily trafficked roads, as well as the pollutant composition and characteristics, differ from those measured distant from heavily trafficked roads. Exposures for populations residing, working, or going to school near major roads are likely higher than for other populations. The vehicle and fuel standards proposed in this rule will reduce those elevated exposures. Following is an overview of concentrations of air toxics and exposure to air toxics in areas heavily impacted by mobile source emissions.

### a. Concentrations Near Major Roadways

The 1999 NATA estimates average concentrations within a census tract, but it does not differentiate between locations near roadways and those further away (within the same tract). Local-scale modeling can better characterize distributions of concentrations, using more refined allocation of highway vehicle emissions. Urban-scale assessments done in Houston, TX and Portland, OR illustrated steep gradients of air toxic concentrations along major roadways, as well as better agreement with monitor data.<sup>91–92 93</sup> Results of the Portland study show average concentrations of motor vehicle-related pollutants are ten times higher at 50 meters from a road than they are at greater than 400 meters a road. These findings are consistent with pollutant dispersion theory, which

<sup>91–92</sup> Kinnee, E.J.; Touma, J.S.; Mason, R.; Thurman, J.; Beidler, A.; Bailey, C.; Cook, R. (2004) Allocation of onroad mobile emissions to road segments for air toxics modeling in an urban area. Transport. Res. Part D 9: 139–150.

<sup>93</sup> Cohen, J.; Cook, R.; Bailey, C.R.; Carr, E. (2005) Relationship between motor vehicle emissions of hazardous pollutants, roadway proximity, and ambient concentrations in Portland, Oregon. Environ. Modelling & Software 20: 7–12.

predicts that pollutants emitted along roadways will show highest concentrations nearest a road, and concentrations exponentially decrease with increasing distance downwind. These near-road pollutant gradients have been confirmed by measurements of both criteria pollutants and air toxics, and they are discussed in detail in Chapter 3 of the RIA.

Air quality monitoring is another means of evaluating pollutant concentrations at locations near sources such as roadways. It is also used to evaluate model performance at a given point and, given adequate data quality, can be statistically analyzed to determine associations with different source types. EPA has been deploying fixed-site ambient monitors that monitor concentrations of multiple air toxics, including benzene, over time. Several studies have found that concentrations of benzene and other mobile source air toxics are significantly elevated near busy roads compared to “urban background” concentrations measured at a fixed site. These studies are discussed in detail in Chapter 3 of the RIA.

Ambient VOC concentrations were measured around residences in Elizabeth, NJ, as part of the Relationship among Indoor, Outdoor, and Personal Air (RIOPA) study. Data from that study was analyzed to assess how concentrations are influenced by proximity to known ambient emission sources.<sup>94 95</sup> The ambient concentrations of benzene, toluene, ethylbenzene, and xylene isomers (BTEX) were found to be

<sup>94</sup> Kwon, J. (2005) Development of a RIOPA database and evaluation of the effect of proximity on the potential residential exposure to VOCs from ambient sources. Rutgers, the State University of New Jersey and University of Medicine and Dentistry of New Jersey. PhD dissertation. This document is available in Docket EPA–HQ–OAR–2005–0036.

<sup>95</sup> Weisel, C.P. (2004) Assessment of the contribution to personal exposures of air toxics from mobile sources. Final report. Submitted to EPA Office of Transportation and Air Quality. Environmental & Occupational Health Sciences Institute, Piscataway, NJ. This document is available in Docket EPA–HQ–OAR–2005–0036.

inversely associated with distances to interstate highways and major urban roads, and with distance to gasoline stations. The data indicate that BTEX concentrations around homes within 200 meters of roadways and gas stations are 1.5 to 4 times higher than urban background levels.

### b. Exposures Near Major Roadways

The modeling assessments and air quality monitoring studies discussed above have increased our understanding of ambient concentrations of mobile source air toxics and potential population exposures. Results from the following exposure studies reveal that populations spending time near major roadways likely experience elevated personal exposures to motor vehicle related pollutants. In addition, these populations may experience exposures to differing physical and chemical compositions of certain air toxic pollutants depending on the amount of time spent in close proximity to motor vehicle emissions. Following is a detailed discussion on exposed populations near major roadways.

#### i. Vehicles

Several studies suggest that significant exposures may be experienced while driving in vehicles. A recent in-vehicle monitoring study was conducted by EPA and consisted of in-vehicle air sampling throughout work shifts within ten police patrol cars used by the North Carolina State Highway Patrol (smoking not permitted inside the vehicles).<sup>96</sup> Troopers operated their vehicles in typical patterns, including highway and city driving and refueling. In-vehicle benzene concentrations averaged  $12.8 \mu\text{g}/\text{m}^3$ , while concentrations measured at an “ambient” site located outside a nearby state environmental office averaged  $0.32 \mu\text{g}/\text{m}^3$ . The study also found that the benzene concentrations were closely

<sup>96</sup> Riediker, M.; Williams, R.; Devlin, R.; et al. (2003) Exposure to particulate matter, volatile organic compounds, and other air pollutants inside patrol cars. Environ. Sci. Technol. 37: 2084–2093.

associated with other fuel-related VOCs measured.

In Boston, the exposure of commuters to VOCs during various commuting modes was examined.<sup>97</sup> For commuters driving a car, the mean time-weighted concentrations of benzene, toluene, and xylenes in-vehicle were measured at 17.0, 33.1, and 28.2  $\mu\text{g}/\text{m}^3$ , respectively.

The American Petroleum Institute funded a screening study of high-end exposure microenvironments as required by section 211(b) of the Clean Air Act.<sup>98</sup> The study included vehicle chase measurements and measurements in several vehicle-related microenvironments in several cities for benzene and other air toxics. In-vehicle microenvironments (average benzene concentrations in parentheses) included the vehicle cabin tested on congested freeways (17.5  $\mu\text{g}/\text{m}^3$ ), in parking garages above-ground (155  $\mu\text{g}/\text{m}^3$ ) and below-ground (61.7  $\mu\text{g}/\text{m}^3$ ), in urban street canyons (7.54  $\mu\text{g}/\text{m}^3$ ), and during refueling (46.0  $\mu\text{g}/\text{m}^3$ ).

In 1998, the California Air Resources Board published an extensive study of concentrations of in-vehicle air toxics in Los Angeles and Sacramento, CA.<sup>99</sup> The data set is large and included a variety of sampling conditions. On urban freeways, benzene in-vehicle concentrations ranged from 3 to 15  $\mu\text{g}/\text{m}^3$  in Sacramento and 10 to 22  $\mu\text{g}/\text{m}^3$  in Los Angeles. In comparison, ambient benzene concentrations ranged from 1 to 3  $\mu\text{g}/\text{m}^3$  in Sacramento and 3 to 7  $\mu\text{g}/\text{m}^3$  in Los Angeles.

Similar findings of elevated concentrations of pollutants have also been found in studies done in diesel buses.<sup>100 101 102</sup>

Overall, these studies show that concentrations experienced by

commuters and other roadway users are substantially higher than those measured in typical urban air. As a result, the time a person spends in a vehicle will significantly affect their overall exposure.

#### ii. Homes and Schools

The proximity of schools to major roads may result in elevated exposures for children due to potentially increased concentrations indoors and increased exposures during outdoor activities. Here we discuss international studies in addition to the limited number of U.S. studies, because while fleets and fuels outside the U.S. can differ significantly, the spatial distribution of concentrations is relevant.

In the Fresno Asthmatic Children's Environment Study (FACES), traffic-related pollutants were measured on selected days from July 2002 to February 2003 at a central site, and inside and outside of homes and outdoors at schools of asthmatic children.<sup>103</sup> Preliminary data indicate that PAH concentrations are higher at elementary schools located near primary roads than at elementary schools distant from primary roads (or located near primary roads with limited access). PAH concentrations also appear to increase with increase in annual average daily traffic on nearest major collector. Remaining results regarding the variance in traffic pollutant concentrations at schools in relation to proximity to roadways and traffic density will be available in 2006.

The East Bay Children's Respiratory Health Study studied traffic-related air pollution outside of schools near busy roads in the San Francisco Bay Area in 2001.<sup>104</sup> Concentrations of the traffic pollutants  $\text{PM}_{10}$ ,  $\text{PM}_{2.5}$ , black carbon, total  $\text{NO}_x$ , and  $\text{NO}_2$  were measured at 10 school sites in neighborhoods that spanned a busy traffic corridor during the spring and fall seasons. The school sites were selected to represent a range of locations upwind and downwind of major roads. Differences were observed in concentrations between schools nearby (< 300 m) versus those more distant (or upwind) from major roads. Investigators found spatial variability in exposure to black carbon,  $\text{NO}_x$ ,  $\text{NO}$ , and (to a lesser extent)  $\text{NO}_2$ , due specifically to roads with heavy traffic within a relatively small geographic area.

<sup>103</sup> Personal communication with FACES Investigators Fred Lurmann, Paul Roberts, and Katharine Hammond. Data is currently being prepared for publication.

<sup>104</sup> Kim J.J.; Smorodinsky S.; Lipsett M.; et al. (2004) Traffic-related air pollution near busy roads. *Am. J. Respir. Crit. Care Med.* 170: 520–526.

A study to assess children's exposure to traffic-related air pollution while attending schools near motorways was performed in the Netherlands.<sup>105</sup> Investigators measured  $\text{PM}_{2.5}$ ,  $\text{NO}_2$  and benzene inside and outside of 24 schools located within 400 m of motorways. The indoor average benzene concentration was 3.2  $\mu\text{g}/\text{m}^3$  with a range of 0.6–8.1  $\mu\text{g}/\text{m}^3$ . The outdoor average benzene concentration was 2.2  $\mu\text{g}/\text{m}^3$  with a range of 0.3–5.0  $\mu\text{g}/\text{m}^3$ . Overall results indicate that indoor pollutant concentrations are significantly correlated with traffic density and composition, percentage of time downwind, and distance from major roadways.

The Toxic Exposure Assessment—Columbia/Harvard (TEACH) study measured the concentrations of VOCs,  $\text{PM}_{2.5}$ , black carbon, and metals outside the homes of high school students in New York City.<sup>106</sup> The study was conducted during winter and summer of 1999 on 46 students and their homes. Average winter (and summer) indoor concentrations exceeded outdoor concentrations by a factor of 2.3 (1.3). In addition, analyses of spatial and temporal patterns of MTBE concentrations were consistent with traffic patterns. MTBE is a tracer for motor vehicle pollution.

Children are exposed to elevated levels of air toxics not only in their homes, classrooms, and outside on school grounds, but also during their commute to school. See the discussion of in-vehicle concentrations of air toxics above and in Chapter 3 of the RIA.

#### iii. Pedestrians and Bicyclists

Researchers have noted that pedestrians and cyclists along major roads experience elevated exposures to motor vehicle related pollutants. Although commuting near roadways leads to higher levels of exposure to traffic pollutants, the general consensus is that exposure levels of those commuting by walking or biking is lower than for those who travel by car or bus, (see discussion on in-vehicle exposure in previous section above). These studies are discussed in Chapter 3 of the RIA for this rule.

<sup>105</sup> Janssen, N.A.H.; van Vliet, P.H.N.; Aarts, F.; et al. (2001) Assessment of exposure to traffic related air pollution of children attending schools near motorways. *Atmos. Environ.* 35: 3875–3884.

<sup>106</sup> Kinney, P.L.; Chillrud, S.N.; Ramstrom, S.; et al. (2002) Exposures to multiple air toxics in New York City. *Environ Health Perspect.* 110 (Suppl 4): 539–546.

<sup>97</sup> Chan C.-C., Spengler J. D., Ozkaynak H., and Lefkopoulou M. (1991) Commuter Exposures to VOCs in Boston, Massachusetts. *J. Air Waste Manage. Assoc.* 41: 1594–1600.

<sup>98</sup> Zielinska, B.; Fujita, E.M.; Sagebiel, J.C.; et al. (2002) Interim data report for Section 211(B) Tier 2 high end exposure screening study of baseline and oxygenated gasoline. Prepared for American Petroleum Institute, November 19, 2002. This document is available in Docket EPA-HQ-OAR-2005-0036.

<sup>99</sup> Rodes, C.; Sheldon, L.; Whitaker, D.; et al. (1998) Measuring concentrations of selected air pollutants inside California vehicles. Final report to California Air Resources Board. Contract No. 95–339.

<sup>100</sup> Fitz, D.R.; Winer, A.M.; Colome, S.; et al. (2003) Characterizing the Range of Children's Pollutant Exposure During School Bus Commutes. Prepared for the California Resources Board.

<sup>101</sup> Sabin, L.D.; Behrentz, E.; Winer, A.M.; et al. (2005) Characterizing the range of children's air pollutant exposure during school bus commutes. *J. Expos. Anal. Environ. Epidemiol.* 15: 377–387.

<sup>102</sup> Batterman, S.A.; Peng, C.Y.; and Braun, J. (2002) Levels and composition of volatile organic compounds on commuting routes in Detroit, Michigan. *Atmos. Environ.* 36: 6015–6030.

### c. Exposure and Concentrations in Homes with Attached Garages

People living in homes with attached garages are potentially exposed to substantially higher concentrations of benzene, toluene, and other VOCs indoors. Homes with attached garages present a special concern related to infiltration of components of fuel, exhaust, and other materials stored in garages (including gasoline in gas cans). A study from the early 1980's found that approximately 30% of an average nonsmoker's benzene exposure originated from sources in attached garages.<sup>107</sup>

Concentrations within garages are often substantially higher than those found outdoors or indoors. A recently-completed study in Michigan found that average concentrations in residential garages were 36.6  $\mu\text{g}/\text{m}^3$ , compared to 0.4  $\mu\text{g}/\text{m}^3$  outdoors.<sup>108</sup> A recent study in Alaska, where fuel benzene concentrations are higher, cold start emissions are higher, and homes are more tightly sealed than in most of the U.S., found average garage concentrations of 101  $\mu\text{g}/\text{m}^3$ .<sup>109</sup> Air passing from these high-benzene locations can cause increased concentrations indoors.

Measurement studies have found that homes with attached garages can have significantly higher concentrations of benzene and other VOCs. One study from Alaska found that in homes without attached garages, average benzene concentrations were 8.6  $\mu\text{g}/\text{m}^3$ , while homes with attached garages had average concentrations of 70.8  $\mu\text{g}/\text{m}^3$ .<sup>110</sup> Another showed that indoor CO and total hydrocarbon (THC) concentrations rose sharply following a cold vehicle starting and pulling out of the attached garage, persisting for an hour or more.<sup>111</sup> The study also showed that cold start emissions accounted for 13–85% of indoor non-methane

<sup>107</sup> Wallace, L. (1996) Environmental exposure to benzene: an update. *Environ Health Perspect.* 104 (Suppl 6): 1129–1136.

<sup>108</sup> Batterman, S.; Hatzivasilis, G.; Jia, C. (2006) Concentrations and emissions of gasoline and other vapors from residential vehicle garages. *Atmos. Environ.* 30: 1828–1844.

<sup>109</sup> George, M.; Kaluza, P.; Maxwell, B.; Moore, G.; Wisdom, S. (2002) Indoor air quality & ventilation strategies in new homes in Alaska. Alaska Building Science Network. [www.cchrc.org](http://www.cchrc.org). This document is available in Docket EPA-HQ-OAR-2005-0036.

<sup>110</sup> Schlapia, A.; Morris, S. (1998) Architectural, behavioral, and environmental factors associated with VOCs in Anchorage homes. Proceedings of the Air & Waste Management Associations 94th Annual Conference. Paper 98-A504.

<sup>111</sup> Graham, L.A.; Noseworthy, L.; Fugler, D.; O'Leary, K.; Karman, D.; Grande, C. (2004) Contribution of vehicle emissions from an attached garage to residential indoor air pollution levels. *J. Air & Waste Manage. Assoc.* 54: 563–584.

hydrocarbons (NMHC), while hot soak emissions accounted for 9–71% of indoor NMHC. Numerous other studies have shown associations between VOCs in indoor air and the presence of attached garages. These studies are discussed in Chapter 3 of the RIA.

EPA has conducted a modeling analysis to examine the influence of attached garages on personal exposure to benzene.<sup>112</sup> The analysis modeled the air flow between the outdoor environment, indoor environment, and the garage, and accounted for the fraction of home air intake from the garage. Compared to national average exposure concentrations of 1.36  $\mu\text{g}/\text{m}^3$  modeled for 1999 in the National-Scale Air Toxics Assessment, which do not account for emissions originating in attached garages, average exposure concentrations for people with attached garages could more than double. For additional details, see Chapter 3 of the RIA.

Overall, emissions of VOCs within attached garages result in substantially higher concentrations of benzene and other pollutants indoors. Proposed reductions in fuel benzene content, new standards for cold temperature exhaust emissions during vehicle starts, and reduced emissions from gas cans are all expected to significantly reduce this major source of exposure.

### d. Occupational Exposure

Occupational settings can be considered a microenvironment in which exposure to benzene and other air toxics can occur. Occupational exposures to benzene from mobile sources or fuels can be several orders of magnitude greater than typical exposures in the non-occupationally exposed population. Several key occupational groups include workers in fuel distribution, storage, and tank remediation; handheld and non-handheld equipment operators; and workers who operate gasoline-powered engines such as snowmobiles and ATV's. Exposures in these occupational settings are discussed in Chapter 3 of the RIA.

In addition, some occupations require that workers spend considerable time in vehicles, which increases the time they spend in a higher-concentration microenvironment. In-vehicle concentrations are discussed in a previous section above.

<sup>112</sup> Bailey, C. (2005) Additional contribution to benzene exposure from attached garages. Memorandum to the Docket. This document is available in Docket EPA-HQ-OAR-2005-0036.

### 3. What Are the Size and Characteristics of Highly Exposed Populations?

A study of the populations in three states (Colorado, Georgia, and New York) indicated that more than half of the population lives within 200 meters of a major road.<sup>113</sup> In addition, analysis of data from the Census Bureau's American Housing Survey suggests that approximately 37 million people live within 300 feet of a 4- or more lane highway, railroad, or airport. American Housing Survey statistics, as well as epidemiology studies, indicate that those houses sited near major transportation sources are more likely to be lower in income or have minority residents than houses not located near major transportation sources. These data are discussed in detail in Chapter 3 of the RIA.

Other population studies also indicate that a significant fraction of the population resides in locations near major roads. At present, the available studies use different indicators of "major road" and of "proximity," but the estimates range from 12.4% of student enrollment in California attending schools within 150 meters of roads with 25,000 vehicles per day or more, to 13% of Massachusetts veterans living within 50 meters of a road with at least 10,000 vehicles per day.<sup>114 115</sup> Using a more general definition of a "major road," between 22% and 51% of different study populations live near such roads.

### 4. What Are the Implications for Distribution of Individual Risk?

We have made revisions to HAPEM5, which is the exposure model used in our national-scale modeling, in order to account for near-road impacts. The effect of the updated model is best understood as widening the distribution of exposure, with a larger fraction of the population being exposed to higher benzene concentrations. Including the effects of residence locations near roads can result in exposures to some individuals that are up to 50% higher than those predicted by HAPEM5.

The revised model, HAPEM6, was run for three states representing different parts of the country. These areas are intended to represent different

<sup>113</sup> Major roads are defined as those roads defined by the U.S. Census as one of the following: "limited access highway," "highway," "major road," or "ramp."

<sup>114</sup> Green, R.S.; Smorodinsky, S.; Kim, J.J.; McLaughlin, R.; Ostro, B. (2004) Proximity of California public schools to busy roads. *Environ. Health Perspect.* 112: 61–66.

<sup>115</sup> Garshick, E.; Laden, F.; Hart, J.E.; Caron, A. (2003) Residence near a major road and respiratory symptoms in U.S. veterans. *Epidemiol.* 14: 728–736.



geographies, development patterns, and housing densities. The states modeled include Georgia, Colorado, and New York. Overall, these study results indicate that proximity to major roads can significantly increase personal exposure for populations living near major roads. These modeling tools will be extended to a national scale for the final rulemaking.

For details on the modeling study with HAPEM6, refer to Chapter 3.2 of the RIA. We used geographic information systems to estimate the population within each U.S. census tract living at various distances from a major road (within 75 meters; between 75 and 200 meters; or beyond 200 meters). An exposure gradient was determined for people living in each zone, based on dispersion modeling.<sup>116</sup> These gradients were confirmed with monitoring studies funded by EPA.<sup>117</sup> The HAPEM5 model was updated to account for elevated concentrations within these defined distances from roadways and the population living in these areas.

### C. Ozone

While the focus of this rule is on air toxics, the proposed vehicle and gas can standards will also help reduce volatile organic compounds (VOCs), which are precursors to ozone.

#### 1. Background

Ground-level ozone, the main ingredient in smog, is formed by the reaction of VOCs and nitrogen oxides (NO<sub>x</sub>) in the atmosphere in the presence of heat and sunlight. These pollutants, often referred to as ozone precursors, are emitted by many types of pollution sources, such as highway and nonroad motor vehicles and engines, power plants, chemical plants, refineries, makers of consumer and commercial products, industrial facilities, and smaller "area" sources. VOCs can also be emitted by natural sources such as vegetation. The gas can controls proposed in this action would help reduce VOC emissions by reducing evaporation, permeation and spillage from gas cans. The proposed vehicle

controls will also reduce VOC emissions; however, because these reductions will occur at cold temperatures the ozone benefits will be limited.

The science of ozone formation, transport, and accumulation is complex.<sup>118</sup> Ground-level ozone is produced and destroyed in a cyclical set of chemical reactions, many of which are sensitive to temperature and sunlight. When ambient temperatures and sunlight levels remain high for several days and the air is relatively stagnant, ozone and its precursors can build up and result in more ozone than typically would occur on a single high-temperature day. Further complicating matters, ozone also can be transported into an area from pollution sources found hundreds of miles upwind, resulting in elevated ozone levels even in areas with low VOC or NO<sub>x</sub> emissions. As a result, differences in VOC and NO<sub>x</sub> emissions contribute to daily, seasonal, and yearly differences in ozone concentrations across different locations.

The current ozone National Ambient Air Quality Standards (NAAQS) has an 8-hour averaging time. The 8-hour ozone NAAQS, established by EPA in 1997, is based on well-documented science demonstrating that more people were experiencing adverse health effects at lower levels of exertion, over longer periods, and at lower ozone concentrations than addressed by the previous one-hour ozone NAAQS. It addresses ozone exposures of concern for the general population and populations most at risk, including children active outdoors, outdoor workers, and individuals with pre-existing respiratory disease, such as asthma. The 8-hour ozone NAAQS is met at an ambient air quality monitoring site when the average of the annual fourth-highest daily maximum 8-hour average ozone concentration over three years is less than or equal to 0.084 ppm.

#### 2. Health Effects of Ozone

The health and welfare effects of ozone are well documented and are critically assessed in the EPA ozone criteria document (CD) and EPA staff paper.<sup>119</sup> In August 2005, the EPA

released the second external review draft of a new ozone CD which is scheduled to be released in final form in February 2006.<sup>121</sup> This document summarizes the findings of the 1996 ozone criteria document and critically assesses relevant new scientific information which has emerged in the past decade. Additional information on health and welfare effects of ozone can also be found in the draft RIA for this proposal.

Ozone can irritate the respiratory system, causing coughing, throat irritation, and/or uncomfortable sensation in the chest. Ozone can reduce lung function and make it more difficult to breathe deeply, and breathing may become more rapid and shallow than normal, thereby limiting a person's normal activity. Ozone can also aggravate asthma, leading to more asthma attacks that require a doctor's attention and/or the use of additional medication. In addition, ozone can inflame and damage the lining of the lungs, which may lead to permanent changes in lung tissue, irreversible reductions in lung function, and a lower quality of life if the inflammation occurs repeatedly over a long time period. People who are of particular concern with respect to ozone exposures include children and adults who are active outdoors. Those people particularly susceptible to ozone effects are people with respiratory disease (e.g., asthma), people with unusual sensitivity to ozone, and children.

There has been new research that suggests additional serious health effects beyond those that had been known when the 1996 ozone CD was published. Since then, over 1,700 new ozone-related health and welfare studies have been published in peer-reviewed journals.<sup>122</sup> Many of these studies have investigated the impact of ozone exposure on such health effects as changes in lung structure and biochemistry, inflammation of the lungs, exacerbation and causation of asthma, respiratory illness-related school absence, hospital and emergency room visits for asthma and other respiratory causes, and premature

Paper, EPA-452/R-96-007. This document is available in Docket EPA-HQ-OAR-2005-0036.

<sup>121</sup> U.S. EPA (2005) Air Quality Criteria for Ozone and Related Photochemical Oxidants (Second External Review Draft). This document is available in Docket EPA-HQ-OAR-2005-0036.

<sup>122</sup> New Ozone Health and Environmental Effects References, Published Since Completion of the Previous Ozone AQCD, National Center for Environmental Assessment, Office of Research and Development, U.S. Environmental Protection Agency, Research Triangle Park, NC 27711 (7/2002). This document is available in Docket EPA-HQ-OAR-2005-0036.

<sup>116</sup> Cohen, J.; Cook, R.; Bailey, C.R.; Carr, E. (2005) Relationship between motor vehicle emissions of hazardous pollutants, roadway proximity, and ambient concentrations in Portland, Oregon. *Environ Modelling & Software* 20: 7-12.

<sup>117</sup> Kwon, J. (2005) Development of a RIOPA database and evaluation of the effect of proximity on the potential residential exposure to VOCs from ambient sources. PhD Dissertation, Rutgers, The State University of New Jersey and University of Medicine and Dentistry of New Jersey. Written under direction of Dr. Clifford Weisel. This document is available in Docket EPA-HQ-OAR-2005-0036.

<sup>118</sup> U.S. EPA (1996). Air Quality Criteria for Ozone and Related Photochemical Oxidants, EPA600-P-93-004aF. This document is available in Docket EPA-HQ-OAR-2005-0036.

<sup>119</sup> U.S. EPA (1996). Air Quality Criteria for Ozone and Related Photochemical Oxidants, EPA600-P-93-004aF. This document is available in Docket EPA-HQ-OAR-2005-0036.

<sup>120</sup> U.S. EPA (1996) Review of National Ambient Air Quality Standards for Ozone, Assessment of Scientific and Technical Information, OAQPS Staff

mortality. EPA is currently in the process of evaluating these and other studies as part of the ongoing review of the air quality criteria document and NAAQS for ozone. Key new health information falls into four general areas: development of new-onset asthma, hospital admissions for young children, school absence rate, and premature mortality.

Aggravation of existing asthma resulting from short-term ambient ozone exposure was reported prior to the 1997 NAAQS standard and has been observed in studies published subsequently.<sup>123 124</sup> In addition, a relationship between long-term ambient ozone concentrations and the incidence of new-onset asthma in adult males (but not in females) was reported by McDonnell et al. (1999).<sup>125</sup> Subsequently, an additional study suggests that incidence of new diagnoses of asthma in children is associated with heavy exercise in communities with high concentrations (*i.e.*, mean 8-hour concentration of 59.6 parts per billion (ppb) or greater) of ozone.<sup>126</sup> This relationship was documented in children who played 3 or more sports and thus spent more time outdoors. It was not documented in those children who played one or two sports.

Previous studies have shown relationships between ozone and hospital admissions in the general population. A study in Toronto reported a significant relationship between 1-hour maximum ozone concentrations and respiratory hospital admissions in children under the age of two.<sup>127</sup> Given the relative vulnerability of children in this age category, there is particular concern about these findings.

Increased rates of illness-related school absenteeism have been associated with 1-hour daily maximum

and 8-hour average ozone concentrations in studies conducted in Nevada<sup>128</sup> in kindergarten to 6th grade and in Southern California in grades four through six.<sup>129</sup> These studies suggest that higher ambient ozone levels may result in increased school absenteeism.

The air pollutant most clearly associated with premature mortality is PM, with many studies reporting such an association. However, recent analyses provide evidence that short term ozone exposure is associated with increased premature mortality. Bell et al. (2004) published new analyses of the 95 cities in the National Morbidity, Mortality, and Air Pollution Study (NMMAPS) data sets, showing associations between daily mortality and the previous week's ozone concentrations which were robust to adjustment for particulate matter, weather, seasonality, and long-term trends.<sup>130</sup> Although earlier analyses undertaken as part of the NMMAPS did not report an effect of ozone on total mortality across the full year, in those earlier studies the NMMAPS investigators did observe an effect after limiting the analysis to summer, when ozone levels are highest.<sup>131 132</sup> Another recent study from 23 cities throughout Europe (APHEA2) also found an association between ambient ozone and daily mortality.<sup>133</sup> Similarly, other studies have shown associations

between ozone and mortality.<sup>134 135</sup> Specifically, Touloumi et al. (1997) found that 1-hour maximum ozone levels were associated with daily numbers of deaths in four cities (London, Athens, Barcelona, and Paris), and a quantitatively similar effect was found in a group of four additional cities (Amsterdam, Basel, Geneva, and Zurich).

In all, the new studies that have become available since the 8-hour ozone standard was adopted in 1997 continue to demonstrate the harmful effects of ozone on public health, and the need to attain and maintain the ozone NAAQS.

### 3. Current and Projected 8-Hour Ozone Levels

Currently, ozone concentrations exceeding the level of the 8-hour ozone NAAQS occur over wide geographic areas, including most of the nation's major population centers.<sup>136</sup> As of September 2005 there are approximately 159 million people living in 126 areas designated as not in attainment with the 8-hour ozone NAAQS. There are 474 full or partial counties that make up the 8-hour ozone nonattainment areas.

EPA has already adopted many emission control programs that are expected to reduce ambient ozone levels. These control programs include the Clean Air Interstate Rule (70 FR 25162, May 12, 2005), as well as many mobile source rules (many of which are described in section V.D). As a result of these programs, the number of areas that fail to achieve the 8-hour ozone NAAQS is expected to decrease.

Based on the recent ozone modeling performed for the CAIR analysis<sup>137</sup>, barring additional local ozone precursor controls, we estimate 37 Eastern counties (where 24 million people are projected to live) will exceed the 8-hour ozone NAAQS in 2010. An additional 148 Eastern counties (where 61 million people are projected to live) are expected to be within 10 percent of violating the 8-hour ozone NAAQS in 2010.

States with 8-hour ozone nonattainment areas will be required to

<sup>123</sup> Thurston, G.D.; Lippman, M.L.; Scott, M.B.; Fine, J.M. (1997) Summertime Haze Air Pollution and Children with Asthma. *American Journal of Respiratory Critical Care Medicine* 155: 654-660.

<sup>124</sup> Ostro, B.; Lipsett, M.; Mann, J.; Braxton-Owens, H.; White, M. (2001) Air pollution and exacerbation of asthma in African-American children in Los Angeles. *Epidemiology* 12(2): 200-208.

<sup>125</sup> McDonnell, W.F.; Abbey, D.E.; Nishino, N.; Lebowitz, M.D. (1999) "Long-term ambient ozone concentration and the incidence of asthma in nonsmoking adults: the AHSMOG study." *Environmental Research* 80(2 Pt 1): 110-121.

<sup>126</sup> McConnell, R.; Berhane, K.; Gilliland, F.; London, S.J.; Islam, T.; Gauderman, W.J.; Avol, E.; Margolis, H.G.; Peters, J.M. (2002) Asthma in exercising children exposed to ozone: a cohort study. *Lancet* 359: 386-391.

<sup>127</sup> Burnett, R.T.; Smith-Doiron, M.; Stieb, D.; Raizenne, M.E.; Brook, J.R.; Dales, R.E.; Leech, J.A.; Cakmak, S.; Krewski, D. (2001) Association between ozone and hospitalization for acute respiratory diseases in children less than 2 years of age. *Am. J. Epidemiol.* 153: 444-452.

<sup>128</sup> Chen, L.; Jennison, B.L.; Yang, W.; Omaye, S.T. (2000) Elementary school absenteeism and air pollution. *Inhalation Toxicol.* 12: 997-1016.

<sup>129</sup> Gilliland, F.D.; Berhane, K.; Rappaport, E.B.; Thomas, D.C.; Avol, E.; Gauderman, W.J.; London, S.J.; Margolis, H.G.; McConnell, R.; Islam, K.T.; Peters, J.M. (2001) The effects of ambient air pollution on school absenteeism due to respiratory illnesses. *Epidemiology* 12:43-54.

<sup>130</sup> Bell, M.L.; McDermott, A.; Zeger, S.L.; Samet, J.M.; Dominici, F. Ozone and short-term mortality in 95 U.S. urban communities, 1987-2000. *JAMA* 292(19): 2372-2378.

<sup>131</sup> Samet, J.M.; Zeger, S.L.; Dominici, F.; Curriero, F.; Coursac, I.; Dockery, D.W.; Schwartz, J.; Zanobetti, A. (2000) The National Morbidity, Mortality and Air Pollution Study: Part II: Morbidity, Mortality and Air Pollution in the United States. Research Report No. 94, Part II. Health Effects Institute, Cambridge, MA, June 2000. This document is available in Docket EPA-HQ-OAR-2005-0036.

<sup>132</sup> Samet, J.M.; Zeger, S.L.; Dominici, F.; Curriero, F.; Coursac, I.; Zeger, S. (2000) Fine Particulate Air Pollution and Mortality in 20 U.S. Cities, 1987-1994. *The New England Journal of Medicine* 343(24): 1742-1749.

<sup>133</sup> Gryparis, A.; Forsberg, B.; Katsouyanni, K.; Analitis, A.; Touloumi, G.; Schwartz, J.; Samoli, E.; Medina, S.; Anderson, H.R.; Niciu, E.M.; Wichmann, H.E.; Kriz, B.; Kosnik, M.; Skorkovsky, J.; Vonk, J.M.; Dortbudak, Z. (2004) Acute effects of ozone on mortality from the "Air Pollution and Health: A European Approach" project. *Am. J. Respir. Crit. Care Med.* 170: 1080-1087.

<sup>134</sup> Thurston, G.D.; Ito, K. (2001) Epidemiological studies of acute ozone exposures and mortality. *J. Exposure Anal. Environ. Epidemiol.* 11: 286-294.

<sup>135</sup> Touloumi, G.; Katsouyanni, K.; Zmirou, D.; Schwartz, J.; Spix, C.; Ponce de Leon, A.; Tobias, A.; Quenel, P.; Rabchenko, D.; Bacharova, L.; Bisanti, L.; Vonk, J.M.; Ponka, A. (1997) Short-term effects of ambient oxidant exposure on mortality: A combined analysis within the APHEA project. *Am. J. Epidemiol.* 146: 177-185.

<sup>136</sup> A map of the 8-hour ozone nonattainment areas is included in the RIA for this proposed rule.

<sup>137</sup> Technical Support Document for the Final Clean Air Interstate Rule Air Quality Modeling. This document is available in Docket EPA-HQ-OAR-2005-0036.

take action to bring those areas into compliance in the future. Based on the final rule designating and classifying 8-hour ozone nonattainment areas (69 FR 23951, April 30, 2004), most 8-hour ozone nonattainment areas will be required to attain the 8-hour ozone NAAQS in the 2007 to 2013 time frame and then be required to maintain the 8-hour ozone NAAQS thereafter.<sup>138</sup> We also expect many of the 8-hour ozone nonattainment areas to adopt additional emission reduction programs, but we are unable to quantify or rely upon future reductions from additional state and local programs that have not yet been adopted. The expected ozone inventory reductions from the standards proposed in this action may be useful to states in attaining or maintaining the 8-hour ozone NAAQS.

A metamodeling tool developed at EPA, the ozone response surface metamodel, was used to estimate the effects of the proposed emission reductions. The ozone response surface metamodel was created using multiple runs of the Comprehensive Air Quality Model with Extensions (CAMx). Base and proposed control CAMx metamodeling was completed for two future years (2020, 2030) over a modeling domain that includes all or part of 37 Eastern U.S. states. For more information on the response surface metamodel, please see the RIA for this proposal or the Air Quality Modeling Technical Support Document (TSD).

We have made estimates using the ozone response surface metamodel to illustrate the types of change in future ozone levels that we would expect to result from this proposed rule, as described in Chapter 3 of the draft RIA. The proposed gas can controls are projected to result in a very small net improvement in future ozone, after weighting for population. Although the net future ozone improvement is small, some VOC-limited areas in the Eastern U.S. are projected to have non-negligible improvements in projected 8-hour ozone design values due to the proposed gas can controls. As stated in Section VII.E.3, we view these improvements as useful in meeting the 8-hour ozone NAAQS. These net ozone improvements are in addition to reductions in levels of benzene due to the proposed gas can controls.

#### D. Particulate Matter

The cold temperature vehicle controls proposed here will result in reductions of primary PM being emitted by

vehicles. In addition, both the proposed vehicle controls and the proposed gas can controls will reduce VOCs that react in the atmosphere to form secondary PM<sub>2.5</sub>, namely organic carbonaceous PM<sub>2.5</sub>.

#### 1. Background

Particulate matter (PM) represents a broad class of chemically and physically diverse substances. It can be principally characterized as discrete particles that exist in the condensed (liquid or solid) phase spanning several orders of magnitude in size. PM is further described by breaking it down into size fractions. PM<sub>10</sub> refers to particles with an aerodynamic diameter less than or equal to a nominal 10 micrometers (μm). PM<sub>2.5</sub> refers to fine particles, those particles with an aerodynamic diameter less than or equal to a nominal 2.5 μm. Coarse fraction particles refer to those particles with an aerodynamic diameter less than or equal to a nominal 10 μm. Inhalable (or “thoracic”) coarse particles refer to those particles with an aerodynamic diameter greater than 2.5 μm but less than or equal to 10 μm. Ultrafine PM refers to particles with diameters of less than 100 nanometers (0.1 μm). Larger particles (>10 μm) tend to be removed by the respiratory clearance mechanisms, whereas smaller particles are deposited deeper in the lungs. Ambient fine particles are a complex mixture including sulfates, nitrates, chlorides, organic carbonaceous material, elemental carbon, geological material, and metals. Fine particles can remain in the atmosphere for days to weeks and travel through the atmosphere hundreds to thousands of kilometers, while coarse particles generally tend to deposit to the earth within minutes to hours and within tens of kilometers from the emission source.

EPA has NAAQS for both PM<sub>2.5</sub> and PM<sub>10</sub>. Both the PM<sub>2.5</sub> and PM<sub>10</sub> NAAQS consist of a short-term (24-hour) and a long-term (annual) standard. The 24-hour PM<sub>2.5</sub> NAAQS is set at a level of 65 μg/m<sup>3</sup> based on the 98th percentile concentration averaged over three years. The annual PM<sub>2.5</sub> NAAQS specifies an expected annual arithmetic mean not to exceed 15 μg/m<sup>3</sup> averaged over three years. The 24-hour PM<sub>10</sub> NAAQS is set at a level of 150 μg/m<sup>3</sup> not to be exceeded more than once per year. The annual PM<sub>10</sub> NAAQS specifies an expected annual arithmetic mean not to exceed 50 μg/m<sup>3</sup>.

EPA has recently proposed to amend the PM NAAQS.<sup>139</sup> The proposal

includes lowering the level of the primary 24-hour fine particle standard from the current level of 65 micrograms per cubic meter (μg/m<sup>3</sup>) to 35 μg/m<sup>3</sup>, retaining the level of the annual fine standard at 15 μg/m<sup>3</sup>, and setting a new primary 24-hour standard for certain inhalable coarse particles (the indicator is qualified so as to include any ambient mix of PM<sub>10-2.5</sub> that is dominated by resuspended dust from high-density traffic on paved roads and PM generated by industrial and construction sources, and excludes any ambient mix of PM<sub>10-2.5</sub> dominated by rural windblown dust and soils and PM generated by agricultural and mining sources) at 70 μg/m<sup>3</sup>. The Agency is also requesting comment on various other standards for fine and inhalable coarse PM (71 FR 2620, Jan. 17, 2006).

#### 2. Health Effects of PM

Scientific studies show ambient PM is associated with a series of adverse health effects. These health effects are discussed in detail in the 1997 PM criteria document, the recent 2004 EPA Criteria Document for PM as well as the 2005 PM Staff Paper.<sup>140 141 142</sup> Further discussion of health effects associated with PM can also be found in the draft RIA for this proposal.

As described in the documents listed above, health effects associated with short-term variation (e.g. hours to days) in ambient PM<sub>2.5</sub> include premature mortality, hospital admissions, heart and lung diseases, increased cough, lower-respiratory symptoms, decrements in lung function and changes in heart rate rhythm and other cardiac effects. Studies examining populations exposed to different levels of air pollution over a number of years, including the Harvard Six Cities Study and the American Cancer Society Study, show associations between long-term exposure to ambient PM<sub>2.5</sub> and premature mortality, including deaths attributed to cardiovascular changes and lung cancer.

17, 2006). This document is also available on the web at: <http://www.epa.gov/air/particlepollution/actions.html>

<sup>140</sup> U.S. EPA (1996) Air Quality Criteria for Particulate Matter, EPA 600/P-95-001aF, EPA 600/P-95-001bF. This document is available in Docket EPA-HQ-OAR-2005-0036.

<sup>141</sup> U.S. EPA (2004) Air Quality Criteria for Particulate Matter (Oct 2004), Volume I Document No. EPA600/P-99/002aF and Volume II Document No. EPA600/P-99/002bF. This document is available in Docket EPA-HQ-OAR-2005-0036.

<sup>142</sup> U.S. EPA (2005) Review of the National Ambient Air Quality Standard for Particulate Matter: Policy Assessment of Scientific and Technical Information, OAQPS Staff Paper. EPA-452/R-05-005. This document is available in Docket EPA-HQ-OAR-2005-0036.

<sup>138</sup> The Los Angeles South Coast Air Basin 8-hour ozone nonattainment area will have to attain before June 15, 2021.

<sup>139</sup> U.S. EPA, National Ambient Air Quality Standards for Particulate Matter (71 FR 2620, Jan.

Recently, several studies have highlighted the adverse effects of PM specifically from mobile sources.<sup>143 144</sup> Studies have also focused on health effects due to PM exposures on or near roadways.<sup>145</sup> Although these studies include all air pollution sources, including both spark-ignition (gasoline) and diesel powered vehicles, they indicate that exposure to PM emissions near roadways, thus dominated by mobile sources, are associated with health effects. The proposed vehicle controls may help to reduce exposures to mobile source related PM<sub>2.5</sub>. Additional information on near roadway health effects can be found in Section III of this preamble.

### 3. Current and Projected PM<sub>2.5</sub> Levels

EPA has recently finalized PM<sub>2.5</sub> nonattainment designations (70 FR 943, Jan 5, 2005).<sup>146</sup> As can be seen from the designations, ambient PM<sub>2.5</sub> levels exceeding the level of the PM<sub>2.5</sub> NAAQS are widespread throughout the country. There are approximately 88 million people living in 39 areas (which include all or part of 208 counties) designated as not in attainment with the PM<sub>2.5</sub> NAAQS.

EPA has already adopted many emission control programs that are expected to reduce ambient PM levels. These rules include the Clean Air Interstate Rule (70 FR 25162, May 12, 2005), as well as many mobile source rules. Section V.D details many of these mobile source rules.<sup>147</sup> As a result of these programs, the number of areas that fail to achieve the 1997 PM<sub>2.5</sub> NAAQS is expected to decrease. Based on modeling performed for the CAIR analysis, we estimate that 28 Eastern counties (where 19 million people are

projected to live) will exceed the PM<sub>2.5</sub> standard in 2010.<sup>148</sup> In addition, 56 Eastern counties (where 24 million people are projected to live) are expected to be within 10 percent of violating the PM<sub>2.5</sub> in 2010.

While the final implementation process for bringing the nation's air into attainment with the 1997 PM<sub>2.5</sub> NAAQS is still being completed in a separate rulemaking action, we expect that most areas will need to attain the 1997 PM<sub>2.5</sub> NAAQS in the 2009 to 2014 time frame, and then be required to maintain the NAAQS thereafter. The expected PM and VOC inventory reductions from the standards proposed in this action will be useful to states in attaining or maintaining the PM<sub>2.5</sub> NAAQS.

### 4. Current PM<sub>10</sub> Levels

Air quality monitoring data indicates that as of September 2005 approximately 29 million people live in 55 designated PM<sub>10</sub> nonattainment areas, which include all or part of 54 counties. The RIA for this proposed rule lists the PM<sub>10</sub> nonattainment areas and their populations.

Based on section 188 of the Act, we expect that most areas will attain the PM<sub>10</sub> NAAQS no later than December 31, 2006, depending on an area's classification and other factors, and then be required to maintain the PM<sub>10</sub> NAAQS thereafter. The expected PM and VOC inventory reductions from the standards proposed in this action could be useful to states in maintaining the PM<sub>10</sub> NAAQS.<sup>149</sup>

### E. Other Environmental Effects

#### 1. Visibility

##### a. Background

Visibility can be defined as the degree to which the atmosphere is transparent to visible light.<sup>150</sup> Visibility is important

because it has direct significance to people's enjoyment of daily activities in all parts of the country. Individuals value good visibility for the well-being it provides them directly, where they live and work, and in places where they enjoy recreational opportunities. Visibility is also highly valued in significant natural areas such as national parks and wilderness areas, because of the special emphasis given to protecting these lands now and for future generations. For more information on visibility see the recent 2004 EPA Criteria Document for PM as well as the 2005 PM Staff Paper.<sup>151 152</sup>

To address the welfare effects of PM on visibility, EPA set secondary PM<sub>2.5</sub> standards in 1997 which would act in conjunction with the establishment of a regional haze program. EPA concluded that PM<sub>2.5</sub> causes adverse effects on visibility in various locations, depending on PM concentrations and factors such as chemical composition and average relative humidity and the secondary (welfare-based) PM<sub>2.5</sub> NAAQS was established as equal to the suite of primary (health-based) NAAQS (62 FR 38669, July 18, 1997). Furthermore, Section 169 of the Act provides additional authorities to remedy existing visibility impairment and prevent future visibility impairment in the 156 national parks, forests and wilderness areas categorized as mandatory Federal class I areas (62 FR 38680–81, July 18, 1997).<sup>153</sup> In July 1999 the regional haze rule (64 FR 35714) was put in place to protect the visibility in mandatory Federal class I areas. Visibility can be said to be impaired in both PM<sub>2.5</sub> nonattainment areas and mandatory Federal class I areas.<sup>154</sup>

available in Docket EPA–HQ–OAR–2005–0036. This book can be viewed on the National Academy Press Website at <http://www.nap.edu/books/0309048443/html/>.

<sup>151</sup> U.S. EPA (2004) Air Quality Criteria for Particulate Matter (Oct 2004), Volume I Document No. EPA600/P–99/002aF and Volume II Document No. EPA600/P–99/002bF. This document is available in Docket EPA–HQ–OAR–2005–0036.

<sup>152</sup> U.S. EPA (2005) Review of the National Ambient Air Quality Standard for Particulate Matter: Policy Assessment of Scientific and Technical Information, OAQPS Staff Paper. EPA–452/R–05–005. This document is available in Docket EPA–HQ–OAR–2005–0036.

<sup>153</sup> These areas are defined in section 162 of the Act as those national parks exceeding 6,000 acres, wilderness areas and memorial parks exceeding 5,000 acres, and all international parks which were in existence on August 7, 1977.

<sup>154</sup> As mentioned above, the EPA has recently proposed to amend the PM NAAQS (71 FR 2620, Jan. 17, 2006). The proposal would set the secondary NAAQS equal to the primary standards for both PM<sub>2.5</sub> and PM<sub>10–2.5</sub>. EPA also is taking comment on whether to set a separate PM<sub>2.5</sub> standard, designed to address visibility (principally in urban areas), on potential levels for that standard

<sup>143</sup> Laden, F.; Neas, L.M.; Dockery, D.W.; Schwartz, J. (2000) Association of Fine Particulate Matter from Different Sources with Daily Mortality in Six U.S. Cities. *Environmental Health Perspectives* 108: 941–947.

<sup>144</sup> Janssen, N.A.H.; Schwartz, J.; Zanobetti, A.; Suh, H.H. (2002) Air Conditioning and Source-Specific Particles as Modifiers of the Effect of PM<sub>10</sub> on Hospital Admissions for Heart and Lung Disease. *Environmental Health Perspectives* 110: 43–49.

<sup>145</sup> Riekider, M.; Cascio, W.E.; Griggs, T.R.; Herbst, M.C.; Bromberg, P.A.; Neas, L.; Williams, R.W.; Devlin, R.B. (2003) Particulate Matter Exposures in Cars is Associated with Cardiovascular Effects in Healthy Young Men. *Am. J. Respir. Crit. Care Med.* 169: 934–940.

<sup>146</sup> US EPA, Air Quality Designations and Classifications for the Fine Particles (PM<sub>2.5</sub>) National Ambient Air Quality Standards, December 17, 2004. (70 FR 943, Jan 5, 2005) This document is also available on the web at: <http://www.epa.gov/pmdesignations/>.

<sup>147</sup> The Clean Air Interstate Rule (CAIR) will reduce emissions of SO<sub>2</sub> and NO<sub>x</sub> from power plants in the Eastern 37 states, reducing interstate transport of nitrogen oxides and sulfur dioxide and helping cities and states in the East meet the ozone and PM NAAQS. (70 FR 25162) (May 12, 2005).

<sup>148</sup> Technical Support Document for the Final Clean Air Interstate Rule Air Quality Modeling. This document is available in Docket EPA–HQ–OAR–2005–0036.

<sup>149</sup> As mentioned above, the EPA has recently proposed to amend the PM NAAQS, by establishing a new indicator for certain inhalable coarse particles, and a new primary 24-hour standard for coarse particles described by that indicator. EPA also proposed to revoke the current 24-hour PM<sub>10</sub> standard in all areas of the country except in those areas with a population of at least 100,000 people and which contain at least one monitor violating the 24-hour PM<sub>10</sub> standard, based on the most recent 3 years of air quality data. In addition, EPA proposed to revoke upon promulgation of this rule the current annual PM<sub>10</sub> standard if EPA finalizes the proposed primary standard for PM<sub>10–2.5</sub> (71 FR 2620, Jan. 17, 2006).

<sup>150</sup> National Research Council, 1993. *Protecting Visibility in National Parks and Wilderness Areas*. National Academy of Sciences Committee on Haze in National Parks and Wilderness Areas. National Academy Press, Washington, DC. This document is

## b. Current Visibility Impairment

Data showing PM<sub>2.5</sub> nonattainment areas, and visibility levels above background at the Mandatory Class I Federal Areas demonstrate that unacceptable visibility impairment is experienced throughout the U.S., in multi-state regions, urban areas, and remote mandatory Federal class I areas.<sup>155</sup> The mandatory federal class I areas are listed in Chapter 3 of the draft RIA for this action. The areas that have design values above the PM<sub>2.5</sub> NAAQS are also listed in Chapter 3 of the draft RIA for this action.

## c. Future Visibility Impairment

Recent modeling for the Clean Air Interstate Rule (CAIR) was used to project visibility conditions in mandatory Federal class I areas across the country in 2015. The results for the mandatory Federal Class I areas suggest that these areas are predicted to continue to have annual average deciview levels above background in the future.<sup>157</sup> Modeling done for the CAIR also projected PM<sub>2.5</sub> levels in the Eastern U.S. in 2010. These projections include all sources of PM<sub>2.5</sub>, including the engines covered in this proposal, and suggest that PM<sub>2.5</sub> levels above the 1997 NAAQS will persist into the future.<sup>158</sup>

The vehicles that would be subject to the proposed standards contribute to visibility concerns in these areas through both their primary PM emissions and their VOC emissions, which contribute to the formation of secondary PM<sub>2.5</sub>. The gas cans that would be subject to the proposed standards also contribute to visibility concerns through their VOC emissions. Reductions in these direct PM and VOC emissions will help to improve visibility across the nation, including mandatory Federal class I areas.

within a range of 20 to 30 µg/m<sup>3</sup>, and on averaging times for the standard within a range of four to eight daylight hours.

<sup>155</sup> US EPA, Air Quality Designations and Classifications for the Fine Particles (PM<sub>2.5</sub>) National Ambient Air Quality Standards, December 17, 2004. (70 FR 943, Jan 5, 2005) This document is also available on the web at: <http://www.epa.gov/pmdesignations/>.

<sup>156</sup> US EPA. Regional Haze Regulations, July 1, 1999. (64 FR 35714, July 1, 1999).

<sup>157</sup> The deciview metric describes perceived visual changes in a linear fashion over its entire range, analogous to the decibel scale for sound. A deciview of 0 represents pristine conditions. The higher the deciview value, the worse the visibility, and an improvement in visibility is a decrease in deciview value.

<sup>158</sup> EPA recently proposed to revise the current secondary PM NAAQS standards by making them identical to the suite of proposed primary standards for fine and coarse particles (71 FR 2620, Jan. 17, 2006).

## 2. Plant Damage From Ozone

Ozone contributes to many environmental effects, with damage to plants and ecosystems being of most concern. Plant damage affects crop yields, forestry production, and ornamentals. The adverse effect of ozone on forests and other natural vegetation can in turn cause damage to associated ecosystems, with additional resulting economic losses. Prolonged ozone concentrations of 100 ppb can be phytotoxic to a large number of plant species, and can produce acute injury and reduced crop yield and biomass production. Ozone concentrations within the range of 50 to 100 ppb have the potential over a longer duration to create chronic stress on vegetation that can result in reduced plant growth and yield, shifts in competitive advantages in mixed populations, decreased vigor, and injury. Ozone effects on vegetation are presented in more detail in the 1996 Criteria Document and the 2005 draft Criteria Document.

## 3. Atmospheric Deposition

Wet and dry deposition of ambient particulate matter delivers a complex mixture of metals (e.g., mercury, zinc, lead, nickel, aluminum, cadmium), organic compounds (e.g., POM, dioxins, furans) and inorganic compounds (e.g., nitrate, sulfate) to terrestrial and aquatic ecosystems. EPA's Great Waters Program has identified 15 pollutants whose deposition to water bodies has contributed to the overall contamination loadings to these Great Waters. These 15 compounds include several heavy metals and a group known as polycyclic organic matter (POM). Within POM are the polycyclic aromatic hydrocarbons (PAHs). PAHs in the environment may be present in the gas or particle phase, although the bulk will be adsorbed onto airborne particulate matter. In most cases, human-made sources of PAHs account for the majority of PAHs released to the environment. The PAHs are usually the POMs of concern as many PAHs are probable human carcinogens.<sup>159</sup> For some watersheds, atmospheric deposition represents a significant input to the total surface water PAH burden.<sup>160</sup> Emissions

<sup>159</sup> Deposition of Air Pollutants to the Great Waters-Third Report to Congress, Office of Air Quality Planning and Standards, June 2000, EPA453-R-00-005. This document is available in Docket EPA-HQ-OAR-2005-0036.

<sup>160</sup> Simcik, M.F.; Eisenrich, S.J.; Golden, K.A.; Liu, S.; Lipiatou, E.; Swackhamer, D.L.; and Long, D.T. (1996) Atmospheric Loading of Polycyclic Aromatic Hydrocarbons to Lake Michigan as Recorded in the Sediments. *Environ. Sci. Technol.* 30:3039-3046.

<sup>161</sup> Simcik, M.F.; Eisenrich, S.J.; and Liroy, P.J. (1999) Source Apportionment and Source/Sink

from mobile sources have been found to account for a percentage of the atmospheric deposition of PAHs. For instance, recent studies have identified gasoline and diesel vehicles as the major contributors in the atmospheric deposition of PAHs to Chesapeake Bay, Massachusetts Bay and Casco Bay.<sup>162</sup> The vehicle controls being proposed may help to reduce deposition of heavy metals and POM.

## 4. Materials Damage and Soiling

The deposition of airborne particles can also reduce the aesthetic appeal of buildings and culturally important articles through soiling, and can contribute directly (or in conjunction with other pollutants) to structural damage by means of corrosion or erosion.<sup>164</sup> Particles affect materials principally by promoting and accelerating the corrosion of metals, by degrading paints, and by deteriorating building materials such as concrete and limestone. Particles contribute to these effects because of their electrolytic, hygroscopic, and acidic properties, and their ability to sorb corrosive gases (principally sulfur dioxide). The rate of metal corrosion depends on a number of factors, including the deposition rate and nature of the pollutant; the influence of the metal protective corrosion film; the amount of moisture present; variability in the electrochemical reactions; the presence and concentration of other surface electrolytes; and the orientation of the metal surface.

## V. What Are Mobile Source Emissions Over Time and How Would This Proposal Reduce Emissions, Exposure and Associated Health Effects?

### A. Mobile Source Contribution to Air Toxics Emissions

In 1999, based on the National Emissions Inventory (NEI), mobile sources accounted for 44% of total

Relationships of PAHs in the Coastal Atmosphere of Chicago and Lake Michigan. *Atmospheric Environment* 33: 5071-5079.

<sup>162</sup> Dickhut, R.M.; Canuel, E.A.; Gustafson, K.E.; Liu, K.; Arzayus, K.M.; Walker, S.E.; Edgecombe, G.; Gaylor, M.O.; and McDonald, E.H. (2000) Automotive Sources of Carcinogenic Polycyclic Aromatic Hydrocarbons Associated with Particulate Matter in the Chesapeake Bay Region. *Environ. Sci. Technol.* 34: 4635-4640.

<sup>163</sup> Golomb, D.; Barry, E.; Fisher, G.; Varanusupakul, P.; Koleda, M.; and Rooney, T. (2001) Atmospheric Deposition of Polycyclic Aromatic Hydrocarbons near New England Coastal Waters. *Atmospheric Environment* 35: 6245-6258.

<sup>164</sup> U.S. EPA (2005) Review of the National Ambient Air Quality Standards for Particulate Matter: Policy Assessment of Scientific and Technical Information, OAQPS Staff Paper. This document is available in Docket EPA-HQ-OAR-2005-0036.

emissions of 188 hazardous air pollutants (on the Clean Air Act section 112(b) list of hazardous air pollutants). Diesel particulate matter (PM) is not included in this list of 188 pollutants. Sixty-five percent of the mobile source tons in this inventory were attributable to highway mobile sources, and the remainder to nonroad sources. Furthermore, over 90% of mobile source emissions of air toxics (not including diesel PM) are attributable to gasoline vehicles and equipment.

Recently, EPA projected trends in air toxic emissions (not including diesel PM) to 2020, using the 1999 National Emissions Inventory (NEI) as a baseline.<sup>165</sup> Overall, air toxic emissions are projected to decrease from 5,030,000 tons in 1999 to 4,010,000 tons in 2020, as a result of emission controls on major, area, and mobile sources. In the

<sup>165</sup> Strum, M., R. Cook, J. Thurman, D. Ensley, A. Pope, T. Palma, R. Mason, H. Michaels, and S. Shedd. 2005. Projection of Hazardous Air Pollutant Emissions to Future Years. Science of the Total Environment, in press.

absence of Clean Air Act emission controls currently in place, EPA estimates air toxic emissions would total 11,590,000 tons in 2020.

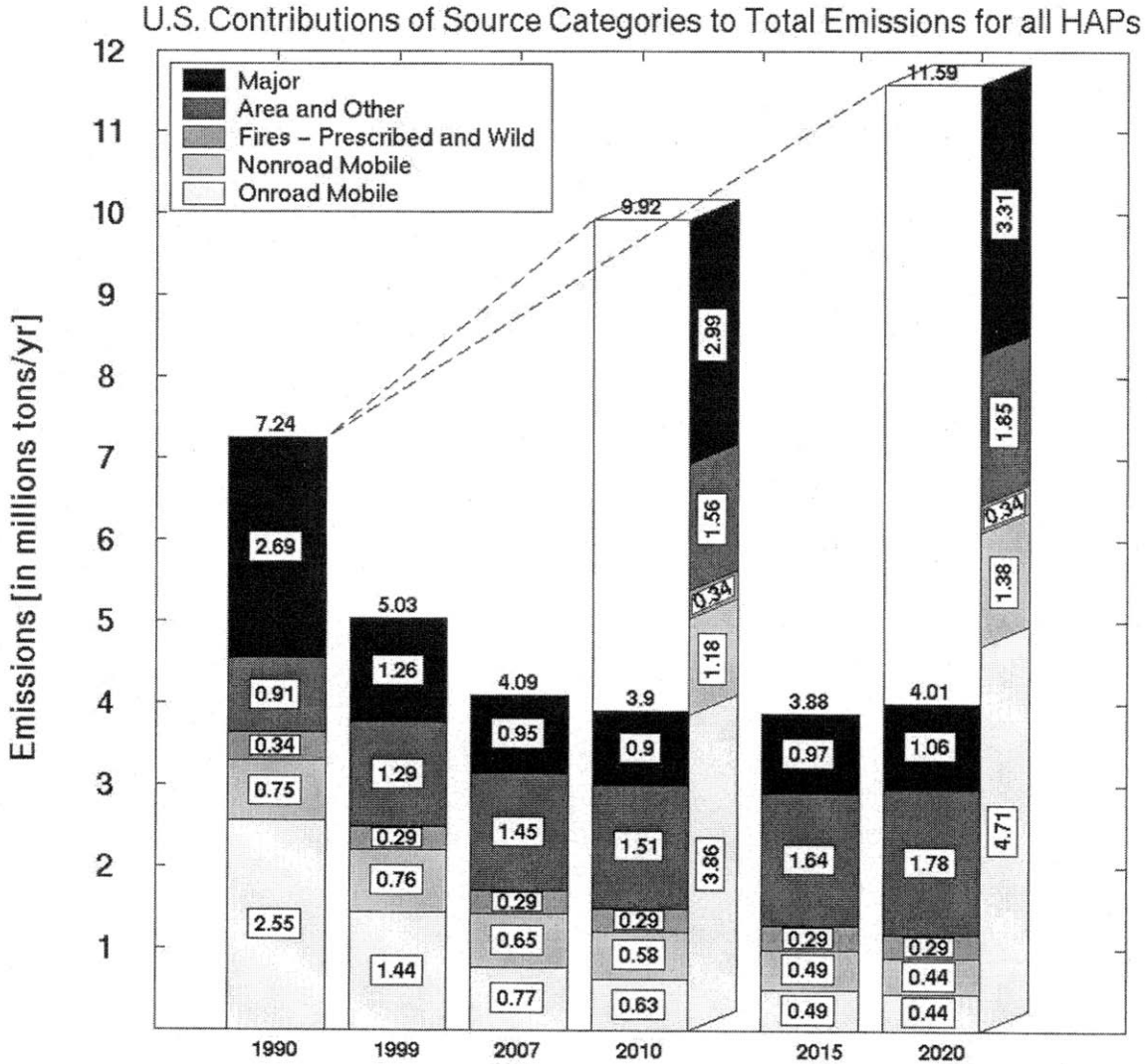
Figure V.A-1 depicts the contributions of source categories to air toxic emissions between 1990 and 2020.<sup>166</sup> As indicated in Figure V.A-1, mobile source air toxic emissions will be reduced 60% between 1999 and 2020, from 2.2 million to 880,000 tons. This reduction will occur despite a projected 57% increase in vehicle miles traveled, and a projected 63% increase in nonroad activity, based on units of work called horsepower-hours. It should be noted, however, that EPA anticipates mobile source air toxic emissions will begin to increase after 2020, from about 880,000 tons in 2020 to 920,000 tons in

<sup>166</sup> It should be noted that after 2010, stationary source emissions are based only on economic growth, and do not account for reductions from ongoing toxics programs such as the urban air toxics program, residual risk standards and area source program, which are expected to further reduce toxics.

2030. This is because, after 2020, reductions from control programs will be outpaced by increases in activity.

In 1999, 29% of air toxic emissions were from highway vehicles and 15% from nonroad equipment. Moreover, 54% of air toxic emissions from highway vehicles were emitted by light-duty gasoline vehicles (LDGVs) and 37% by light-duty trucks (LDGTs) (see Table V.A-1). EPA projects that in 2020, only 27% of highway vehicle toxic emissions will be from LDGVs and 63% will be from LDGTs. Air toxic emissions from nonroad equipment are dominated by lawn and garden equipment, recreational equipment, and pleasure craft, which collectively accounted for almost 80% of nonroad toxic emissions in 1999 and 2020 (see Table V.A-2).

Figure V.A-1 Contribution of Source Categories to Air Toxic Emissions, 1990 to 2020 (not including diesel particulate matter). **Note:** Dashed line represents projected emissions without Clean Air Act controls.



If diesel PM emissions were added to the mobile source total, mobile sources would account for 48% of a total 5,398,000 tons in 1999. Figure V.A.-2 summarizes the trend in diesel PM between 1999 and 2020, by source category. Diesel PM emissions will be reduced from 368,000 tons in 1999 to 114,000 tons in 2020, a decrease of 70%. As controls on highway diesel engines

and nonroad diesel engines phase in, diesel-powered locomotives and commercial marine vessels increase from 11% of the inventory in 1999 to 27% in 2020.

Subsequent to the development of these projected inventories for mobile source air toxics, a number of inventory revisions have occurred. Data EPA has collected indicate that the MOBILE6.2

emission factor model is under predicting hydrocarbon emissions (including air toxics) and PM emissions at lower temperatures, from light-duty vehicles meeting National Low Emission Vehicle (NLEV) and Tier 2 tailpipe standards. The inventories presented in sections V.B, V.C., and V.E. reflect these enhancements.

TABLE V.A-1.—PERCENT CONTRIBUTION OF VEHICLE CLASSES TO HIGHWAY VEHICLE AIR TOXIC EMISSIONS, 1999 TO 2020

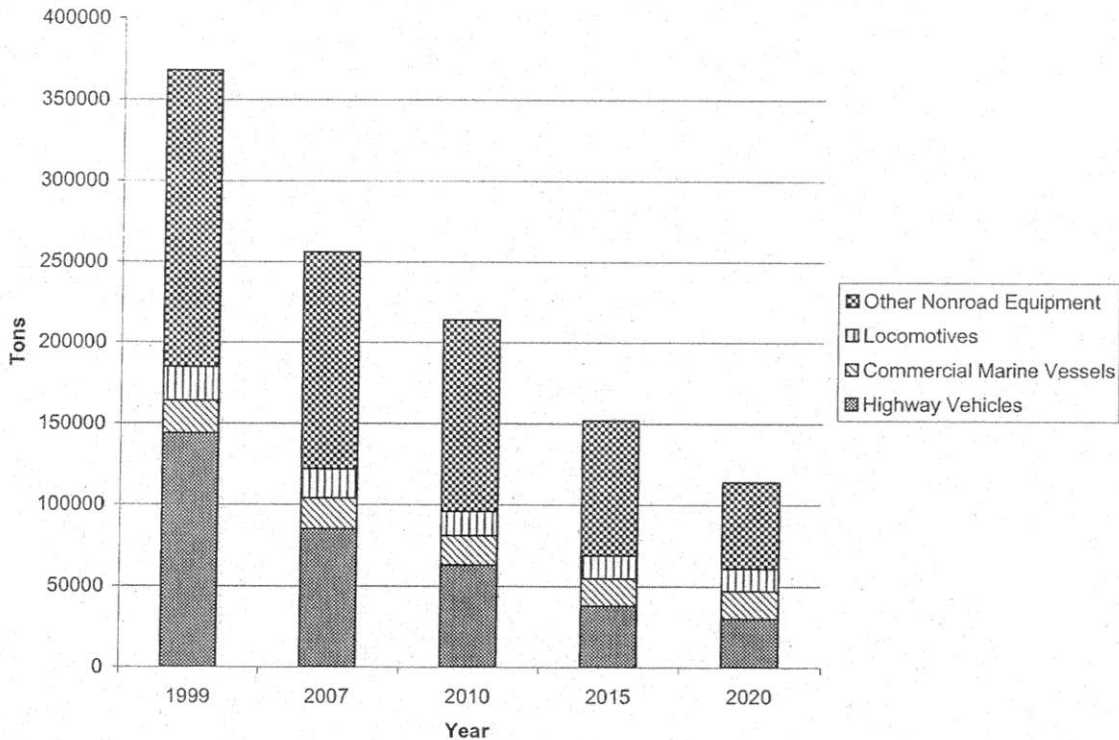
[Not including diesel particulate matter]

Vehicle	1999 (%)	2007 (%)	2010 (%)	2015 (%)	2020 (%)
Light-Duty Gasoline Vehicles .....	54	41	37	31	27
Light-Duty Gasoline Trucks .....	37	49	53	59	63
Heavy-Duty Gasoline Vehicles .....	6	5	4	4	3
Heavy-Duty Diesel Vehicles .....	3	4	4	4	5
Other (motorcycles and light-duty diesel vehicles and trucks) .....	1	1	1	2	2

TABLE V.A-2.—CONTRIBUTION OF EQUIPMENT TYPES TO NONROAD AIR TOXIC EMISSIONS, 1999 TO 2020

Equipment type	1999 (%)	2007 (%)	2010 (%)	2015 (%)	2020 (%)
Lawn and Garden .....	26	18	17	21	25
Pleasure Craft .....	34	27	25	25	25
Recreational .....	19	38	40	35	29
All Others .....	21	17	18	19	21

Figure V.A-2. Contribution of Mobile Source Categories to Diesel Particulate Matter Emissions, 1999 to 2020



B. VOC Emissions From Mobile Sources

Table V.B-1 presents 48-State VOC emissions from key mobile source sectors in 1999, 2010, 2015, and 2020, not including the effects of this proposed rule. The 1999 inventory estimates for nonroad equipment were

obtained from the National Emissions Inventory, and the 2010 and later year estimates were obtained from the inventories developed for the Clean Air Interstate Air Quality Rule (CAIR). The table provides emissions for nonroad equipment such as commercial marine vessels, locomotives, aircraft, lawn and

garden equipment, recreational vehicles and boats, industrial equipment, and construction equipment. The estimates for highway vehicle classes were developed for this rule. The estimates for light-duty gasoline vehicles reflect revised estimates of hydrocarbon emissions at low temperatures.

TABLE V.B-1.—48-STATE VOC EMISSIONS (TONS) FROM KEY MOBILE SOURCE SECTORS IN 1999, 2010, 2015, AND 2020

[Without this proposed rule]

Category	1999	2010	2015	2020
Light Duty Gasoline Vehicles and Trucks .....	4,873,000	2,896,000	2,566,000	2,486,000



TABLE V.B-1.—48-STATE VOC EMISSIONS (TONS) FROM KEY MOBILE SOURCE SECTORS IN 1999, 2010, 2015, AND 2020—Continued

[Without this proposed rule]

Category	1999	2010	2015	2020
Heavy Duty and Other Highway Vehicles .....	672,000	255,000	212,000	200,000
Nonroad Equipment .....	2,785,000	1,739,000	1,500,000	1,387,000

VOC emissions from highway vehicles are about twice those from nonroad equipment in 1999. Emissions from both highway vehicles and nonroad equipment decline substantially between 1999 and 2020 as a result of EPA control programs that are already adopted. The VOC emission reductions associated with this proposed rule are presented in section V.E, below.

### C. PM Emissions From Mobile Sources

Table V.C-1 presents 48-State PM<sub>2.5</sub><sup>167</sup> emissions from key mobile source sectors in 1999, 2010, 2015, and 2020, not including the effects of this proposed rule. The estimates in Table V.C-1 come from the same sources as the VOC estimates in section V.B. EPA is considering revisions to estimates of the PM emissions inventory for motor

vehicles. Recent data suggest PM emissions are significantly higher than currently estimated in the MOBILE6 emissions model. In addition, testing done for this rule demonstrates that PM emissions are elevated at cold temperatures. The estimates in Table V.C-1 do not account for the effects of cold temperature.

TABLE V.C-1.—48-STATE PM<sub>2.5</sub> EMISSIONS (TONS) FROM KEY MOBILE SOURCE SECTORS IN 1999, 2010, 2015, AND 2020

[Without this proposed rule]

Category	1999	2010	2015	2020
Light-Duty Gasoline Vehicles and Trucks .....	48,000	33,000	36,000	39,000
Heavy-Duty and Other Highway Vehicles .....	136,000	51,000	28,000	20,000
Nonroad Equipment .....	332,000	232,000	201,000	178,000

Section V.E, below, presents estimates of PM emission reductions associated with the proposed cold-temperature vehicle standards.

### D. Description of Current Mobile Source Emissions Control Programs That Reduce MSATs

As described in section V.A, existing mobile source control programs will reduce MSAT emissions (not including diesel PM) by 60% between 1999 and 2020. Diesel PM from mobile sources will be reduced by 70% between 1999 and 2020. The mobile source programs include controls on fuels, highway vehicles, and nonroad equipment. These programs are also reducing hydrocarbons and PM more generally, as well as oxides of nitrogen. The sections immediately below provide general descriptions of these programs, as well as voluntary programs to reduce mobile source emissions, such as the National Clean Diesel Campaign and Best Workplaces for Commuters. A more detailed description of mobile source programs is provided in Chapter 2 of the RIA.

#### 1. Fuels Programs

Several federal fuel programs reduce MSAT emissions. Some of these programs directly control air toxics, such as the reformulated gasoline (RFG) program's benzene content limit and required reduction in total toxics emissions, and the anti-backsliding requirements of the anti-dumping and current MSAT programs, which require that gasoline cannot get dirtier with respect to toxics emissions. Others, such as the gasoline sulfur program, control toxics indirectly by reducing hydrocarbon and related toxics emissions.

##### a. RFG

The RFG program contains two direct toxics control requirements. The first is a fuel benzene standard, requiring RFG to average no greater than 0.95 volume percent benzene annually (on a refinery or importer basis). The RFG benzene requirement includes a per-gallon cap on fuel benzene level of 1.3 volume percent. In 1990, when the Clean Air Act was amended to require reformulated gasoline, fuel benzene averaged 1.60 volume percent. For a variety of reasons, including other

regulations, chemical product prices and refining efficiencies, most refiners and importers have achieved significantly greater reductions in benzene than required by the program. In 2003, RFG benzene content averaged 0.62 percent. The RFG benzene requirement includes a per-gallon cap on fuel benzene level of 1.3 volume percent.

The second RFG toxics control requires that RFG achieve a specific level of toxics emissions reduction. The requirement has increased in stringency since the RFG program began in 1995, when the requirement was that RFG annually achieve a 16.5% reduction in total (exhaust plus evaporative) air toxics emissions. Currently, a 21.5% reduction is required. These reductions are determined using the Complex Model. As mentioned above, for a variety of reasons most regulated parties have overcomplied with the required toxics emissions reductions. During 1998–2000, RFG achieved, on average, a 27.5% reduction in toxics emissions.

##### b. Anti-Dumping

The anti-dumping regulations were intended to prevent the dumping of "dirty" gasoline components, which

<sup>167</sup> PM<sub>2.5</sub> is particulate matter under 2.5 microns in diameter. Over 85% of the mass of PM from mobile sources is PM<sub>2.5</sub>.

were removed to produce RFG, into conventional gasoline (CG). Since the dumping of "dirty" gasoline components, for example, benzene or benzene-containing blending streams, would show up as increases in toxics emissions, the anti-dumping regulations require that a refiner's or importer's CG be no more polluting with respect to toxics emissions than the refiner's or importer's 1990 gasoline. The anti-dumping program considers only exhaust toxics emissions and does not include evaporative emissions.<sup>168</sup> Refiners and importers have either a unique individual anti-dumping baseline or they have the statutory anti-dumping baseline if they did not fulfill the minimum requirements for developing a unique individual baseline. In 1990, average exhaust toxics emissions (as estimated by the Complex Model) were 104.5 mg/mile;<sup>169</sup> in 2004, CG exhaust toxics emissions averaged 90.7 mg/mile. Although CG has no benzene limit, benzene levels have declined significantly from the 1990 level of 1.6 volume percent to 1.1 volume percent for CG in 2004.

#### c. 2001 Mobile Source Air Toxics Rule (MSAT1)

As discussed above, both RFG and CG have, on average, exceeded their respective toxics control requirements. In 2001, EPA issued a mobile source air toxics rule (MSAT1, for the purposes of this second proposal), as discussed in section I.D. The intent of MSAT1 is to prevent refiners and importers from backsliding from the toxics performance that was being achieved by RFG and CG. In order to lock in superior levels of control, the rule requires that the annual average toxics performance of gasoline must be at least as clean as the average performance of the gasoline produced or imported during the three-year period 1998–2000. The period 1998–2000 is called the baseline period. Toxics performance is determined separately for RFG and CG, in the same manner as the toxics determinations required by the RFG<sup>170</sup> and anti-dumping rules.

Like the anti-dumping provisions, MSAT1 utilizes an individual baseline against which compliance is determined. The average 1998–2000 toxics performance level, or baseline, is determined separately for each refinery and importer.<sup>171</sup> To establish a unique

individual MSAT1 baseline, EPA requires each refiner and importer to submit documentation supporting the determination of the baseline. Most refiners and many importers in business during the baseline period had sufficient data to establish an individual baseline. An MSAT1 baseline volume is associated with each unique individual baseline value. The MSAT1 baseline volume reflects the average annual volume of such gasoline produced or imported during the baseline period. Refiners and importers who did not have sufficient refinery production or imports during 1998–2000 to establish a unique individual MSAT1 baseline must use the default baseline provided in the rule.

The MSAT1 program began with the annual averaging period beginning January 1, 2002. Since then, the toxics performance for RFG has improved from a baseline period average of 27.5% reduction to 29.5% reduction in 2003. Likewise, CG toxics emissions have decreased from an average of 95 mg/mile during 1998–2000 to 90.7 mg/mile in 2003.

#### d. Gasoline Sulfur

EPA's gasoline sulfur program<sup>172</sup> requires, beginning in 2006, that sulfur levels in gasoline can be no higher in any one batch than 80 ppm, and must average 30 ppm annually. When fully effective, gasoline will have 90 percent less sulfur than before the program. Reduced sulfur levels are necessary to ensure that vehicle emission control systems are not impaired. These systems effectively reduce non-methane organic gas (NMOG) emissions, of which some are air toxics. With lower sulfur levels, emission control technologies can work longer and more efficiently. Both new and older vehicles benefit from reduced gasoline sulfur levels.

#### e. Gasoline Volatility

A fuel's volatility defines its evaporation characteristics. A gasoline's volatility is commonly referred to as its Reid vapor pressure, or RVP. Gasoline summertime RVP ranges from about 6–9 psi, and wintertime RVP ranges from about 9–14 psi, when additional vapor is required for starting in cold temperatures. Gasoline vapors contain a subset of the liquid gasoline components, and thus can contain toxics compounds such as benzene. EPA has controlled summertime gasoline RVP since 1989 primarily as a VOC and

requirements for conventional gasoline must be met on the same aggregate basis (40 CFR Part 80, Subpart E).

<sup>172</sup> 65 FR 6822 (February 10, 2000).

ozone precursor control, which also results in some toxics pollutant reductions.

#### f. Diesel Fuel

In early 2001, EPA issued rules requiring that diesel fuel for use in highway vehicles contain no more than 15 ppm sulfur beginning June 1, 2006.<sup>173</sup> This program contains averaging, banking and trading provisions, as well as other compliance flexibilities. In June 2004, EPA issued rules governing the sulfur content of diesel fuel used in nonroad diesel engines.<sup>174</sup> In the nonroad rule, sulfur levels are limited to a maximum of 500 ppm sulfur beginning in 2007 (current levels are approximately 3000 ppm). In 2010, nonroad diesel sulfur levels must not exceed 15 ppm.

EPA's diesel fuel requirements are part of a comprehensive program to combine engine and fuel controls to achieve the greatest emission reductions. The diesel fuel provisions enable the use of advanced emission-control technologies on diesel vehicles and engines. The diesel fuel requirements will also provide immediate public health benefits by reducing PM emissions from current diesel vehicles and engines.

#### g. Phase-Out of Lead in Gasoline

One of the first programs to control toxic emissions from motor vehicles was the removal of lead from gasoline. Beginning in the mid-1970s, unleaded gasoline was phased in to replace leaded gasoline. The phase-out of leaded gasoline was completed January 1, 1996, when lead was banned from motor vehicle gasoline. The removal of lead from gasoline has essentially eliminated on-highway mobile source emissions of this highly toxic substance.

#### 2. Highway Vehicle and Engine Programs

The 1990 Clean Air Act Amendments set specific emission standards for hydrocarbons and for PM. Air toxics are present in both of these pollutant categories. As vehicle manufacturers develop technologies to comply with the hydrocarbon (HC) and particulate standards (e.g., more efficient catalytic converters), air toxics are reduced as well. Since 1990, we have developed a number of programs to address exhaust and evaporative hydrocarbon emissions and PM emissions.

Two of our recent initiatives to control emissions from motor vehicles

<sup>173</sup> 66 FR 5002 (January 18, 2001) <http://www.epa.gov/otaq/diesel.html>.

<sup>174</sup> 69 FR 38958 (June 29, 2004).

<sup>168</sup> See RFG rule for why evaporative emissions are not included in the anti-dumping toxics determination.

<sup>169</sup> Phase II.

<sup>170</sup> 40 CFR Part 80, Subpart D.

<sup>171</sup> Except for those who comply with the anti-dumping requirements for conventional gasoline on an aggregate basis, in which case the MSAT1

and their fuels are the Tier 2 control program for light-duty vehicles and the 2007 heavy-duty engine rule. Together these two initiatives define a set of comprehensive standards for light-duty and heavy-duty motor vehicles and their fuels. In both of these initiatives, we treat vehicles and fuels as a system. The Tier 2 control program establishes stringent tailpipe and evaporative emission standards for light-duty vehicles and a reduction in sulfur levels in gasoline fuel beginning in 2004.<sup>175</sup> The 2007 heavy-duty engine rule establishes stringent exhaust emission standards for new heavy-duty engines and vehicles for the 2007 model year as well as reductions in diesel fuel sulfur levels starting in 2006.<sup>176</sup> Both of these programs will provide substantial emissions reductions through the application of advanced technologies. We expect 90% reductions in PM from new diesel engines compared to engines under current standards.

Some of the key earlier programs controlling highway vehicle and engine emissions are the Tier 1 and NLEV standards for light-duty vehicles and trucks; enhanced evaporative emissions standards; the supplemental federal test procedures (SFTP); urban bus standards; and heavy-duty diesel and gasoline standards for the 2004/2005 time frame.

### 3. Nonroad Engine Programs

There are various categories of nonroad engines, including land-based diesel engines (*e.g.*, farm and construction equipment), small land-based spark-ignition (SI) engines (*e.g.*, lawn and garden equipment, string trimmers), large land-based SI engines (*e.g.*, forklifts, airport ground service equipment), marine engines (including diesel and SI, propulsion and auxiliary, commercial and recreational), locomotives, aircraft, and recreational vehicles (off-road motorcycles, "all terrain" vehicles and snowmobiles). Chapter 2 of the RIA provides more information about these programs. As with highway vehicles, the VOC standards we have established for nonroad engines will also significantly reduce VOC-based toxics from nonroad engines. In addition, the standards for diesel engines (in combination with the stringent sulfur controls on nonroad diesel fuel) will significantly reduce diesel PM and exhaust organic gases, which are mobile source air toxics.

In addition to the engine-based emission control programs described below, fuel controls will also reduce emissions of air toxics from nonroad

engines. For example, restrictions on gasoline formulation (the removal of lead, limits on gasoline volatility and RFG) are projected to reduce nonroad MSAT emissions because most gasoline-fueled nonroad vehicles are fueled with the same gasoline used in on-highway vehicles. An exception to this is lead in aviation gasoline. Aviation gasoline, used in general (as opposed to commercial) aviation, is a high octane fuel used in a relatively small number of aircraft (those with piston engines). Such aircraft are generally used for personal transportation, sightseeing, crop dusting, and similar activities.

### 4. Voluntary Programs

In addition to the fuel and engine control programs described above, we are actively promoting several voluntary programs to reduce emissions from mobile sources, such as the National Clean Diesel Campaign, anti-idling measures, and Best Workplaces for Commuters. While the stringent emissions standards described above apply to new highway and nonroad diesel engines, it is also important to reduce emissions from the existing fleet of about 11 million diesel engines. EPA has launched a comprehensive initiative called the National Clean Diesel Campaign, one component of which is to promote the reduction of emissions in the existing fleet of engines through a variety of cost-effective and innovative strategies. The goal of the Campaign is to reduce emissions from the 11 million existing engines by 2014. Emission reduction strategies include switching to cleaner fuels, retrofitting engines through the addition of emission control devices, and engine replacement. For example, installing a diesel particulate filter achieves diesel particulate matter reductions of approximately 90 percent (when combined with the use of ultra low sulfur diesel fuel). The Energy Policy Act of 2005 includes grant authorizations and other incentives to help facilitate voluntary clean diesel actions nationwide.

The National Clean Diesel Campaign is focused on leveraging local, state, and federal resources to retrofit or replace diesel engines, adopt best practices, and track and report results. The Campaign targets five key sectors: School buses, ports, construction, freight, and agriculture.

Reducing vehicle idling provides important environmental benefits. As a part of their daily routine, truck drivers often keep their vehicles at idle during stops to provide power, heat and air conditioning. EPA's SmartWay Transport Partnership is helping the freight industry to adopt innovative idle

reduction technologies and take advantage of proven systems that provide drivers with basic necessities without using the engine. To date, there are 50 stationary anti-idling projects, and mobile technology has been installed on nearly 20,000 trucks. The SmartWay Transport Partnership also works with the freight industry to reduce fuel use (with a concomitant reduction in emissions) by promoting a wide range of new technologies such as advanced aerodynamics, single-wide tires, weight reduction speed control and intermodal shipping.

Daily commuting represents another significant source of emissions from motor vehicles. EPA's Best Workplaces for Commuters<sup>SM</sup> program is working with employers across the country to reverse the trend of longer, single-occupancy vehicle commuting. OTAQ has created a national list of the Best Workplaces for Commuters to formally recognize employers that offer superior commuter benefits such as free transit passes, subsidized vanpools/carpools, and flexi-place, or work-from-home, programs. More than 1,300 employers representing 2.8 million U.S. workers have been designated Best Workplaces for Commuters.

Much of the growth in the Best Workplaces for Commuters program has been through metro area-wide campaigns. Since 2002, EPA has worked with coalitions in 14 major metropolitan areas to increase the penetration of commuter benefits in the marketplace and the visibility of the companies that have received the BWC designation. Another significant path by which the program has grown is through Commuter Districts including corporate and industrial business parks, shopping malls, business improvement districts and downtown commercial areas. To date EPA has granted the Best Workplaces for Commuters "District" designation to twenty locations across the country including downtown Denver, Houston, Minneapolis and Tampa.

## E. Emission Reductions From Proposed Controls

### 1. Proposed Vehicle Controls

We are proposing a hydrocarbon standard for gasoline passenger vehicles at cold temperatures. This standard will reduce VOC at temperatures below 75 °F, including air toxics such as benzene, 1,3-butadiene, formaldehyde, acetaldehyde, acrolein and naphthalene, and will also reduce emissions of direct and secondary PM. We are also proposing new evaporative emissions standards for Tier 2 vehicles starting in

<sup>175</sup> 65 FR 6697, February 10, 2000.

<sup>176</sup> 66 FR 5001, January 18, 2001.

2009. These new evaporative standards reflect the emissions levels already being achieved by manufacturers.

a. Volatile Organic Compounds (VOC)  
Table V.E-1 shows the VOC exhaust emission reductions from light-duty gasoline vehicles and trucks that would result from our proposed standards. The proposed standards would reduce VOC

emissions in 2030 by 32%. Overall VOC exhaust emissions from these vehicles would be reduced by 81% between 1999 and 2030 (including the effects of the proposed standards as well as standards already in place, such as Tier 2).

TABLE V.E-1.—ESTIMATED NATIONAL REDUCTIONS IN EXHAUST VOC EMISSIONS FROM LIGHT-DUTY GASOLINE VEHICLES AND TRUCKS, 1999 TO 2030

	1999	2015	2020	2030
VOC Without Rule (tons) .....	4,899,891	2,625,076	2,556,751	2,899,269
VOC With Proposed Vehicle Standards (tons) .....	N.A	2,305,202	2,020,267	1,985,830
VOC Reductions from Proposed Vehicle Standards (tons) .....	N.A	319,874	536,484	913,439
Percentage Reduction .....	N.A	12	21	32

b. Toxics

In 2030, we estimate that the proposed vehicle standards would

result in a 38% reduction in benzene emissions and 37% reduction in total emissions of the MSATs<sup>177</sup> from light-

duty vehicles and trucks (see Tables V.E-2 and V.E-3).

TABLE V.E-2.—ESTIMATED NATIONAL REDUCTIONS IN BENZENE EXHAUST EMISSIONS FROM LIGHT-DUTY GASOLINE VEHICLES AND TRUCKS, 1999 TO 2030

	1999	2015	2020	2030
Benzene Without Rule (tons) .....	171,154	101,355	106,071	124,897
Benzene With Proposed Vehicle Standards (tons) .....	N.A	84,496	77,966	77,208
Benzene Reductions from Proposed Vehicle Standards (tons) .....	N.A	16,859	28,105	47,689
Percentage Reduction .....	N.A	17	26	38

TABLE V.E-3.—ESTIMATED NATIONAL REDUCTIONS IN EXHAUST MSAT EMISSIONS FROM LIGHT-DUTY GASOLINE VEHICLES AND TRUCKS, 1999 TO 2030

	1999	2015	2020	2030
MSATs Without Rule (tons) .....	1,341,572	707,877	724,840	844,366
MSATs With Proposed Vehicle Standards (tons) .....	N.A	599,492	543,332	535,479
MSAT Reductions from Proposed Vehicle Standards (tons) .....	N.A	108,385	181,509	308,887
Percentage Reduction .....	N.A	15	25	37

c. PM<sub>2.5</sub>

EPA expects that the proposed cold-temperature vehicle standards would reduce exhaust emissions of direct PM<sub>2.5</sub> by over 20,000 tons in 2030 nationwide (see Table V.E-4 below). Our analysis of the data from vehicles meeting Tier 2 emission standards indicate that PM emissions follow a monotonic

relationship with temperature, with lower temperatures corresponding to higher vehicle emissions. Additionally, the analysis shows the ratio of PM to total non-methane hydrocarbons (NMHC) to be independent of temperature.<sup>178</sup> Our testing indicates that strategies which reduce NMHC start emissions at cold temperatures also reduce direct PM emissions. Based on

these findings, direct PM emissions at cold temperatures were estimated using a constant PM to NMHC ratio. PM emission reductions were estimated by assuming that NMHC reductions will result in proportional reductions in PM. This assumption is supported by test data. For more detail, see Chapter 2.1 of the RIA.

TABLE V.E-4.—ESTIMATED NATIONAL REDUCTIONS IN DIRECT PM<sub>2.5</sub> EXHAUST EMISSIONS FROM LIGHT-DUTY GASOLINE VEHICLES AND TRUCKS, 2015 TO 2030

	2015	2020	2030
PM <sub>2.5</sub> Reductions from Proposed Vehicle Standards (tons) .....	7,037	11,803	20,096

2. Proposed Fuel Benzene Controls

The proposed fuel benzene controls would reduce benzene exhaust and

evaporative emissions from both on-road and nonroad mobile sources that are fueled by gasoline. In addition, the

proposed fuel benzene standard would reduce evaporative emissions from gasoline distribution and gas cans.

<sup>177</sup> Table IV.A-1 lists the MSATs included in this analysis.

<sup>178</sup> U.S. EPA. 2005. Cold-temperature exhaust particulate matter emissions. Memorandum from Chad Bailey to docket EPA-HQ-OAR-2005-0036.

Impacts on 1,3-butadiene, formaldehyde, and acetaldehyde emissions are not significant, but are presented in Chapter 2 of the RIA. We do not expect the fuel benzene standard to have quantifiable impacts on any other air toxics, total VOCs, or PM.

Table V.E-5 shows national estimates of total benzene emissions from these source sectors with and without the proposed fuel benzene standard. These estimates do not include effects of the proposed vehicle or gas can standards (see section V.E.4 for the combined

effects of the controls). The proposed fuel benzene standard would reduce total benzene emissions from on-road and nonroad gasoline mobile sources, gas cans, and gasoline distribution by 12% in 2015.

TABLE V.E-5.—ESTIMATED REDUCTIONS IN BENZENE EMISSIONS FROM PROPOSED GASOLINE STANDARD BY SECTOR IN 2015

	Gasoline on-road mobile sources	Gasoline nonroad mobile sources	Gas cans	Gasoline distribution	Total
Benzene Without Rule (tons) .....	103,797	37,747	2,262	5,999	149,805
Benzene With Proposed Gasoline Standard (tons) .....	92,513	33,247	1,359	4,054	131,173
Benzene Reductions from Proposed Gasoline Standard (tons) .....	11,284	4,500	903	1,945	18,632
Percentage Reduction .....	11	12	40	32	12

3. Proposed Gas Can Standards

a. VOC

Table V.E-6 shows the reductions in VOC emissions that we expect from the

proposed gas can standard. In 2015, VOC emissions from gas cans would be reduced by 60% because of reduced permeation, spillage, and evaporative

losses. These estimates do not include the effects of a fuel benzene standard (see section V.E.4 for the combined effects of the proposed controls).

TABLE V.E-6.—ESTIMATED NATIONAL REDUCTIONS IN VOC EMISSIONS FROM GAS CANS, 2010 TO 2030

	1999	2010	2015	2020	2030
VOC Without Rule (tons) .....	318,596	279,374	296,927	318,384	362,715
VOC With Proposed Gas Can Standard (tons) .....	N.A.	250,990	116,431	125,702	144,634
VOC Reductions from Proposed Gas Can Standard (tons) .....	N.A.	28,384	180,496	192,683	218,080
Percentage Reduction .....	N.A.	10	61	61	60

b. Toxics

The proposed gas can standard would reduce emissions of benzene, naphthalene, toluene, xylenes, ethylbenzene, n-hexane, 2,2,4-

trimethylpentane, and MTBE. We estimate that benzene emissions from gas cans would be reduced by 65% (see Table V.E-7) and, more broadly, air toxic emissions by 61% (see Table V.E-8) in year 2015. These reductions do not

include effects of the proposed fuel benzene standard (see section V.E.4 for the combined effects of the proposed controls). Chapter 2 of the RIA provides details on the emission reductions of the other toxics.

TABLE V.E-7.—ESTIMATED NATIONAL REDUCTIONS IN BENZENE EMISSIONS FROM GAS CANS, 2010 TO 2030

	1999	2010	2015	2020	2030
Benzene Without Rule (tons) .....	2,229	2,118	2,262	2,423	2,757
Benzene With Proposed Gas Can Standard (tons) .....	N.A.	1,885	794	856	985
Benzene Reductions from Proposed Gas Can Standard (tons) .....	N.A.	233	1,468	1,567	1,772
Percentage Reduction .....	N.A.	11	65	65	64

TABLE V.E-8.—ESTIMATED NATIONAL REDUCTIONS IN TOTAL MSAT EMISSIONS FROM GAS CANS, 2010 TO 2030

	1999	2010	2015	2020	2030
MSATs Without Rule (tons) .....	39,581	34,873	37,076	39,751	45,284
MSATs With Proposed Gas Can Standard (tons) .....	N.A.	31,312	14,445	15,593	17,942
MSAT Reductions from Proposed Gas Can Standard (tons) .....	N.A.	3,561	22,631	24,158	27,342
Percentage Reduction .....	N.A.	10	61	61	60

Chapter 2 of the RIA describes how we estimated emissions from gas cans, including the key assumptions used and uncertainties in the analysis. We request

comments on the emissions inventory methodology used by EPA and we encourage commenters to provide relevant data where possible.

4. Total Emission Reductions From Proposed Controls

Sections V.E.1 through V.E.3 present the emissions impacts of each of the

proposed controls individually. This section presents the combined emissions impacts of the proposed controls.

a. Toxics

Air toxic emissions from light-duty vehicles depend on both fuel benzene content and vehicle hydrocarbon emission controls. Similarly, the air toxic emissions from gas cans depend

on both fuel benzene content and the gas can emission controls. Tables V.E-9 and V.E-10 below summarize the expected reductions in benzene and MSAT emissions, respectively, from our proposed vehicle, fuel, and gas can controls. In 2030, annual benzene emissions from gasoline on-road mobile sources would be 44% lower as a result of this proposal (see Figure V.E-1).

Annual benzene emissions from gasoline light-duty vehicles would be 45% lower in 2030 as a result of this proposal. Likewise, this proposal would reduce annual emissions of benzene from gas cans by 78% in 2030 (see Figure V.E-2). For MSATs from on-road mobile sources, Figure V.E-3 below shows a 33% reduction in MSAT emissions in 2030.

TABLE V.E-9.—ESTIMATED REDUCTIONS IN BENZENE EMISSIONS FROM PROPOSED CONTROL MEASURES BY SECTOR, 2015 TO 2030

Benzene	1999	2015			2020			2030		
		Without rule (tons)	With rule (tons)	Reductions (tons)	Without rule (tons)	With rule (tons)	Reductions (tons)	Without rule (tons)	With rule (tons)	Reductions (tons)
Gasoline On-road Mobile Sources .....	178,465	103,798	77,155	26,643	108,256	71,326	36,930	127,058	70,682	56,376
Gasoline Nonroad Mobile Sources .....	58,710	37,747	33,247	4,500	36,440	32,018	4,422	39,162	34,400	4,762
Gas Cans .....	2,229	2,262	492	1,770	2,423	531	1,892	2,757	610	2,147
Gasoline Distribution .....	5,502	5,999	4,054	1,945	6,207	4,210	1,997	6,207	4,210	1,997
Total .....	244,905	149,806	114,948	34,858	153,326	108,085	45,241	175,184	109,902	65,282

Figure V.E-1. Benzene Emissions from Gasoline On-Road Mobile Sources

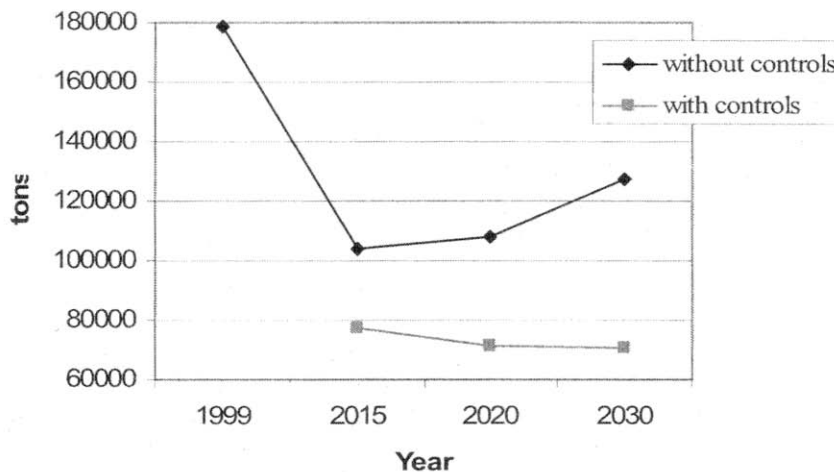


Figure V.E-2. Benzene Emissions from Gas Cans

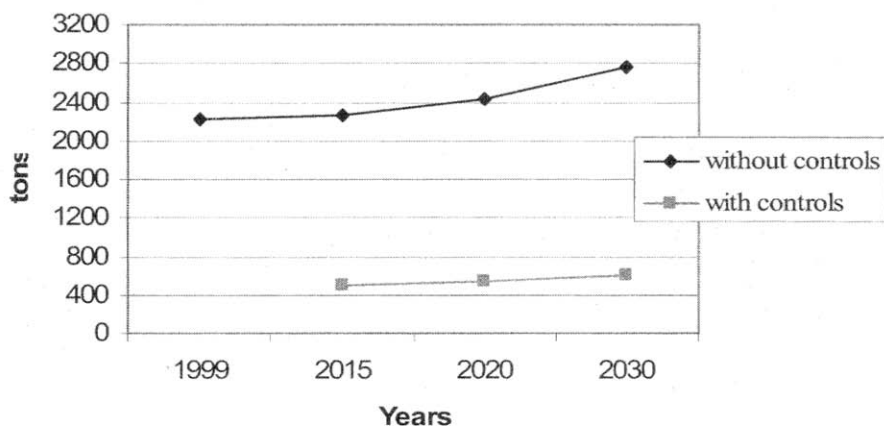
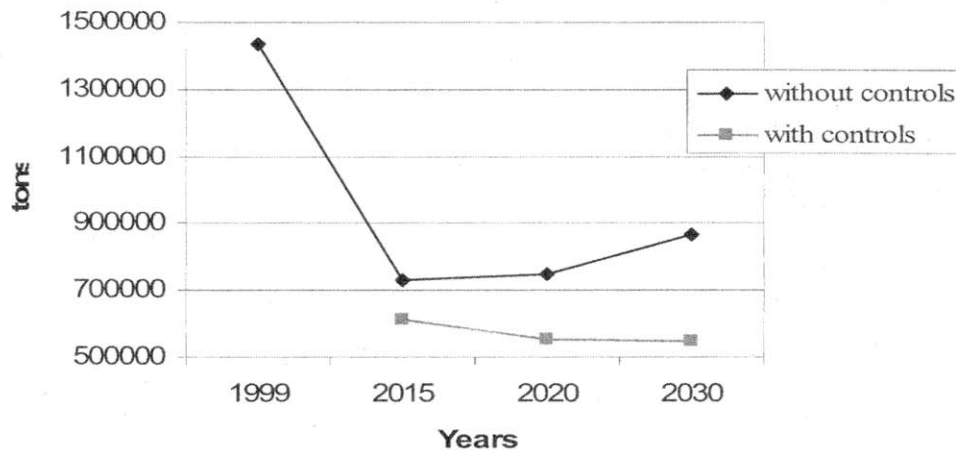


TABLE V.E-10.—ESTIMATED REDUCTIONS IN MSAT EMISSIONS FROM PROPOSED CONTROL MEASURES BY SECTOR, 2015 TO 2030

MSAT	1999	2015			2020			2030		
		Without rule (tons)	With rule (tons)	Reductions (tons)	Without rule (tons)	With rule (tons)	Reductions (tons)	Without rule (tons)	With rule (tons)	Reductions (tons)
Gasoline On-road Mobile Sources .....	1,415,502	731,283	613,227	118,056	745,769	555,541	190,228	865,767	548,298	317,469
Gasoline Nonroad Mobile Sources .....	673,922	432,953	428,506	4,447	390,468	386,095	4,373	405,119	400,408	4,711
Gas Cans .....	39,581	37,076	14,143	22,933	39,751	15,268	24,483	45,284	17,567	27,717
Gasoline Distribution .....	50,625	62,804	60,859	1,945	64,933	62,936	1,997	64,933	62,936	1,997
Total .....	2,179,630	1,264,116	1,116,735	147,381	1,240,921	1,019,840	221,081	1,381,103	1,029,209	351,894

Figure V.E-3. MSAT Emissions from Gasoline On-Road Mobile Sources



b. VOC

VOC emissions would be reduced by the hydrocarbon emission standards for

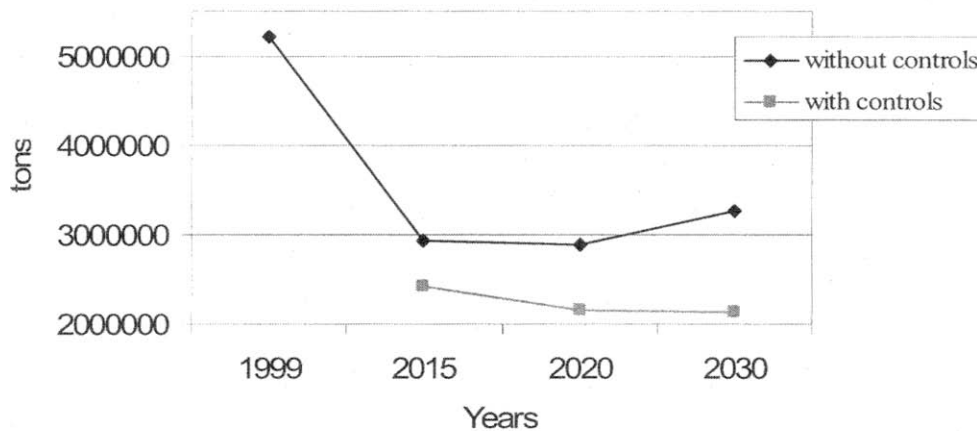
both light-duty vehicles and gas cans. As seen in the table and accompanying figure below, annual VOC emission

reductions from both of these sources would be 35% lower in 2030 because of proposed control measures.

TABLE V.E-11.—ESTIMATED REDUCTIONS IN VOC EMISSIONS FROM LIGHT-DUTY GASOLINE VEHICLES AND GAS CANS, 2015 TO 2030

	2015	2020	2030
VOC Without Rule (tons) .....	2,922,003	2,875,135	3,261,984
VOC With Proposed Vehicle and Gas Can Standards (tons) .....	2,421,633	2,145,969	2,130,464
VOC Reduction (tons) .....	500,370	729,168	1,131,520

Figure V.E-4. VOC Emissions from Proposed Light-Duty Vehicles and Gas Cans



c. PM<sub>2.5</sub>

We expect that only the proposed vehicle control would reduce emissions of direct PM<sub>2.5</sub>. As shown in Table V.E-4, we expect this control to reduce direct PM<sub>2.5</sub> emissions by about 20,000 tons in 2030. In addition, the VOC reductions from the proposed vehicle

and gas can standards would also reduce secondary formation of PM<sub>2.5</sub>.

*F. How Would This Proposal Reduce Exposure to Mobile Source Air Toxics and Associated Health Effects?*

The proposed benzene standard for gasoline would reduce both evaporative

and exhaust emissions from motor vehicles and nonroad equipment. It would also reduce emissions from gas cans and stationary source emissions associated with gasoline distribution. Therefore, it would reduce exposure to benzene for the general population, and also for people near roadways, in



vehicles, in homes with attached garages, operating nonroad equipment, and living or working near sources of gasoline distribution emissions (such as bulk terminals, bulk plants, tankers, marine vessels, and service stations). Section IV.B.2 of this preamble provides more details on these types of exposures.

We performed national-scale air quality, exposure, and risk modeling in order to quantitatively assess the impacts of the proposed fuel benzene standard. However, in addition to the limitations of the national-scale modeling tools (discussed in section IV.A), this modeling did not account for the elevated hydrocarbon emissions from motor vehicles at cold temperatures, which we recently discovered and are further described in section VI and the RIA. The modeling also examined the gasoline benzene standard alone, without the proposed vehicle or gas can standards. Nevertheless, the modeling is useful as a preliminary assessment of the impacts of the fuel standard.

The fuel benzene standard being proposed in this rule would reduce both the number of people above the 1 in

100,000 increased cancer risk level, and the average population cancer risk, by reducing exposures to benzene from mobile sources. The number of people above the 1 in 100,000 cancer risk level due to exposure to all mobile source air toxics from all sources would decrease by over 3 million in 2020 and by about 3.5 million in 2030, based on average census tract risks. The number of people above the 1 in 100,000 increased cancer risk level from exposure to benzene from all sources would decrease by over 4 million in 2020 and 5 million in 2030. It should be noted that if it were possible to estimate impacts of the proposed standard on “background” concentrations, the estimated overall risk reductions would be even larger. The proposed standard would have little impact on the number of people above various respiratory hazard index levels, since this potential non-cancer risk is dominated by exposure to acrolein.

Table V.F–1 depicts the impact on the mobile source contribution to nationwide average population cancer risk from benzene in 2020. Nationwide, the cancer risk attributable to mobile

source benzene would be reduced by over 8%. Reductions in areas not subject to reformulated gasoline controls are almost 13 percent relative to risks without the proposed control; and in some states with high fuel benzene levels, such as Minnesota and Washington, the risk reduction would exceed 17 percent. In Alaska, which has the highest fuel benzene levels in the country, reductions would exceed 30%. Reductions for other modeled years are similar. The methods and assumptions used to model the impact of the proposed control are described in more detail in the Regulatory Impact Analysis. Although not quantified in the risk analyses for this rule, controls proposed for portable fuel containers will also reduce exposures and risk from benzene, and cold temperature hydrocarbon standards for exhaust emissions will reduce cancer and noncancer risks for all gaseous mobile source air toxics. These reductions will vary geographically since reductions from vehicle control are higher at colder temperatures, and reductions from gas can controls are higher at higher temperatures.

TABLE V.F–1.—IMPACT OF PROPOSED FUEL BENZENE CONTROL ON THE MOBILE SOURCE CONTRIBUTION TO NATIONWIDE AVERAGE POPULATION CANCER RISK IN 2020

	U.S.	RFG areas	Non-RFG areas
Without Proposal .....	2.57×10 <sup>-6</sup>	3.64×10 <sup>-6</sup>	1.96×10 <sup>-6</sup>
0.62% Benzene Standard .....	2.35×10 <sup>-6</sup>	3.51×10 <sup>-6</sup>	1.72×10 <sup>-6</sup>
% Reduction .....	8.6	3.6	12.2

Table V.F–2 summarizes the change in median and 95th percentile benzene inhalation cancer risk from all outdoor sources in 2015, 2020, and 2030, with the fuel benzene controls proposed in

this rule. The reductions in risk would be larger if the modeling fully accounted for a number of factors, including: benzene emissions at cold temperature; exposure to benzene emissions from

vehicles, equipment, and gas cans in attached garages; near-road exposures; and the impacts of the control program on “background” levels attributable to transport.

TABLE V.F–2.—CHANGE IN MEDIAN AND 95TH PERCENTILE BENZENE INHALATION CANCER RISK FROM OUTDOOR SOURCES IN 2015, 2020, AND 2030 WITH THE FUEL BENZENE CONTROLS PROPOSED IN THIS RULE

	2015		2020		2030	
	median	95th	median	95th	median	95th
Current Controls .....	5.73×10 <sup>-6</sup>	1.38×10 <sup>-5</sup>	5.61×10 <sup>-6</sup>	1.35×10 <sup>-5</sup>	5.75×10 <sup>-6</sup>	1.41×10 <sup>-5</sup>
Proposed Benzene Standard .....	5.49×10 <sup>-6</sup>	1.32×10 <sup>-5</sup>	5.39×10 <sup>-6</sup>	1.29×10 <sup>-5</sup>	5.51×10 <sup>-6</sup>	1.35×10 <sup>-5</sup>
Percent Change .....	4.2	4.3	3.9	4.4	4.2	4.3

We did not model the air quality, exposure, and risk impacts of the proposed vehicle and gas can standards. However, the proposed vehicle standards would reduce exposure to several MSATs, including benzene. Like the proposed fuel standard, the vehicle standards would reduce the general population’s exposure to MSATs, as

well as people near roadways and in vehicles. Since motor vehicle emissions are ubiquitous across the U.S. and widely dispersed, reductions in exposure and risk will be approximately proportional to reductions in emissions.

The gas can standard will reduce evaporative emissions of several MSATs, including benzene. We expect

that these standards would significantly reduce concentrations of benzene and other MSATs in attached garages and inside homes with attached garages. Accordingly, exposure to benzene and other MSATs would be significantly reduced. As discussed in section IV.B.2, exposures to emissions occurring in attached garages can be quite high.

The proposed vehicle and gas can standards would also reduce precursors to ozone and PM. We have modeled the ozone impacts of the proposed gas can standard and the PM health benefits that would be associated with the direct PM reductions from the proposed vehicle standards. These results are discussed in sections IV.D and IX, respectively.

### *G. Additional Programs Under Development That Will Reduce MSATs*

#### 1. On-Board Diagnostics for Heavy-Duty Vehicles Over 14,000 Pounds

We are planning to propose on-board diagnostics (OBD) requirements for heavy-duty vehicles over 14,000 pounds. In general, OBD systems monitor the operation of key emissions controls to detect major failures that would lead to emissions well above the standards during the life of the vehicle. Given the nature of the heavy-duty trucking industry, 50-state harmonization of emissions requirement is an important consideration. In order to work towards this goal, the Agency signed a Memorandum of Agreement in 2004 with the California Air Resources Board which expresses both agencies' interest in working towards a single, nationwide program for heavy-duty OBD. Since that time, California has established their heavy-duty OBD program, which will begin implementation in 2010. We expect the Agency's program will also begin in the 2010 time frame. These requirements would help ensure that the emission reductions we projected in the 2007 rulemaking for heavy-duty engines occur in-use.

#### 2. Standards for Small SI Engines

We are developing a proposal for Small SI engines (those typically used in lawn and garden equipment) and recreational marine engines. This proposal is being developed in response to Section 428 of the Omnibus Appropriations Bill for 2004, which requires EPA to propose regulations under Clean Air Act section 213 for new nonroad spark-ignition engines under 50 horsepower. We plan to propose standards that would further reduce the emissions for these nonroad categories, and we anticipate that the new standards would provide significant further reductions in HC (and VOC-based toxics) emissions.

#### 3. Standards for Locomotive and Marine Engines

In addition, we are planning to propose more stringent standards for large diesel engines used in locomotive and marine applications, as discussed in

a recent Advance Notice of Proposed Rulemaking.<sup>179</sup> New standards for marine diesel engines would apply to engines less than 30 liters per cylinder in displacement (all engine except for Category 3). We are considering standards modeled after our Tier 4 nonroad diesel engine program, which achieve substantial reductions in PM, HC, and NO<sub>x</sub> emissions. These standards would be based on the use of high efficiency catalyst aftertreatment and would also require fuel sulfur control. As discussed in our recent ANPRM, we are considering implementation as early as 2011.

### **VI. Proposed New Light-Duty Vehicle Standards**

#### *A. Why Are We Proposing New Standards?*

##### 1. The Clean Air Act and Air Quality

As described in section V of this preamble, the U.S. has made significant progress in reducing emissions from passenger cars and light trucks since the passage of the 1990 Clean Air Act Amendments. Many emission control programs adopted to implement the 1990 Clean Air Act Amendments are reducing and will continue to reduce air toxics from light-duty vehicles. These include our reformulated gasoline (RFG) program, our Supplemental Federal Test Procedure (SFTP) standards, our national low emission vehicle program (NLEV), and, most recently, our Tier 2 motor vehicle emissions standards and gasoline sulfur control requirements.<sup>180</sup> While these vehicle programs were put in place primarily to reduce ambient concentrations of criteria pollutants and their precursors (NO<sub>x</sub>, VOC, CO, and PM), they have reduced and will continue to significantly reduce light-duty vehicle emissions of air toxics. For example, there are numerous chemicals that make up total VOC emissions, including several gaseous toxics (e.g., benzene, formaldehyde, 1,3-butadiene, and acetaldehyde). These toxics are all reduced by VOC emissions standards. It is the stringent control of hydrocarbons in particular that results in stringent control of gaseous toxics. There are no vehicle-based technologies of which we are aware that reduce these air toxics individually.

At the time of our 2001 MSAT rule, we had recently finalized the Tier 2

<sup>179</sup> 69 FR 39276, June 29, 2004.

<sup>180</sup> Unless otherwise noted, we use "light-duty vehicles" or "vehicles" to generally refer to passenger vehicles, light-duty trucks such as sport utility vehicles (SUVs) and pick-ups, and medium-duty passenger vehicles (MDPVs) which includes larger SUVs and passenger vans up to 10,000 pounds Gross Vehicle Weight Rating.

emissions standards and gasoline sulfur control requirements (described in more detail below in section V.D). As explained earlier, we concluded then under section 202(l) that the Tier 2 standards represented the greatest degree of emissions control achievable for those vehicles. However, we also committed to continue to consider the feasibility of additional vehicle-based MSAT controls in the future.

#### 2. Technology Opportunities for Light-Duty Vehicles

Since the 2001 MSAT rule, we have identified potential situations where further reductions of light-duty vehicle hydrocarbon emissions—and, therefore, mobile source air toxics—are technically feasible, cost-effective, and do not have adverse energy or safety implications. First, recent research and analytical work shows that the Tier 2 exhaust emission standards for hydrocarbons (which are typically tested at 75° F) do not, in the case of many vehicles, result in robust control of hydrocarbon emissions at lower temperatures. We believe that cold temperature hydrocarbon control can be substantially improved using the same technological approaches generally already in use in the Tier 2 vehicle fleet to meet the stringent standards at 75° F. Second, we believe that harmonization of evaporative emission standards with California would prevent backsliding by codifying current industry practices. Sections VI.B.1 and VI.B.2, below, provide our rationale for proposing new cold temperature and evaporative controls and describe the detailed provisions of our proposal. We request comment on all aspects of these proposals and encourage commenters to provide detailed rationales and supporting data where possible.

Aside from these proposed standards, we continue to believe that the remaining Tier 2 exhaust emission standards (i.e., those that apply over the standard Federal Test Procedure at temperatures between 68° F and 86° F) represent the greatest emissions reductions achievable as required under Clean Air Act section 202(l). We therefore are not proposing further emission reductions from these vehicles. (Please see section VI.D for further discussion.)

#### 3. Cold Temperature Effects on Emission Levels

##### a. How Does Temperature Affect Emissions?

With the possible exception of high-load operation, Tier 2 gasoline-powered vehicles emit the overwhelming

majority of hydrocarbon emissions in the first few minutes of operation following a cold start (i.e., starting the vehicles after the engine has stabilized to the ambient temperatures, such as overnight). This is true at all cold start temperatures, and the general trend is that hydrocarbon emissions progressively increase as engine start temperatures decrease. The level of hydrocarbon emissions produced by the engine will vary with start temperature, engine hardware design and most importantly, engine management control strategies. Furthermore, due to the heavy dependence on the aftertreatment system to perform the main emission reducing functions, any delayed or non-use of emission controls (hardware or software) will further increase the amount of hydrocarbon emissions emitted from the vehicle following the cold start.

Elevated hydrocarbon levels at cold temperatures, specifically, the non-methane hydrocarbons (NMHC) portion of total hydrocarbons (THC), also indicate higher emissions of gaseous air toxics. A detailed description of the relationship between NMHC and air toxics can be found in Chapter 2 of the RIA. Recent EPA research studies<sup>181</sup> on Tier 2 gasoline vehicles, and past EPA studies<sup>182</sup> on older generation gasoline vehicles, demonstrate that many air toxics (e.g., benzene) are a relatively constant fraction of NMHC. This relationship is observed regardless of vehicle type, NMHC emissions level, or temperature. The relationship remains relatively constant for different vehicles with different levels of NMHC emissions, and for the same vehicle at colder temperatures. Therefore, it can be concluded that reductions in NMHC will result in proportional reductions in gaseous air toxics which are components of HC. These observations and findings indicate that controlling NMHC is an effective approach to reducing toxics which are a component of NMHC, including benzene emissions.

In addition to control of air toxics, another benefit of regulating NMHC at cold temperatures is reductions in particulate matter (PM). PM is a criteria pollutant and for gasoline-fueled vehicles is an emerging area of interest on which we are continuing to collect data (see sections III.E and IV.F for more details on PM). We have limited data indicating that PM emissions can be significantly higher at cold temperatures

compared to emissions at the 68–86° F testing temperatures used in the FTP. Data also indicate that HC and direct PM emissions correlate fairly well as temperature changes and that some direct PM emissions reductions can be expected when VOCs are reduced. Also, from a technological standpoint, we can expect reductions in PM as manufacturers reduce over-fueling at cold temperatures for NMHC control. Although section 202(l) deals with control of air toxics, and not criteria pollutants like PM, this co-benefit of cold temperature control is significant.

#### b. What Are the Current Emissions Control Requirements?

There are several requirements currently in place that have resulted in significant NMHC reductions and provided experience with control strategies that apply across a broad range of in-use driving conditions, including cold temperatures. These requirements include the Tier 2 standards, the Supplemental Federal Test Procedure (SFTP) standards, the cold temperature carbon monoxide (CO) standard, and the California 50° F hydrocarbon standard.

The Tier 2 program (and, before that, the NLEV program) contains stringent new standards for light-duty vehicles that have resulted in significant hydrocarbon reductions. To meet these standards, vehicle manufacturers have responded with emissions control hardware and control strategies that have very effectively minimized emissions, particularly immediately following the vehicle start-up. In addition, the SFTP rule (effective beginning in model year 2001) significantly expanded the area of operation where stringent emission control was required, by adding a high load/speed cycle (US06) and an air conditioning cycle (SC03). Vehicle manufacturers responded with additional control strategies across a broader range of in-use driving conditions to successfully meet SFTP requirements.

We also have cold temperature carbon monoxide (CO) standards which began in model year 1994 for light-duty vehicles (LDVs) and light-duty trucks (LDTs).<sup>183</sup> This program requires manufacturers to comply with a 20° F CO standard. The 20° F cold CO test replicates the 75° F FTP drive cycle, but at the colder temperature. While the

recent Tier 2 program is primarily designed to reduce ozone, the cold CO requirement was enacted to address exceedances of the national ambient air quality standards (NAAQS) for CO, which were mostly occurring during the cold weather months. While the cold CO standard was considered challenging at its introduction, manufacturers quickly developed emission control strategies and today comply with the standard with generally large compliance margins. This indicates that manufacturers do in fact have experience with emission control strategies at colder temperatures.

Under the Low Emission Vehicle (LEV) programs, California implemented stringent emissions standards for a 50° F FTP test condition in addition to stringent 75° F standards. By creating a unique 50° F standard, California ensures that emission control strategies successfully used at 75° F are also utilized at the slightly cooler temperatures that encompass a larger range of California's expected climates. The 50° F non-methane organic gases (NMOG) standards are directly proportional to the 75° F certification standard; that is, they are two times the 75° F standard. These standards have resulted in proportional emissions improvements at 50° F for vehicles certified to the California standards, as observed in the manufacturer certification data. Manufacturers have met the standards and have successfully obtained these proportional improvements at 50° F by implementing the same emission control strategies developed for 75° F requirements.

#### c. Opportunities for Additional Control

As emissions standards have become more stringent from Tier 1 to NLEV, and now to Tier 2, manufacturers have concentrated primarily on emissions performance just after the start of the engine in order to further reduce emissions. To comply with stringent hydrocarbon emission standards at 75° F, manufacturers developed new emission control strategies and practices that resulted in significant emissions reductions at that start temperature. For California, the LEV II program contains a standard at 50° F (as just explained), which essentially requires proportional control of hydrocarbon emissions down to that temperature. On the national level, even though there is no explicit requirement, we expected that proportional reductions in hydrocarbon emissions would occur at other colder start temperatures—including the 20° F Cold CO test point—as a result of the more stringent NLEV and Tier 2 standards. We believe that there is no

<sup>181</sup> "VOC/PM Cold Temperature Characterization and Interior Climate Control Emissions/Fuel Economy Impact," Volume I and II, October 2005.

<sup>182</sup> "Characterization of Emissions from Malfunctioning Vehicles Fueled with Oxygenated Gasoline-Ethanol (E10) Fuel," Part I, II and III.

<sup>183</sup> 57 FR 31888 "Control of Air Pollution from New Motor Vehicles and New Motor Vehicle Engines: Cold Temperature Carbon Monoxide Emissions from 1994 and Later Model Year Gasoline-Fueled Light-Duty Vehicles and Light-Duty Trucks", Final Rule, July 17, 1992.

engineering reason why proportional control should not be occurring on a widespread basis.

However, reported annual manufacturer certification results (discussed in the next paragraph) indicate that for many engine families, very little improvement in hydrocarbon emissions was realized at the colder 20° F Cold CO test conditions, despite the improved emission control systems designed for the vehicle under normal 75° F test conditions. Thus although all vehicle manufacturers have been highly successful at reducing emissions at the required FTP start temperature range, in general, they do not appear to be capitalizing on NMHC emission control strategies and technologies at lower temperatures.

Certification reports submitted by manufacturers for recent model years of light duty vehicles in fact show a sharp rise in hydrocarbon<sup>184</sup> emissions at 20° F when compared to the reported 75° F hydrocarbon emission levels. Any rise in hydrocarbon emissions, specifically NMHC, will result in proportional rise in VOC-based air toxics<sup>185</sup>. While some increase in NMHC emissions can be expected simply due to combustion limitations of gasoline engines at colder temperatures, the reported levels of hydrocarbon emissions seem to indicate a significantly diminished use of hydrocarbon emissions controls occurring at colder temperatures. For example, on recent Tier 2 certified vehicles, the reported 20° F hydrocarbon levels on average were 10 to 12 times higher than the equivalent vehicle's measured 75° F hydrocarbon levels. Some vehicles which were certified to more stringent Tier 2 bins (bins 2, 3, and 4) demonstrated 20° F hydrocarbon levels no different than less stringent Tier 2 bins (bins 5, 6, 7, and 8), likewise suggesting no discernable attempt to use the 75° F hydrocarbon controls at the 20° F temperature. On the other hand, in some select cases, individual vehicles did demonstrate proportional improvements in hydrocarbon emission results at 20° F relative to their 75° F results, confirming our belief that proportional control is feasible and indeed is occasionally practiced. One manufacturer's certification results reflected proportional improvements

<sup>184</sup> Most certification 20° F hydrocarbon levels are reported as THC, but NMHC accounts for approximately 95% of THC as seen in results with both THC and NMHC levels reported. This relationship also is confirmed in EPA test programs supporting this rule-making.

<sup>185</sup> "VOC/PM Cold Temperature Characterization and Interior Climate Control Emissions/Fuel Economy Impact", Volume I and II, October 2005.

across almost its entire vehicle lines (including vehicles up to 5665 GVWR), further supporting that proportional control is feasible.

*B. What Cold Temperature Requirements Are We Proposing?*

1. NMHC Exhaust Emissions Standards

We are proposing a set of standards that will achieve proportional NMHC control from the 75° F Tier 2 standards to the 20° F test point. The proposed standard would achieve the greatest degree of hydrocarbon emissions reductions feasible by fully utilizing the substantial existing emission control hardware required to meet Tier 2 standards. We believe these standards would be achievable through calibration and software control strategies on Tier 2 level vehicles without use of additional hardware. The proposed standards are shown in Table VI.B-1.

TABLE VI.B-1.—PROPOSED 20° F FTP EXHAUST EMISSION STANDARDS

Vehicle GVWR and category	NMHC sales-weighted fleet average standard (grams/mile)
≤ 6000 lbs: Light-duty vehicles (LDV) & Light light-duty trucks (LLDT) .....	0.3
> 6000 lbs: Heavy light-duty trucks (HLDT) up to 8,500 lbs & Medium-duty passenger vehicles (MDPV) up to 10,000 lbs .....	0.5

We are proposing two separate sales-weighted fleet average NMHC levels: (1) 0.3 g/mile for vehicles at or below 6,000 pounds GVWR and (2) 0.5 g/mile for vehicles over 6,000 pounds, including MDPVs.<sup>186</sup> The new standard would not require additional certification testing beyond what is required today with "worst case" model selection of a durability test group.<sup>187</sup> NMHC emissions would be measured during

<sup>186</sup> Tier 2 created the medium-duty passenger vehicle (MDPV) category to include larger complete passenger vehicles, such as SUVs and vans, with a GVWR of 8,501–10,000 pounds GVWR. Large pickups above 8,500 pounds are not included in the MDPV category but are included in the heavy-duty vehicle category.

<sup>187</sup> The existing cold FTP test procedures are specified in 40 CFR Subpart C. In the proposed rule for fuel economy labeling, recently signed on January 10, 2006 (71, FR 5426, February 1, 2006), EPA is seeking comment on the issue of requiring manufacturers to run the heater and/or defroster while conducting the cold FTP test. As discussed in the fuel economy labeling proposed rule, we do not believe this requirement would have a significant impact on emissions.

the Cold CO test, which already requires hydrocarbon measurement.<sup>188</sup>

The separate fleet average standards are proposed to address challenges related to vehicle weight. We examined the certification data from interim non-Tier 2 vehicles (i.e., vehicles not yet phased in to the final Tier 2 program, but meeting interim standards established by Tier 2), and we determined that there was a general trend of increasing hydrocarbon levels with heavier GVWR vehicles. Heavier vehicles generally produce higher levels of emissions for several reasons. First, added weight results in additional work required to accelerate the vehicle mass. This generally results in higher emissions, particularly early in the test right after engine start-up. Second, the design of these vehicle emission control systems may incorporate designs for heavy work (i.e., trailer towing) that may put them at some disadvantage at 20° F cold starts. For example, the catalyst may be located further away from the engine so it is protected from high exhaust temperatures. This catalyst placement may delay the warm-up of the catalyst, especially at colder temperatures. Therefore, we believe a standard that is higher than the 0.3 g/mile level proposed for vehicles below 6,000 lbs GVWR, is what is technically feasible for heavier vehicles. The proposed 0.5 g/mile standard would apply for vehicles over 6000 lbs GVWR, which includes both HLDTs (6000 lbs to 8500 lbs) and MDPVs.

We are proposing the sales-weighted fleet average approach because it achieves the greatest degree of emission control feasible for Tier 2 vehicles, while allowing manufacturers flexibility to certify different vehicle groups to different levels and thus providing both lower cost and feasible lead times. We believe this is an appropriate approach because the base Tier 2 program is also based on emissions averaging, and will result in a mix of emissions control strategies across the fleet that would have varying cold temperature capabilities. These capabilities won't be fully understood until manufacturers go through the process of evaluating each Tier 2 package for cold temperature emissions control potential. Also, Tier 2 is still being phased in and some Tier 2 vehicle emissions control packages are still being developed. A fleet average provides manufacturers with flexibility to balance challenging vehicle families with ones that more easily achieve the standards.

<sup>188</sup> 40 CFR Subpart C, § 86.244-94 requires the measurement of all pollutants measured over the FTP except NO<sub>x</sub>.

There are several ways fleet averaging can work. In Tier 2, we established bins of standards to which individual vehicle families were certified. Each bin contains a NO<sub>x</sub> standard, and these NO<sub>x</sub> standards are then sales-weighted to demonstrate compliance with the corporate average NO<sub>x</sub> standard. In other emissions control programs, such as the highway motorcycle program and the highway and nonroad heavy-duty engine programs, we have established a Family Emissions Limit (FEL) structure. In this approach, manufacturers establish individual FELs for each group of vehicles certified. These FELs serve as the standard for each individual group, and the FELs are averaged together on a sales-weighted basis to demonstrate overall compliance with the standards. For the proposed new cold temperature NMHC standards, we are proposing to use the FEL-based approach. We believe the FEL approach adds flexibility and should lead to cost-effective improvements in vehicle emissions performance. The FEL approach is discussed further in Section VI.B.4 below.

We are proposing to apply the new cold temperature NMHC standards to Tier 2 gasoline-fueled vehicles. We are not proposing to apply the standards to diesel vehicles, alternative-fueled vehicles, or heavy-duty vehicles, in general, due to a lack of data on which to base standards. Section VI.B., below, provides a detailed discussion of applicability.

As discussed above, we are expecting PM reductions at cold temperatures as a result of the control strategies we expect manufacturers to meet under the proposed cold temperature NMHC standards. We may consider the need for a separate PM standard under CAA section 202(a), as part of a future rulemaking, to further ensure that PM reductions occur under cold temperature conditions. We also request comments on what testing challenges exist for testing PM under cold conditions. We request that comments be supported by data where possible.

We request comments on the level of the new standards and the averaging approach we are proposing, and we urge commenters to include supporting information and data where possible.

## 2. Feasibility of the Proposed Standards

We believe the proposed standards are feasible, based on our analysis of the stringency of the standard provided below and the lead time and flexibilities described in section VI.B.3. We believe that the proposed standards could be achieved using a number of the technologies discussed in the following

section, but that none of these potential technologies performs markedly better than any other. Moreover, as explained in section VI.D, we do not believe that additional reductions would be feasible without significant changes in Tier 2 technology, and we are not yet in a position to fully evaluate the achievability of standards based on such technologies. We thus are not considering more stringent cold temperature NMHC standards. We request comment on our analysis of the feasibility of the proposed standards.

### a. Currently Available Emission Control Technologies

We believe that the cold temperature NMHC standards being proposed today for gasoline-fueled vehicles are challenging but within the reach of Tier 2 level emission control technologies. Our proposed determination of feasibility is based on the emission control hardware and strategies that are already in use today on Tier 2 vehicles. These emission control technologies are successfully used to meet the stringent Tier 2 standards for HC at the FTP temperature range of 68° F to 86° F, but generally are not fully used or activated at colder temperatures. As discussed in section VI.D, we are not proposing standards that would force changes to Tier 2 technology at this time. As discussed above, many current engine families are already achieving emissions levels at or below the proposed emission standards (see RIA Chapter 5), while other engine families are at levels greater than twice the proposed standard. The only apparent reason for the difference is the failure of some vehicles to use the Tier 2 control technologies at cold temperatures. While manufacturers could always choose to use additional hardware to facilitate compliance with the proposed standard, many of the engine families already at levels below the proposed standard do not necessarily contain any unique enabling hardware. These vehicles appear to achieve their results through mainly software and calibration control technologies. Thus, we believe our proposed standards can be met by the application of calibration and software approaches similar to those currently used at 50° F and 75° F, and we have estimated cost of control based on use of calibration and software approaches. Estimated costs are provided in section IX below, and in Chapter 8 of the RIA. As described in section VI.B.2.c, our own feasibility testing of a vehicle over 6000 lbs GVWR achieved NMHC reductions consistent with the proposed standard without the use of new hardware.

In addition, a 20° F cold hydrocarbon requirement has been in place in Europe since approximately the 2002 model year.<sup>189</sup> Many manufacturers currently have common vehicle models offered in Europe and the U.S. market. While the European standard is over a different drive cycle, unique strategies have been developed to comply with this standard. In fact, when the new European cold hydrocarbon standard was implemented in conjunction with a new 75° F standard (Euro4), many manufacturers responded by implementing NLEV level hardware and supplementing this hardware with advanced cold start emission control strategies. Although we are proposing a sales-weighted fleet average standard, the European standard is a fixed standard that cannot be exceeded by any vehicle model. Like the standard we are proposing, Europe also has made distinctions in the level of the standard reflecting that heavier weight vehicles cannot achieve as stringent a standard. Those manufacturers with European models shared with the U.S. market have the opportunity to leverage their European models or divisions in an attempt to transfer the emission control technologies that are used today for 20° F hydrocarbon control.

There are several different approaches or strategies used in the vehicles that are achieving proportional improvements in NMHC emissions at 20° F FTP. Several European models sold in the U.S. market that demonstrate excellent cold hydrocarbon performance are utilizing secondary air systems at the 20° F start temperature. These secondary air systems, sometimes called air pumps, inject ambient air into the exhaust immediately after the cold start. This performs additional combustion of unburned hydrocarbons prior to the catalytic converter and also accelerates the necessary heating of the catalytic converter. In the past and even recently, these systems have been used extensively to improve hydrocarbon performance at 75° F starts. As predicted in the Tier 2 Final Rule, a portion of the Tier 2 fleet is being equipped with secondary air systems in order to comply with Tier 2 standards.

Some manufacturers that currently have these systems available on their vehicles have indicated that they are simply not utilizing them at temperatures below freezing due to past engineering issues. The manufacturers that are using secondary air at 20° F, mainly European manufacturers, have indicated that these engineering

<sup>189</sup> European Union (EU) Type VI Test (–7° C) required for new vehicle model certified as of 1/1/2002.

challenges have been addressed through design changes. The robustness of these systems below freezing has also been confirmed with the manufacturers and with the suppliers of the secondary air components.<sup>190</sup> While not necessarily producing 20° F NMHC emission results better than other available technologies, vehicles equipped with this technology should be able to meet the proposed 20° F standard by capitalizing on this hardware.

Manufacturers have also used several other strategies to successfully produce proportional improvements in hydrocarbon emissions at 20° F. These include lean limit fuel strategies, elevated idle speeds, retarded spark timing, and accelerated closed loop times. Some software design strategies include fuel injection strategies detailed in past Society of Automotive Engineers (SAE) papers<sup>191</sup> that synchronize fuel injection timing with engine intake valve position to provide optimal fuel preparation. Spark delivery strategies have also been entertained that include higher energy levels and even redundant spark delivery to possibly complete additional combustion of unburned hydrocarbons. We expect that software and/or calibration changes, such as previously described, will generally perform as well or better than added hardware. This is because critical hardware such as the catalyst may not be immediately usable directly following the cold start. See RIA Chapter 5 for further discussion.

#### b. Feasibility Considering Current Certification Levels, Deterioration and Compliance Margin

Of the vehicles that were certified to Tier 2 and demonstrated proportional improvements in hydrocarbon emissions, approximately 20% of vehicles below 6,000 pounds GVWR had certification levels in the range of two to three times the 75° F Tier 2 bin 5 full useful life standard (.18 g/mile to .27 g/mile). These reported hydrocarbon levels are from Cold CO test results for certification test vehicles with typically only 4,000 mile aged systems, without full useful life deterioration applied. Due to rapid advances in emission control hardware technology, deterioration factors used today by manufacturers to demonstrate full useful life compliance are very low and

typically even indicate little or no deterioration over the life of the vehicle. The deterioration factors generated today by manufacturers are common across all required test cycles including cold temperature testing. The standards we are proposing will have a full useful life of 120,000 miles, consistent with Tier 2 standards. Additionally, manufacturers typically target certification emission levels that incorporate a 20% to 30% compliance margin primarily to account for in-use issues that may cause emissions variability. The 0.3 g/mile FEL standard would leave adequate flexibility for compliance margins and any emissions deterioration concerns. See RIA Chapter 5 for further discussion and details regarding current certification levels.

Given enough lead time, we believe manufacturers would be able to develop control strategies for each of their widely varying product lines utilizing the approaches outlined above without fundamentally changing the design of the vehicles.

#### c. Feasibility and Test Programs for Higher Weight Vehicles

While a few of the heavier vehicles achieved a standard similar to the lighter weight class, there were limited certification results available for Tier 2 compliant vehicles over 6000 lbs GVWR (due to the later Tier 2 phase-in schedule for these vehicles). To further support the feasibility of the standard for heavier vehicles, we conducted a feasibility study for Tier 2 vehicles over 6000 lbs GVWR to assess their capabilities with typical Tier 2 hardware. We were able to reduce HC emissions for one vehicle with models above and below 6,000 pounds GVWR by between 60–70 percent, depending on control strategy, from a baseline level of about 1.0 g/mile. The results are well within the 0.5 g/mile standard including compliance margin, and we even achieved a 0.3 g/mile level on some tests. We achieved these reductions through recalibration without the use of new hardware. The findings from the study are provided in detail in the RIA.

We believe the proposed standards are feasible while at the same time providing the greatest degree of emission reduction achievable through the application of available technology. Our feasibility assessment, provided above, is based on our analysis of the stringency of the standard given current emission levels at certification (considering deterioration, compliance margin, and vehicle weight); available emission control techniques; and our own feasibility testing. In addition, sections VI.B.3–6 describe the proposed

lead time and flexibility within the program structure, which also contribute to the feasibility of the proposed standards. Chapter 8 of the RIA provides our cost estimations per vehicle and on a nationwide basis, including capital and development costs. We believe the estimated costs are reasonable and the proposal is cost effective, as provided in section IX, below. Given the emission control strategies we expect manufacturers to utilize, we expect feasible implementation of technologies without a significant impact on vehicle noise, energy consumption, or safety factors. Although manufacturers would need to employ new emissions control strategies at cold temperatures, fundamental Tier 2 vehicle hardware and designs are not expected to change. In addition, we are providing necessary lead time for manufacturers to identify and resolve any related issues as part of overall vehicle development. We request comment on our analysis of the feasibility of the proposed standards.

### 3. Standards Timing and Phase-in

#### a. Phase-In Schedule

EPA must consider lead time in determining the greatest degree of emission reduction achievable under section 202(l) of the CAA. We are proposing to begin implementing the standard in the 2010 model year (MY) for LDVs/LLDTs and 2012 MY for HLDTs/MDPVs. The proposed implementation schedule, in Table VI.B–2, begins 3 model years after Tier 2 phase-in is complete for both vehicle classes. Manufacturers would demonstrate compliance with phase-in requirements through sales projections, similar to Tier 2. The 3-year period between completion of the Tier 2 phase-in and the start of the new cold NMHC standard should provide vehicle manufacturers sufficient lead time to design their compliance strategies and determine the product development plans necessary to meet the new standards. We believe that this phase-in schedule is needed to allow manufacturers to develop compliant vehicles without significant disruptions in the product development cycles. Also, for vehicles above 6,000 GVWR, section 202(a) of the Act requires that four years of lead time be provided to manufacturers.

We recognize that the new cold temperature standards we are proposing could represent a significant new challenge for manufacturers and development time will be needed. The issue of NMHC control at cold temperatures was not anticipated by

<sup>190</sup> Memo to docket "Discussions Regarding Secondary Air System Usage at 20° F with European Automotive Manufacturers and Suppliers of Secondary Air Systems," December 2005.

<sup>191</sup> Meyer, Robert and John B. Heywood, "Liquid Fuel Transport Mechanisms into the Cylinder of a Firing Port-Injected SI Engine During Start-up," SAE 970865, 1997.

many entities, and research and development to address the issue is consequently at a rudimentary stage. Lead time is therefore necessary before compliance can be demonstrated. While

certification will only require one vehicle model of a durability group to be tested, manufacturers must do development on all vehicle combinations to ensure full compliance

within the durability test group. We believe a phase-in allows the program to begin sooner than would otherwise be feasible.

TABLE VI.B-2.—PROPOSED PHASE-IN SCHEDULE FOR 20 °F NMHC STANDARD BY MODEL YEAR

Vehicle GVWR (category)	2010	2011	2012	2013	2014	2015
≤ 6000 lbs (LDV/LLDT)	25%	50%	75%	100%	.....	.....
> 6000 lbs HLDLT and MDPV	.....	.....	25%	50%	75%	100%

In considering a phase-in period, manufacturers have raised concerns that a rapid phase-in schedule would lead to a significant increase in the demand for their cold testing facilities, which could necessitate substantial capital investment in new cold test facilities to meet development needs. This is because manufacturers would need to use their cold testing facilities not only for certification but also for vehicle development. If vehicle development is compressed into a narrow time window, significant numbers of new facilities would be needed. Manufacturers were further concerned that investment in new test facilities would be stranded at the completion of the initial development and phase-in period.

As stated earlier, durability test groups may be large and diverse and therefore require significant development effort and cold test facility usage for each model. Our proposed phase-in period accommodates test facilities and work load concerns by distributing these fleet phase-in percentage requirements over a 4-year period for each vehicle weight category. The staggered start dates for the phase-in schedule between the two weight categories should further alleviate manufacturers' concerns with needing to construct new test facilities. Some manufacturers may still determine that upgrades to their current cold facility are needed to handle increased workload. Some manufacturers have indicated that they would simply add additional shifts to their facility work schedules that are not in place today. Some manufacturers will already meet the first-year requirement based on current certification reporting, essentially providing an additional year for distributing the anticipated development test burden for the remaining fleet. The 4-year phase-in period provides ample time for vehicle manufacturers to develop a compliance schedule that is coordinated with their future product plans and projected product sales volumes of the different vehicle models.

We request comments on the proposed start date and duration of the phase-in schedule. We also request comment on allowing a volume-based offset during the phase-in period for cases where manufacturers voluntarily certify heavy-duty vehicles above 8,500 pound GVWR to the proposed cold temperature standards. This may provide incentive for voluntary certification of these heavier vehicles.

b. Alternative Phase-In Schedules

Alternative phase-in schedules essentially credit the manufacturer for its early or accelerated efforts and allow the manufacturer greater flexibility in subsequent years during the phase-in. By introducing vehicles earlier than required, manufacturers would earn the flexibility to make offsetting adjustments, on a vehicle-year basis, to the phase-in percentages in later years. Under these alternative schedules, manufacturers would have to introduce vehicles that meet or surpass the NHMC average standards before they are required to do so, or else introduce vehicles that meet or surpass the standard in greater quantities than required.

We are proposing that manufacturers may apply for an alternative phase-in schedule that would still result in 100% phase-in by 2013 and 2015, respectively, for the lighter and heavier weight categories. As with the primary phase-in, manufacturers would base an alternative phase-in on their projected sales estimates. An alternate phase-in schedule submitted by a manufacturer would be subject to EPA approval and would need to provide the same emissions reductions as the primary phase-in schedule. We propose that the alternative phase-in could not be used to delay full implementation past the last year of the primary phase-in schedule (2013 for LDVs/LDTs and 2015 for HLDTs/MDPVs).

An alternative phase-in schedule would be acceptable if it passes a specific mathematical test. We have designed the test to provide manufacturers a benefit from certifying

to the standards early, while ensuring that significant numbers of vehicles are introduced during each year of the alternative phase-in schedule. Manufacturers would multiply their percent phase-in by the number of years the vehicles are phased in prior to the second full phase-in year. The sum of the calculation would need to be greater than or equal to 500, which is the sum from the primary phase-in schedule (4\*25 + 3\*50 + 2\*75 + 1\*100=500). For example, the equation for LDVs/LLDTs would be as follows:

$$(6 \times \text{API}_{2008}) + (5 \times \text{API}_{2009}) + (4 \times \text{API}_{2010}) + (3 \times \text{API}_{2011}) + (2 \times \text{API}_{2012}) + (1 \times \text{API}_{2013}) \geq 500\%$$

Where:

API is the anticipated phase-in percentage for the referenced model year.

California used this approach to an alternative phase-in for the LEVII program.<sup>192</sup> It provides alternative phase-in credit for both the number of vehicles phased in early and the number of years the early phase-in occurs.

As described above, the final sum of percentages for both LDVs/LDTs and HLDTs/MDPVs must equal or exceed 500—the sum that results from a 25/50/75/100 percent phase-in. For example, a 10/25/50/55/100 percent phase-in for LDVs/LDTs that begins in 2009 will have a sum of 510 percent and is acceptable. A 10/20/40/70/100 percent phase-in that begins the same year has a sum of 490 percent and is not acceptable.

To ensure that significant numbers of LDVs/LDTs are introduced in the 2010 time frame (2012 for HLDTs/MDPVs), manufacturers would not be permitted to use alternative phase-in schedules that delay the implementation of the requirements, even if the sum of the phase-in percentages ultimately meets or exceeds 500. Such a situation could occur if a manufacturer delayed implementation of its compliant production until 2011 and began an 80/85/100 percent phase-in that year for

<sup>192</sup> Title 13, California Code of Regulations, Section 1961(b)(2).

LDVs/LDTs. To protect against this possibility, we are proposing that for any alternative phase-in schedule, a manufacturer's phase-in percentages\* years factor from the 2010 and earlier model years sum to at least 100 (2012 and earlier for HLDTs/MDPVs). The early phase-in also encourages the early introduction of vehicles meeting the new standard or the introduction of such vehicles in greater quantity than required. This would achieve early emissions reductions and provide an opportunity to gain experience in meeting the standards.

Phase-in schedules, in general, add little flexibility for manufacturers with limited product offerings because a manufacturer with only one or two test groups cannot take full advantage of a 25/50/75/100 percent or similar phase-in. Therefore, consistent with the recommendations of the Small Advocacy Review Panel (SBAR Panel), which we discuss in more detail later in section VI.E, manufacturers meeting EPA's definition of "small volume manufacturer" would be exempt from the phase-in schedules and would be required to simply comply with the final 100% compliance requirement. This provision would only apply to small volume manufacturers and not to small test groups of larger manufacturers.

#### 4. Certification Levels

Manufacturers typically certify groupings of vehicles called durability groups and test groups, and they have some discretion on what vehicle models are placed in each group. A durability group is the basic classification used by manufacturers to group vehicles to demonstrate durability and predict deterioration. A test group is a basic classification within a durability group used to demonstrate compliance with FTP 75° F standards.<sup>193</sup> For Cold CO, manufacturers certify on a durability group basis, whereas for 75° F FTP testing, manufacturers certify on a test group basis. In keeping with the current cold CO standards, we are proposing to require testing on a durability group basis for the cold temperature NMHC standard. We also propose to allow manufacturers the option of certifying on the smaller test group basis, as is allowed under current cold CO standards. Testing on a test group basis would require more tests to be run by manufacturers but may provide them with more flexibility within the averaging program. In either case, the worst case vehicle within the group

from an NMHC emissions standpoint would be tested for certification.

For the new standard, manufacturers would declare a family emission limit (FEL) for each group either at, above, or below the fleet averaging standard. The FEL would be based on the certification NMHC level, including deterioration factor, plus the compliance margin manufacturers feel is needed to ensure in-use compliance. The FEL becomes the standard for each group, and each group could have a different FEL so long as the projected sales-weighted average level met the fleet average standard at time of certification. Like the standard, the certification resolution for the FEL would be one decimal point. This FEL approach would be similar to having bins in 0.1 g/mile intervals, with no upper limit. Similar to a bin approach, manufacturers would compute a sales-weighted average for the NMHC emissions at the end of the model year and then determine credits generated or needed based on how much the average is above or below the standard.

#### 5. Credit Program

As described above, we are proposing that manufacturers average the NMHC emissions of their vehicles and comply with a corporate average NMHC standard. In addition, we are proposing that when a manufacturer's average NMHC emissions of vehicles certified and sold falls below the corporate average standard, it could generate credits that it could save for later use (banking) or sell to another manufacturer (trading). Manufacturers would consume any credits if their corporate average NMHC emissions were above the applicable standard for the weight class.

EPA views the proposed averaging, banking, and trading (ABT) provisions as an important element in setting emission standards reflecting the greatest degree of emission reduction achievable, considering factors including cost and lead time. If there are vehicles that will be particularly costly or have a particularly hard time coming into compliance with the standard, a manufacturer can adjust the compliance schedule accordingly, without special delays or exceptions having to be written into the rule. This is an important flexibility especially given the current uncertainty regarding optimal technology strategies for any given vehicle line. In addition, ABT allows us to consider a more stringent emission standard than might otherwise be achievable under the CAA, since ABT reduces the cost and improves the technological feasibility of achieving the standard. By enhancing the

technological feasibility and cost effectiveness of the proposed standard, ABT allows the standard to be attainable earlier than might otherwise be possible.

Credits may be generated prior to, during, and after the phase-in period. Manufacturers could certify LDVs/LLDTs to standards as early as the 2008 model year (2010 for HLDTs/MDPVs) and receive early NMHC credits for their efforts. They could use credits generated under these "early banking" provisions after the phase-in begins in 2010 (2012 for HLDTs/MDPVs).

#### a. How Credits Are Calculated

The corporate average for each weight class would be calculated by computing a sales-weighted average of the NMHC levels to which each FEL was certified. As discussed above, manufacturers group vehicles into durability groups or test groups and establish an FEL for each group. This FEL becomes the standard for that group. Consistent with FEL practices in other programs, manufacturers may opt to select an FEL above the test level. The FEL would be used in calculating credits. The number of credits or debits would then be determined using the following equation:

$$\text{Credits or Debits} = (\text{Standard} - \text{Sales weighted average of FELs to nearest tenth}) \times \text{Actual Sales}$$

If a manufacturer's average was below the 0.3 g/mi corporate average standard for LDVs/LDTs, credits would be generated (below 0.5 g/mi for HLDTs/MDPVs). These credits could then be used in a future model year when its average NMHC might exceed the 0.3 or the 0.5 standard. Conversely, if the manufacturer's fleet average was above the corporate average standard, banked credits could offset the difference, or credits could be purchased from another manufacturer.

#### b. Credits Earned Prior to Primary Phase-in Schedule

We propose that manufacturers could earn early emissions credits if they introduce vehicles that comply with the new standards early and the corporate average of those vehicles is below the applicable standard. Early credits could be earned starting in 2008 for vehicles meeting the 0.3 g/mile standard and in 2010 for vehicles meeting the 0.5 g/mile standard. These emissions credits generated prior to the start of the phase-in could be used both during and after the phase-in period and have all the same properties as credits generated by vehicles subject to the primary phase-in schedule. As previously mentioned, we are also proposing that manufacturers

<sup>193</sup> 40 CFR 86.1803-01.



may apply for an alternative phase-in schedule for vehicles that are introduced early. The alternative phase-in and early credits provisions would operate independent of one another.

#### c. How Credits Can Be Used

A manufacturer could use credits in any future year when its corporate average was above the standard, or it could trade (sell) the credits to other manufacturers. Because of separate sets of standards for the different weight categories, we are proposing that manufacturers compute their corporate NMHC averages separately for LDV/LLDTs and HLDTs/MDPVs. Credit exchanges between LDVs/LLDTs and HLDTs/MDPVs would be allowed. This will provide added flexibility for full-line manufacturers who may have the greatest challenge in meeting the new standards due to their wide disparity of vehicle types/weights and emissions levels.

#### d. Discounting and Unlimited Life

Credits would allow manufacturers a way to address unexpected shifts in their sales mix. The NMHC emission standards in this proposed program are quite stringent and do not present easy opportunities to generate credits. Therefore, we are not proposing to discount unused credits. Further, the degree to which manufacturers invest the resources to achieve extra NMHC reductions provides true value to the manufacturer and the environment. We do not want to take measures to reduce the incentive for manufacturers to bank credits, nor do we want to take measures to encourage unnecessary credit use. Consequently we are not proposing that the NMHC credits would have a credit life limit. However, we are proposing that they only be used to offset deficits accrued with respect to the proposed 0.3/0.5 g/mile cold temperature standards. We request comment on the need for discounting of credits or credit life limits and what those discount rates or limits, if any, should be.

#### e. Deficits Could Be Carried Forward

When a manufacturer has an NMHC deficit at the end of a model year—that is, its corporate average NMHC level is above the required corporate average NMHC standard—we are proposing that the manufacturer be allowed to carry that deficit forward into the next model year. Such a carry-forward could only occur after the manufacturer used any banked credits. If the deficit still existed and the manufacturer chose not to, or was unable to, purchase credits, the deficit could be carried over. At the end

of that next model year, the deficit would need to be covered with an appropriate number of credits that the manufacturer generated or purchased. Any remaining deficit would be subject to an enforcement action.

To prevent deficits from being carried forward indefinitely, we propose that manufacturers would not be permitted to run a deficit for two years in a row. We believe that it is reasonable to provide this flexibility to carry a deficit for one year given the uncertainties that manufacturers face with changing market forces and consumer preferences, especially during the introduction of new technologies. These uncertainties can make it hard for manufacturers to accurately predict sales trends of different vehicle models.

#### f. Voluntary Heavy-Duty Vehicle Credit Program

In addition to MDPV requirements in Tier 2, we also currently have chassis-based emissions standards for other complete heavy-duty vehicles (e.g., large pick-ups and cargo vans) above 8,500 pound GVWR. However, these standards do not include cold temperature CO standards. As noted below in section VI.B.6.a, we are not proposing to apply cold temperature NMHC standards to heavy-duty gasoline vehicles due to a current lack of emissions data on which to base such standards. We plan to revisit the need for and feasibility of standards as data become available.

During discussions with manufacturers, we discussed a voluntary program for chassis-certified complete heavy-duty vehicles. We believe that there may be opportunities within the framework of a cold temperature NMHC program to allow for emissions credits from chassis-certified heavy-duty vehicles above 8,500 pounds GVWR to be used to meet the proposed standards. It is possible that some control strategies developed for meeting cold NMHC emissions standards could also be applied to these vehicles above 8,500 pounds GVWR.

One approach would be to allow manufacturers to certify heavy-duty vehicles voluntarily to the 0.5 g/mile cold NMHC standards proposed for HLDTs/MDPVs. To the extent that heavy-duty vehicles achieve FELs below the 0.5 g/mile standard, manufacturers could earn credits which could be applied to any vehicle subject to the proposed standard. It is unclear, however, if this approach would provide a meaningful opportunity for credit generation, given the stringency of the standard. We would expect that most heavy-duty vehicles would have

emissions well above the 0.5 g/mile level, based on the additional weight of the vehicle. We request comment on this approach, as well as others for voluntary certification and credit generation.

It may be possible to establish a voluntary standard above 0.5 g/mile for purposes of generating credits, but we would need data on which to base this level of the standard. Suggestions on an appropriate level of a voluntary standard are welcomed, as well as any data that support such a recommendation. Comments on testing protocols, such as use of the vehicle's adjusted loaded vehicle weight (ALVW) or loaded vehicle weight (LVW), are also encouraged. We believe such a voluntary program could provide significant data that would help us evaluate the feasibility of a future standard for these vehicles.

#### 6. Additional Vehicle Cold Temperature Standard Provisions

We request comments on all of the following proposed provisions.

##### a. Applicability

We are proposing to apply the new cold temperature standards to all gasoline-fueled light-duty vehicles and MDPVs sold nationwide. While we have significant amounts of data on which to base our proposals for gasoline-fueled light-duty vehicles, we have very little data for light-duty diesels. For 75° F FTP standards, the same set of standards apply, but in the 20° F context we know very little about diesel emissions due to a lack of data. Currently, diesel vehicles are not subject to the cold CO standard, so there are no requirements to test diesel vehicles at cold temperatures. There are sound engineering reasons, however, to expect cold NMHC emissions for diesel vehicles to be as low as or even lower than the proposed standards. This is because diesel engines operate under leaner air-fuel mixtures compared to gasoline engines, and therefore have fewer engine-out NMHC emissions due to the abundance of oxygen and more complete combustion. A very limited amount of confidential manufacturer-furnished information is consistent with this engineering hypothesis. A comprehensive assessment of appropriate standards for diesel vehicles would require a significant amount of investigation and analysis of issues such as feasibility and costs. This effort would be better suited to a future rulemaking. Therefore, at this time, we are not proposing to apply the cold NMHC standards to light-duty diesel vehicles. We will continue to evaluate

data for these vehicles as they enter the fleet and will reconsider the need for standards if data indicate that there may be instances of high NMHC emissions from diesels at cold temperatures. We have proposed cold temperature FTP testing for diesels as part of the Fuel Economy Labeling rulemaking, including NMHC measurement.<sup>194</sup> This testing data would allow us to assess NMHC certification type data over time. However, this wouldn't include development testing manufacturers would need to do in order to meet a new diesel cold temperature standard.

In addition, there currently is no cold CO testing requirement for alternative fuel vehicles. There are little data upon which to evaluate NMHC emissions when operating on alternative fuels at cold temperatures. For fuels such as ethanol, it is difficult to develop a reasonable proposal due to a lack of fuel specifications, testing protocols, and current test data. Other fuels such as methanol and natural gas pose similar uncertainty. Therefore, we are not proposing a cold NMHC testing requirement for alternative fuel vehicles. We will continue to investigate these other technologies and request comment on standards for vehicles operating on fuels other than gasoline.

We are proposing that flex-fuel vehicles would still require certification to the applicable cold NMHC standard, though only when operated on gasoline. For multi-fuel vehicles, manufacturers would need to submit a statement at the time of certification that either confirms the same control strategies used with gasoline would be used when operating on ethanol, or that identifies any differences as an Auxiliary Emission Control Device (AECDD). Again, dedicated alternative-fueled vehicles, including E-85 vehicles, would not be covered.

For heavy-duty gasoline-fueled vehicles, we have no data, but we would expect a range of emissions performance similar to that of lighter gasoline-fueled trucks. Due to the lack of test data on which to base feasibility and cost

analyses, we are not proposing cold temperature NMHC standards for these vehicles at this time. We request comments and data on these vehicles and plan to revisit this issue when sufficient data is available.

b. Useful Life

The "useful life" of a vehicle means the period of use or time during which an emission standard applies to light-duty vehicles and light-duty trucks.<sup>195</sup> Consistent with the current definition of useful life in the Tier 2 regulations, for all LDVs/LDTs and HLDTs/MDPVs, we are proposing new full useful life standards for cold temperature NMHC standards. Given that we expect that manufacturers will make calibration or software changes to existing Tier 2 technologies, it is reasonable for there to be the same useful life as for the Tier 2 standards themselves. For LDV/LLDT, the full useful life values would be 120,000 miles or 10 years, whichever comes first, and for HLDT/MDPV, full useful life is 120,000 miles or 11 years, whichever comes first.<sup>196</sup>

c. High Altitude

We do not expect emissions to be significantly different at high altitude due to the use of common emissions control calibrations. Limited data submitted by a manufacturer suggest that FTP emissions performance at high altitude generally follows sea level performance. Furthermore, there are very limited cold temperature testing facilities at high altitudes. Therefore, under normal circumstances, manufacturers would not be required to submit vehicle test data for high altitude. Instead, manufacturers would be required to submit an engineering evaluation indicating that common calibration approaches are utilized at high altitude. Any deviation from sea level in emissions control practices would be required to be included in the auxiliary emission control device (AECDD) descriptions submitted by manufacturers at certification. Additionally, any AECDD specific to high altitude would require engineering

emission data for EPA evaluation to quantify any emission impact and validity of the AECDD.

d. In-Use Standards for Vehicles Produced During Phase-In

As we have indicated, the standards we are proposing would be more challenging for some vehicles than for others. With any new technology, or even with new calibrations of existing technology, there are risks of in-use compliance problems that may not appear in the certification process. In-use compliance concerns may discourage manufacturers from applying new calibrations or technologies. Thus, it may be appropriate for the first few years, for those vehicles most likely to require the greatest applications of effort, to provide assurance to the manufacturers that they will not face recall if they exceed standards in use by a specified amount. Therefore, similar to the approach used in Tier 2, we are proposing an in-use standard that is 0.1 g/mile higher than the certification FEL for any given test group for a limited number of model years.<sup>197</sup> For example, a test group with a 0.2 g/mile FEL would have an in-use standard of 0.3 g/mile. This would not change the FEL or averaging approaches and would only apply in cases where EPA tests vehicles in-use to ensure emissions compliance.

We propose that the in-use standards be available for the first few model years of sales after a test group meeting the new standards is introduced, according to a schedule that provides more years for test groups introduced earlier in the phase-in. This schedule provides manufacturers with time to determine the in-use performance of vehicles and learn from the earliest years of the program to help ensure that vehicles introduced after the phase-in period meet the final standards in-use. It also assumes that once a test group is certified to the new standards, it will be carried over to future model years. The tables below provide the proposed schedule for the availability of the in-use standards.

TABLE VI.B-3.—SCHEDULE FOR IN-USE STANDARDS FOR LDVs/LLDTs

Model year of introduction	2008	2009	2010	2011	2012	2013
Models years that the in-use standard is available for carry-over test groups .....	2008 2009 2010 2011	2009 2010 2011 2012	2010 2011 2012 2013	2011 2012 2013	2012 2013 2014	2013 2014

<sup>194</sup> "Fuel Economy Labeling of Motor Vehicles; Revisions to Improve Calculation of Fuel Economy Estimates," Proposed Rule, 71, FR 5426, February 1, 2006.

<sup>195</sup> 40 CFR 86.1803-01.

<sup>196</sup> 40 CFR 86.1805-04.

<sup>197</sup> "Control of Air Pollution from New Motor Vehicles: Tier 2 Motor Vehicle Emissions Standards and Gasoline Sulfur Control Requirements", Final Rule, 65 FR 6796, February 10, 2000.