PBT National Action Plan For Alkyl-lead

Prepared by

The U.S. Environmental Protection Agency (EPA)
Persistent, Bioaccumulative, and
Toxic Pollutants (PBT) Program

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TABLE OF CONTENTS

TABLE OF CONTENTS
(Continued)

LIST OF TABLES

LIST OF FIGURES

GLOSSARY

ASTM	American Society for Testing and Materials
ATSDR	Agency for Toxic Substances and Disease Registry
CAA	Clean Air Act
CAAA	Clean Air Act Amendments
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CRC	Coordinating Research Council
CWA	Clean Water Act
FAA	Federal Aviation Administration
G-8 Nations	Canada, France, Germany, Great Britain, Italy, Japan, Russia, and the United States
GLNPO	Great Lakes National Program Office
GPRA	Government Performance and Results Act of 1993
MTBE	Methyl tert-butyl ether
NASCAR	National Association for Stock Car Automobile Racing
NAAQS	National Ambient Air Quality Standards
NIOSH	National Institute for Occupational Safety and Health
NOAA	National Oceanic and Atmospheric Administration
OAQPS	Office of Air Quality Planning and Standards
OAR	EPA Office of Air and Radiation
OECA	Office of Enforcement and Compliance Assurance
OIA	EPA Office of International Activities
ORD	Office of Research and Development
OSHA	Occupational Safety and Health Administration
OTAQ	EPA Office of Transportation and Air Quality
PBT	Persistent, Bioaccumulative, and Toxic
RCRA	Resource Conservation and Recovery Act
SARA/EPCRA	Superfund Amendments and Reauthorization Act / Emergency Planning and Community Right-to-Know Act
SDWA	Safe Drinking Water Act
TEL	Tetraethyllead
TML	Tetramethyllead
TRI	Toxic Release Inventory
TSCA	Toxic Substances Control Act

PART I

PRIORITIES FOR ACTION

PART I

PRIORITIES FOR ACTION

1.1 THE PROBLEM

Alkyl-lead compounds are man-made compounds used as a fuel additive to reduce "knock" in combustion engines and also to help lubricate internal engine components. Research has clearly shown that exposure to alkyl-lead can cause serious toxic effects to the nervous system of humans, with the potential to cause neurological disorders, such as mood shifts and impairment of memory. While these exposures do not appear to pose a health risk for most of the human population, certain groups, such as children and certain occupational groups may be at risk. The human exposure pathways for alkyl-lead are through inhalation of leaded gasoline vapors, or by dermal exposure to leaded gasoline. In the body, alkyl lead compounds are distributed through the blood to "soft tissues," particularly the liver, kidneys, muscles and brain. Children are at a higher risk of lead poisoning than adults due to their lower body weights and developing neurological systems. Blood-lead concentrations as low as 10 µg/dL have been associated with neurological damage in children, and increasing blood-lead levels have been highly correlated with decreased performance on standardized intelligence tests (i.e., lower I.Q. test scores) (CDC 2000; ATSDR, 1999).

Over the past twenty years, there has been significant progress in reducing lead exposures, particularly with respect to preventing childhood lead poisoning. Data from the Center for Disease Control's third National Health and Nutrition Examination Survey, Phase 2 (1991 - 1994) (CDC, 1997) shows that average blood lead levels in children have decreased approximately 80% since the late 1970s (CDC, 2000). The geometric mean for blood-lead levels in children has declined from approximately 15 µg/dL in 1976 (Mahaffey et al., 1982) to 2 µg/dL in 1999 (CDC, 2000). Total lead emissions have been reduced by 98 percent between 1970 and 1996 (USEPA, 1997b). Much of this can be attributed to the passage of the 1971 Lead-based Paint Poisoning Prevention Act, the phase-out of lead in gasoline under the Clean Air Act, and the banning of lead-based paint.

While the use of alkyl-lead and associated health risks have been tremendously reduced, limited uses remain in the United States. Gasoline containing alkyl-lead is still currently being used as fuel, particularly for airplanes (general aviation piston engine aircraft) and race cars. In addition, significant international use of gasoline containing alkyl-lead is still occurring. These remaining uses are the focus of this action plan.

1.2 OUR LONG-TERM GOAL

The ultimate goal of this alkyl-lead action plan is to identify and reduce risks to human health and the environment from current and future exposure to alkyl-lead. EPA believes that, with the actions it has taken to date, this goal is within reach. However, the Agency is concerned about any sub-populations that may remain at risk, for example, individuals exposed at racetracks or general aviation airports. The Agency also recognizes that these remaining risks should not be taken lightly.

EPA does not have the authority under the Clean Air Act to regulate the use of leaded gasoline for the racing industry, and the authority to regulate aircraft fuel lies with the Federal Aviation Administration. Therefore, the Agency has chosen to address the risks that remain for alkyl-lead through voluntary efforts under its Persistent, Bioaccumulative and Toxic (PBT) pollutants program. The PBT program provides a holistic approach and an agency-wide perspective. It is likely that further reductions in exposures to this chemical will come only through product substitution and voluntary measures. A holistic approach such as that provided by the PBT program will ensure that the ultimate substitute has been carefully evaluated within and among all media offices in EPA. This will reduce the chances of replacing one environmental problem with another. It is from this perspective, then, that the Agency sets the following priorities for action for alkyl-lead.

1.3 PRIORITY ACTIONS (2001– 2006)

Alkyl-lead is one of 12 chemicals identified as Level 1 priority PBT pollutants. Historically, the health effects and environmental concerns related to the use of alkyl-lead are well documented, but EPA regulations under the Clean Air Act (CAA) requiring the use of unleaded gasoline in on-road vehicles have dramatically reduced environmental and human health impacts from the use of alkyl-lead. Current domestic use may still pose a threat to certain populations. However, because of funding constraints, EPA must consider the proposed actions for alkyl-lead in the larger context of the proposed actions for all twelve Level 1 substances. Within this context, the following priority actions emerged.

Voluntary Partnership with NASCAR. The Agency has identified one key priority for action for alkyl-lead over the next five years. It will work in voluntary partnership with the National Association for Stock Car Automobile Racing (NASCAR) to permanently remove alkyl-lead from racing fuels used, specifically, in the Busch, Winston Cup and Craftsman Truck Series. NASCAR has also committed to making their athletes available for outreach and communication efforts targeted at reducing use and release of PBT substances.

NASCAR and its fuel supplier TOSCO Corporation (TOSCO) are recognized leaders in the auto racing industry. For quite some time, NASCAR has expressed its commitment to removing alkyl-lead from its racing fuels. The presidents of NASCAR and TOSCO are working together to develop an alternative fuel recipe that will not include alkyl-lead. Any changes that they make are expected to have a significant effect throughout the industry.

In 1998, NASCAR was very close to having an alternative fuel, only to learn that the fuel additive they were considering as a replacement had its own potential environmental consequences. It was subsequently abandoned. This has led NASCAR into discussions with the EPA's PBT Program staff. NASCAR will continue to work with TOSCO over the next several months to accelerate its efforts to find an appropriate fuel substitute. EPA will offer technical assistance to NASCAR and work with them on this effort, specifically in facilitating an agency-wide multimedia review of any alkyl-lead substitute they develop.

Other Continued Efforts. Although EPA will focus its attention and resources primarily on the action outlined above, it will continue to explore additional opportunities and engage in other activities that will help meet the goals of this National Action Plan. Most importantly, these include continuing current international efforts to reduce the use of leaded gasoline and dialogues with the Federal Aviation Administration (FAA). Continued current international efforts to reduce the use of leaded gasoline will include participation in the United Nations Commission on Sustainable Development, Summit of the Americas, Earth Summit +5, the G-8 (includes Canada, France, Germany, Italy, Japan, Russia, the United Kingdom, and the United States) and the Great Lakes Binational Toxics Strategy. The United States is committed to being a world leader in promoting the phase-out of leaded gasoline used in motor vehicles. The Agency will also continue to dialogue with the Federal Aviation Administration on the use of leaded gasoline in the aviation industry and the possibilities of reducing the lead content and/or replacing leaded gasoline with unleaded gasoline. Similar discussions will continue with the Coordinating Research Council task force investigating alternative (no-lead) gasoline for aircraft.

1.4 IMPLEMENTATION

The key Agency players in the implementation of this action plan will be the Office of Pollution and Prevention Toxics (OPPT), the Office of International Activities (OIA), the Office of Air and Radiation (OAR), the Great Lakes National Program Office (GLNPO), and the Office of Transportation and Air Quality (OTAQ) Ann Arbor Facility. OPPT and OTAQ will continue to take the lead in supporting the efforts of NASCAR and TOSCO to develop a viable substitute for alkyl-lead in racing gasoline. Technical assistance to NASCAR, specifically in facilitating an agency-wide multimedia review of any alkyl-lead substitute they develop, will also be coordinated under OPPT lead. EPA's involvement in current international efforts to reduce the use of leaded gasoline will continue under the direction of OIA. Dialogues with the FAA and the Coordinating Research Council task force investigating alternative (non-lead) gasoline for aircraft will be coordinated by OPPT and OTAQ.

EPA also considers stakeholder involvement essential to reaching the goal of the PBT Strategy. EPA has considered stakeholder input in the development of this draft national action plan for alkyl-lead, and will now seek stakeholder input for its implementation. EPA will also encourage all interested partners to join in establishing voluntary agreements to reduce risk to human health and the environment from exposure to alkyl-lead. Primary stakeholders in this effort are the Federal Aviation Administration (FAA), the National Association for Stock Car

Automobile Racing (NASCAR), the Coordinating Research Council (CRC), Agency for Toxic Substances and Disease Registry (ATSDR), National Oceanic and Atmospheric Administration (NOAA), the U.S. Coast Guard, National Institute for Occupational Safety and Health (NIOSH), and the Occupational Safety and Health Administration (OSHA). EPA anticipates that each of these groups will have a significant role in reducing the use, releases, and exposure to alkyl-lead compounds.

PART II

TECHNICAL ASSESSMENT

PART II

TECHNICAL ASSESSMENT

2.1 HEALTH AND ENVIRONMENTAL ASSESSMENT

2.1.1 Description of Alkyl-lead

Lead (CAS number 7439-92-1) is a naturally occurring, bluish-gray metal originating in the earth's crust. It is odorless, tasteless, and has no known physiological value. It does not dissolve in water and does not burn. The vast majority of lead chemical compounds are inorganic. However, lead can be combined with organic chemicals to form lead compounds with very different characteristics from metallic lead. This action plan does not address inorganic lead, but addresses one of the more predominant types of organic lead compounds: alkyl-lead.

Organolead compounds are man-made compounds in which a carbon atom of one or more organic molecules is bound to a lead atom. Generally, "alkyl-lead" compounds are classified as "tetraalkyllead" compounds (e.g., tetraethyllead [TEL] and tetramethyllead [TML]), "trialkyllead" compounds (e.g., trimethyllead chloride [TriML] and triethyllead chloride [TriEL]), or "dialkyllead" compounds (e.g., dimethyllead chloride [DiML] and diethyllead chloride [DiEL]). Of these, the tetraalkyllead compounds, TEL and TML, are the most common alkyl-lead compounds that have been used in the past and are still in use today in the United States. These two alkyl-lead compounds are the focus of this National Action Plan.

Alkyl-lead is produced through several different methods including through the electrolysis of an ethyl Grignard reagent or through alkylation of a lead-sodium alloy. Alkyl-lead is used as a fuel additive to reduce "knock" in combustion engines (by contrast, inorganic lead is used in leaded paint). The most common alkyl-lead compound used as an anti-knock agent in gasoline is TEL lead, though TML lead is also used as an anti-knock agent. These alkyl-lead compounds also help to lubricate internal engine components and protect intake and exhaust valves against recession.

Although the use of alkyl-lead has been prohibited by legislation in on-road automotive gasoline, several authorized uses of alkyl-lead still remain. Currently, the largest use of alkyl-lead occurs in aviation gasoline for general aviation (piston-engine) aircraft, racing gasoline, and recreational marine. None of these uses are subject to any of the regulations that restrict leaded motor gasoline use. These current uses, as well as trace amounts of lead in automotive gasoline, result in releases to the environment.

Sources of alkyl-lead emissions include:

- Airport fuel terminals
- Bulk plants-aviation gasoline
- Bulk plants-leaded racing and other non-road vehicle gasoline
- Evaporative emissions from aircraft
- Evaporative emissions from non-road vehicles
- Spills from fuel loading, transfer, storage and fueling

Sinks [1] include:

- Soils and sediments
- Fish and shellfish

2.1.2 Alkyl-lead Use

Leaded gasoline (containing alkyl-lead) is used as fuel predominantly in the aviation (piston engine) industry, but also in non-road competition race vehicles (cars, boats, etc.) [2].

Current overall production and use rates of alkyl-lead in gasoline in the U.S., particularly for non-road motor vehicles, are difficult to determine due to the fact that the U.S. Department of Energy discontinued the tracking of leaded gasoline in 1990. Thus, most of the available information on alkyl-lead use in gasoline is limited to older data on sales, imports, exports and throughput at bulk distribution plants.

The EPA TSCA Chemical Inventory Chemical Update System indicates that alkyl-lead was not manufactured domestically as of 1994. However, the U.S. Department of Commerce web site documents that, in 1998, the quantity of antiknock preparations imported into the U.S. was approximately 14.4 million pounds per year (based on TEL or TEL/TML mixtures) and the quantity exported was 7.07 million pounds per year (based on lead compounds) (U.S. Department of Commerce, 1998). It is reasonable to assume the majority of the 7 million pound difference between imports and exports was used for the production of leaded gas.

2.1.2.1 Aviation Fuel

Aviation gasoline (avgas) is currently the fuel with the greatest alkyl-lead (TEL) content, ranging from 4.4×10^{-3} to 8.8×10^{-3} lbs as lead/gal (USEPA, 1998a). Only TEL is used in aviation gasoline. The other aviation fuels, such as Jet kerosene and JP-4, do not contain alkylated lead compounds. Leaded avgas is currently available in several grades with differing lead concentrations, and is used primarily in civil aviation for reciprocating piston engine aircraft. Avgas 80/87 has the lowest lead content at 0.5 grams lead per gallon, and is only used in very low compression ratio engines. Avgas 100/130 is a higher octane grade aviation gasoline, containing about 4 grams of lead per gallon. Finally, a lower-lead blend, Avgas 100LL ("low

[1] Additional information on alkyl-lead sinks, fate and transport, and exposure pathways is presented in sections 2.1.4 and 2.1.5.
[2] Current data on the use of leaded gasoline for these sources was not available at the time of this action plan development.

lead") was designed to replace Avgas 100/130. Avgas 100LL contains about 2 grams of lead per gallon, and is typically the most commonly used aviation gasoline (Purvis, 1999).

First sales of total aviation gasoline (all grades) in 1990 totaled 322.6 million gallons (U.S. DOE, 1991), and throughput at bulk plants was also 322 million gallons (USEPA, 1993). In 1998, the quantities of finished aviation gasoline (all grades) produced at refineries and imported into the U.S. totaled 298.8 million gallons and 1.8 million gallons, respectively (U.S. DOE, 1998). There were no exports of aviation gasoline in 1998 (U.S. DOE, 1998). Adjusting for changes in avgas stocks, the total volume of aviation gasoline supplied as a product in 1998 was 295.3 million gallons (U.S. DOE, 1998). Trends in the total finished aviation gasoline supplied in the U.S. between 1995-1998 are summarized in Figure 1.

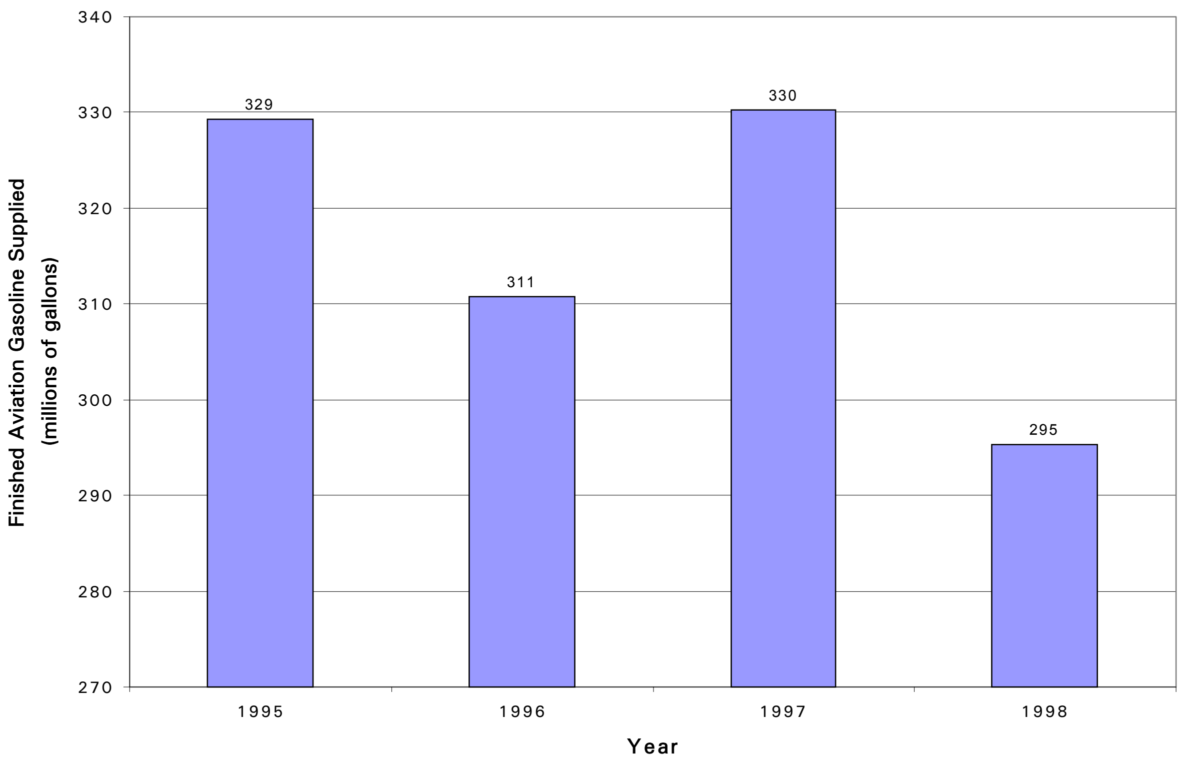

Figure 1. Finished Aviation Gasoline Supplied in the U.S. 1995-1998.

As the volumes above represent only total gallons of aviation gasoline, the exact amount of alkyl-lead associated with this total is unknown without information which breaks down the production and use of aviation gasoline by grade. However, based on American Society for Testing and Materials (ASTM) specifications for 100LL aviation gasoline (which typically constitutes the majority of avgas consumption), a rough conservative estimate of TEL used in aviation can be derived for 1998 as 295.3 million gallons of gasoline x 2.128 g (TEL)/gallon = 628 million grams of TEL, which is equivalent to 1.39 million pounds of TEL.

2.1.2.2 Other Non-highway Uses

In addition to aviation, non-road leaded fuel consumption includes use in competitive race vehicles (cars, boats, etc.) (USEPA, 1993). In 1990, first sales of leaded motor gasoline in the U.S. were estimated to total 5.8 billion gallons, which comprised about 4.8 percent of the total gasoline sales (U.S. DOE, 1991). By 1991, use of leaded gasoline had declined to 3.1 billion gallons representing 3.2 percent of total gasoline use. (Unpublished data, USEPA, 1991).

Although more recent data on total motor gasoline production levels is available, the proportion of leaded gasoline produced, as well as the rate of leaded gasoline use by each of the non-road sources, is unknown. Total (leaded and unleaded) motor gasoline supplied in the U.S. between the years 1995 and 1998 has gradually increased from 119.4 billion gallons in 1995 to 126.5 billion gallons in 1998 (U.S. DOE, 1998). If the supply of leaded gasoline has not increased from the 1991 level of 3.1 billion gallons, the percentage of leaded gas based on 1998 total motor gasoline supply levels would be 2.45%. However, it is more likely that the volume of leaded gasoline supply has actually decreased since 1991.

In 1997, imports of leaded gasoline into the U.S. totaled more than 9.4 million gallons, and exports were about 9.1 million gallons (U.S. Bureau of the Census, 1998).

2.1.2.3 Competition Vehicles (Cars, Boats, etc.)

Currently, no readily available government source of information exists on the amount of leaded fuel used by racing cars and boats. The National Motor Sports Council (1999) estimates that approximately 100,000 gallons of leaded gasoline were used by NASCAR in 1998. There are many different suppliers of leaded racing fuel in the United States. Almost all of these suppliers offer racing fuel at various octanes and lead content. For example, $76_{®}$ Racing Gasoline, the “Official Fuel of NASCAR,” offers four different types of racing gasoline: 100 Octane Unleaded, 110 Octane Leaded, 114 Octane Leaded, and 118 Octane Leaded. In addition to $76_{®}$, many suppliers offer unleaded fuel as well as leaded fuel. Therefore, it seems likely that, to some extent, unleaded gasoline is being used for races or at least in particular race vehicles. Table 1 illustrates several suppliers and the types of racing fuel they offer.

As an alternative to the purchase of commercial racing gasoline, gasoline additives may be purchased that can be added to unleaded motor gasoline to raise the octane level. For example, Tosco Racing Fuels offers the “Accelerator Race Fuel Concentrate” in both a leaded and unleaded form.

There is also evidence that, to some degree, leaded aviation gasoline may be added to the fuel used for some racing vehicles. For example, some of the suppliers of gasoline additive products present information on how their concentrate can be blended with 100LL to create a higher octane racing fuel.

Table 1. Illustration of Available Racing Gasoline

Supplier	Racing Gasolines Offered	Octane	Lead Content
76 Racing Gasoline (Union 76)	76 Unleaded Racing Gasoline	100	Unleaded
	76 Leaded Racing Gasoline	110	Unknown
	76 Superstock Racing Gasoline	114	Unknown
	76 Prostock Racing Gasoline	118	Unknown
Phillips 66	Phillips B-32	110	4.0 ml/gal
	Phillips B-33	114	4.0 ml/gal
	Phillips B-35	101	Unleaded
	Phillips B-37	118	6.0 ml/gal
	Phillips B-42	105	Unleaded
Sunoco	Sunoco GT Unleaded	100	Unleaded
	Sunoco GT Plus Unleaded	104	Unleaded
	Sunoco Standard	110	Unknown
	Sunoco Supreme	112	Unknown
	Sunoco Maximal	116	Unknown
	Sunoco Supreme N.O.S	117	5.0 ml/gal
	Sunoco Maximal #5	116	6.0 ml/gal

2.1.2.4 Bulk Terminals, Bulk Plants and Service Stations

Bulk gasoline terminals are the primary distribution facilities for the gasoline produced at refineries prior to its distribution by tank trucks to consumers. Some gasoline is distributed from bulk terminals to secondary distribution facilities called bulk plants before it is distributed to smaller consumers such as small service stations. Bulk terminals and plants may distribute both leaded and unleaded gasolines for various uses (e.g., motor vehicle gasoline and aviation gasoline). In 1990, the number of distribution facilities nationwide were estimated at 748 bulk terminals, 12,600 bulk plants, and 387,750 service stations (USEPA, 1993). The majority of leaded aviation gasoline is distributed by tank truck directly from the refinery to the storage tanks and refueling equipment at airports.

2.1.3 Emissions

Overall lead emissions (all forms of lead and lead compounds, including alkyl-lead) in the U.S. have decreased by two orders of magnitude between 1970 (220,869 short tons emitted) and 1996 (3,869 short tons emitted) (USEPA, 1997b). Figure 2 summarizes estimates of total lead emissions by year.

Most notable in Figure 2 is that the greatest reduction in lead emissions occurred between 1970 and 1985. This large reduction is a direct result of the regulated phase-out of leaded gasoline (reductions in both the lead content per gallon and the total gallons produced) and the increased availability of unleaded gasoline (USDHHS, 1997). Remaining sources of airborne lead emissions [3] include bulk production plants for aviation gasoline, non-road vehicles, waste incinerators, metal processing facilities, and other fuel combustion facilities (e.g., electrical utility, industrial). The available data on specific types of releases of lead compounds are discussed below, including exhaust emissions, evaporative emissions, and spills and/or leaks (from fuel loading, transfer, storage, and fueling). The focus of the discussion is on lead emissions attributable to the use of alkyl-lead, either direct alkyl-lead emissions or lead emissions resulting from combustion of fuel containing alkyl-lead. Data specific to alkyl-lead are presented where possible. However, in some cases, the information is limited to reports of inorganic lead releases only.

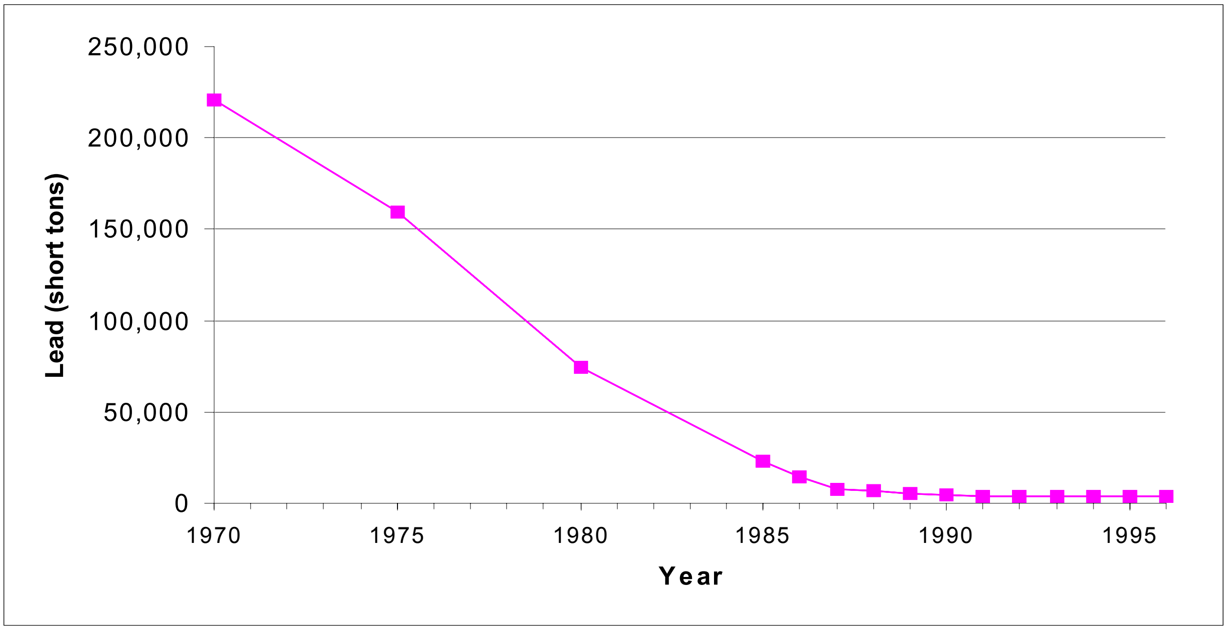

Figure 2. Total Lead Emissions (Short Tons) by Year.

[Figure reproduced from National Air Pollutant Emission Trends Report, 1970-1996 (USEPA, 1997]

Evaporative Emissions. No significant amounts of alkyl-lead have been observed to be released via tailpipe emission during the combustion of leaded gasoline (USEPA, 1993), as only a very small percentage (0.2%-0.4%) of alkyl-lead is typically exhausted uncombusted when driving at constant speeds (Grandjean, 1983). Lead releases from the combustion of leaded gasoline predominantly occur in the form of inorganic lead / lead halides. Alkyl-lead releases from these sources are primarily associated with evaporative emissions or spills that may occur during fuel distribution or refueling, as well as evaporative emissions that can originate from unburned fuel in the carburetor or gas tank.

[3] Through the combustion process in automotive engines, alkyl-lead compounds combine with fuel scavengers to form lead oxides. Alkyl-lead is the only known significant source of lead in gasoline.

In response to the 1990 Clean Air Act Amendments (CAAA), which call for the identification of source categories emitting 90 percent of the total national alkyl-lead emissions (plus six other air toxics) the EPA published the *1990 Emissions Inventory of Section 112(c)(6) Pollutants* in April of 1998. In the inventory, the total national emissions of TEL and TML in 1990 were estimated to be 810.6 lbs of TEL and 481.23 lbs of TML. The 112(c)(6) estimates assumed that evaporative emissions associated with the use of alkyl-lead in custom blended fuels (i.e., in competitive race vehicles) were negligible compared to evaporative emissions associated with aviation.

2.1.4 Environmental Transport, Transformation, and Fate

Alkyl-lead is released to the environment primarily through evaporative emissions from unburned gasoline retained in an engine's carburetor or fuel tanks and through evaporative losses during the filling of gasoline tanks, accidental spillages, and releases during production. However, alkyl-lead compounds combine with other compounds during the combustion process to form lead halides (e.g., PbBrCl, $2PbBrCl \bullet NH_4Cl$, etc.) that are subsequently emitted as microparticulates in exhaust.

Alkyl-lead in the atmosphere degrades rapidly by direct photolysis, reaction with ozone, and by reaction with hydroxyl compounds. The half-lives of TEL and TML in summer atmospheres are approximately two hours and nine hours, respectively. In winter atmospheres, the half lives of both TEL and TML are several days. In water and soil, alkyl-lead compounds are also degraded to other forms of lead, eventually forming stable inorganic lead compounds. Therefore, alkyl-lead itself is not a persistent environmental compound. However, it breaks down in the environment (or is emitted following combustion) to other forms of lead which are much more persistent.

Airborne lead particles (such as those emitted as exhaust) may remain airborne for up to 10 days and, therefore, may be transported far from the original source. Lead is removed from the atmosphere and deposited on soil and water surfaces via wet or dry deposition. In soils, most lead is retained via the formation of stable solid phase compounds, precipitates, or complexes with organic matter. In general, most of these forms of lead are quite insoluble and thus not easily leached to underground water. However, leaching may occur under acidic conditions, where lead concentrations are extremely high, or in the presence of substances (e.g., soluble organic matter, high concentrations of chlorides or sulfates) that form relatively soluble complexes with lead. In most surface and ground waters, relatively little lead is found in a dissolved form; lead is typically bound to sediments. Transport of lead to surface waters can occur through direct deposition from the atmosphere, via industrial waste water discharge, or as runoff (e.g., lead associated with suspended solids in the erosional process) (ATSDR, 1999).

Inorganic lead may bioconcentrate in some aquatic animals, especially benthic organisms such as bottom feeding fish and shellfish such as mussels, and some crops can become contaminated with lead by exposure to exhaust in the air or lead in the soil (ATSDR, 1999). However, inorganic lead does not appear to be biomagnified in aquatic or terrestrial food chains (ATSDR, 1999). Alkyl-lead and other organolead compounds have also been found to significantly bioconcentrate in aquatic organisms (e.g., fish and shellfish), although, again, biomagnification of organolead compounds has not been shown (ATSDR, 1999).

2.1.5 Human Exposure and Health Risks

The human exposure pathways for alkyl-lead are through inhalation of leaded gasoline vapors, or by dermal exposure to leaded gasoline. Unlike metallic forms of lead, alkyl-lead is easily absorbed through the skin. Additionally, through the combustion process, alkyl-lead in gasoline is converted to lead halides and exhausted into the air where it can be inhaled. These lead halides create the potential for exposure to lead through ingestion of soil or dust containing lead, and ingestion of lead-contaminated food or water.

The absorption of lead is influenced by the route of exposure. Due to the lipophilic nature of alkyl-lead and its ability to permeate biological membranes, alkyl-lead is absorbed rapidly and extensively through the skin. For this reason, alkyl-lead is much more bioavailable and is considered to be much more toxic than inorganic forms of lead. Further, the toxicity of alkyl-lead compounds varies with the degree of alkylation. Tetraalkyllead compounds such as TEL and TML are considered to be more toxic than trialkylead or dialkyllead compounds.

With the phase-out of leaded gasoline used in on-road vehicles, there has been a substantial reduction in the risk of exposure for the general public. However, as gasoline containing alkyl-lead is still currently being used as fuel (particularly for race cars and airplanes), certain subpopulations may remain at risk.

Lead particles can remain airborne for some time following the initial introduction into the atmosphere. Therefore, residents in the vicinity of race tracks and general aviation airports where leaded gasoline is still being used as fuel may have an increased risk of lead exposure. Similarly, spectators at racing events or air shows may also be exposed to alkyl-lead emissions resulting from fueling or to lead compounds emitted as exhaust. However, the available information is too limited at this time to pursue a quantitative analysis of risk for this source and potential exposure pathway.

Aviation fuel attendants and mechanics are potentially exposed due to inhalation of alkyl-lead compounds during fueling, evaporative emissions from spills, or evaporative emissions from unused gasoline remaining in the engine or fuel tanks. Further, these populations are also at risk because of possible dermal absorption of gasoline containing alkyl-lead compounds. However, the available information is too limited at this time to pursue a quantitative analysis of risk for this source and potential exposure pathway.

In the body, alkyl-lead compounds are metabolized in the liver by oxidative dealkylation catalyzed by cytochrome P-450. Through this process, alkyl-lead compounds are converted to triethyllead- and trimethyllead-metabolites and inorganic lead. It is these three compounds that are thought to cause the toxic effects of lead. In the body, triethyllead and trimethyllead compounds are distributed through the blood to “soft tissues” particularly the liver, kidneys, muscles, and brain. Experiments on mice and rabbits have suggested that the highest concentration of triethyllead compounds is found in the liver, kidneys, brain, and muscles in that order. Initial symptoms of alkyl-lead poisoning include, among others: anorexia, insomnia, tremor, weakness, fatigue, nausea and vomiting, mood shifts such as aggression or depression, and impairment of memory. In the case of acute alkyl-lead poisoning, possible health effects include mania, convulsions, delirium, fever, coma, and in some cases even death.

The inorganic lead compounds emitted as exhaust (e.g., PbBrCl, $2PbBrCl \bullet NH_4Cl$, etc.) through the combustion process (as a direct result of the use of alkyl-lead in gasoline) also contribute to human exposure through ingestion and/or inhalation. The biochemistry and toxicology of inorganic lead differs from that of alkyl-lead compounds. However, lead poisoning due to the ingestion or inhalation of inorganic lead compounds is a widely recognized public health problem. Blood-lead concentration is a commonly used measure of body lead burden. Children are at a higher risk of lead poisoning than adults due to their lower body weights and developing neurological systems. Blood-lead concentrations as low as 10 to 15 µg/dL have been associated with neurological damage in children, and increasing blood-lead levels have been highly correlated with decreased performance on standardized intelligence tests (i.e., lower I.Q. test scores). Adverse health effects such as impaired hearing acuity and interference with vitamin D metabolism have also been observed at blood-lead levels of 10 to 15 µg/dL. Increased blood pressure, delayed reaction times, anemia, and kidney disease may become apparent at blood-lead concentrations between 20 and 40 µg/dL. Symptoms of very severe lead poisoning, such as kidney failure, abdominal pain, nausea and vomiting, and pronounced mental retardation can occur at blood-level concentrations as low as 60 µg/dL. At even higher concentrations, inorganic lead poisoning can result in convulsions, coma, or death.

2.2 PROGRAMMATIC ASSESSMENT

2.2.1 Current Regulations and Programs

Current regulations and programs targeting lead emissions and releases (including alkyl-lead compounds) are presented in Table 2.

As seen in the table, the 1990 CAAA specifically target the use of leaded gasoline for on-road vehicles, calling for a complete prohibition on the use of leaded gasoline in on-road vehicles after December 31, 1995 (§220). However, the 1990 CAAA specifically exempt fuels for race cars or "Competition Use Vehicles."

Table 2. Current Regulations and Programs

	Regulations					
	CAA / CAAA	CWA	SDWA	RCRA	SARA / EPCRA	CERCLA
Current Standards and Regulations	§109: NAAQS is 1.5 µg/m³ (lead) §112(b): Lead is designated a HAP; Source categories identified under §112(c)(6); Emission standards to be promulgated §220: Use of gasoline containing > 0.05 grams of lead per gallon in on-road vehicles prohibited (Leaded gasoline is still permitted in non-road vehicles) §211(g): Prohibits misfueling of vehicles built after 1990 designed for unleaded gasoline	CWA Priority: Lead and lead compounds are listed priority pollutants (40CFR 423); subject to NPDES effluent limitations under §304(b) (40CFR 122) and general pretreatment (40CFR 403)	NPDWR: Action Level is 0.15 mg/L lead (treatment technique) MCL Goal is zero	Subtitle C: Lead-containing substances may be classified hazardous wastes based on toxicity characteristic (40CFR 261.24); subject to hazardous waste regulations (40CFR 260 - 266 and 268) and ground water monitoring requirements (40CFR 264 and 265) Universal treatment standards for lead in waste (40CFR 268.40)	§313: Releases of lead and lead compounds (by facilities with 10 or more employees and that process 25,000 lbs., or otherwise use 10,000 lbs.) must be reported to TRI (40CFR 372.65) Jan. 17, 2001 Federal Register amendment lowered the TRI reporting threshold for lead and lead compounds to 100 lbs/year (66 FR 4499)	§103: Spills of tetraethyl lead > 10 lbs. must be reported to the National Response Center
Policy and Programs	– Binational Toxics Strategy Level 1 substance – International Joint Commission (IJC) Critical Pollutant – Tier I chemical under the Canada-Ontario Agreement – Recognized pollutant in Lake Superior Lakewide Management Plan (LaMP) – Targeted chemical in the Great Lakes Regional Air Toxic Emissions Inventory Project – Included in the USEPA Cumulative Exposure Project (lead compounds) – Included in CAA §112(m) program, Atmospheric Deposition to Great Lakes and Coastal Waters – Children's blood lead levels monitored in NHANES – OIA program on international efforts to phase-out lead in gasoline					

2.2.1.1 Regulations Controlling Use

In the early 1970s, EPA issued two regulations under the statutory authority of the 1970 Clean Air Act (CAA). First, EPA required major gasoline retailers to begin selling one grade of unleaded gasoline by July 1, 1974. This mandate was primarily focused on preventing the deterioration, as a result of leaded gasoline, of emissions control systems (e.g., catalytic converters) in motor vehicles so equipped. In developing these regulations, EPA first established the working definition of "unleaded" gasoline as "gasoline containing not more than 0.05 gram of lead per gallon and not more than 0.005 gram of phosphorus per gallon" [38FR1255, January 10, 1973]. Second, EPA issued a regulation calling for the gradual phase-out of leaded gasoline. The schedule for reduction of lead content in automobile gasoline was 1.7 grams per gallon (g/gal) in 1975, to 1.4 g/gal in 1976, 1.0 g/gal in 1977, 0.8 g/gal in 1978, and 0.5 g/gal in 1979 [38FR33741, December 6, 1973]. Subsequent regulations reduced the allowable lead content to 0.1 g/gal in 1986 [50FR9397, March 7, 1985], and prohibited leaded gas use after 1995 [61FR3837, February 2, 1996]. Most recently, alkylated lead compounds have been regulated under the 1990 CAAA. Section 220 of the CAAA specifically targets the use of leaded gasoline for on-road vehicles, calling for a complete prohibition on the use of leaded gasoline in on-road vehicles after December 31, 1995. However, as outlined below, the 1990 CAAA specifically exempt fuels for race cars or "Competition Use Vehicles." The following components of the 1990 CAAA relate to the use of alkyl-lead in gasoline:

- Prohibition on the Use of Leaded Gasoline in On-Road Vehicles. Section 211(n) of the 1990 CAAA states: "After December 31, 1995, it shall be unlawful for any person to sell, offer for sale, supply, offer for supply, dispense, transport, or introduce into commerce, for use as fuel in any motor vehicle (as defined in Section 219(2)) any gasoline which contains lead or lead additives." This provision applies only to on-road vehicles. Enacting regulations were promulgated [61FR3837, February 2, 1996].

- Misfueling with Leaded Gasoline. Section 211(g) of the 1990 CAAA prohibits misfueling vehicles built after 1990 (or vehicles designated solely for unleaded gasoline) with leaded gasoline.

- Prohibition on Production of Engines Requiring Leaded Gasoline. Section 218 of the 1990 CAAA requires USEPA to promulgate rules that prohibit the "manufacture, sale, or introduction into commerce of any engine that requires leaded gasoline." Further, these rules apply to all motor vehicle engines and non-road engines manufactured after the 1992 model year.

Thus, the sale or use of gasoline containing alkyl-lead (greater than 0.05 grams of lead per gallon) is now prohibited in on-road vehicles [40CFR Part 80.22].

2.2.1.2 Regulations Governing Emissions, Releases and Spills

The 1990 CAAA also contain language specific to emissions of lead compounds resulting from the use of leaded gasoline. Lead compounds (not alkyl-lead specifically) are included in the CAA Section 112 list of hazardous air pollutants (HAPs). The EPA developed a list of categories of stationary sources that emit HAPs for development of emissions standards established under Section 112, including maximum achievable control technology standards (MACT)(40CFR Part 63).

The Clean Water Act (CWA) prohibits any person from discharging a pollutant from a point source into navigable waters without a National Pollutant Discharge Elimination System (NPDES) permit (33 U.S.C. sec. 1342, 40 CFR 122). Under the CWA, lead and lead compounds are listed priority pollutants (40CFR 423). As a result, many facilities are subject to lead effluent limits or monitoring requirements in their NPDES permits.

Lead-containing substances may be classified as hazardous wastes under the Resource Conservation and Recovery Act (RCRA), Subtitle C (40CFR 261.24). As such, lead-containing wastes may be subject to hazardous waste regulations (40CFR 260 through 266 and 268) and ground water monitoring requirements (40CFR 264 and 265). RCRA also establishes Universal Treatment Standards for lead in wastes (40CFR 268.40).

Section 313 of Title III of the 1986 Superfund Amendments and Reauthorization Act (SARA) also requires that releases of lead and lead compounds to air, water, or land be reported to the Toxic Release Inventory (TRI) by manufacturing facilities (SIC codes 20-39, plus other specific facilities), that have 10 or more full time employees, and manufacture/process 25,000 lbs. of a listed chemical, or otherwise use 10,000 pounds of a listed chemical (40CFR 372.65). An amendment to lower the TRI reporting threshold to 100 pounds for lead and lead compounds was published on January 17, 2001 (66 FR 4499), and took effect on February 16, 2001. First reports at the lower threshold are due on or before July 1, 2002.

Finally, Section 103(a) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) requires that any spills/releases of tetraethyl lead in quantities exceeding 10 lbs. must be reported immediately to the National Response Center (40CFR302.4).

2.2.1.3 Regulations Calling for Source Identification

The CAAA also contain requirements pertaining to the identification of sources of alkyl-lead. Section 112(c)(6) of the CAA specifically directs EPA to include source categories that account for at least 90 percent of the emissions of alkyl-lead (among other pollutants) on its lest of source categories for development of emission standards. The listing of sources was published in the *Federal Register* in April 1998.

2.2.1.4 Compliance and Enforcement

The potential for illegal misfueling of leaded gasoline cannot be entirely eliminated because leaded gasoline is still produced in the United States for use in non-road vehicles (primarily as general aviation fuel and in race cars) and is dispensed by private citizens. Historically, EPA’s Office of Enforcement has not found this to be the case in public gasoline service stations. In previous years, EPA’s Office of Enforcement screened for lead during routine inspections at service stations. However, as leaded gasoline became increasingly scarce, the number of violations related to the misuse of leaded gasoline dropped dramatically, as shown in Table 3 (USEPA, 1998d). As a result of finding virtually no cases of misfueling, EPA’s Office of Enforcement no longer routinely screens for lead as part of the typical inspection process. EPA, does, however, continue to test for lead on a case-by-case basis if illegal misfueling is suspected.

Although it is possible for misfueling of on-road automobiles to occur using leaded racing gasoline, such misfueling, if it occurs at all, is likely to be rare. Limited supply, limited distribution, higher costs, incompatibility with emission control systems on production automobiles, and limited performance benefits in production automobiles designed for unleaded gasoline all weigh against use of leaded racing gasoline in on-road automobiles.

Table 3. **Violations Issued for Excess Lead-Levels in Gasoline** [Source: USEPA,1998d]

Year	Number of Service Station Inspections	Number of Violations Issued	Violation Rate
1980	5,021	83	1.65%
1981	10,179	73	0.72%
1982	10,266	60	0.5%
1983	9,896	41	0.41%
1984	4,652	24	0.52%
1985	5,363	30	0.56%
1986	5,363	8	0.15%
1987	9,003	4	0.04%

2.2.1.5 International Activities

The United States is committed to being a world leader in promoting the phase-out of leaded gasoline use in motor vehicles. Since 1994, national governments have committed to the phase-out of lead in gasoline at key international and regional agreements, including the United Nations Commission on Sustainable Development, Summit of the Americas, Earth Summit + 5 and the G-8 (an informal group of eight developed democracies – Canada, France, Germany, Italy, Japan, Russia, the United Kingdom, and the United States – with interests in global developments on a range of broad economic and foreign policy issues). As a result of the active campaign to remove lead from gasoline, seven countries in Latin America, one country in Eastern Europe and two countries in Asia have totally phased out the use of lead in gasoline. Efforts by the United States have resulted in lower levels of lead added to the leaded gasoline in one country in Asia, two in Latin America, and one in Eastern Europe where leaded gasoline is still sold.

The impact of the activities undertaken by EPA in Latin America and the Caribbean has been to accelerate the formulation and implementation of lead phase-out plans throughout the region. The use of leaded gasoline is declining rapidly. By the year 2002, about 85 percent of the gasoline consumed in the region will be lead-free. According to World Bank figures, the amount of lead added to gasoline in Latin America and the Caribbean declined from 27,000 metric tons in 1990 to 8,200 tons in 1996. It is estimated that, based on national phase-out, the lead added to gasoline in 1999 will be approximately 4,200 metric tons.

Worldwide, at least 25 additional countries have made significant commitments to phase-out, but are hampered from comprehensive action by technical complications. Using the Implementer's Guide on Phase-out of Lead in Gasoline that EPA and the U.S. Agency for International Development (USAID) recently completed, associated workshops will be planned and conducted to target the 25 countries with technical difficulties. EPA will continue in its current efforts to enhance and promote the phase-out of leaded gasoline worldwide.

2.2.1.6 Activities Related to Products

Alternative Aviation Fuel Research. Industry is currently researching an alternative to alkyl-lead for aviation fuel. An industry group, the Coordinating Research Council (CRC) has formed a task force for the purpose of finding a no-lead gasoline substitute for the existing aviation fleet. Working cooperatively with the CRC, the FAA has initiated an Unleaded Fuels Research Program to complete research on the development of unleaded aviation gasoline for civil aircraft. Under this program, engine and fuel testing (e.g., engine performance, emissions, fuel consumption changes, etc.) at the FAA's small-engine and fuel test facilities began in 1994. Data from this testing will aid the FAA in replacement fuel certification for 100-octane low-lead gasoline, as well as developing fuel specifications with the ASTM. Considering all of the testing that must be conducted (different conditions, different engine/airframe combinations, toxicity, etc.), as well as the approvals from FAA and the acceptance by the aviation industry, petroleum companies, and gasoline distributers that must be obtained, it is not possible to currently estimate a time frame for the change over to an unleaded high-octane aviation gasoline.

Racing Gasoline. NASCAR is evaluating and testing the use of unleaded racing gasoline in the Busch, Winston Cup and Craftsman Truck Series. NASCAR and its fuel supplier TOSCO Corporation (TOSCO) are recognized leaders in the auto racing industry, and any changes that they make are expected to have a significant effect throughout the industry.

2.3 RELATIONSHIP TO THE CANADA-U.S. GREAT LAKES BINATIONAL TOXICS STRATEGY

The overall goal of the PBT Strategy, to identify and reduce risks to human health and the environment from current and future exposure to PBTs, builds upon the objectives and goals contained in *The Canada-United States Strategy for the Virtual Elimination of Persistent Toxic Substances in the Great Lakes Basin* (Binational Toxics Strategy), which was established in 1997. For alkyl-lead, the Binational Toxics Strategy identifies the following national challenge goal:

> *"Confirm by 1998, that there is no longer use of alkyl-lead in automotive gasoline. Support and encourage stakeholder efforts to reduce alkyl-lead releases from other sources."*

The Binational Toxics Strategy has the overall goal of virtual elimination of persistent toxic substances in the Great Lakes Basin and in the case of alkyl-lead, throughout the United States. Significant work has already been completed by EPA's Great Lakes National Program Office to confirm the "no-use of alkyl-lead in automotive gasoline." (USEPA, 1999a)

2.4 OPPORTUNITIES ASSESSMENT

2.4.1 Issues Considered in the Development of the Strategic Approach

2.4.1.1 Priority Setting

As outlined in Part I, EPA has considered the proposed actions for alkyl-lead within the larger context of actions and resources necessary to reduce risk for all twelve Level 1 substances currently being addressed under the PBT Strategy. The specific actions within the Alkyl-lead National Action Plan were prioritized based on several key factors such as the likelihood of health risks, amount of resources required, the availability and willingness of non-agency partners and stakeholders, and the anticipated impact on the amount of alkyl-lead released into the environment. These key factors need to be examined simultaneously to determine the appropriate prioritization. For example, at the current time, data seem to indicate that the amount of leaded aviation gasoline is significantly higher than the amount of leaded gasoline used by the automotive racing industry. However, technical considerations may limit the amount of progress that can be made toward an alternative aviation fuel. On the other hand, there are fewer technical limitations associated with racing fuel and representatives from the automotive racing industry have expressed a willingness to work with EPA to develop alternatives. Priority Actions were presented in Part I of this Action Plan.

2.4.1.2 Data Gaps

EPA estimated national emissions for alkyl-lead for 1990 in conjunction with its analysis under section 112 (c)(6) of the CAA. However, sufficient data were not available to develop emissions estimates for operations of aircraft, operations of non-road vehicles, or alkyl-lead production.

Additionally, other than aviation gasoline, very little data exist on current levels of leaded gasoline use. Since 1991, the Department of Energy (DOE) stopped tracking information on the production of leaded gasoline for non-aviation uses. Consequently, there is no readily accessible information on how much leaded gasoline is being produced for the continued, legal use of alkyl-lead in racing cars. However, it may be possible to derive upper bound estimates for these uses from other available information and from industry representatives.

Finally, there is insufficient information to assess whether the remaining uses of leaded gasoline result in adverse environmental or health effects. Most notably, there is no information to determine whether there is increased risk of lead exposure to at-risk populations (especially children) living in the vicinity of race tracks or general aviation airports, spectators at racing events or air shows, and fuel handlers (aviation or racing crews).

Bridging these data gaps is discussed below in section 2.4.3.2 Proposed Research / Information Needs.

2.4.1.3 Regulatory Constraints

EPA does not have the authority to regulate aviation fuel (e.g., the constituents of the fuel). This authority lies with the FAA. EPA also does not have the authority under the CAA to regulate the use of unleaded gasoline for the racing industry. There is a provision in the CAA that prohibits EPA from regulating engines (or their fuels) that are designed solely for competition, but the regulation of fuel could potentially occur under the TSCA Section 6 Rule.

2.4.1.4 Stakeholder Issues/Concerns

There are a large number of experimental aircraft with lower performance piston engines that use unleaded gasoline, as well as various alternative fuels that have been researched. However, the identification of alternatives for leaded aviation gasoline will present a technical challenge, as some alternative additives (e.g., methyl tert-butyl ether (MTBE) and toluene) may have adverse environmental and human health effects as well. These alternatives include those containing alcohols (e.g., ethanol), aromatics (e.g., toluene), and ethers (e.g., MTBE and ETBE). A manganese-based additive, MMT (methyl-cyclopentadienyl manganese tricarbonyl), has also been used in gasoline blends as an octane booster, although research indicates that it will probably not find widespread usage due to potential deposit-control problems. For many years MTBE has been used as a blending agent in gasoline to raise the octane number, eliminate corrosive action, and serve as an oxygenate. In fact, reformulated gasoline containing an oxygenate (such as MTBE) is required to be sold in many states to reduce air pollution (smog) levels. Recently, however, due to evidence that MTBE is polluting groundwater supplies, an independent Blue Ribbon panel has recommended to EPA that oil companies should not be required to sell MTBE-blended gas, and that use of MTBE be sharply reduced (USEPA, 1999b).

While an alternative fuel for aircraft is desirable, care must be taken to balance this with safety concerns. Aircraft are certified for very specific fuels. The performance of an alternative unleaded high-octane aviation gasoline under all possible operational and environmental conditions must be thoroughly tested because of concerns regarding aircraft safety. High-performance piston aircraft engines require high-octane gasoline, and alkylated lead compounds are extremely efficient at raising the octane without causing any other undue performance effects. To re-certify aircraft for a different fuel is time-consuming and expensive. To date, EPA has not focused on fuel alternatives due to the financial hardships it would impose on the small aircraft industry.

Although there are a large number of experimental aircraft that use unleaded gasoline for lower performance piston engines, there appears to be no ready substitute for the 100-octane low-lead gasoline used by high performance piston engines. However, one new fuel specification has been approved by ASTM. This new fuel, which will be known as 82UL, is an unleaded aviation grade fuel that can be used only by the low compression ratio segment of the reciprocating-engine-aircraft fleet. The initial production and supply of this new fuel is currently being studied by fuel suppliers. As a move forward in promoting 82UL, the FAA has extended approval for use of this fuel by aircraft previously approved to use auto fuel under Supplemental Type Certificates (STC). In addition, the FAA has recently certified another new unleaded fuel, AGE85, developed by the National Alternate Fuels Laboratory (NAFL) at the University of North Dakota Energy and Environmental Research Center (EERC). With the initial certification completed, the developers of the fuel are moving forward to obtaining FAA certification for more engine and airframe combinations (EERC, 1999).

2.4.2 Strategic Assessment – The Priorities for Action

The Agency recognizes that tremendous progress has been made in reducing lead emissions related to the use of alkyl-lead. Total lead emissions have been reduced from 220,869 short tons in 1970 to 3,869 short tons in 1996, totaling a reduction in emissions of approximately 98 percent (USEPA, 1997b). This large reduction is primarily due to the regulated phase-out of leaded gasoline in on-road vehicles. Based on considerations of all opportunities, and taking into account the issues discussed in section 2.4.1, the Agency has identified one key priority for action for alkyl-lead over the next five years. It will work in voluntary partnership with the National Association for Stock Car Automobile Racing (NASCAR) to permanently remove alkyl-lead from their racing fuels, specifically, in the Busch, Winston Cup and Craftsman Truck Series.

In addition, EPA will continue other activities that will help to meet the goals of this action plan. In particular, EPA will continue its commitment to international efforts to reduce the use of leaded gasoline, including those being conducted under the United Nations Commission on Sustainable Development, Summit of the Americas, Earth Summit + 5, the G-8, and the Great Lakes Binational Toxics Strategy. On a global basis, lead in gasoline has been estimated to contribute 95 percent of the lead air pollution found in the world's major cities. Goal 6 of EPA's Ten Year Strategic Plan GPRA Goals calls for the reduction in worldwide levels of lead in gasoline. EPA will also continue dialogues with the Federal Aviation Administration (FAA) to discuss the use of leaded gasoline in the aviation industry and the possibilities of reducing the lead content and/or replacing leaded gasoline with unleaded gasoline. EPA will continue to support and encourage such research activities as that undertaken by the Coordinating Research Council (CRC) task force investigating alternative (no-lead) gasoline for aircraft.

2.4.3 Other Actions Considered

As discussed in section 2.4.1.1, proposed actions for alkyl-lead were evaluated in the larger context of proposed actions for all Level 1 substances and in the context of available resources. Following are actions that were considered to have merit but which could not be implemented or planned at this point in time in light of other higher priorities.

2.4.3.1 Proposed Outreach and Education

EPA, along with others, has conducted an extensive outreach/education campaign to make the general public aware of the dangers of lead. However, these efforts have primarily focused on inorganic forms of lead such as those found in lead-based paint. While EPA continues its efforts to inform the general public on the dangers of inorganic lead, EPA considered investigating new possibilities for expanding the outreach/education campaign to include targeted audiences. For example, outreach/education campaigns on the dangers of alkyl-lead (especially the hazards of dermal exposure) could be targeted to persons that routinely fuel vehicles with leaded gasoline.

2.4.3.2 Proposed Research/Information Needs

Research on several issues was considered to address the data gaps identified above and as the initial step in promoting the voluntary phase-out of leaded gasoline. In particular, the following research activities and information collection efforts were discussed:

- Develop Current Emission Estimates: The last air emissions inventory specific to alkyl-lead represented the year 1990. Since then, the overall use of leaded gasoline may have been further reduced. Further, estimates could be made for competitive use vehicles (such as those used by NASCAR). EPA considered developing rough estimates of the potential emissions from race cars through modeling of emissions, monitoring during races, soil sampling in the vicinity of race tracks, or other means as appropriate.

- Investigate Exposure to At-Risk Populations: As discussed above, gasoline containing alkyl-lead compounds is still being used today and as such there remains the potential for exposure to certain populations. EPA considered research activities to evaluate the risk for these subpopulations, including research to assess whether exposure in the vicinity of general aviation airports or race tracks contributes to elevated blood-lead levels in at-risk populations (i.e., nearby residents (especially children) and spectators of racing events).

- Update Inventory of Leaded Gasoline Production and Use: As stated above, the Department of Energy (DOE) stopped tracking information on the production of leaded gasoline for non-aviation uses. Information on the extent to which leaded gasoline is currently used could be developed through published statistics, discussions with petroleum manufacturers, and discussions with end-users.

- Determine the Availability of Leaded Gasoline and Potential for Misfueling: The extent to which racing gasoline containing lead is available for purchase at the roadside could be estimated. Although EPA's Office of Enforcement no longer routinely screens for lead during routine inspections at service stations, information on the extent to which misfueling occurs could be consolidated and estimates of the extent of misfueling developed.

- Determine the Extent to Which Leaded Gasoline Is Available for Purchase at Marine Fuel Docks: It is unknown whether leaded gasoline is still being widely used as a marine fuel. However, fuel is known to overflow from fuel tanks frequently during operations into waterways, lakes, etc. While the quantities may be small, the number of such sites may be much larger than for race tracks.

2.5 MEASURING PROGRESS

As stated in the PBT Strategy, EPA will use the following measures to track progress in reducing risks from alkyl-lead: (1) environmental or human health indicators, (2) chemical release, waste generation, or use indicators, or (3) programmatic output measures.

In addition to the goals and programmatic measures given in Table 4 below, EPA will measure progress towards the virtual elimination of alkyl-lead production and use throughout the United States by comparison to the following quantifiable baseline measures:

- The amount of leaded aviation gasoline produced: In 1996, U.S. refineries produced 305,000,000 gallons of aviation gasoline (USDOE, 1998).

- The amount of leaded gasoline used by the racing industry: In 1998, approximately 100,000 gallons of leaded gasoline were used by NASCAR (National Motor Sports Council, 1999).

- The amount of anti-knock preparations imported into the US: In 1998, the United States imported approximately 14,318,800 pounds of anti-knock preparations based on TEL and/or TML and 1,316,800 pounds of anti-knock preparations based on lead compounds (U.S. Department of Commerce, 1998). (These compounds are used to make leaded fuel for aviation, racing fuel, marine vessels, etc.) Assuming anti-knock agents containing TEL typically contain 62 percent TEL, a rough estimate for the amount of TEL imported into the U.S. in 1998 would be about 9.7 million pounds of TEL. However, according to Ethyl Corporation (1999), only approximately 2,866,000 pounds of anti-knock fluid were consumed in the U.S. in 1998, equating to approximately 1,129,000 pounds of alkyl-lead. Approximately 331,000 pounds of this anti-knock fluid was used to serve the NASCAR industry.

- The lead content in aviation gasoline: Currently, aviation gasoline has a maximum lead TEL standard of 0.13 mL TEL/L for Grade 80, 0.53 mL TEL/L for Grade 100LL, and 1.06 mL TEL/L for Grade 100. The maximum lead standard is 0.14 g Pb/L for Grade 80, 0.56 g Pb/L for Grade 100LL, and 1.12 g Pb/L for Grade 100 (ASTM, 1997).

- The number of petroleum refining facilities submitting lead or lead compound reports to TRI: In 1995, 29 petroleum refining facilities (SIC 2911) submitted forms to TRI (USEPA, 1998b). This number may have an increase from 1995 levels with the proposed threshold reductions.

Table 4. Measures of Progress for Actions to Reduce Risks from Alkyl-lead

Focus	Action	Measure of Progress
Voluntary phase-out of leaded gasoline use by NASCAR	■ Encourage a NASCAR voluntary phase-out partnership/program	■ NASCAR Agreement; lead-free Busch, Winston Cup and Craftsman Truck Series ■ Reductions in lead exposure and blood-lead levels among at-risk populations
Dialogues with the FAA and CRC	■ Continue work with the Federal Aviation Administration (FAA) and Coordinating Research Council (CRC) to promote alternative, unleaded fuels and the phase-out of leaded aviation gasoline	■ FAA Agreements or voluntary partnerships/programs ■ Reductions in lead exposure and blood-lead levels among at-risk populations
International efforts	■ Continue to support international efforts to reduce the use of leaded gasoline	■ Number of countries that have initiated/reached a phase-out of leaded gasoline; amount of leaded gasoline used worldwide

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APPENDIX A:

LIST OF KEY CONTACTS AND GPRA GOALS

LIST OF KEY CONTACTS

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	STAKEHOLDER AND OTHERS	
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Paul Dodson	International Marina Institute	(941) 480-1212
James Erickson	Federal Aviation Administration	(202) 267-3576
Dallas Gardner	National Hot Rod Association	(626) 914-4761
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Edward Klim	International Snowmobile Manufacturers Association	(517) 339-7788
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GPRA GOALS

The goal of this action plan is to identify and reduce risks to human health and the environment from current and future exposure to alkyl-lead. This goal is consistent with the goal of the PBT Strategy. Achieving this goal will help EPA meet the following Government Performance and Results Act of 1993 (GPRA) goals that pertain to alkyl-lead:

GPRA Goal 1: Clean Air

- By 2010, reduce air toxics emissions by 75% from 1993 levels to significantly reduce the risk to Americans of cancer and other serious health effects caused by airborne toxics;

- By 2005, improve air quality for Americans living in areas that do not meet NAAQS for carbon monoxide, sulfur dioxide, lead, and nitrogen dioxide;

GPRA Goal 4: Preventing Pollution and Reducing Risk in Communities, Homes, Workplaces, and Ecosystems

- By 2005, the number of young children with high levels of lead in their blood will be significantly reduced from numbers in the early 1990's;

GPRA Goal 6: Reduction of Global and Cross-Border Environmental Risks

- By 2005, consistent with international obligations, the need for upward harmonization of regulatory systems, and expansion of toxics release reporting, reduce the risks to U.S. human health and ecosystems from selected toxics (including pesticides) that circulate in the environment at global and regional scales. Results will include a 50% reduction of mercury from 1990 levels in the United States. Worldwide levels of lead in gasoline will be below 1993 levels;

GPRA Goal 8: Sound Science, Improved Understanding of Environmental Risk, and Greater Innovation to Address Environmental Problems

- Incorporate innovative approaches to environmental management into EPA programs, so that EPA and external partners achieve greater and more cost-effective public health and environmental protection.