IV.

PROPOSAL TO ELIMINATE LEADED GASOLINE IN CALIFORNIA

A. INTRODUCTION

Traditionally, lead is added to gasoline as an inexpensive additive to increase its octane rating. While at the present time, the allowable level in leaded gasoline is 0.1 grams per gallon (g/gal) and 0.05 g/gal for unleaded gasoline, in the mid-1970s, some leaded gasoline contained lead in concentrations as high as 2.5 g/gal. Since a large percentage of the lead in the atmosphere (about 90 percent) comes from automobile exhaust, these high concentrations of lead caused violation of ambient lead standards. In the 1970s, the ambient lead standard of 1.5 microgram per cubic meter of air averaged over 30 days was exceeded in many areas of the state by a significant margin. As a result of regulatory efforts to reduce the amount of lead in gasoline and the decreased market for leaded gasoline caused by the introduction of catalyst-equipped vehicles, the state is now in attainment of the ambient lead standard.

However, the attainment of ambient standards does not result in full protection of public health. Lead particles can deposit on soils and plant surfaces, which allows the particles to be reentrained many times in the environment. These particles are small enough to be inhaled into the lungs. Once in the lungs, these particles are readily absorbed into the bloodstream and circulated throughout the body.

There is overwhelming evidence attesting to the toxicity of lead. Studies have shown that children are more susceptible to the effects of lead exposure because they retain more lead in their bloodstream than adults. Lead affects key enzymes in the production of red blood cells and can cause damage to the central nervous system. Other organ systems such as the liver, brain, kidney, and reproductive organs are affected by lead in the body. In upholding EPA's lead phase-down regulations adopted in 1982, a federal court of appeals stated that the demonstrated health data "would justify EPA in banning lead from gasoline entirely" (Small Refiners Lead Phase-Down Task Force v. EPA, 705 F2d 506, 531 (U.S. App. D.C., 1983).)

Ethylene dibromide (EDB) and ethylene dichloride (EDC) are added to leaded gasoline for the purpose of scavenging lead deposits in engine cylinders. Because of their carcinogenicity, EDB and EDC have been identified by the ARB as toxic air contaminants. As lead is removed, there is less need for these products in gasoline. Therefore, the staff's proposed regulation will reduce public exposures to both of these identified toxic air contaminants, as well as reducing exposure to lead.

1. Air Resources Board's Lead Program

In an effort to reduce public exposure to lead, in 1976 the ARB adopted a regulation (CCR, Title 13, Section 2253) that set a maximum quarterly average lead content, effective January 1977, of 1.4 g/gal of lead for the total gasoline pool and required over a three year period that the maximum quarterly average lead content be reduced to 0.4 g/gal for the total gasoline pool. Small refiners were required in 1979 to meet an average lead content of 1.7 g/gal for the total gasoline pool, which was later lowered to 1.4 g/gal. In 1982, the Board adopted a new lead regulation (CCR, Title 13, Section 2253.2), which established a limit of 0.8 g/gal of lead in leaded gasoline, which applies to both small and large refiners. Table 5 summarizes the history of ARB limits for lead in gasoline.

2. U.S. EPA's Lead Program

EPA implemented a similar lead phase-down program as the one implemented by the ARB for leaded gasoline in order to minimize the adverse health and environmental impacts of lead in gasoline. As in the case of Reid vapor pressure, both the EPA and ARB lead regulations apply in California.

In 1978, EPA required large refiners to meet a limit of 0.8 g/gal of lead averaged over the total gasoline pool, which was lowered to 0.5 g/gal of lead averaged over the total gasoline pool. In 1982, EPA promulgated a regulation which established an interim limit of 1.1 g/gal of lead for leaded gasoline and a final limit limit of 0.1 g/gal of lead. This is the current allowable limit for leaded gasoline. Since the EPA 0.1 g/gal limit is more stringent than the ARB's 0.8 g/gal lead limit, the EPA limit is the one that effectively controls California refiners and importers. Table 6 summarizes the history of EPA limits for lead in gasoline.

Beginning in mid-1974, EPA has required larger output service stations which sell leaded gasoline to also sell unleaded gasoline (40 CFR, Sec. 80.22(b).) The purpose is to assure the availability of unleaded gasoline for catalyst-equipped vehicles that have been produced to meet the more stringent vehicle exhaust standards starting in the mid-1970's. Leaded gasoline cannot be used in these vehicles because the lead would poison the catalyst, thereby making the catalyst ineffective.

TABLE 5

History of ARB Lead Limits for Gasoline

Effective Dates	Large Refiners	Small Refiners
1/1/77 to 12/31/77	1.4 g/gal total pool	----
1/1/78 to 12/31/78	1.9 g/gal total pool	----
1/1/79 to 12/31/79	0.7 g/gal total pool	1.7 g/gal total pool
1/1/80 to 6/30/83	0.4 g/gal total pool	1.4 g/gal total pool
7/1/83 to 9/30/84	1.1 g/gal leaded pool	1.1 g/gal leaded pool
10/1/84 and after	0.8 g/gal leaded pool	0.8 g/gal leaded pool

TABLE 6

History of EPA Lead Limits for Gasoline

Effective Dates	Large Refiners	Small Refiners
1/1/77 to 12/31/77	----	----
1/1/78 to 9/30/79	0.8 g/gal total pool	----
10/1/79 to 10/31/82	0.5 g/gal total pool	0.8 to 2.65 g/gal
11/1/82 to 6/30/83	1.1 g/gal leaded pool	2.15 to 2.65 g/gal
7/1/83 to 6/30/85	1.1 g/gal leaded pool	1.1 g/gal leaded pool
7/1/85 to 12/31/85	0.5 g/gal leaded pool	0.5 g/gal leaded pool
1/1/86 and after	0.1 g/gal leaded pool	0.1 g/gal leaded pool

In order to help prevent the misfueling of leaded gasoline into cars requiring unleaded, since the mid-1970's, EPA has also administered a program governing spout sizes for nozzles used to dispense different gasolines. Unleaded gasoline must have a spout small enough to fit into the smaller fill pipe openings of unleaded cars. Leaded gasoline must have wider nozzle spouts which will not fit into an unleaded car but will fit into cars not requiring unleaded gasoline. The EPA regulations provide that if a retailer offers more than one grade of unleaded gasoline, only one grade need have the narrower spout. (40 CFR Sec. 80.22(f), (h).)

B. TRENDS IN GASOLINE PRODUCTION AND LEAD USAGE

The production of catalyst-equipped vehicles to meet vehicular exhaust standards has resulted in an increased demand for unleaded gasoline and a commensurate decrease in demand for leaded gasoline. In 1977, leaded gasoline production in California was approximately 9 billion gallons or about 75 percent of the total gasoline produced. In 1989, leaded gasoline production decreased to about 2 billion gallons or about 15 percent of the total gasoline production. It is expected that this trend for leaded gasoline will continue to decline.

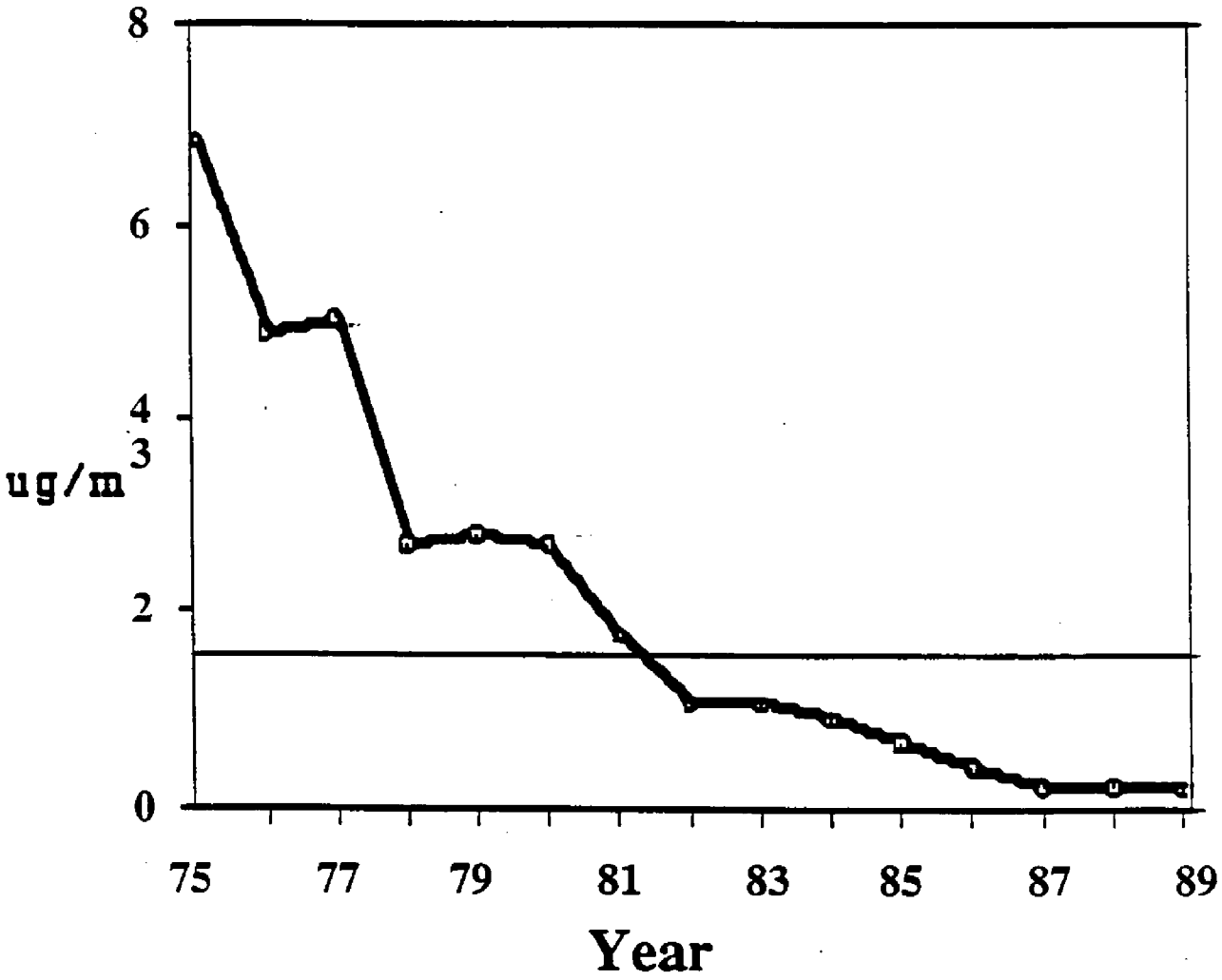
The leaded gasoline production trend and the lead phase-down efforts account for significant decreases in the total amount of lead added to the gasoline pool. In 1977, it was reported that over 15,000,000 Kg (16,500 tons) was added, while in 1989, only 176,000 Kg (194 tons) was used. This represents a decline in lead usage of about 99 percent over this 12 year period.

The impact of the decreased usage of lead is reflected in the ambient concentrations of lead that is measured throughout California. As shown in Figure 3, the ambient lead concentrations in downtown Los Angeles measured almost 7 microgram per cubic meter of air in 1975. As a result of regulatory efforts to limit lead in gasoline and the increased usage of unleaded gasoline, the current ambient lead concentrations in downtown Los Angeles are now around 0.2 microgram per cubic meter of air and meet the ambient air quality standard for lead. Although this example is for downtown Los Angeles, similar trends are observed throughout the state.

In many areas of the country, leaded gasoline is already phased out. In California, one major oil company has not offered leaded gasoline at its service stations for about 10 years. Last year, another major oil company phased out leaded gasoline in the South Coast Air Basin and in its place, offered a lead-free "reformulated" gasoline.

FIGURE 3

AMBIENT LEAD CONCENTRATION
(Downtown Los Angeles)



C. DISCUSSION OF THE PROPOSED REGULATION

The ARB staff's proposal will further reduce lead, EDB, and EDC by virtually eliminating leaded gasoline in California. The proposed regulation would require that, starting January 1, 1992, no person shall sell, offer for sale, supply, or offer for supply, motor gasoline in California which has a lead content exceeding 0.05 gram per gallon (g/gal) (the limit for unleaded gasoline) or to which lead has been purposefully added. Starting January 1, 1994, motor gasoline would have to meet all the specifications of unleaded gasoline and be represented as unleaded when offered for sale.

Current ARB regulations limit the sulfur content of unleaded gasoline to 300 parts per million (13 CCR sec. 2252(a)-(c)), limit the phosphorous content to 0.005 gram per gallon (13 CCR sec. 2253.2(a)(12)), and prohibit adding manganese or manganese compounds to unleaded gasoline (13 CCR sec. 2254). The primary rationale for these limits is to ensure that the catalysts in catalyst-equipped vehicles are not poisoned. The staff proposes that these regulations be amended so that they apply to gasoline represented as unleaded; only gasoline represented as unleaded may be sold through the smaller nozzle spouts that fit cars requiring unleaded gasoline (40 CFR sec. 80.22(e),(f)). Whether unleaded gasoline is <u>represented</u> as unleaded will affect whether it is subject to sulfur and manganese content restrictions. As a result, in 1992 and 1993 retailers would be permitted to sell through big nozzles unleaded gasoline which does not meet the sulfur, phosphorous, or manganese requirements. Starting in 1994, all gasoline will be subject to the sulfur, phosphorous, and manganese requirements because gasoline for on-road vehicles will have to be represented as unleaded gasoline and meet all appropriate specifications. Retailers will no longer be able to sell gasoline through big nozzles.

The staff proposes giving refiners until 1994 to meet the sulfur, phosphorus, and manganese content requirements because in some cases refiners will require additional time to obtain permits and to construct additional desulfurization facilities needed to comply with the sulfur requirement. In the two years that refiners would be permitted to sell big nozzle unleaded gasoline with a higher sulfur content, it does not appear appropriate to limit the manganese or phosphorus content of such gasoline.

A major additional benefit of phasing out leaded gasoline by 1994 is eliminating the opportunity to misfuel catalyst-equipped cars with gasoline containing excessive lead, sulfur, phosphorous, or manganese which might foul the catalysts. A recent nationwide EPA survey to evaluate the tampering of catalyst-equipped cars showed that in Bakersfield, California, an 8 percent misfueling rate was determined based on over 500 vehicle inspections. Even though leaded gasoline is now limited to 0.1 g/gal, misfueling can cause catalyst poisoning which leads to increases in vehicular emissions. In 1989, the ARB conducted roadside smog tests on catalyst-equipped vehicles. It was found that vehicles which had been misfueled has significant increases in hydrocarbon idle emissions, up to 9 times higher than the allowable standard. Carbon monoxide idle emissions were up to 3 times higher than the allowable carbon monoxide standard.

In addition, universal application of the sulfur limit would also result in reduced levels of sulfur dioxide emissions and particulate matter emissions. The ambient particulate matter that is formed from reactions of sulfur dioxide in the atmosphere will also be reduced. In addition, the elimination of leaded gasoline will in some instances free up dispensing equipment for possible use for alternative clean fuels.

Gasoline shown to be used exclusively in certain categories of off-road vehicles (e.g., implements of husbandry and construction equipment) would be excluded from the restrictions in the regulatory proposal. These off-road vehicles, under certain conditions, could suffer valve-seat damage when operated with unleaded gasoline. Agricultural and construction users of gasoline presently obtain most of their fuel through gasoline bulk plants. Staff expects this will continue in the future, and have provided language in the proposal to accommodate this situation. However, off-road leaded gasoline would still be required to meet EPA's current 0.10 g/gal limit for gasoline.

Prior to 1971, many on-road engines were designed with cast iron, soft valve-seats. The use of unleaded gasoline in those engines may cause valve seat damage which would ruin the engine. However, an EPA study indicates that light duty vehicles operated under normal conditions should not suffer any significant valve seat damage. Phosphorous also serves to protect valve seats. Allowing phosphorous to be used until 1994, gives two additional years for these pre '71 vehicles to leave the fleet. Also, an oil company representative has indicated that there may be non-metallic additives which can be used in unleaded gasoline to prevent the soft valve-seat problem.

Finally, like the existing lead regulation, the proposed regulation would generally prohibit the sale of motor gasoline consumer additives containing lead. There would also be restrictions on the sale and marketing of such products. These restrictions are necessary to help assure that lead is not added to gasoline. Consumer additives used in off-road vehicles, special construction equipment, and implements of husbandry would not be so restricted.

D. EMISSIONS AND EMISSIONS REDUCTIONS

The effects of the downward trend in leaded gasoline production and lowering of the allowable lead content has resulted in significant decreases in total lead emissions. In 1975, the total lead emissions from both on and off-road motor vehicles in California were estimated to be approximately 46 tons/day. Based on available information, the staff estimated that in 1992, the total vehicular-related lead emissions will be less than one ton/day. When the regulatory proposal for lead is implemented, lead emissions from on-road motor vehicles will be essentially zero or reduced by about 90 percent. Off-road vehicles would account for less than 0.1 ton/day of the remaining lead emissions from leaded gasoline use.

This regulatory proposal would also result in reductions of sulfur dioxide, EDB, and EDC emissions. EDB and EDC are emitted in motor vehicle exhaust and evaporate from gasoline marketing and production operations. Based on the proportions of EDB and EDC added to 2.2 billion gallons of leaded gasoline produced, the ARB staff estimated that in 1989, 95 tons of EDB and 95 tons of EDC were used in leaded gasoline. Since EDB and EDC are combusted in the engine, only small amounts of EDB and EDC are emitted as part of the exhaust emissions. Based on the limited data available, the ARB staff estimated that about 1 ton of EDB and 1 ton of EDC were emitted in 1989 from motor vehicles exhaust. In addition, staff has estimated that evaporative EDB and EDC emissions from gasoline marketing and production operations and vehicular fuel systems are both significantly less than 1 ton/year, respectively. The staff's proposal would result in the elimination of these remaining emissions.

Reducing the sulfur content is an additional benefit from this regulatory proposal. Sulfur in gasoline results in emissions of sulfur dioxide and particulate sulfates. In the atmosphere, sulfur dioxide can be converted to particulate matter of less than 10 micron in equivalent aerodynamic diameter. Based on information from the ARB's Compliance Division, it is determined that in 1989, the average sulfur content in leaded gasoline is about 260 ppm with a range of 0 to 1290 ppm. Sulfur dioxide benefits will result from eliminating the batches of leaded gasoline that exceed the 300 ppm limit which will now be applied. Assuming that all the sulfur contained in leaded gasoline is converted to sulfur dioxide, the statewide sulfur dioxide emissions from vehicles using leaded gasoline is estimated to be about 10 tons per day. If the on-road leaded gasoline is replaced by unleaded gasoline, sulfur dioxide emissions will be reduced by about 5 tons per day. PM10 emissions will also be proportionally reduced to the extent sulfur is converted to PM10 in the fuel combustion and to the extent that sulfur dioxide reacts in the atmosphere to form PM10. Elimination of misfueling could potentially result in emissions savings of up to 30 tons per day of hydrocarbon emissions and 400 tons per day of carbon monoxide emissions.

E. ECONOMIC AND ENVIRONMENTAL IMPACTS

1. Cost of the Proposed Regulation

Lead is added to leaded gasoline to increase the octane of gasoline. An allowable 0.1 g/gal lead limit provides about a one octane number benefit. Phasing out on-road leaded gasoline will result in increased cost if refiners choose to make up the lost octane. Otherwise, no increase cost is expected. The octane can be made up by adding in MTBE or increasing the concentrations of higher octane components in gasolines such as branched chain paraffins and aromatics.

The use of MTBE is becoming an increasingly attractive option because of the recent trend of increasing oxygen content to reduce exhaust emissions. If refiners choose to make up the octane using MTBE, the cost to

the refiner and ultimately, the consumer is estimated to be about 0.4 cent per gallon.

Using higher octane components such as branched chain paraffins or aromatics to make up the octane can increase the demand for those components. However, since on-road leaded gasoline accounts for about 10 percent of the total gasoline pool and only one octane number is needed, the cost impact of adding higher octane components will be minimal. The ARB staff believes that this option will not necessitate additional refinery equipment.

Most refiners have sufficient desulfurization capacity and are able, through blending, to meet the 300 ppm sulfur limit. Two refiners indicated that they may need to increase their desulfurization capacity by modifying existing facilities or constructing new facilities. While there will be a cost impact associated with those facilities, it should be noted that because of the decreasing demand for leaded gasoline, such an increase in desulfurization capacity will probably be needed by those refiners in any case to meet the demand for unleaded gasoline.

2. Environmental Impacts

The environmental benefits of the proposed regulations are reduced emissions of lead, EDB, and EDC and several criteria pollutants such as sulfur dioxide and PM10.

The proposed regulation will result in slight increases in emissions for those refiners who need additional processing equipment to comply with the staff's proposal. The new source review regulations of the local air pollution control districts will minimize this impact by requiring the use of best available control technology

No other adverse environmental impacts were identified as a result of the staff's proposed regulation.