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Gasoline Distribution Industry (Stage I) - Background Information for Proposed Standards

NESHAP

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Background Information for Proposed Standards

Emission Standards Division

U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Air and Radiation
Office of Air Quality Planning and Standards
Research Triangle Park, North Carolina 27711

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ENVIRONMENTAL PROTECTION AGENCY

Background Information
and Draft
Environmental Impact Statement
for Gasoline Distribution Facilities

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1/13/94
(Date)

1. The proposed standards of performance would limit hazardous air pollutant (HAP) emissions from existing and new major source bulk gasoline terminals and pipeline breakout stations. Under section 112(d) of the 1990 Clean Air Act, EPA is required to regulate sources of HAPs listed pursuant to section 112(c).

2. Copies of this document have been sent to the following Federal Departments: Labor, Health and Human Services, Defense, Transportation, Agriculture, Commerce, Interior, and Energy; the National Science Foundation; the Council on Environmental Quality; members of the State and Territorial Air Pollution Program Administrators; the Association of Local Air Pollution Control Officials; EPA Regional Administrators; and other interested parties.

3. The comment period for review of this document is 60 days from the date of publication of the proposed standards in the <u>Federal Register</u>. Mr. Steve Shedd may be contacted at (919) 541-5397 regarding the date of the comment period.

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1.0 SUMMARY

1.1 STATUTORY AUTHORITY

National emission standards for hazardous air pollutants (NESHAP) are established in accordance with section 112(d) of the Clean Air Act, as amended in 1990. Emission standards under section 112 apply to new and existing sources of a substance that has been listed as a hazardous air pollutant [section 112(b)]. This study examines hazardous air pollutant (HAP) emission sources in the gasoline distribution (Stage I) network of the petroleum marketing source category which has been identified under section 112(c) of the Act as presenting a threat of adverse effects to human health or the environment. The gasoline distribution network consists of the following subcategories, or facility types:

Source Category	Subcategory
Gasoline Distribution (Stage I)	-Pipeline pumping stations -Pipeline breakout stations -Bulk terminals -Bulk plants -Service stations

1.2 REGULATORY ALTERNATIVES

Six regulatory alternatives were developed by employing various combinations of the available control techniques utilized by facilities in the affected network. Reflecting increasing levels of emission reduction, these control options range from requiring no new controls to imposing very stringent standards at some facilities. Chapter 5, Section 5.2 provides a detailed discussion of these alternatives.

In summary, Regulatory Alternative IV describes the gasoline distribution network controlled under minimum statutory requirements and represents a 4.6 percent reduction from baseline emissions. It provides for a leak detection and repair (LDAR) program for equipment leaks at new major source bulk terminals and pipeline breakout stations. Additionally, it provides for installation of additional vapor control equipment (e.g., vapor processors and primary and secondary storage tank seals) at all major sources of these two facility types. This alternative provides the basis for incremental comparison of the other regulatory alternatives.

Regulatory Alternative IV-Q provides for an LDAR program to be implemented at existing major source bulk terminals and pipeline breakout stations. These existing major source sites would be monitored on a quarterly basis. Implementation of this alternative would result in a 5.1 percent reduction in emissions from the baseline level.

Implementation of Regulatory Alternative IV-M would result in a 5.5 percent reduction in emissions by increasing the frequency of leak detection and repair of equipment components at existing major source bulk terminals and pipeline breakout stations. Monthly leak detection and repair would be required for detection of equipment leaks at these facilities.

Regulatory Alternative III would increase the emission reduction to 25 percent by requiring a quarterly LDAR program for some sources and by requiring additional equipment as well. In addition to the controls required by Alternative IV-Q, Regulatory Alternative III would require a quarterly LDAR program for fugitive equipment leaks at area source bulk terminals and pipeline breakout stations and require additional equipment to be installed at these same facilities as well.

Implementation of Regulatory Alternative II would improve control efficiency to 56 percent by requiring controls at pipeline pumping stations, bulk plants, and service stations. Installation of additional equipment (e.g. vapor balance piping) would be required at service stations and bulk plants along with the implementation of a quarterly LDAR program for equipment leaks at bulk plants and pipeline pumping stations.

Lastly, Regulatory Alternative I would effect a 57 percent control efficiency by requiring installation of additional equipment at area source bulk terminals. Installation of this equipment would be the only change from controls specified in Alternative II.

1.3 ENVIRONMENTAL IMPACT

Included in the evaluation of environmental impacts are estimates of air quality, water, noise, and solid waste impacts. Table 1-1 summarizes the environmental impact assessments for each regulatory alternative.

1.3.1 Air Quality Impact

1.3.1.1 Existing Sources. For the existing gasoline distribution network (approximately 390,500 sources), the total nationwide HAP emissions are estimated to be approximately 45,800 megagrams per year (Mg/yr) at baseline. Regulatory Alternative IV would reduce these emissions 4.4 percent to a total of 43,800 Mg/yr. Alternative IV-Q would reduce emissions by 5.0 percent, from 45,800 Mg/yr to 43,400 Mg/yr. Alternative IV-M would reduce emissions to 43,300 Mg/yr, yielding a 5.5 percent reduction. Alternative III would yield a 27 percent reduction in HAP emissions to a level of 33,400 Mg/yr. Alternative II would reduce emissions by 26,900 Mg/yr, to 18,900 Mg/yr (a 58.7 percent reduction), and lastly, Alternative I would yield a 59 percent emission reduction to a total of 18,500 Mg/yr.

1.3.1.2 New Sources. For new sources through 1998, total nationwide HAP emissions from gasoline distribution facilities, approximately 13,100 total sources, are estimated to be about 6,700 Mg/yr at baseline. Regulatory Alternative IV, IV-Q, or IV-M would reduce these emissions to about 6,220 Mg/yr, a 6.6 percent reduction. Alternative

TABLE 1-1. ENVIRONMENTAL AND ECONOMIC IMPACTS OF REGULATORY ALTERNATIVES

Alternative	Air Impact	Water Impact	Solid Waste Impact	Energy Impact	Noise Impact	Economic Impact
IV	+1**	0	-1**	+1**	0	-1*
IV-Q	+2**	0	-1**	+1**	0	-1*
IV-M	+2**	0	-1**	+1**	0	-1*
III	+3**	0	-1**	+2**	0	-1*
II	+4**	0	-1**	+3**	0	-2*
I	+4**	0	-1**	+3**	0	-2*

Key:
+ Beneficial Impact
- Adverse Impact

0 No Impact
1 Negligible Impact
2 Small Impact
3 Moderate Impact
4 Large Impact

* Short-Term Impact
** Long-Term Impact
*** Irreversible

III would reduce emissions from 6,660 Mg/yr at baseline to about 5,880 Mg/yr, an 11.8 percent reduction. Alternative II would reduce emissions to about 4,020 Mg/yr, a 40 percent reduction. Finally, Alternative I would reduce emissions by about 2,780 Mg/yr to a total of 3,880 Mg/yr, a 42 percent reduction through 1998.

1.3.2 Water, Solid Waste, and Energy Impacts for New and Existing Sources

Since none of these alternatives would result in any additional water discharges, there would be no negative impact on water quality. There is potential for a positive benefit to water quality, however, due to decreased amounts of organic materials entering drains, sewers, and waste water discharges because of better leak control.

There would be no significant solid waste or noise impact as a result of implementing any of the regulatory alternatives. Additionally since it is projected that many additional facilities will use vapor recovery devices, there will be energy benefits (gasoline that would have evaporated but is now recovered) gained from implementation of each of the alternatives. This benefit increases with the stringency of the alternative because each successive alternative requires additional control measures.

1.4 ECONOMIC IMPACT

The impacts of the proposed standards were analyzed (see Chapter 8) with regard to their effect on gasoline price and consumption, facility closures, and employment. While Alternatives IV, IV-Q, and IV-M require additional controls only at bulk gasoline terminals and pipeline breakout stations, facilities downstream from terminals and breakout stations are affected by implementation of controls due to higher gasoline wholesale prices and reduced enduse demand, again due to higher prices. The national average base year increase in the price of retail motor gasoline as a result of these alternatives is estimated at $0.001 per gallon. The national base year decline in gasoline consumption is estimated at less than 100 million gallons. There is a limited number of facility closures projected to result from the regulatory alternatives. The base year facility closure estimate is nearly 650, more than 90 percent of which are projected for the service station sector. While the number of service station closures is estimated to be in the hundreds, it should be noted that a total number of over 380,000 stations are projected in the base year, so that the number of facilities closed constitutes less than two tenths of one percent. Furthermore, due to a consumption-spurred projection of modest industry growth from 1993 to 1998, closures due to implementation of controls may be more accurately interpreted as reductions in new facility openings rather than closures of existing facilities. Employment reductions due to reduced consumption and facility closure are estimated at just over 1100 jobs, 70 percent of which are estimated for the service station sector. For the same reasons given for facility closure, employment reductions may be more accurately interpreted as reductions in industry job opportunities rather than losses of existing jobs.

2.0 INTRODUCTION

2.1 BACKGROUND AND AUTHORITY FOR STANDARDS

According to industry estimates, more than 2.4 billion pounds of toxic pollutants were emitted to the atmosphere in 1988 ("Implementation Strategy for the Clean Air Act Amendments of 1990," EPA Office of Air and Radiation, January 15, 1991). These emissions may result in a variety of adverse health effects, including cancer, reproductive effects, birth defects, and respiratory illnesses.

Title III of the Clean Air Act Amendments (CAAA) of 1990 provides the tools for controlling emissions of these pollutants. Emissions from both large and small facilities that contribute to air toxics problems in urban and other areas will be regulated. The primary consideration in establishing national emission standards must be demonstrated technology. Before NESHAP are proposed as Federal regulations, air pollution prevention and control methods are examined in detail with respect to their feasibility, environmental impacts, and costs. Various control options based on different technologies and degrees of efficiency are examined, and a determination is made regarding whether the various control options apply to each emission source or if dissimilarities exist among the sources. In most cases, regulatory alternatives are subsequently developed that are then studied by EPA as a prospective basis for a standard. The alternatives are investigated in terms of their impacts on the environment, the economics and well-being of the industry, the national economy, and energy and other impacts. This document summarizes the information obtained through these studies so that interested persons will be able to evaluate the information considered by EPA in developing the proposed standards.

National emission standards for hazardous air pollutants for new and existing sources are established under section 112 of the Clean Air Act as amended in 1990 [42 U.S.C. 7401 et seq., as amended by PL 101-549, November 15, 1990], hereinafter referred to as the Act. Section 112 directs the EPA Administrator to promulgate standards that "require the maximum degree of reduction in emissions of the hazardous air pollutants subject to this section (including a prohibition of such emissions, where achievable) that the Administrator, taking into consideration the cost of achieving such emission reductions, and any non-air quality health and environmental impacts and energy requirements, determines is achievable ... ." The Act allows the Administrator to set standards that "distinguish among classes, types, and sizes of sources within a category or subcategory."

The Act differentiates between major sources and area sources. A major source is defined as "any stationary source or group of stationary sources located within a contiguous area and under common control that emits or has the potential to emit considering controls, in the aggregate, 10 tons per year or more of any hazardous air pollutant or 25 tons per year or more of any combination of hazardous air pollutants." The Administrator, however, may establish a lesser quantity cutoff to distinguish between major and area sources. The level of the cutoff is based on the potency, persistence, or other characteristics or factors of the air pollutant. An area source is defined as "any stationary source of hazardous air pollutants that is not a major source." For new sources, the amendments state that the "maximum degree of reduction in emissions that is deemed achievable for new sources in a category or subcategory shall not be less stringent than the emission control that is achieved in practice by the best controlled similar source, as determined by the Administrator."

- Emission standards for existing sources "may be less stringent than the standards for new sources in the same category or subcategory but shall not be less stringent, and may be more stringent than -- (A) the average emission limitation achieved by the best performing 12 percent of the existing sources (for which the Administrator has emissions information), excluding those sources that have, within 18 months before the emission standard is proposed or within 30 months before such standard is promulgated, whichever is later, first achieved a level of emission rate or emission reduction which complies, or would comply if the source is not subject to such standard, with the lowest achievable emission rate (as defined by section 171) applicable to the source category and prevailing at the time, in the category or subcategory for categories and subcategories with 30 or more sources, or (B) the average emission limitation achieved by the best performing five sources (for which the Administrator has or could reasonably obtain emissions information) in the category or subcategory for categories or subcategories with fewer than 30 sources."

The Federal standards are also known as "MACT" standards and are based on the maximum achievable control technology previously discussed. The MACT standards may apply to both major and area sources, although the existing source standards may be less stringent than the new source standards, within the constraints presented above. The MACT is considered to be the basis for the standard, but the Administrator may promulgate more stringent standards, which may have several advantages. First, they may help achieve long-term cost savings by avoiding the need for more expensive retrofitting to meet possible future residual risk standards, which may be more stringent (discussed in Section 2.6). Second, Congress was clearly interested in providing incentives for improving technology. Finally, in the CAAA of 1990, Congress gave EPA a clear mandate to reduce the health and environmental risk of air toxics emissions as quickly as possible.

For area sources, the Administrator may "elect to promulgate standards or requirements applicable to sources in such categories or subcategories which provide for the use of generally available control technologies or management practices by such sources to reduce emissions of hazardous air pollutants." These area source standards are also known as "GACT" (generally available control technology) standards, although MACT may be applied at the Administrator's discretion, as discussed previously.

The standards for hazardous air pollutants (HAPs), like the new source performance standards (NSPS) for criteria pollutants required by Section 111 of the Act (42 U.S.C. 7411), differ from other regulatory programs required by the Act (such as the new source review program and the prevention of significant deterioration program) in that NESHAP and NSPS are national in scope (versus site-specific). Congress intended for the NESHAP and NSPS programs to provide a degree of uniformity to State regulations to avoid situations where some States may attract industries by relaxing standards relative to other States. States are free under section 116 of the Act to establish standards more stringent than section 111 or 112 national standards.

Although NESHAP are normally structured in terms of numerical emission limits, alternative approaches are sometimes necessary. In some cases, physically measuring emissions from a source may be impossible or at least impracticable due to technological and economic limitations. Section 112(h) of the Act allows the Administrator to promulgate a design, equipment, work practice, or operational standard, or combination thereof, in those cases where it is not feasible to prescribe or enforce an emissions standard. For example, emissions of volatile organic compounds (many of which may be HAPs, such as benzene) from storage vessels for volatile organic liquids are greatest during tank filling. The nature of the emissions (i.e., high concentrations for short periods during filling and low concentrations for longer periods during storage) and the configuration of storage tanks make direct emission measurement impractical. Therefore, the MACT or GACT standards may be based on equipment specifications. Under section 112(h)(3), the Act also allows the use of alternative equivalent technological systems: "If, after notice and opportunity for comment, the owner or operator of any source establishes to the satisfaction of the Administrator that an alternative means of emission limitation" will reduce emissions of any air pollutant at least as much as would be achieved under the design, equipment, work practice, or operational standard, the Administrator shall permit the use of the alternative means.

Efforts to achieve early environmental benefits are encouraged in Title III. For example, source owners and operators are encouraged to use the section 112(i)(5) provisions, which allow a 6-year compliance extension of the MACT standard in exchange for the implementation of an early emission reduction program. The owner or operator of an existing source must demonstrate a 90 percent emission reduction of HAPs (or 95 percent if the HAPs are particulates) and meet an alternative emission limitation, established by permit, in lieu of the otherwise applicable MACT standard. This alternative limitation must reflect the 90 (95) percent reduction and is in effect for a period of 6 years from the compliance date for the otherwise applicable standard. The 90 (95) percent early emission reduction must be achieved before the otherwise applicable standard is first proposed, although the reduction may be achieved after the standard's proposal (but before January 1, 1994) if the source owner or operator makes an enforceable commitment before the proposal of the standard to achieve the reduction. The source must meet several criteria to qualify for the early reduction standard, and section 112(i)(5)(A) provides that the State may require additional reductions.

2.2 SELECTION OF POLLUTANTS AND SOURCE CATEGORIES

As amended in 1990, the Act includes a list of 189 HAPs. Petitions to add or delete pollutants from this list may be submitted to EPA. Using this list of pollutants, EPA is to publish a list of source categories (major and area sources) for which emission standards will be developed. Within 2 years of enactment (November 1992), EPA is to publish a schedule establishing dates for promulgating these standards. Petitions may also be submitted to EPA to remove source categories from the list. The schedule for standards for source categories will be determined according to the following criteria:

"(A) the known or anticipated adverse effects of such pollutants on public health and the environment;

(B) the quantity and location of emissions or reasonably anticipated emissions of hazardous air pollutants that each category or subcategory will emit; and

(C) the efficiency of grouping categories or subcategories according to the pollutants emitted, or the processes or technologies used."

After the source category has been chosen, the types of facilities within the source category to which the standard will apply must be determined. A source category may have several facilities that cause air pollution, and emissions from these facilities may vary in magnitude and control cost. Economic studies of the source category and applicable control technology may show that air pollution control is better served by applying standards to the more severe pollution sources. For this reason, and because there is no adequately demonstrated system for controlling emissions from certain facilities, standards often do not apply to all facilities at a source. For the same reasons, the standards may not apply to all air pollutants emitted. Thus, although a source category may be selected to be covered by standards, the standards may not cover all pollutants or facilities within that source category.

2.3 PROCEDURE FOR DEVELOPMENT OF NESHAP

Standards for major and area sources must (1) realistically reflect MACT or GACT; (2) adequately consider the cost, the non-air quality health and environmental impacts, and the energy requirements of such control; (3) apply to new and existing sources; and (4) meet these conditions for all variations of industry operating conditions anywhere in the country.

The objective of the NESHAP program is to develop standards to protect the public health by requiring facilities to control emissions to the level achievable according to the MACT or GACT guidelines. The standard-setting process involves three principal phases of activity: (1) gathering information, (2) analyzing the information, and (3) developing the standards.

During the information-gathering phase, industries are questioned through telephone surveys, letters of inquiry, and plant visits by EPA representatives. Information is also gathered from other sources, such as a literature search. Based on the information acquired about the industry, EPA selects certain plants at which emissions tests are conducted to provide reliable data that characterize the HAP emissions from well-controlled existing facilities.

In the second phase of a project, the information about the industry, the pollutants emitted, and the control options are used in analytical studies. Hypothetical "model plants" are defined to provide a common basis for analysis. The model plant definitions, national pollutant emissions data, and existing State regulations governing emissions from the source category are then used to establish "regulatory alternatives." These regulatory alternatives may be different levels of emissions control or different degrees of applicability, or both.

The EPA conducts studies to determine the cost, economic, environmental, and energy impacts of each regulatory alternative. From several alternatives, EPA selects the single most plausible regulatory alternative as the basis for the NESHAP for the source category under study.

In the third phase of a project, the selected regulatory alternative is translated into standards which, in turn, are written in the form of a Federal regulation. The Federal regulation limits emissions to the levels indicated in the selected regulatory alternative.

As early as is practical in each standard-setting project, EPA representatives discuss the possibilities of a standard and the form it might take with members of the National Air Pollution Control Techniques Advisory Committee, which is composed of representatives from industry, environmental groups, and State and local air pollution control agencies. Other interested parties also participate in these meetings.

The information acquired in the project is summarized in the background information document (BID). The draft BID, proposed standards, and a preamble explaining the standards are widely circulated to the industry being considered for control, environmental groups, other government agencies, and offices within EPA. Through this extensive review process, the points of view of expert reviewers are taken into consideration as changes are made to the documentation. A "proposal package" is assembled and sent through the offices of EPA Assistant Administrators for concurrence before the proposed standards are officially endorsed by the EPA Administrator. After being approved by the EPA Administrator, the preamble and the proposed regulation are published in the Federal Register.

The public is invited to participate in the standard-setting process as part of the Federal Register announcement of the proposed regulation. The EPA invites written comments on the proposal and may also hold a public hearing to discuss the proposed standards with interested parties. All public comments are summarized and incorporated into a second volume of the BID. All information reviewed and generated in studies in support of the standards is available to the public in a "docket" on file in Washington, D.C. Comments from the public are evaluated, and the standards may be altered in response to the comments.

The significant comments and EPA's position on the issues raised are included in the preamble of a promulgation package, which also contains the draft of the final regulation. The regulation is then subjected to another round of internal EPA review and refinement until it is approved by the EPA Administrator. After the Administrator signs the regulation, it is published as a "final rule" in the Federal Register.

2.4 CONSIDERATION OF COSTS

The prime objective of the cost analysis is to identify the incremental economic impacts associated with compliance with the standards based on each regulatory alternative compared to baseline. Other environmental regulatory costs may be factored into the analysis wherever appropriate. Air pollutant emissions may cause water pollution problems, and captured potential air pollutants may pose a solid waste disposal problem. The total environmental impact of an emission source must, therefore, be analyzed and the costs determined whenever possible.

A thorough study of the profitability and price-setting mechanisms of the industry is essential to the analysis so that an accurate estimate of potential adverse economic impacts can be made for proposed standards. It is also essential to know the capital requirements for pollution control systems already placed on plants so that the additional capital requirements necessitated by these Federal standards can be placed in proper perspective. Finally, it is necessary to assess the availability of capital to provide the additional control equipment needed to meet the standards.

2.5 CONSIDERATION OF ENVIRONMENTAL IMPACTS

Section 102(2)(C) of the National Environmental Policy Act (NEPA) of 1969 requires Federal agencies to prepare detailed environmental impact statements on proposals for legislation and other major Federal actions significantly affecting the quality of the human environment. The objective of the NEPA is to build into the decision-making process of Federal agencies a careful consideration of all environmental aspects of proposed actions.

In a number of legal challenges to standards for various industries, the United States Court of Appeals for the District of Columbia Circuit has held that environmental impact statements need not be prepared by EPA for proposed actions under the Clean Air Act. Essentially, the Court of Appeals has determined that the best system of emissions reduction requires the Administrator to take into account counterproductive environmental effects of proposed standards as well as economic costs to the industry. On this basis, therefore, the Courts established a narrow exemption from the NEPA for EPA determinations.

In addition to these judicial determinations, the Energy Supply and Environmental Coordination Act (ESECA) of 1974 (PL-93-319) specifically exempted proposed actions under the Clean Air Act from NEPA requirements. According to Section 7(c)(1), "No action taken under the Clean Air Act shall be deemed a major Federal action significantly affecting the quality of the human environment within the meaning of the National Environmental Policy Act of 1969" (15 U.S.C. 793(c)(1)).

Nevertheless, EPA has concluded that preparing environmental impact statements could have beneficial effects on certain regulatory actions. Consequently, although not legally required to do so by Section 102(2)(C) of the NEPA, EPA has adopted a policy requiring that environmental impact statements be prepared for various regulatory actions, including NESHAP developed under section 112 of the Act. This voluntary preparation of environmental impact statements, however, in no way legally subjects EPA to NEPA requirements.

To implement this policy, a separate section included in this document is devoted solely to an analysis of the potential environmental impacts associated with the proposed standards. Both adverse and beneficial impacts in such areas as air and water pollution, increased solid waste disposal, and increased energy consumption are discussed.

2.6 RESIDUAL RISK STANDARDS

Section 112 of the Act provides that 8 years after MACT standards are established (except for those standards established 2 years after enactment, which have 9 years), standards to protect against the residual health and environmental risks remaining must be promulgated, if necessary. The standards would be triggered if more than one source in a category or subcategory exceeds a maximum individual risk of cancer of 1 in 1 million. These residual risk regulations would be based on the concept of providing an "ample margin of safety to protect public health." The Administrator may also consider whether a more stringent standard is necessary to prevent--considering costs, energy, safety, and other relevant factors--an adverse environmental effect. In the case of area sources controlled under GACT standards, the Administrator is not required to conduct a residual risk review.

3.0 PROCESSES AND POLLUTANT EMISSIONS

3.1 GENERAL

The gasoline distribution network consists of the storage and transfer facilities that move gasoline from its production to its end consumption. The network includes tanker ships and barges, pipelines, tank trucks and railcars, storage tanks, and service stations. Crude petroleum is shipped to refineries, which manufacture a wide range of liquid petroleum products. Finished gasoline is then distributed in a complex system comprised of wholesale and retail outlets. The focus of this document is to assess the impacts of distributing gasoline from gasoline storage and loading operations at refineries to the loading of storage tanks at gasoline dispensing facilities. Other sources, such as those associated with the production of gasoline, vehicle refueling at service stations, and ship and barge loading, are or will be covered in separate documents. The main elements in the distribution network are depicted in Figure 3-1.

Gasoline is delivered to bulk terminals from refineries by way of pipeline, ship, or barge. Large transport trucks (30,000 to 38,000 liter or 8,000 to 10,000 gallon capacity) deliver the gasoline to service stations or to intermediate bulk storage facilities known as bulk plants. The situation also exists where gasoline is loaded into a railcar at one terminal and transported to another terminal that does not have access to a pipeline, or a waterway that could support a ship or barge.

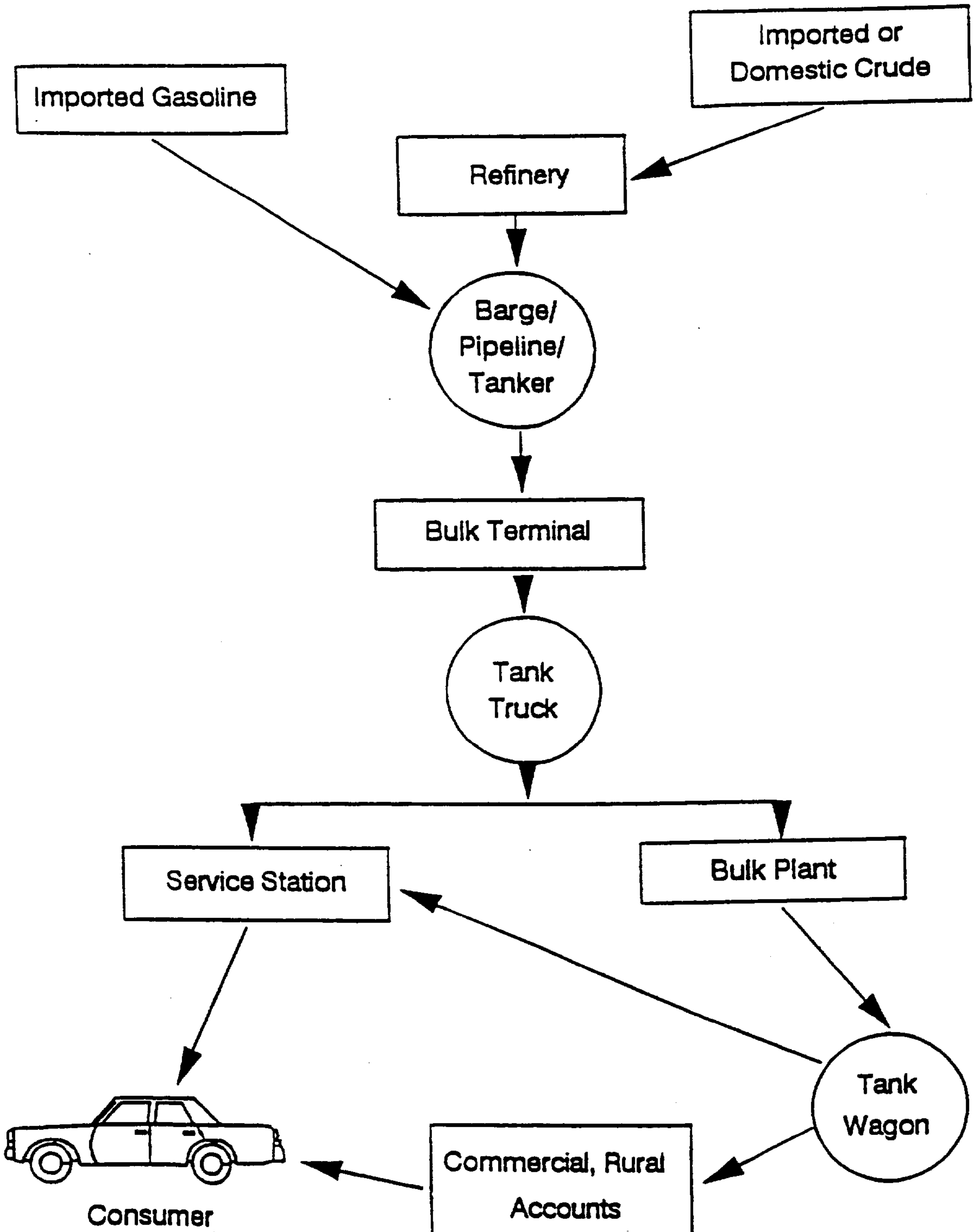

Figure 3-1. Gasoline Distribution Facilities - United States

A bulk plant typically receives product by truck from a terminal and has a smaller storage capacity than a terminal. In addition, daily product throughput at a terminal is much greater, averaging about 950,000 liters (250,000 gallons), in contrast to about 19,000 liters (5,000 gallons) for an average size bulk plant.

Both bulk terminals and bulk plants deliver gasoline to private, commercial, and retail accounts. Bulk plants, using 5,700 to 11,000 liter (1,500 to 2,900 gallon) capacity delivery trucks, service primarily agricultural accounts and service stations that are either long distances from terminals or inaccessible to the large transports. The trend in recent years has been toward more terminal deliveries at the expense of bulk plant deliveries. Retail and commercial level dispensing facilities include the familiar service stations, as well as commercial accounts such as fleet services (rental car agencies, private companies, governmental agencies), parking garages, and buses. Another important consumer category consists of small farms (approximately 2.7 million).

This chapter discusses the sources of emissions at each segment of the gasoline distribution chain, including pipeline pumping stations, pipeline breakout stations, bulk terminals, bulk plants, and service stations. Section 3.2 discusses the factors influencing emissions, emission factors, and volatile organic compound (VOC) and HAP emissions for typical facilities. Section 3.3 then presents the national 1998 baseline emissions for all industry sectors.

3.2 FACILITIES AND THEIR EMISSIONS

The pollutants emitted by each of the gasoline distribution facilities are essentially the same. However, the operations that occur at each and the rates of emissions to the atmosphere differ. The emissions consist of a mixture of VOC vapors and air. The factors influencing emissions, including gasoline composition, temperature, vapor pressure, and methods of loading gasoline are discussed in Section 3.2.1. Sections 3.2.2 through 3.2.5 present separate discussions of the operations at each industry sector and of the associated emission rates.

3.2.1 Factors Influencing Emissions

3.2.1.1 Hazardous Air Pollutant Content of Gasoline Vapor. As discussed in Section 2.2, the 1990 Clean Air Act Amendments contain a list of 189 HAPs. A comparison of profiles of gasoline vapor with this HAP list reveals several compounds common to both. This section discusses the HAPs found in traditional, or "normal", gasoline vapor and how this is expected to change in response to requirements contained in Title II of the Amendments. This section also presents vapor profiles that will be used in evaluating HAP emissions from gasoline distribution sources throughout this analysis.

Motor gasoline is a complex organic mixture of varying amounts of paraffins, olefins, and aromatics. A study conducted for the EPA which analyzed gasoline samples in the northeastern United States in the early 1980's (Northeast Corridor Study) reported liquid gasoline paraffin contents ranging from 37-67 weight percent, olefins ranging from 0-12 weight percent, and aromatics ranging from 28-52 percent.[1] The average carbon number for gasoline generally falls in the C^5-C^7 range, but gasoline composition can vary widely.

The National Institute for Petroleum and Energy Research (NIPER) reports gasoline composition trends semi-annually. For the winter of 1991-92,[2] the reported aromatic volume percentage for unleaded gasolines ranged from approximately three percent to almost 65 percent in the samples analyzed, with the averages being 25.9 percent for regular unleaded, 27.9 percent for mid-grade, and 30.3 percent for premium. Olefin content ranged from under one to almost 69 percent, with the averages reported as 11.6 percent for regular, 9.8 percent for mid-grade, and 6.1 percent for premium.

This variation in liquid composition causes the vapor composition to vary a great deal. The Northeast Corridor Study indicated that paraffins made up from 76 to 98 percent by weight of the vapors, 0 to 22 weight percent for olefins, and 0.8 to 3.2 weight percent for aromatics. The small percentage of aromatics is due to the low volatility of these compounds. Conversely, the vapor profiles showed a high percentage of paraffins due to the high volatility of C_4 and C_5 paraffins.

3.2.1.1.1 <u>Normal gasoline</u>. In order to estimate HAP emissions from sources in the gasoline distribution chain, an investigation was conducted to identify and quantify the HAPs in gasoline vapor. A search was initiated to obtain relevant data regarding gasoline vapor phase composition during gasoline storage and transfer operations. This effort revealed that while a great deal of research was being conducted related to the composition of tailpipe emissions from automobiles, information related to the composition of evaporative emissions from gasoline transfer and storage operations was more limited.

However, sufficient data were received to establish a list of HAP compounds commonly present in gasoline vapor and to provide an estimate of the quantity of these HAPs. The existence of benzene in gasoline vapors has been recognized for a long time. In addition, several other aromatic HAPs were found in gasoline vapors. These include toluene, ethylbenzene, naphthalene, cumene, and all three orientations of xylene (para, meta, and ortho).

As discussed above, gasoline vapors are made up largely of paraffins. Therefore, the existence of n-hexane is not surprising. Based on the data received, n-hexane is usually the most prevalent HAP in gasoline vapor. In addition, 2,2,4 trimethylpentane, or iso-octane, was found in gasoline vapors.

In order to quantify the HAP content of gasoline vapor, the data were analyzed to determine the portion of the vapor made up of HAPs. For each vapor or liquid sample, the HAP weight percentage was calculated for individual as well as total HAPs.

The HAP contents were expressed as ratios by weight of HAP to total VOC. This was because VOC emissions from gasoline distribution facilities have been studied and are well documented, and HAP emissions from these sources could be easily estimated by multiplying this HAP to VOC ratio by the VOC mass emissions.

The minimum, maximum, and arithmetic averages for the HAP to VOC ratios calculated from the data are shown in Table 3-1. HAP emissions presented in this chapter and the remainder of the document will be presented as total HAPs, and not by individual HAP. The arithmetic average ratio of 0.048 will be used throughout this document to represent the total HAP to VOC ratio for normal gasoline. A description of the data and the analysis is contained in Appendix C (Section C.1).

3.2.1.1.2 Reformulated/oxygenated gasoline. Title II of the 1990 CAAA addresses emission standards for mobile sources. There are several elements in Title II that will affect gasoline composition in the 1998 base year and, thus, HAP emissions from gasoline storage and transfer operations.

Section 219 of Title II amends the 1977 Clean Air Act by adding Section 211. Section 211(k) requires the distribution of reformulated gasoline in those nine areas having a 1980 population in excess of 250,000 and having the highest ozone design values during the 1987-89 period. All other ozone nonattainment areas can "opt-in" to the program regardless of 1980 population. Beginning in 1995, reformulated gasoline with the following limits must be sold and marketed in these nonattainment areas: 1) benzene content cannot exceed 1 percent; 2) no heavy metals can be present; and 3) minimum oxygen content must be 2.0 percent. Additionally, the more stringent of the Formula Standard concerning aromatics (level of 25 percent) or the Performance Standards concerned with VOC or toxic emissions

TABLE 3-1. VAPOR PROFILE OF NORMAL GASOLINE

	HAP TO VOC RATIO (percentage by weight)		
HAZARDOUS AIR POLLUTANT[a]	MINIMUM	ARITHMETIC AVERAGE	MAXIMUM
Hexane	0.3	1.6	4.4
Benzene	0.2	0.9	2.2
Toluene	0.4	1.3	4
2,2,4 Trimethylpentane (iso-octane)	0.03	0.8	2.6
Xylenes	0.05	0.5	1.5
Ethylbenzene	0.03	0.1	0.5
TOTAL HAPs[b]	2	4.8	11

[a] Cumene and naphthalene were also identified in some of the data points in small quantities. They are not shown as their addition does not significantly change the totals.

[b] The total HAP ratios shown in the table are not simply sums of the individual HAP percentages listed in the columns; rather, total HAPs were calculated for each individual sample in the data base. The values represented in the table reflect the maximum, minimum, and arithmetic average total HAPs of these samples.

(15 percent reduction from emissions using a 1990 baseline fuel) shall also apply. Concerning these final two alternatives, it is most likely that in the future the aromatic content of reformulated/oxygenated gasolines will approach 25 percent.

Also, section 211(m) requires the purchase and sale of fuels with higher levels of alcohols or oxygenates in the winter months in the areas exceeding the carbon monoxide (CO) standard. Beginning in 1992, these "oxygenated" fuels must have at least 2.7 percent oxygen.

The reformulated gasoline requirements will cause reductions in the benzene and aromatic contents of the fuel sold in those areas in the reformulated fuels program. Since many of the HAPs in gasoline vapor are aromatic compounds, this will reduce the total HAP content of the gasoline liquid and vapors. However, the addition of oxygen containing compounds will cause a significant increase in the HAP content.

Methyl tert-butyl ether (MTBE), an oxygenate, is one of several compounds that is expected to be added to gasoline to increase its oxygen content. Further, it has been estimated and assumed in this report's analysis that MTBE will make up at least 70 percent of the market of compounds added to gasolines in the reformulated and oxygenated programs in ozone nonattainment areas[3]. MTBE is also listed in the CAAA as a HAP. Traditionally, MTBE has been used as an octane booster in unleaded gasolines. If the octane was lower than expected, small allotments of MTBE would be added to reach the desired octane level. MTBE has many advantages as an octane enhancer. It has a high average blending octane rating, dissolves easily in the refinery streams, and will not precipitate out of solution when it comes into contact with water. Therefore, the quantity of normal gasoline in the nation that contains some MTBE was large prior to the implementation of section 211, although the MTBE was present in only low percentages. None of the data received for normal gasoline reported measurable levels of MTBE.

Other possible oxygenates are ethanol 113, ethyl tert-butyl ether (ETBE), and tertiary amyl methyl ether (TAME). ETBE has a lower Reid Vapor Pressure (3-5 psi) compared to MTBE (8 psi), but its blending octane rating is higher. However, there are limits on ETBE and the other blending agents. Ethanol 113 is not economical without government subsidies and ETBE is similarly affected, as ethanol feedstock is needed to produce ETBE. Therefore, the amount of ethanol and ETBE available will always be limited by government subsidies. The lack of isoamylene feedstock will limit the use of TAME as well. As a consequence, it is expected that MTBE will be one of the most common oxygenates used to meet the reformulated and oxygenated fuel oxygen requirements.

Widespread industry estimates indicate that it will require approximately 15 volume percent of MTBE in liquid gasoline to meet the 2.7 weight percent oxygen limit, and 11 volume percent to meet the 2.0 weight percent oxygen limit. The moderate volatility of MTBE would cause high concentrations in the vapor phase relative to the less volatile aromatics. In the search discussed above for gasoline containing MTBE, vapor data and the corresponding liquid composition were available for some samples. Using these samples, a relationship of liquid content of MTBE to vapor content of MTBE was derived. This MTBE ratio was applied to the volume percents discussed to estimate the MTBE to VOC percentage in the vapor. Results of the analysis showed that MTBE to VOC ratios were 8.8 weight percent for the 11 volume percent liquid and 12 weight percent for the 15 volume percent liquid. A complete discussion of this analysis is presented in Appendix C. Consequently, it is expected that the inclusion of MTBE in the liquid to meet the oxygen demands will increase the HAP to VOC ratio in gasoline vapor from approximately 5 weight percent shown in Table 3-1 to near 16 percent (with the 15 percent MTBE gasoline).

Because of these drastic differences in the HAP content of gasoline vapor, the estimation of vapor phase composition (HAP to VOC ratios) for several different fuel types was considered necessary. There will be four basic types of fuels in use after full implementation of these programs. These are 1) normal fuels (to be used in attainment areas and those ozone nonattainment areas not opting into the reformulated program), 2) oxygenated fuels (to be used in CO nonattainment areas during the winter months), 3) reformulated fuels (to be used in ozone nonattainment areas in the reformulated program year round), and 4) reformulated fuels with 2.7 percent oxygen, or reformulated/oxygenated fuels (to be used in areas that are nonattainment for both CO and ozone and require the reformulated fuels year round and require oxygenated fuels in the winter months).

Therefore, HAP to VOC ratios were developed for each of these fuel types. The situation is further complicated because two different ratios are required for the types containing oxygenates (reformulated, oxygenated, and reformulated/oxygenated) to account for MTBE. One ratio includes MTBE and the other uses one of the other, non-HAP oxygenates. This results in a total of seven different HAP/vapor profiles. The various profiles are shown in Table 3-2. These profiles are used throughout the analysis. Following is a brief discussion of the generation of these profiles. More discussion of the procedures is provided in Appendix C (Section C.2).

Since these programs are not in effect at this time, HAP to VOC ratios were theoretically developed using the arithmetic average vapor profile for normal fuel shown in Table 3-1. For reformulated and reformulated/oxygenated fuels, the benzene content in the vapor was calculated using an equation from earlier EPA analyses[4] based on a 1.0 weight percent benzene content in the liquid. The other aromatic compounds were reduced equally by an amount determined

TABLE 3-2. VAPOR PROFILES USED IN ANALYSIS (HAP to VOC percentage by weight)

		TYPE OF GASOLINE					
		Reformulated		Oxygenated		Reformulated/Oxygenated	
HAP	Normal	with MTBE	w/o MTBE	with MTBE	w/o MTBE	with MTBE	w/o MTBE
Hexane	1.6	1.4	1.4	1.4	1.4	1.4	1.4
Benzene	0.9	0.4	0.4	0.7	0.7	0.4	0.4
Toluene	1.3	1.1	1.1	1.1	1.1	1.1	1.1
2,2,4 Trimethylpentane	0.8	0.7	0.7	0.7	0.7	0.7	0.7
Xylenes	0.5	0.4	0.4	0.4	0.4	0.4	0.4
Ethyl Benzene	0.1	0.1	0.1	0.1	0.1	0.1	0.1
MTBE		8.7		11.9		11.9	
TOTAL HAPs	4.8	12.9	4.2	16.3	4.4	16	4.2

Source: Data collected from various sources used to calculate normal gasoline vapor profile which was adjusted to represent possible compositions of reformulated and oxygenated gasolines. See Appendix B.

necessary to reduce total aromatics to a level of 25 percent in the liquid. The nonaromatic compounds in the liquid were also reduced to account for the volume of oxygenate added.

3.2.1.2 Temperature and Vapor Pressure. Volatility and temperature have major impacts on emissions from the evaporation of gasoline. Evaporation can be explained by the kinetic-molecular model. A liquid molecule near the surface of the liquid can escape to the vapor phase whenever it gains sufficient kinetic energy to overcome its attraction to other particles surrounding it in the liquid. The weaker the attractive forces, the more readily vaporization occurs, and the more "volatile" the liquid. The rate of vaporization increases with increasing temperature, as this increased temperature provides more kinetic energy to the liquid, causing more molecules to vaporize.

Reid vapor pressure (RVP) is a standard industry measure of fuel volatility and represents the vapor pressure of the fuel at 100°F. Although RVP is a measure of fuel volatility at 100°F, the empirical emissions equations used to calculate emissions in this analysis reflect actual temperature conditions.

The RVP of gasoline is adjusted through blending at the refinery to account for temperature and pressure differences across the country. In the summer when warm temperatures enhance volatilization, gasolines can be blended with a lower RVP and still provide ample vaporization for combustion in the vehicle engine. Reducing RVP in the summer, therefore, reduces emissions from gasoline transfers without reducing vehicle performance. Too high an RVP in the summer can create excess volatilization in the engine, causing vapor lock. During the winter months when cold temperatures inhibit volatilization, gasolines can be blended with a higher RVP to ensure sufficient volatilization for engine start-up and operation. This increase in RVP when temperatures decrease, and decrease in RVP when temperatures increase, is an attempt to provide a uniform fuel volatility for smooth engine performance all year.

In order to reduce emissions, EPA has established maximum volatility levels for gasoline sold during the summertime months. On March 22, 1989 (54 FR 11868), EPA published a final rule restricting gasoline volatility. This initial rule is referred to as Phase I. The EPA later promulgated a second level (phase II) of more stringent volatility controls on June 11, 1991 (55 FR 23658), scheduled to take effect in the summer of 1992. The second phase of volatility controls set monthly RVP requirements for each State based upon many factors including, for example, meteorological conditions. Under Phase II the maximum allowable RVP of gasoline sold in northern states was set at 9.0 psi and the maximum allowable RVP of gasoline sold in southern States was set at 7.8 psi. The summertime RVP limitations promulgated are shown in Table 3-3 along with RVP values for the remainder of the year.

However, the CAAA of 1990 limited EPA's authority to set gasoline volatility levels below 9.0 psi. The 1990 CAAA specify that EPA may set RVP limitations below 9.0 only for ozone nonattainment areas and former ozone nonattainment areas. Therefore, on May 29, 1991 (56 FR 24242), EPA proposed to change the volatility standards to eliminate the volatility level requirements (9.0 psi) for those areas where EPA no longer had the authority to adopt such levels. Specifically, EPA proposed that the RVP for areas designated attainment for ozone be restricted to 9.0, even if nonattainment areas in the State are restricted to 7.8.

Attempts to locate data on the temperature of gasoline in aboveground storage tanks were unsuccessful. Therefore, a temperature of 60°F was used in all emission factor calculations for aboveground storage tanks and 60°F for below ground storage tanks. These are the temperatures used in previous EPA analyses of gasoline distribution regulatory strategies.[5,6]

TABLE 3-3. RVP BY STATE BY MONTH

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	WEIGHTED AVERAGE RVPs NOV - FEB	MAR - OCT	ANNUAL
ALABAMA	13.5	13.5	12.5	11.5	9.0	7.8	7.8	7.8	7.8	11.5	12.5	13.5	13.2	10.1	11.1
ALASKA	15.0	15.0	15.0	15.0	14.2	13.5	13.5	13.5	14.2	15.0	15.0	15.0	15.0	14.1	14.3
ARIZONA	13.5	12.5	10.8	10.0	9.0	7.8	7.8	7.8	7.8	9.5	10.8	12.5	12.3	9.1	10.2
ARKANSAS	14.2	13.5	12.5	11.5	9.0	7.8	7.8	7.8	7.8	12.5	13.5	14.2	13.9	9.9	11.2
CALIFORNIA	13.6	13.4	12.6	11.6	9.0	7.8	7.8	7.8	7.8	10.5	12.1	13.6	13.2	9.4	10.6
COLORADO	15.0	14.2	12.5	11.5	9.0	7.8	7.8	7.8	7.8	10.8	12.5	14.2	14.0	9.9	11.1
CONNECTICUT	15.0	15.0	14.2	13.5	9.0	9.0	9.0	9.0	9.0	13.5	14.2	15.0	14.8	10.7	12.0
DELAWARE	15.0	15.0	14.2	13.5	9.0	9.0	9.0	9.0	9.0	12.5	14.2	15.0	14.8	10.6	11.9
DIST. OF COL.	15.0	14.2	13.5	12.5	9.0	7.8	7.8	7.8	7.8	12.5	14.2	15.0	14.6	9.9	11.4
FLORIDA	13.5	13.5	12.5	11.5	9.0	7.8	7.8	7.8	7.8	11.5	12.5	13.5	13.3	9.9	11.0
GEORGIA	13.5	13.5	12.5	11.5	9.0	7.8	7.8	7.8	7.8	11.5	12.5	13.5	13.2	9.8	10.9
HAWAII	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5
IDAHO	15.0	14.2	13.5	12.5	9.0	9.0	9.0	9.0	9.0	10.8	12.5	14.2	13.9	10.1	11.3
ILLINOIS	15.0	15.0	14.2	13.0	9.0	9.0	9.0	9.0	9.0	12.5	13.9	14.6	14.6	10.7	12.0
INDIANA	15.0	15.0	14.2	13.5	9.0	9.0	9.0	9.0	9.0	12.5	14.2	15.0	14.8	10.6	11.9
IOWA	15.0	15.0	14.2	12.5	9.0	9.0	9.0	9.0	9.0	12.5	14.2	15.0	14.8	10.5	11.8
KANSAS	15.0	14.2	12.5	11.5	9.0	7.8	7.8	7.8	7.8	10.8	12.5	14.2	13.9	9.9	11.2
KENTUCKY	15.0	14.2	13.5	12.5	9.0	9.0	9.0	9.0	9.0	12.5	14.2	15.0	14.6	10.4	11.7
LOUISIANA	13.5	13.5	12.5	11.5	9.0	7.8	7.8	7.8	7.8	11.5	12.5	13.5	13.2	10.0	11.0
MAINE	15.0	15.0	14.2	13.5	9.0	9.0	9.0	9.0	9.0	13.5	14.2	15.0	14.8	10.7	11.9
MARYLAND	15.0	15.0	14.2	13.5	9.0	7.8	7.8	7.8	7.8	12.5	14.2	15.0	14.8	10.2	11.6
MASSACHUSETTS	15.0	15.0	14.2	13.5	9.0	9.0	9.0	9.0	9.0	13.5	14.2	15.0	14.8	10.7	12.0
MICHIGAN	15.0	15.0	14.2	13.5	9.0	9.0	9.0	9.0	9.0	13.5	14.2	15.0	14.8	10.7	12.0
MINNESOTA	15.0	15.0	14.2	13.5	9.0	9.0	9.0	9.0	9.0	12.5	14.2	15.0	14.8	10.5	11.8
MISSISSIPPI	13.5	13.5	12.5	11.5	9.0	7.8	7.8	7.8	7.8	11.5	12.5	13.5	13.2	10.1	11.1
MISSOURI	15.0	14.2	13.5	12.5	9.0	7.8	7.8	7.8	7.8	12.5	13.5	14.2	14.2	10.2	11.4
MONTANA	15.0	15.0	14.2	12.5	9.0	9.0	9.0	9.0	9.0	12.5	14.2	15.0	14.8	10.4	11.7
NEBRASKA	15.0	15.0	14.2	12.5	9.0	9.0	9.0	9.0	9.0	10.8	12.5	14.2	14.1	10.3	11.4
NEVADA	14.2	13.4	12.2	11.2	9.0	7.8	7.8	7.8	7.8	10.2	11.6	13.4	13.1	9.8	10.9
NEW HAMPSHIRE	15.0	15.0	14.2	13.5	9.0	9.0	9.0	9.0	9.0	13.5	14.2	15.0	14.8	10.7	12.0
NEW JERSEY	15.0	15.0	14.2	13.5	9.0	9.0	9.0	9.0	9.0	13.5	14.2	15.0	14.8	10.9	12.1

TABLE 3-3. (Concluded)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	WEIGHTED AVERAGE RVPs NOV - FEB	MAR - OCT	ANNUAL
NEW MEXICO	13.9	12.2	11.6	10.4	9.0	7.8	7.8	7.8	7.8	10.8	12.5	13.5	13.0	9.7	10.7
NEW YORK	15.0	15.0	14.2	13.5	9.0	9.0	9.0	9.0	9.0	13.5	14.2	15.0	14.8	10.8	12.0
NORTH CAROLINA	14.2	13.5	13.5	12.5	9.0	7.8	7.8	7.8	7.8	12.5	13.5	14.2	13.9	10.2	11.4
NORTH DAKOTA	15.0	15.0	14.2	13.5	9.0	9.0	9.0	9.0	9.0	12.5	14.2	15.0	14.8	10.5	11.7
OHIO	15.0	15.0	14.2	13.5	9.0	9.0	9.0	9.0	9.0	12.5	14.2	15.0	14.8	10.6	11.9
OKLAHOMA	14.2	13.5	12.5	11.5	9.0	7.8	7.8	7.8	7.8	10.8	12.5	14.2	13.6	9.9	11.1
OREGON	15.0	14.2	13.5	13.5	9.0	7.8	7.8	7.8	7.8	12.5	13.9	14.6	14.4	10.5	11.6
PENNSYLVANIA	15.0	15.0	14.2	13.5	9.0	9.0	9.0	9.0	9.0	13.5	14.2	15.0	14.8	10.7	12.0
RHODE ISLAND	15.0	15.0	14.2	13.5	9.0	9.0	9.0	9.0	9.0	13.5	14.2	15.0	14.8	10.7	12.1
SOUTH CAROLINA	13.5	13.5	13.5	12.5	9.0	7.8	7.8	7.8	7.8	12.5	13.5	13.5	13.5	10.5	11.4
SOUTH DAKOTA	15.0	15.0	14.2	12.5	9.0	9.0	9.0	9.0	9.0	10.8	12.5	14.2	14.1	10.1	11.3
TENNESSEE	14.2	13.5	13.5	12.5	9.0	7.8	7.8	7.8	7.8	12.5	13.5	14.2	13.9	10.3	11.4
TEXAS	13.5	13.0	11.6	10.8	9.0	7.8	7.8	7.8	7.8	10.8	12.5	13.5	13.1	9.5	10.6
UTAH	15.0	14.2	13.5	12.5	9.0	7.8	7.8	7.8	7.8	10.8	12.5	14.2	14.0	9.9	11.1
VERMONT	15.0	15.0	14.2	13.5	9.0	9.0	9.0	9.0	9.0	13.5	14.2	15.0	14.8	10.7	12.0
VIRGINIA	15.0	14.2	13.5	12.5	9.0	7.8	7.8	7.8	7.8	12.5	14.2	15.0	14.6	10.4	11.7
WASHINGTON	15.0	15.0	14.2	13.5	9.0	9.0	9.0	9.0	9.0	12.5	14.2	15.0	14.8	10.6	11.9
WEST VIRGINIA	15.0	15.0	14.2	13.5	9.0	9.0	9.0	9.0	9.0	12.5	14.2	15.0	14.8	10.6	11.9
WISCONSIN	15.0	15.0	14.2	13.5	9.0	9.0	9.0	9.0	9.0	12.5	14.2	15.0	14.8	10.5	11.9
WYOMING	15.0	15.0	14.2	12.5	9.0	9.0	9.0	9.0	9.0	10.8	12.5	14.2	14.2	10.2	11.5
NATIONWIDE													14.0	10.2	11.4

Source : June 11, 1990 and May 29, 1991 FEDERAL REGISTERS for summertime RVPs,
RVPs for remainder of the year provided in fax communication from Bob Johnson, EPA/OMS, April 10, 1991.

Note: Weighted average RVPs based on 1990 State gasoline throughput

Using the RVP values in Table 3-3 (taking into account those southern State attainment areas) and the State gasoline throughputs (see Appendix D), a national weighted average RVP was calculated, as well as weighted average RVPs for the winter season (November through February) and the nonwinter season (March through October). The rationale for calculating RVP for these time periods is discussed in Section 3.3 and Appendix D. This annual weighted average RVP is 11.4 psi, the winter season is 14.0, and the nonwinter season 10.2. These will be used throughout the analysis to calculate emission factors.

3.2.1.3 Methods of Loading Gasoline. Many of the operations under consideration in this study involve the loading of gasoline into a storage vessel or tank. The method of loading can affect the emissions generated during the gasoline transfer. There are two basic methods of loading, splash and submerged fill. In the splash loading method, the nozzle is inserted into the top of the tank. Significant turbulence and vapor/liquid contact occur during the splash loading operation, resulting in high levels of vapor generation and loss. If the turbulence is great enough, liquid droplets will be entrained in the vented vapors.

The second method of loading is submerged fill. This category is further broken down into the submerged fill pipe method and the bottom loading method. In the submerged fill pipe method, the fill pipe extends almost to the bottom of the tank. In the bottom loading method, a permanent fill pipe is attached to the cargo tank bottom. Most of the time using the submerged fill pipe method and always using bottom loading, the fill pipe is below the liquid surface level. Liquid turbulence is controlled significantly during submerged loading, resulting in much lower vapor generation than encountered during splash loading.

Cargo carriers are sometimes designated to transport only one product, and in such cases are practicing "dedicated service". Dedicated gasoline cargo carriers return to a loading terminal containing air fully or partially saturated with vapor from the previous load. Cargo tanks may also be "switch loaded" with various products, such as diesel fuel, so that a nonvolatile product being loaded may expel the vapors remaining from a previous load of a volatile product such as gasoline. These circumstances vary with the type of cargo tank and with the ownership of the carrier, the petroleum liquids being transported, geographic location, and season of the year.

One control measure for gasoline tank trucks is called "vapor balance service", in which the cargo tank of the truck retrieves the vapors displaced during product unloading at bulk plants or service stations and transports the vapors back to the loading terminal. A truck whose cargo tank is in vapor balance service normally is saturated with organic vapors. Therefore the presence of these vapors at the start of submerged loading results in greater loading losses than encountered during nonvapor balance, or "normal", service.

Emissions from loading gasoline were estimated using the following expression:[7]

$$L_L = 12.46\ SPM/T$$

where:

L_L = Loading loss, lb/10^3 gal of gasoline loaded

M = Molecular weight of vapors , lb/lb-mole

P = True vapor pressure of liquid loaded, psia

T = Temperature of bulk liquid loaded, °R (°F + 460)

S = A saturation factor

The saturation factor, S, represents the expelled vapor's fractional approach to saturation, and it accounts for the variations observed in emission rates from the different unloading and loading methods. Table 3-4 lists the saturation factors as found in AP-42.[8]

TABLE 3-4. SATURATION (S) FACTORS FOR CALCULATING GASOLINE LOADING LOSSES

Cargo Carrier	Mode of Operation	S Factor
Tank trucks and rail tank cars	Submerged loading: dedicated normal service	0.60
	Submerged loading: dedicated vapor balance service	1.00
	Splash loading: dedicated normal service	1.45
	Splash loading: dedicated vapor balance service	1.00

Source: AP-42, page 4.4-6.

An examination of this equation and the saturation factors in Table 3-4 indicates that the emissions from submerged loading are approximately 40 percent of those for splash filling. The only variable that differentiates splash from submerged loading is the saturation factor. The normal service saturation factors are 0.6 for submerged loading and 1.45 for splash, which represents a 60 percent increase.

3.2.2 Emissions from Pipeline Facilities

As discussed in Chapter 8, there are 79,624 miles of gasoline product pipeline in the United States. Pipelines transport approximately one half of the gasoline shipped in the U.S. The pipeline itself is only one component of the product pipeline system. Other major components of this system include terminals, pumping stations, and breakout stations.

Product is carried from refineries to terminals by the pipeline, often over great distances. The pipeline is made of sections of steel, welded together, and usually buried underground. At the refinery, a pump sends the refined product toward its destination. Since this pump is not strong enough to "push" the material the entire distance, pumping stations are located along the pipeline to keep the product flowing. Occasionally, flow may be interrupted and the product pumped off of the pipeline into storage tanks. These "breakout" stations usually occur at pumping stations.

3.2.2.1 Pumping Stations. Pumps carry product from refineries to the pipeline, where a larger pump pushes the product toward its destination. In route to its destination, product passes through numerous pumping stations (approximately one every 30-50 miles)[9], where it is pumped along its way.

The centrifugal pump is the most widely used pump. However, other types, such as the positive-displacement pump and the reciprocating pump are also used at pipeline pumping stations.

Two generic types of sealing devices, packed and mechanical, are used on pumps in the petroleum industry. Packed seals can be used on both centrifugal and reciprocating types of pumps. A packed seal consists of a cavity in which the pump casing is filled with special packing material that is compressed with a packing gland to form a seal around the shaft. To prevent the buildup of frictional heat between the seal and shaft, lubrication is required. A sufficient amount of either the gasoline being pumped or another liquid that is injected must be allowed to flow between the packing and the shaft to provide the necessary lubrication. Deterioration of this packing and/or the shaft seal face after a period of usage can be expected to eventually result in leakage of organic compounds to the atmosphere.

Mechanical seals are limited in application to pumps with rotating shafts and can be further categorized as single and dual mechanical seals. There are many variations to the basic design of mechanical seals, but all have a lapped seal face between a stationary element and a rotating seal ring. In a single mechanical seal application, the rotating-seal ring and stationary element faces are lapped to a very high degree of flatness to maintain contact throughout their entire mutual surface area. As with pump packing, mechanical seal faces must be lubricated to remove frictional heat. However, because of the seal's construction, much less lubrication is needed. If the seal becomes imperfect due to wear, the gasoline being pumped can leak between the seal faces and be emitted to the atmosphere.

In a dual mechanical seal application, two seals can be arranged back-to-back or in tandem. In the back-to-back arrangement the two seals provide a closed cavity between them. A barrier fluid is circulated through the cavity. Because the barrier fluid surrounds the dual seal and lubricates both sets of seal faces, the heat transfer and seal life characteristics are much better than those of the single seal. In order for the seal to function, the barrier fluid must be held at a pressure greater than the operating pressure of the stuffing box. As a result some barrier fluid will leak across the seal faces. Liquid leaking across the inboard face will enter the stuffing box and mix with the gasoline. Barrier fluid going across the outboard face will exit to the atmosphere. Therefore, the barrier fluid must be compatible with the petroleum liquid as well as with the environment.

In a tandem dual mechanical seal arrangement, the seals face the same direction. The secondary seal provides a backup for the primary seal. A seal flush is used in the stuffing box to remove the heat generated by friction. As with the back-to-back seal arrangement, the cavity between the two tandem seals is filled with a barrier fluid. However, the barrier fluid is maintained at a lower pressure than the fluid in the stuffing box. Therefore, any leakage will be from the stuffing box into the seal cavity containing the barrier fluid. Since this liquid is routed to a closed reservoir, gasoline that has leaked into the seal cavity will also be transferred to the reservoir. At the reservoir, the petroleum liquid could vaporize and be emitted to the atmosphere. To ensure that VOCs do not leak from the reservoir, the reservoir can be vented to a control device.

There are also numerous valves at a pumping station. The types of valves commonly used are globe, gate, plug, ball, relief and check valves. All except the relief valve and check valve are activated by a valve stem, which may have either a rotational or linear motion, depending on the specific design. This stem requires a seal to isolate the process fluid inside the valve from the atmosphere. The possibility of a leak through this seal makes it a potential source of VOC and HAP emissions. Since check valves do not have an external actuating mechanism in contact with process fluids, they are not considered to be potential sources of emissions.

Pipeline pumping stations contain on the average approximately 55 valves and 5 pumps. Uncontrolled emissions from an example pipeline pumping station are shown in Table 3-5. These emissions were calculated using AP-42 emission factors developed for light liquid components at petroleum refineries of 0.26 kg/component/day for valves and 2.7 kg/component/day for pump seals.[10] A more recent study has provided evidence that emission factors for leaking equipment components may be lower than those reported in AP-42[11]; however, since these new data were limited to only a few terminals, the data were deemed insufficient to justify changes to the national emission factors and as such, the refinery data were considered appropriate for this analysis.

3.2.2.2 Breakout Stations. Pipelines often occur in clusters of two or three pipes that carry product from the same origin to the same destination. At some point along the path, one, two, or all three of the lines branch off in

TABLE 3-5. UNCONTROLLED EMISSIONS FROM EXAMPLE PIPELINE FACILITIES

Emission Source	VOC Emission Factor[a]	Emission Factor Units	Annual Emissions (Mg/yr) HAP[b]	Annual Emissions (Mg/yr) VOC
PUMPING STATION[c]				
Valves	0.26	kg VOC/valve/day	0.3	5.2
Pumps	2.7	kg VOC/pump seal/day	0.5	9.8
		Total for Example Pumping Station	0.8	15.0
BREAKOUT STATION				
Storage Tanks[d]				
Standing storage losses	18.1	Mg VOC/yr/tank	3.5	72.4
Withdrawal losses	4.61×10^{-8}	Mg VOC/bbl	0.1	0.4
Fugitive Emissions[e]				
Valves	0.26	kg VOC/valve/day	1.1	23.7
Pumps	2.7	kg VOC/pump seal/day	0.8	17.7
		Total for Example Breakout Station	5.5	114.2

[a] Emission factors for pumps and valves taken from AP-42, Section 9.1, for light liquid components at petroleum refineries. Storage tank emission factors taken from Table 3-7.

[b] Calculated using the arithmetic average HAP to VOC ratio for normal fuel in Table 3-1.

[c] Assuming the example pumping station has 55 valves and 5 pumps (2 pump seals per pump) operating 365 days/yr.

[d] Assuming the example breakout station has four "equivalent dedicated tanks" that are external floating roof tanks with primary seals each having a capacity of 8,000 m^3 (50,000 bbls) and an annual throughput of 1.2×10^9 liters (315×10^6 gallons) which represents 150 turnovers per year.

[e] Assuming the example breakout station has 250 valves and 9 pumps (2 pump seals per pump) operating 365 days/yr.

different directions. When this occurs, the throughput to any one line is altered. Storage tanks at breakout stations are used in this situation to temporarily store the product until compensation for the reduced flow can be made. Also, at times the diameter of a pipeline will be changed (reduced or increased). This also causes a change in the flow rates, and breakout stations are needed to store product at these locations.

There are two major sources of emissions at breakout stations. These are the storage tanks and the pumps and valves used to transport the gasoline. Fugitive emissions from pumps and valves are discussed above under pumping stations.

Many tanks in gasoline service have an external floating roof to prevent the loss of product due to evaporation and working losses. Fixed-roof tanks, used in some areas to store gasoline, use pressure-vacuum (P-V) vents to control breathing losses and may use vapor balancing or processing equipment to control working losses. A typical fixed-roof tank consists of a cylindrical steel shell with a cone- or dome-shaped roof that is permanently affixed to the tank shell. A breather valve (pressure-vacuum valve), which is commonly installed on many fixed-roof tanks, allows the tank to operate at a slight internal pressure or vacuum. Because this valve prevents the release of vapors only during very small changes in temperature, barometric pressure, or liquid level, the emissions from a fixed-roof tank can be appreciable.

The sources of greatest emissions from fixed-roof tanks are breathing and working losses. Breathing loss is the expulsion of vapor from a tank vapor space that has expanded or contracted because of daily changes in temperature and barometric pressure. These emissions occur in the absence of any liquid level change in the tank. Emptying losses occur when the air that is drawn into the tank during liquid removal saturates with hydrocarbon vapor and expands, thus exceeding the fixed capacity of the vapor space and overflowing through the pressure vacuum valve. Combined breathing and emptying losses are called "working losses."

A typical external floating roof tank consists of a cylindrical steel shell equipped with a deck or roof that floats on the surface of the stored liquid, rising and falling with the liquid level. The liquid surface is completely covered by the floating roof except in the small annular space between the roof and the shell. A seal attached to the roof touches the tank wall (except for small gaps in some cases) and covers the remaining area. The seal slides against the tank wall as the roof is raised or lowered.

An internal floating roof tank has both a permanently affixed roof and a roof that floats inside the tank on the liquid surface (contact roof), or supported on pontoons several inches above the liquid surface (noncontact roof). The internal floating roof rises and falls with the liquid level.

Standing-storage losses, which result from causes other than changes in the liquid level, constitute the greatest source of emissions from external floating roof tanks. The largest potential source of these losses is an improper fit between the seal and the tank shell (seal losses). As a result, some liquid surface is exposed to the atmosphere. Air flowing over the tank creates a pressure differential around the floating roof. As air flows into the annular vapor space (ring-shaped space between the seal edge and the tank wall) on the leeward side, an air-vapor mixture flows out on the windward side. Another source of standing-storage loss is associated with roof fittings. Roof fittings can be a source of evaporative loss when they require openings in the floating roof. Typical roof fittings include access hatches, unslotted guide-pole wells, slotted guide-pole/sample wells, gauge-float wells, gauge-hatch/sample wells, vacuum breakers, roof drains, roof legs, and rim vents.[12]

Withdrawal loss is another source of emissions from a floating roof tank. When liquid is withdrawn from a tank, the floating roof is lowered, and a wet portion of the tank wall is exposed. Withdrawal loss is the vaporization of liquid from the wet tank wall.

As the wind flows over the exterior of an internal floating roof tank, air flows into the enclosed space between the fixed and floating roofs through some of the shell vents and out of the enclosed space through others. Any vapors that have evaporated from exposed liquid surface and that have not been contained by the floating deck will be swept out of the enclosed space. The withdrawal loss from an internal floating roof tank is similar to that discussed for external floating roofs. The other losses, seal losses, fitting losses and deck seam losses, occur not only during the working operations of the tank but also during free standing periods. A practice that is becoming more popular is the installation of geodesic dome covers over external floating roof tanks. These domes do not allow air to flow directly over the floating roof and therefore reduce emissions.

Tables 3-6 and 3-7 present emission factors for storage tanks. These emission factors were calculated using the emission factor equations contained in Section 4.4 of AP-42, assuming 60°F and the national weighted average RVP of 11.4 as shown in Table 3-3.

While a breakout station may contain a large number of storage tanks, there will only be a select few that are used for gasoline at any one time. It is estimated that a breakout station typically has four "equivalent dedicated storage tanks" for gasoline. That is, at any one time, only four storage tanks are being filled with and storing gasoline. These facilities also contain approximately 250 valves and 9 pumps.

Emissions for an example breakout station were shown in Table 3-5. It was assumed that the average throughput

TABLE 3-6. STORAGE TANK EMISSION FACTORS FOR BULK TERMINAL STORAGE TANKS[a,b]

Type of Emission	VOC Emission Factor	Units
Fixed-Roof Uncontrolled		
Breathing losses	10.1	Mg VOC/yr/tank
Working losses	38.1	Mg VOC/yr/tank
Internal Floating Roof[c]		
Rim Seal losses	0.5	Mg VOC/yr/tank
Fitting losses	1.2	Mg VOC/yr/tank
Deck Seam losses	0.6	Mg VOC/yr/tank
Working losses	7.33×10^{-8}	Mg VOC/bbl throughput
External Floating Roof		
Standing Storage losses		
Primary seal[d]	14.5	Mg VOC/yr/tank
Secondary seal[e]	7.0	Mg VOC/yr/tank
Working losses	4.61×10^{-8}	Mg VOC/bbl throughput

[a] Emission factors calculated with equations from Section 4.3 of AP-42 using the nationwide weighted average RVP of 11.4 and temperature of 60°F, as discussed in Section 3.2.1.2.

[b] Assumes storage tanks at bulk terminals have a capacity of 2,680 m^3 (16,750 bbl), a diameter of 15.2 meters (50 feet), and a height of 14.6 meters (48 feet).

[c] Assumes that internal floating roof is equipped with a liquid-mounted resilient seal (primary only).

[d] Assumes that external floating roof is equipped with a primary metallic shoe seal.

[e] Assumes that external floating roof tank is equipped with a shoe-mounted secondary seal.

TABLE 3-7. STORAGE TANK EMISSION FACTORS FOR PIPELINE BREAKOUT STATION STORAGE TANKS[a,b]

Type of Emission	VOC Emission Factor	Units
<u>Fixed-Roof Uncontrolled</u>		
Breathing losses	30.4	Mg VOC/yr/tank
Working losses	472.4	Mg VOC/yr/tank
<u>Internal Floating Roof</u>[c]		
Rim Seal losses	1.2	Mg VOC/yr/tank
Fitting losses	1.3	Mg VOC/yr/tank
Deck Seam losses	2.6	Mg VOC/yr/tank
Working losses	7.33×10^{-8}	Mg VOC/bbl throughput
<u>External Floating Roof</u>		
Standing Storage losses		
Primary seal[d]	18.1	Mg VOC/yr/tank
Secondary seal[e]	8.5	Mg VOC/yr/tank
Working losses	4.61×10^{-8}	Mg VOC/bbl throughput

[a] Emission factors calculated with equations from Section 4.3 of AP-42 using the nationwide weighted average RVP of 11.4 and temperature of 60°F, as discussed in Section 3.2.1.2.

[b] Assumes storage tanks at pipeline breakout stations have a capacity of 8,000 m^3 (50,000 bbl), a diameter of 30 meters (100 feet), and a height of 12 meters (40 feet).

[c] Assumes that internal floating roof is equipped with a liquid-mounted resilient seal (primary only).

[d] Assumes that external floating roof is equipped with a primary metallic shoe seal.

[e] Assumes that external floating roof is equipped with a shoe-mounted secondary seal.

for a breakout station storage tank is approximately 1.2 x 10^9 liters/year (315 x 10^6 gallons/year).

3.2.3 Bulk Terminals

As noted above, bulk terminals receive gasoline from refineries by way of pipeline, ship, or barge. Some terminals are located at the refinery. The product is stored and then loaded into transport trucks that carry it further down the distribution chain. In a few situations, gasoline is loaded at bulk terminals into railcars. This gasoline is usually carried to other terminals that do not have access to a pipeline, ship, or barge.

There are three categories of emission sources at bulk terminals. These are the emissions associated with the loading of transport trucks or railcars (loading rack emissions), storage tank emissions, and fugitive emissions from leaking pumps and valves.

3.2.3.1 Loading Rack Emissions. Bulk gasoline terminals serve as the major distribution point for the gasoline produced at refineries. Movement of gasoline at a bulk terminal involves loading, unloading, and transfer of the liquid from storage tanks into tank trucks and railcars. Gasoline stored in large aboveground tanks is pumped through metered loading areas, called loading racks, and into delivery tank trucks, which service various wholesale and retail accounts in the distribution network. Loading racks contain the equipment (such as pumps, meters, piping, grounding, etc.) necessary to fill delivery tank trucks with liquid products. Terminals generally utilize two to four rack positions for gasoline, but there can be as many as eight to ten rack positions at large throughput terminals. Each loading rack will typically have from one to four loading arms, depending on the products available for loading at that rack position. Each arm is dedicated to one product.

Emissions from the tank truck and railcar loading operations at terminals occur when the product being loaded displaces the vapors in the delivery tank and forces the vapors to the atmosphere. Loading may be performed using either splash, top submerged, or bottom loading methods. Top loading involves loading of gasoline into the tank truck compartment or railcar through the hatchway located on top of either the truck tank or railcar using a top loading fill pipe (splash fill). Attachment of a fixed or extensible downspout to the fill pipe provides a means of introducing the product near the bottom of the tank (submerged fill). As discussed in Section 3.2.1.3, top splash loading creates considerable turbulence during loading and can create a vapor mist resulting in higher emissions from the truck loading operation. Submerged loading greatly reduces the turbulence, and therefore reduces the emissions. Bottom loading refers simply to the loading of products into the cargo tank from the bottom. This results in the same emission reduction as associated with top submerged loading. A long established trend in the industry is to build new terminals with bottom loading racks and to convert existing terminal top loading racks to bottom loading. Some of the advantages cited for bottom loading include: (1) improved safety, (2) faster loading, and (3) reduced labor costs. Loading rack emission factors and emissions at bulk terminals are summarized in Table 3-8.

3.2.3.2 Storage Tank Emissions. Bulk terminals typically have four or five aboveground storage tanks for gasoline, each with a capacity ranging from 1,500 to 15,000 m^3 (9,400 to 94,000 barrels).[16] Table 3-8 also illustrates the magnitude of emissions from a bulk terminal with four storage tanks for gasoline, using the emission factors shown in Table 3-6.

3.2.3.3 Fugitive Emissions. There are numerous pumps and valves at bulk terminals that convey liquid gasoline and gasoline vapors. As discussed in Section 3.2.2.2 under pipeline pumping stations, these components can be sources of HAP emissions. Table 3-8 also summarizes the magnitude of the fugitive emissions from a bulk terminal with 150 valves and 10 pumps.

TABLE 3-8. UNCONTROLLED EMISSIONS FROM BULK TERMINALS

Emission Source	VOC Emission Factor[a]	Emission Factor Units	Emissions (Mg/yr) HAP[b]	VOC
Loading Racks[c]				
Submerged loading	658	mg VOC/liter	11	230
Splash Fill	1,590	mg VOC/liter	27	556
Storage Tanks[d]				
Fixed-roof				
Working losses	38.1	Mg VOC/yr/tank	7	152
Breathing losses	10.1	Mg VOC/yr/tank	2	40
Internal Floating Roof				
Working Losses	7.33×10^{-8}	Mg VOC/bbl throughput	<1	<1
Breathing Losses	2.3	Mg VOC/yr/tank	0.4	9
External Floating Roof				
Working Losses	4.61×10^{-8}	Mg VOC/bbl throughput	<1	<1
Primary Seal Losses	14.5	Mg VOC/yr/tank	4	72
Secondary Seal Losses	7.0	Mg VOC/yr/tank	2	34
Fugitive Emissions[e]				
Valves	0.26	kg VOC/valve/day	1	15
Pumps	2.7	kg VOC/pump seal/day	1	20

a Loading rack and storage tank factors are calculated using the weighted average RVP of 11.4 (summer RVP = 10.2, winter RVP = 14) and temperature of 60°F (see discussion in Section 3.2.1.2). Fugitive emission factors are from AP-42 section 9.1, and are those for light liquid components at refineries.

b Calculated using the arithmetic average HAP to VOC ratio for normal fuel of 4.8 percent as derived in Table 3-1.

c Assuming a throughput of 950,000 liters/day (250,000 gallons/day) for 340 days/yr (average annual throughput of 35×10^7 liters).

d Assuming four storage tanks, each having a capacity of 2,680 m^3 (16,750 bbl) and a throughput of 950,000 liters/day (250,000 gallons/day) for 340 days/yr (13 turnovers per year).

e Assuming that bulk terminals typically have 150 valves and 10 pumps (2 pump seals per pump).

3.2.4 Bulk Plants

Bulk gasoline plants are secondary distribution facilities that receive gasoline from bulk terminals by truck transports, store it in aboveground, fixed-roof storage tanks, and subsequently dispense it via smaller account trucks to local farms, businesses, and service stations. Bulk plants typically have a throughput of about 19,000 liters (5,000 gallons) of gasoline per day with storage capacity of about 189,000 liters (50,000 gallons) of gasoline.[17] A bulk plant is defined as having a throughput of less than 76,000 liters (20,000 gallons) of gasoline per day averaged over the work days in one year.

3.2.4.1 Storage Tank Filling Emissions. Gasoline is delivered to bulk plants in large tank trucks from bulk terminals. One source of emissions is during the filling of the storage tank at the bulk plant. The storage tanks at bulk plants are almost always fixed-roof tanks. Consequently, before the filling of the tank, the space available for filling contains saturated gasoline vapors. Emissions are generated when the incoming liquid forces these vapors out the vent. Due to the configuration of the aboveground tanks, this loading is usually accomplished using bottom loading.

3.2.4.2 Loading Rack Emissions. The methods of loading gasoline into tank trucks at bulk plants are the same as those used at terminals. The first is the splash filling method, which usually results in high levels of vapor generation and loss. The second method is submerged filling with either a submerged fill pipe or bottom filling, which significantly reduces liquid turbulence and vapor-liquid contact, resulting in much lower emissions. In a 1976 survey of bulk plants, 75 percent used either top-submerged filling or bottom filling and 25 percent used top splash filling.[18] These bulk plants that use top splash filling are typically located in areas where no control is required. Emissions from an example bulk plant with a daily throughput of 19,000 liters/day (5,000-gallons/day) are shown in Table 3-9.

3.2.4.3 Storage Tank Emissions. As discussed in the previous section, vapors can escape from fixed-roof storage tanks at bulk plants, even when there is no transfer activity. Temperature induced pressure differentials can expel vapor-laden air or induce fresh air into the tank (breathing loss). Liquid transfers create draining and filling losses that combined are called "working losses". Storage tank emissions are also estimated for an example bulk plant with three storage tanks in Table 3-9.

3.2.4.4 Fugitive Emissions. As with bulk terminals, there are numerous pumps and valves at bulk plants that convey liquid gasoline and gasoline vapors. As discussed in Section 3.2.2.2 under pipeline pumping stations, these components can be sources of HAP emissions. The estimated emissions shown in Table 3-9 are for an example plant that has 50 valves and 4 pumps.

3.2.5 Service Stations

The discussion on service station operations is divided into three areas: (1) the filling of the underground storage tank, (2) automobile refueling, and 3) storage tank emissions. Although terminals and bulk plants also have two distinct operations (tank filling and truck loading), the filling of the underground tank at the service station ends the wholesale gasoline distribution chain. The automobile refueling operations interact directly with the public, and control of these operations can be performed by putting control equipment on either the service station or the automobile. Storage tank emissions occur due to storage tank breathing during pressure and temperature changes and the inbreathing and subsequent outbreathing during storage tank emptying.

3.2.5.1 Storage Tank Filling Emissions. Normally, gasoline is delivered to service stations in large tank trucks from bulk terminals or smaller account trucks from bulk plants. Emissions are generated when hydrocarbon

TABLE 3-9. UNCONTROLLED EMISSIONS FROM AN EXAMPLE BULK PLANT[a]

Emission Source	VOC Emission Factor[b]	Emission Factor Units	Annual Emissions (Mg/yr) HAP[c]	VOC
Storage Tanks[d]				
Working Losses	432	mg VOC/liter	0.1	2.5
Breathing Losses	203	mg VOC/liter	0.1	1.2
Tank Truck Unloading/ Storage Tank Filling	1,081	mg VOC/liter	0.3	6.2
Loading Racks				
Submerged loading	738	mg VOC/liter	0.2	4.2
Fugitive Emissions[e]				
Valves	0.26	kg VOC/valve/day	0.2	3.9
Pumps	2.7	kg VOC/pump seal/day	0.3	6.5
		Total for an Example Bulk Plant	1.2	24.4

[a] Assuming the example bulk plant has a gasoline throughput of 19,000 liters/day (5,000 gallons/day), 3 storage tanks, 50 valves, and 4 pumps, and operates 300 days/yr.

[b] Storage tank filling (working loss) and breathing loss, emission factors calculated using equations in Section 4.4 of AP-42. Loading rack emission factor calculated using the AP-42 equation from section 4.4 discussed in Section 3.2.2.2 of this document. Fugitive emission factors taken from Section 9.1 of AP-42 for light liquid components at refineries. Nationwide weighted average RVP of 11.4 and temperature of 60°F as discussed in Section 3.2.1.2.

[c] Calculated using the arithmetic average HAP to VOC ratio for normal fuel of 4.8 percent as derived in Table 3-1.

[d] Assumes storage tank capacity of 76 m^3 (640 bbl).

[e] Assuming the example bulk plant has 50 valves and 4 pumps (2 pump seals per pump).

vapors in the underground storage tank are displaced to the atmosphere by the gasoline being loaded into the tank. As with other loading losses, the quantity of the service station tank loading loss depends on several variables, including the quantity of liquid transferred, size and length of the fill pipe, the method of filling, the tank configuration and the gasoline temperature, vapor pressure, and composition. Estimated emissions for an example 190,000 liters/months (50,000 gallons/month) service station are shown in Table 3-10.

3.2.5.2 Vehicle Refueling Emissions. In addition to service station tank loading losses, vehicle refueling operations are considered to be a source of emissions. Vehicle refueling emissions are attributable to vapor displaced from the automobile tank by dispensed gasoline and to spillage of fuel. The major factors affecting the quantity of emissions are gasoline temperature, auto tank temperature, and gasoline RVP. Table 3-10 illustrates the uncontrolled emissions from an example gasoline service station. The refueling emission factors presented in Table 3-10 are from a technology guidance document for vehicle refueling controls.[20]

3.2.5.3 Storage Tank Breathing and Emptying Emissions. Emissions have also been reported at service stations due to storage tank emptying and breathing losses. Breathing losses are attributable to gasoline evaporation due to barometric pressure and temperature changes. Breathing losses in fixed volume storage tanks are caused by vapor and liquid expansion and contraction due to diurnal temperature changes. As temperatures increase, vapor volume increases, pushing vapor out of the vent pipe (out-breathing). When temperatures decrease, vapor volume decreases and air is drawn into the tank (in-breathing). Breathing loss emissions have traditionally been minimal at service stations since storage tanks have generally been located underground, insulated by the earth, with a very stable temperature profile. However, breathing losses from service

TABLE 3-10. UNCONTROLLED EMISSIONS FROM AN EXAMPLE SERVICE STATION[a]

Emission Source	VOC Emission Factor[b]	Emission Factor Units	Annual Emissions (Mg/yr) HAP[c]	Annual Emissions (Mg/yr) VOC
Tank Truck Unloading/ Storage Tank Filling				
Splash fill	1,556	mg VOC/liter	0.2	3.5
Storage Tank Breathing/Emptying	120	mg VOC/liter	0.01	0.3
Vehicle Refueling				
Refueling	1,340	mg VOC/liter	0.1	3.1
Spillage	80	mg VOC/liter	0.01	0.2
Total for an Example Service Station			0.3	7.1

a Assuming the example service station has a gasoline throughput of 190,000 liters/month (50,000 gallon/month).

b Emission factor for storage tank filling calculated using the AP-42 equation discussed in Section 3.2.2.2 of this document, and the nationwide weighted average RVP of 11.4 and temperature of 60°F as discussed in Section 3.2.1.2. Storage tank breathing emission factor taken from Section 4.4 of AP-42 and discussed in Section 3.2.5.3. Refueling emission factors calculated using the equation from a Stage II technical guidance document[19] and spillage from AP-42, Section 4.4.

c Calculated using the arithmetic average HAP to VOC ratio for normal fuel of 4.8 percent as derived in Table 3-1.

station storage tanks are becoming more prevalent due to the popularity of aboveground storage tanks and the installation of vaulted underground storage tanks. Aboveground storage tanks are more susceptible to temperature and pressure changes than underground tanks and thus are more likely to experience both vapor growth and vapor shrinkage quite similar to working and breathing losses for fixed-roof tanks at bulk terminals which were discussed earlier in this chapter (see Section 3.2.3.3). Consequently, the emission factors cited in AP-42 and which appear in Table 3-8 may be used to calculate emissions from these tanks even though they are necessarily smaller than bulk terminal fixed-roof storage tanks. It is also reported that the double wall, or vaulted underground storage tanks being installed to comply with underground storage tank (UST) regulations are susceptible to thermal effect and therefore breathing losses as well. However, these losses are reported to be insignificant.[21,22]

Emptying losses occur when gasoline is withdrawn from the tank, allowing fresh air to enter. This enhances evaporation (i.e., vapor growth) and causes vapors to be vented from the pipe as the saturated gasoline vapors tend to occupy a larger volume than air. The EPA's AP-42 cites an average breathing emission rate of 120 milligrams per liter of throughput.[23]

The original source for this factor was an article in the Journal of the Air Pollution Control Association (November 1963) based on a study by the Air Pollution Control District of Los Angeles County (LAAPCD) and was entitled "Emissions from Underground Gasoline Storage Tanks".[24] This article describes emptying losses as follows:

> When an automobile is fueled, gasoline is pumped from the underground tank, causing air to be inhaled through the vent pipe, the volume being approximately equal to the volume of gasoline withdrawn. The air then becomes saturated with gasoline vapors, tending to occupy a larger volume. This, in turn, causes the vapor-air

mixture to exhaust from the underground tank until a pressure equilibrium is attained.

The mg/l emission factor listed in AP-42 was estimated in this study by measuring air expelled from the vent pipe after vehicle fueling. Since the authors concluded that it was impractical, in their study, to collect representative vapor samples for analysis, they assumed a theoretical gasoline vapor to air ratio of 40 percent. Using these data, an emission factor of one pound per thousand gallons of throughput (approximately 120 mg/l) resulted. While an emission factor was calculated by the authors, they went on to discuss complexities with estimating emissions. The study concluded:

> Factors affecting the breathing losses are complex and interrelated, depending on the service station operation, pumping rate, frequency of pumping, ratio of liquid surface to vapor volume, diffusion and mixing of air and gasoline vapors, vapor pressure and temperature of the gasoline, the volume and configuration of the tank, and the size and length of the vent pipe. Because of these many variables involved, much more data from a number of representative retail stations would be necessary before an accurate determination of overall, basin-wide breathing losses could be made.

Since the time of this original analysis, several studies have been conducted to attempt to account for many of these variables. These range from studies that conclude there are no VOC emptying losses to those reporting emissions much higher than those predicted by the AP-42 emission factor.

Dr. R.A. Nichols has studied this subject extensively throughout the 1970's and 1980's. In a 1987 paper on the subject,[25] his conclusion was that the model used in the LAAPCD analysis ignored the effect of the vent line. Dr. Nichols states:

> As can be seen when air enters a nearly flat tank containing saturated vapors, as it layers, it is exposed to a large area for diffusion and quickly saturates....Consequently, as the surface layer gains vapor, the lighter upper vapor free area is vented from the tank....if a tank being

> continuously defueled is then held quiescent, the roughly steady-state but unsaturated profiles in the vapor space will slowly but continuously enrichen. As the profiles enrichen, the amount of vapor in the vapor space will grow and this amount of vapor will be exhausted into the vent line....emissions will result. However, since high turnover tanks subject to appreciable concentration profiles in the vapor space...are also subject to higher more uniformly frequent withdrawals and typically have fuel which is unsaturated with respect to air to a greater degree..., little vapor is expected to be vented.
>
> There is an additional effect which tends to mitigate venting....as saturated vapor moves up the vent pipe, it creates a slight pressure on the remaining vapor space. Until the entire vent pipe + 1.5 gallons of vapor saturation is produced, virtually no vapors will be vented.

Dr. Nichols indicates that vapor emissions could only occur during periods of long refueling inactivity. He concludes that high fueling activity followed by long periods of inactivity will lead to the highest (and possibly the only) vapor venting emissions. This paper did not provide any emission factor for these emissions.

The California Air Resources Board (CARB) conducted a study in 1987 to estimate storage tank breathing losses.[26] Emissions were measured at a low throughput (15,000 gallons per month per tank) station and a high throughput (50,000 gallons per month per tank) station. The study found different results for the two stations. The emission factor calculated for the low throughput station was 0.92 lbs VOC per 1,000 gallon throughput (110 mg/l), and 0.21 pounds per 1,000 gallon (25 mg/l) for the high throughput station. Observations made during the testing indicated that mass emissions from the underground storage tanks appeared to occur during periods when dispensing of product was the lowest, that emissions were at a minimum during conditions of near continuous fuelings, and that the highest mass emissions occurred during intermittent vehicle fuelings followed by relatively long periods of dispensing inactivity. The differences in emission factors at the high and low throughput stations are explained in these observations.

The National Institute for Petroleum and Energy Research (NIPER) conducted a study and reached conclusions partially in agreement with those of both Dr. Nichols and CARB.[27] NIPER's study concluded that no vent losses would occur if the dispensing frequency were high enough and that vent losses would be markedly reduced if the height of the vent was increased. The rationale for the origin of emissions agreed with the discussion provided in the original LAAPCD study. This was that emissions were due to 1) air induction through the vent; 2) dilution of the hydrocarbon vapor in the tank; and 3) saturation of the diluted vapor by evaporation of the liquid fuel, resulting in increased pressure in the tank. When this pressure was greater than that exerted by the column of vapor in the vent, emissions resulted. The emissions measured for high flow stations were 0.85 and 1.05 grams per gallon dispensed (225 and 277 mg/l, respectively).

A comparison of the CARB and NIPER studies shows that the NIPER emission factors are much higher than those from CARB. Recognizing this discrepancy, CARB and NIPER met on August 24, 1987 to discuss the differences. The conclusion reached at this meeting was that NIPER's results should be adjusted because the dispensing period during NIPER's tests was not considered representative of the effective dispensing period at a high volume station. Adjustments were made and it was determined that a more appropriate emission factor for the NIPER data is 0.6 lbs/1,000 gallons (72 mg/l) for a high throughput station.[28]

In summary, these studies indicate that the emissions from storage tank emptying are affected by several factors, most notably the height of the vent pipe and the vehicle fueling activity. Additionally, for this analysis, calculations of emissions are based on emission factors for underground storage tanks even though it is recognized that there are above ground tanks in existence (the number of above ground tanks is very small in comparison to the number of underground tanks). Therefore, for the purposes of the analysis in this document, it is believed that the AP-42 factor of 120 mg/l for underground tanks represents an emission factor that may be very conservative, but is not unrealistic.

3.3 BASELINE EMISSIONS

The baseline is defined as the quantity of emissions expected in the "base year" in the absence of additional regulation. The purpose of establishing an emission baseline is to be able to estimate the impacts of reducing emissions from this baseline through the implementation of additional control measures. The baseline emissions must take into account the level of control already in place in the base year to get an accurate assessment of the impacts of the control alternatives.

The base year for the gasoline distribution source category was selected as 1998. This year represents the fifth year after the expected proposal of the regulation when the selected regulation would be in full effect. The general approach for establishing the emission baseline was basically the same for each sector of the industry.

As discussed in Section 3.2.1.1.2, there are four basic types of fuels that will be used. These are normal, reformulated, oxygenated, and reformulated/oxygenated. During the winter months, all four types will be used while only normal and reformulated will be required in the remainder of the year. The use of each of these fuels depends on the ozone and CO area attainment designations as well as area populations. For purposes of this analysis, it is assumed that all nonattainment areas would "opt-in" to the program. Consequently, it is estimated that these areas would utilize approximately 42 percent of the total gasoline consumed nationwide. Due to the different types of fuels that will be in use in the base year, the parameters for calculating emissions (either gasoline throughput or facility population) were separated according to location.

For each State, data were obtained on the level of control already in use. The appropriate regulatory coverage for each fuel type area in each State was determined and the parameters for the area attributed to that control level. Table 3-11 shows the baseline parameters by control level for all industry sources.

VOC emission factors were selected to represent the level of control in both controlled and uncontrolled situations. VOC emissions were calculated by multiplying the VOC emission factors by the corresponding throughput or facility population. HAP emissions were then estimated by multiplying the VOC emissions by the appropriate HAP to VOC ratio.

The HAP and VOC emissions for the base year of 1998 are presented in Table 3-12. A complete description of the baseline emissions analysis is provided in Appendix D.

TABLE 3-11. 1998 BASELINE PARAMETERS USED IN EMISSIONS ANALYSIS

Source Category/Control Level	Annual Gasoline Throughput (10^6 liters)	Number of Sources
PIPELINE FACILITIES		
<u>Pipeline Pumping Stations</u>		
Fugitive Emissions		
Uncontrolled		1,989
<u>Pipeline Breakout Stations</u>		
Fugitive Emissions		
Uncontrolled		270
Storage Tanks[a]		
External Floating Roof Tanks		
Primary and Secondary Seals	325,000	272
Primary Seals	567,000	476
Fixed Roof Tanks		
Internal Floating Roofs	105,000	88
Uncontrolled	171,000	143

[a] These tank populations represent the "equivalent dedicated" storage tanks used for the emissions analysis (see Section 3.2.2.2). The total storage tank population at breakout stations is estimated to be 2,227 external floating roof tanks (808 with primary and secondary seals and 1,419 with primary seals only) and 1,073 fixed-roof tanks (662 with internal floating roofs and 411 uncontrolled).

TABLE 3-11. (Continued)

Source Category/Control Level	Annual Gasoline Throughput (10^6 liters)	Number of Sources
BULK TERMINALS		
<u>Loading Racks</u>		
80 mg/l and 90% Control	115,000	265
35 mg/l	187,000	430
10 mg/l	13,000	29
Submerged Fill	123,000	282
Splash Fill	8,000	18
<u>Storage Tanks</u>		
External Floating Roof Tanks		
Primary and Secondary Seals	134,000	1,802
Primary Seals	180,000	2,426
Fixed Roof Tanks		
Internal Floating Roofs	95,000	2,732
Uncontrolled	37,000	1,072
<u>Tank Trucks</u>		
Annual Vapor Tightness Testing	317,000	31,169
Uncontrolled	129,000	12,731

TABLE 3-11. (Concluded)

Source Category/Control Level	Annual Gasoline Throughput (10^6 liters)	Number of Sources
BULK PLANTS		
<u>Incoming Loads</u>		
Vapor Balance	52,600	5,661
Uncontrolled	34,700	6,936
<u>Outgoing Loads</u>		
Vapor Balance	48,800	4,488
Submerged Fill	29,800	6,375
Splash Fill	8,700	1,734
<u>Tank Trucks</u>		
Annual Vapor Tightness Testing	52,400	22,440
Uncontrolled	34,900	21,360
SERVICE STATIONS		
<u>Underground Tank Filling</u>		
Vapor Balance/No Exemption	156,100	135,146
Vapor Balance/With Exemption	142,700	123,562
Submerged Fill	75,800	66,476
Splash Fill	71,400	62,566

TABLE 3-12. 1998 BASELINE EMISSIONS FROM GASOLINE DISTRIBUTION SOURCES

Facility/Emission Source	Annual Emissions (Mg/yr) HAP	Annual Emissions (Mg/yr) VOC
Pipeline Facilities		
Pumping Stations	2,370	31,610
Breakout Stations		
Storage Tanks	6,370	84,110
Fugitive Emissions	860	11,450
	9,600	127,170
Bulk Terminals		
Storage Tanks	5,510	90,210
Loading Racks	2,960	48,020
Tank Truck Leakage	3,730	53,960
Fugitive Emissions	4,340	56,450
	16,540	248,640
Bulk Plants		
Storage Tank Filling	1,960	35,600
Truck Loading	2,390	41,200
Truck Leakage	890	13,210
Fugitive Emissions	9,190	130,760
	14,430	220,770
Service Stations (Stage I)	11,880	213,970
TOTALS	52,450	810,550

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4.0 EMISSION CONTROL TECHNIQUES

4.1 CONTROL TECHNIQUES

This chapter describes available control techniques that can be used to reduce emissions from sources in the gasoline distribution network. A large portion of the gasoline distribution industry employs vapor control technology that has been demonstrated, installed, and operated at facilities for many years. The control strategy for storage tanks has been to reduce emissions by use of submerged fill and/or floating roofs. The control strategy for truck loading and unloading areas at bulk terminals, bulk plants, and service stations, has been to incorporate submerged fill and to collect and transfer vapors back to the bulk terminal vapor recovery unit (VRU) or thermal oxidizer for treatment. The control of fugitive emissions from pumps and valves has been studied extensively for other petroleum and chemical process industries but never specifically applied to gasoline marketing sources through EPA rules. Controls for storage tanks, bulk plants, bulk terminals, and underground tank filling at service stations are commonly referred to as Stage I. Controlling emissions as a result of vehicle refueling at service stations is commonly referred to as Stage II, but is not included in this source category effort.

This chapter discusses techniques for controlling emissions from each of the sources in the gasoline marketing chain. For each source or type of sources, the control techniques discussion is followed by a section addressing the technique effectiveness. In most instances, this discussion is in terms of effectiveness for controlling

VOCs. Since the focus of Title III is the control of HAPs, the effectiveness of controlling HAPs is critical. In all instances except bulk gasoline terminal loading racks, the effectiveness for HAPs should be comparable to that for VOC. This is because all of these technologies involve the simple capture and/or collection of the vapors (in the case of bulk plants and service stations), the prevention of vapor formation (in the case of floating roofs for storage tanks), or the prevention of vapor leaks from equipment. A difference would not be expected in these methods for the control of HAPs. The section on bulk terminal vapor processors contains a discussion specific to the control of HAPs.

4.1.1 Submerged Fill

One basic method of reducing vapors generated during the loading of gasoline into tank trucks, aboveground storage tanks, underground storage tanks, or any container or vessel is by using submerged fill. Submerged fill is the introduction of liquid gasoline into the tank being filled with the transfer line outlet being below the liquid surface. Submerged filling minimizes droplet entrainment, evaporation, and turbulence. This is compared to splash loading where the transfer line outlet is at the top of the tank (Figure 4-1a).

Submerged filling of tank trucks at outgoing loading racks can be either by a submerged fill pipe or bottom loading. In the top submerged fill pipe method, the fill pipe descends to within 15 centimeters of the bottom of the tank truck (Figure 4-1b). In the bottom filling method, the fixed fill pipe enters the tank truck from the bottom (Figure 4-1c).

As discussed in Chapter 3 (Section 3.2.1.3), submerged filling can reduce emissions by approximately 60 percent compared to splash filling.

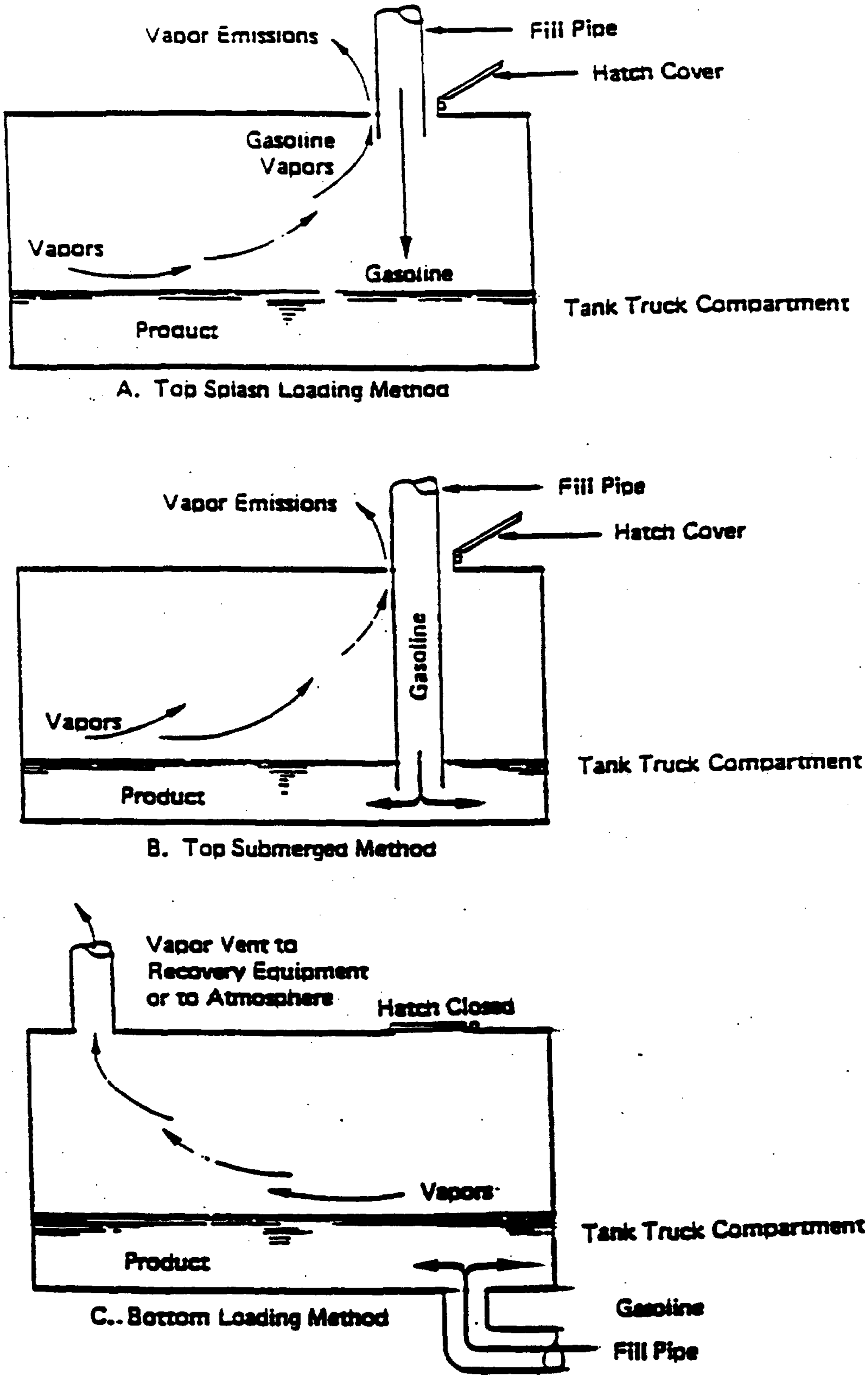


Figure 4-1. Gasoline Tank Truck Loading Methods

4.1.2 Loading Racks at Bulk Terminals

4.1.2.1 Location and Applicability. Bulk gasoline terminals are the first key transfer points from refineries to tank truck distribution. Loading racks at terminals allow the metered loading of products from bulk terminal storage to large transport trucks. Loading rack equipment does not vary in type from small to large facilities; instead, the number of loading positions increases.

The control techniques described in this section are applicable to all terminal loading racks. In addition, these controls have been used at terminals for many years and the baseline analysis presented in Chapter 3 (see Table 3-10) estimates that approximately 70 percent of the bulk terminals will have some type of vapor processor in place in 1990.

4.1.2.2 Description of Control Techniques. Emissions resulting from outgoing transfer operations at terminals are controlled by two main elements, a vapor processing system (or vapor processor) and a vapor collection system. A simplified example of controls at bulk gasoline terminals is shown in Figure 4-2. The vapor collection system consists of all the piping and components necessary to transfer the air-vapor mixture from the loading rack and tank truck or railcar to a vapor processor. A properly designed vapor collection system at the terminal should not result in excessive backpressure at the tank truck or railcar during loading and should have no vapor leakage during transfer. It is also necessary that provisions be made in the vapor collection system to prevent vapor displacement from one loading position to another. Check valves are typically used for this purpose.

There are three major types of vapor processors commonly used at bulk terminals: (1) carbon adsorbers, (2) thermal oxidizers, and (3) refrigeration condenser systems. All can be monitored for correct operation through

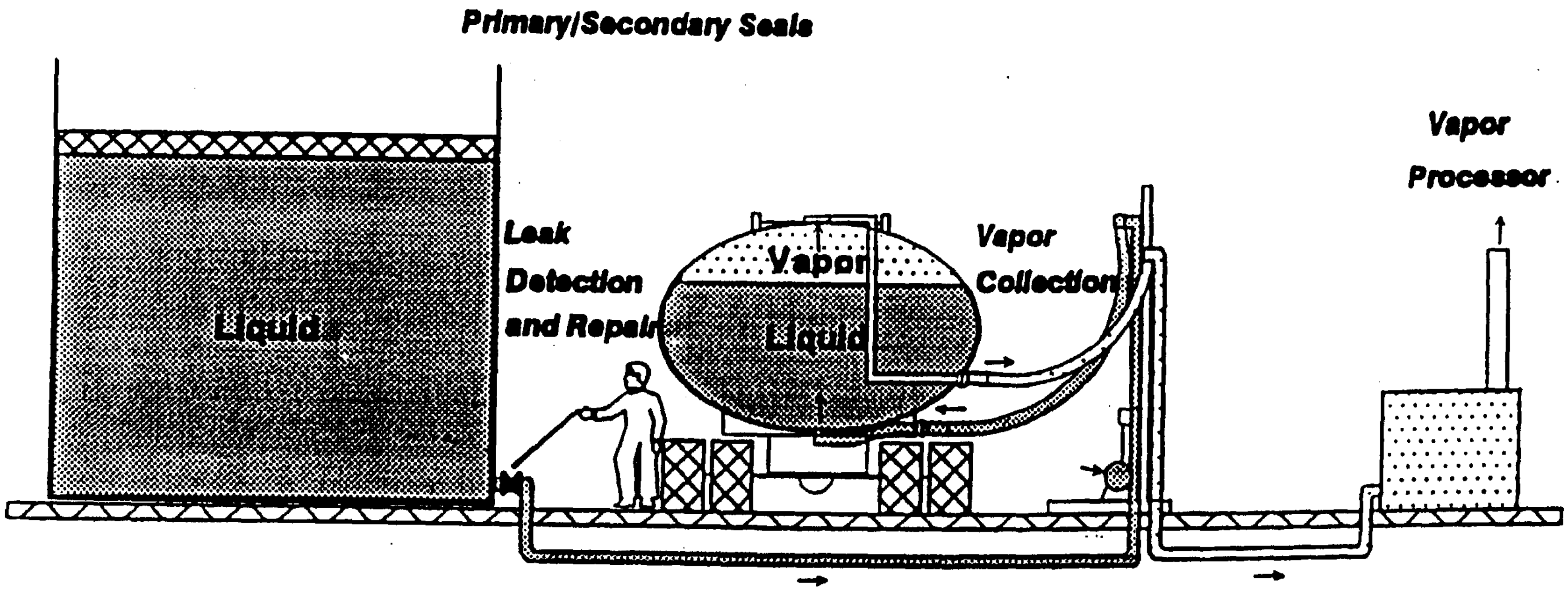


Figure 4-2. A Simplified Example of Controls at Bulk Gasoline Terminals

use of hydrocarbon exhaust concentration or temperature monitors in lieu of continuous emission monitors (CEMs) that monitor specific pollutants in an emission stream. However, CEMs are used at industry facilities similar to bulk gasoline terminals to measure break-through on carbon adsorbers. Carbon adsorption vapor recovery systems use beds of activated carbon to remove gasoline vapors from the air-vapor mixture. These units generally consist of two vertically positioned carbon beds and a carbon regeneration system. During gasoline tank truck loading activity, one carbon bed is used for adsorption while the other bed is being regenerated, usually by vacuum application accompanied by an air purge.

Figure 4-3 illustrates a simplified schematic of a typical carbon adsorption system. The vapors enter the active carbon bed through the bottom and are dispersed upward through the carbon. Hydrocarbons are adsorbed on to the carbon, and purified air exits to the atmosphere through the top vent. As hydrocarbons are being adsorbed in the on-stream bed, the other carbon bed is being regenerated. Regeneration occurs by applying a high vacuum to the carbon bed using a liquid ring vacuum pump. Near the end of the regeneration cycle, an ambient air purge is introduced into the carbon bed to enhance regeneration. Hydrocarbon vapors and condensed hydrocarbon liquids discharge from the vacuum pump to a separator/absorber vessel. The liquid collected in the separator is returned to storage. Non-condensed vapors, along with a small quantity of air, flow to the base of the packed absorber column and rise upward. Liquid gasoline from storage is pumped to the top of the column and, as it cascades downward through the packing into the separator, absorbs virtually all of the hydrocarbons from the air/hydrocarbon mixture. The small amount of hydrocarbon vapor and air exiting the top of the absorber is recycled to the carbon bed that is on-stream. Two carbon beds are used for continuous service.

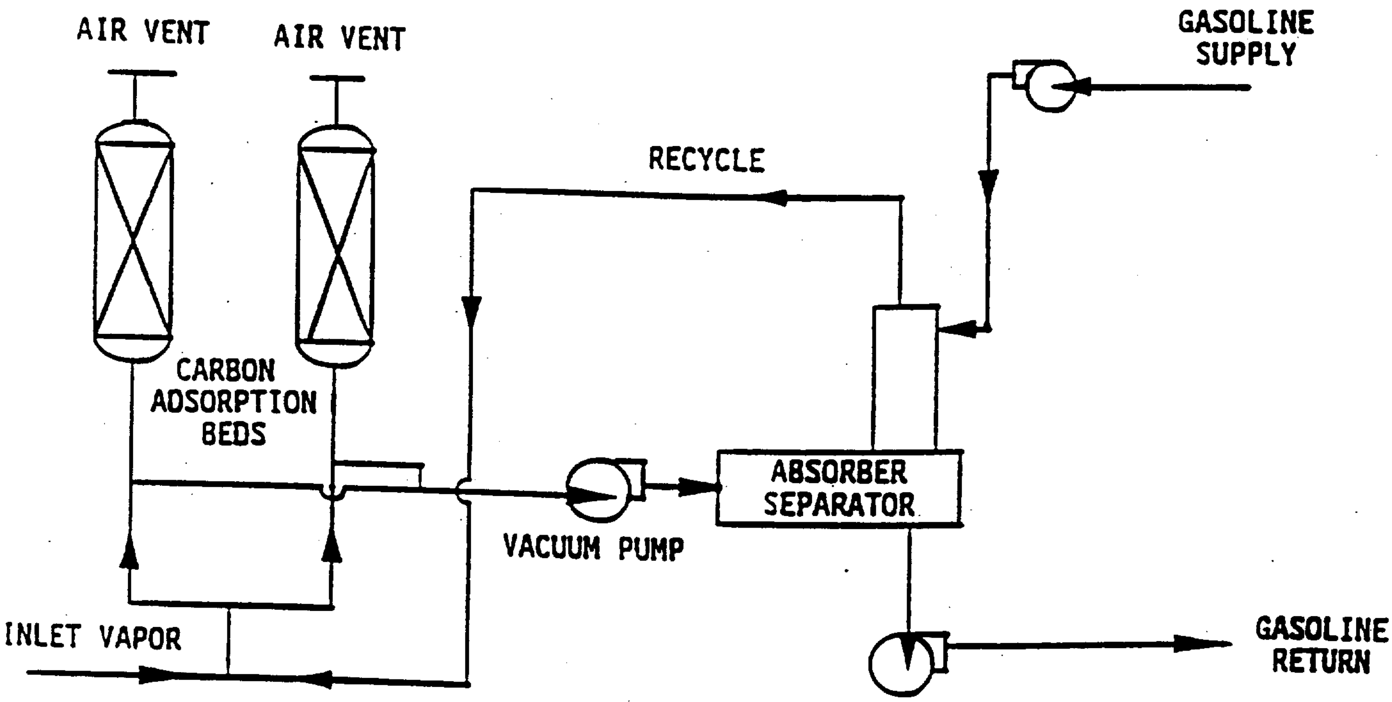


Figure 4-3. A Simplified Schematic of a Typical Carbon Adsorption System
(Diagram Courtesy of the John Zink Company)

Manufacturers indicate that most carbon adsorber-absorber systems on the market can meet the emission level of 35 mg of hydrocarbon per liter of product loaded, as specified in the regulations. One manufacturer estimates that a carbon adsorption/absorption system can recover approximately 2 gallons per 1,000 gallons of gasoline loaded at an average inlet hydrocarbon vapor concentration of 40 percent.[1]

Manufacturers also report that they can provide vapor recovery units using the same technology that will achieve emission rates under 10 mg/l. These more efficient units are equipped with more activated carbon and greater vacuum capacity to accomplish this additional emission reduction.[2]

Thermal oxidation units are used to control emissions from bulk terminals without recovering any gasoline. The gasoline vapor-air mixture generated from transfer operations at the loading rack can be piped to either a vapor holder or directly to the oxidizer unit. The vapor holder stores the air-vapor mixture from the loading rack so that the system can process gasoline vapors at a relatively constant concentration and flow. Once ignition has been initiated in the thermal oxidizer, the air-vapor mixture serves as the fuel and the combustion process continues until all of the vapors have been burned. Typical thermal oxidation units include elevated flares, enclosed flares, and temperature controlled combustors (including those devices where only the combustion air is controlled).

The elevated flare system typically contains a combustion unit, special anti-flashback burner(s), automatic ignition pilot with a continuous monitor, motor operated vapor block valve(s), flame arrestor(s), an air-assist blower, a liquid seal, piping, instrumentation and a master control panel. Figure 4-4 illustrates a simplified flow diagram for an elevated flare system. When not in use, the vapor combustion system is in a standby mode with no pilot flame, the vapor block valve is closed, and the air-assist

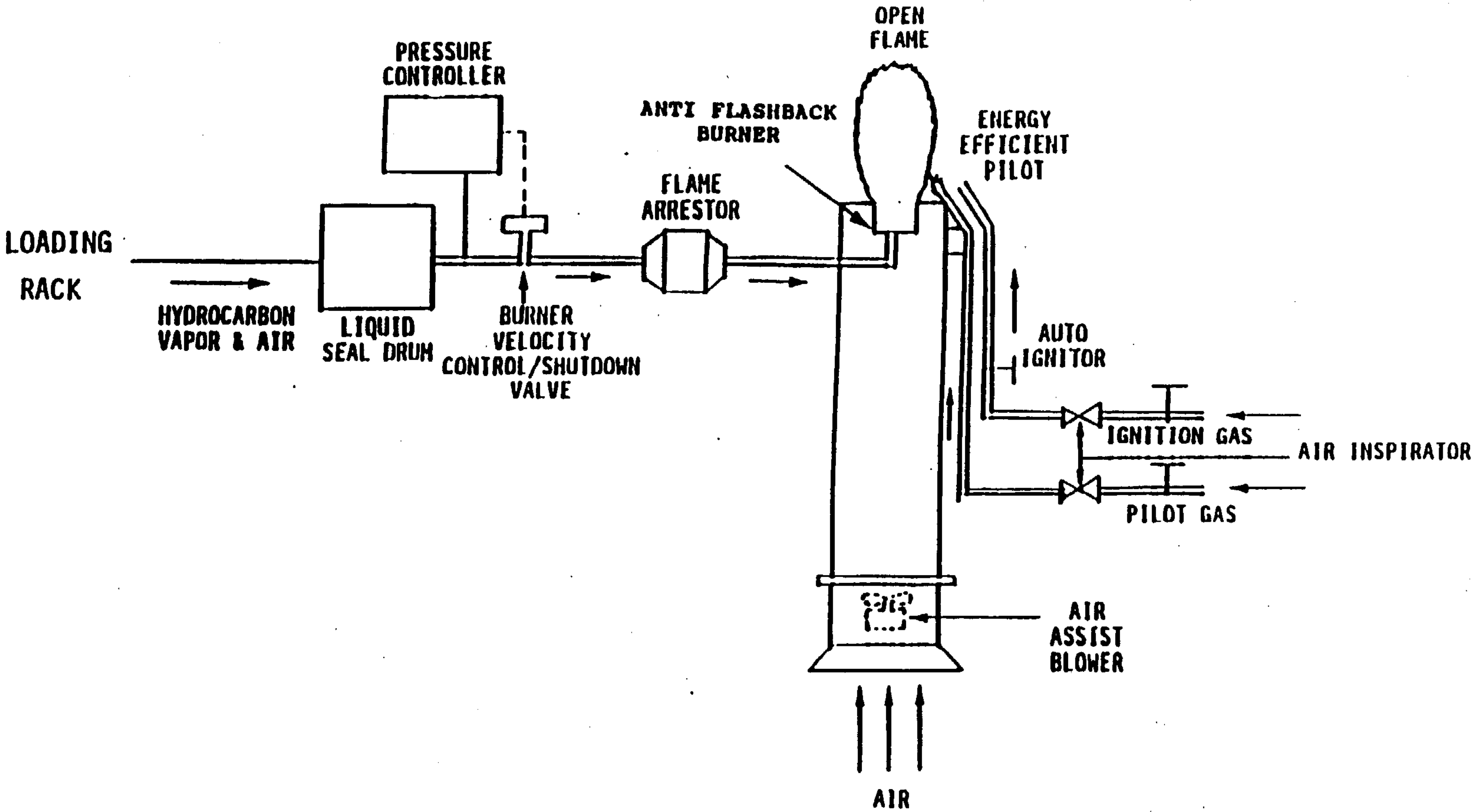


Figure 4-4. A Simplified Flow Diagram for a Typical Elevated Flare System
(Diagram Courtesy of the John Zink Company)

blower is off. The start-up sequence begins with a short air purge using the air-assist blower to purge the air plenum of any combustibles prior to pilot ignition. This brief air purge is followed by automatic electronic ignition of the pilot. Pilot fuel of propane or natural gas is used.

After the pilot ignition, product loading begins at the loading rack and an air-vapor mixture begins to flow from the transports being loaded to the vapor combustion system. Flow through the vapor combustion system first consists of the air-vapor mixture from the loading rack bubbling through a liquid seal. As soon as sufficient flow is attained, the pressure monitoring controls automatically open the vapor block valve allowing the air vapor mixture to flow through the flame arrestor to the burner, where the combustible vapors are ignited by the pilot and burned. Only minimal pilot fuel is needed. The gasoline vapor air mixture provides sufficient fuel to maintain combustion temperatures. The air assist blower provides partial combustion air and mixing energy to the burner tips to assure smokeless combustion. As the loading operation is completed, vapor flow to the combustion unit decreases. The pressure monitoring system closes the vapor block valve when the vapor flow is insufficient to maintain minimum burner velocity. If no further loading occurs, the combustion unit will shut down and return to the standby mode to await automatic re-start as previously described.

The enclosed flare operates similarly to the elevated flare but has the advantage that the flame is totally contained in a refractory-lined cylinder. This can help to minimize thermal radiation and noise. Figure 4-5 illustrates a typical enclosed flare.

The temperature controlled flare is generally used if the combustion temperature has to be maintained at a minimum temperature or if the waste vapor does not have sufficient combustible content to maintain combustion. This system has

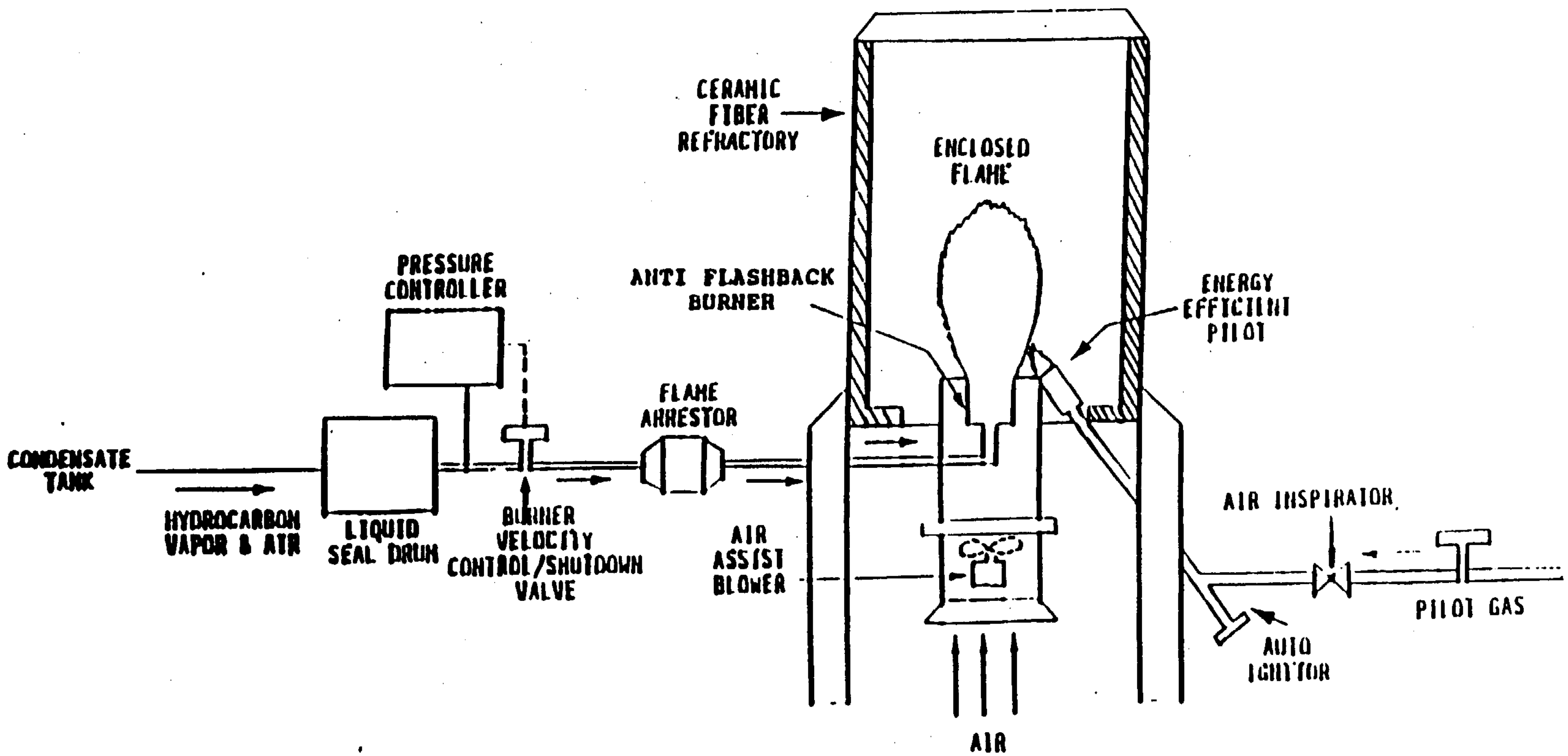
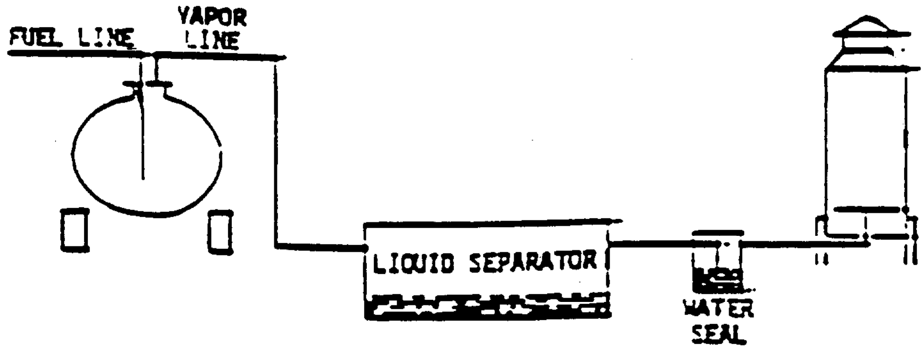


Figure 4-5. A Simplified Flow Diagram for a Typical Enclosed Flare System
(Diagram Courtesy of the John Zink Company)

the same features as the enclosed flare with the addition of automatic temperature control which is accomplished by the application of quench air and supplemental fuel. Combustion air is controlled by dampers to ensure the proper oxygen content and temperature. This system also automatically supplements the waste vapor, as needed, with assist gas (normally natural gas or propane). Figure 4-6 illustrates a temperature controlled flare.

Refrigeration condenser systems recover gasoline vapors from the loading operation in the form of a liquid product. In these systems, the air-vapor mixture from the loading racks is routed to a condensation chamber and passed over a series of cooling coils. Temperatures in the condensation section can be as low as -180°F (-118°C). The gasoline vapors condense, with some water vapor in the air, and are separated in a gasoline/water separator.

In this unit, the vapor mixture is precooled to a water vapor dew point of approximately 34°F (1°C) to remove most of the water vapor. From the precooler unit, the vapor enters the condenser where vapor with heavier molecular weight is condensed and collected. The design and use of refrigeration direct expansion condensing coil heat exchangers permits raising the refrigeration compressor suction pressure. This results in increased capacity of the unit at a constant condensing temperature. At periodic intervals, defrosting the finned surfaces may be required. This is accomplished by circulation of a warm solution which is stored in a separate reservoir. Defrosting is normally completed in 30 to 60 minutes, depending upon the amount of frost collected on the finned surfaces. The warm solution temperature is maintained by heat reclamation from the compressor equipment. There are also multi-stage refrigeration units that allow the vapor to be cooled to even lower temperatures. In these units, refrigerants are used to cool other refrigerants that in turn cool the vapor.



Schematic Diagram Showing
Incorporation of Temperature
Controlled Flare

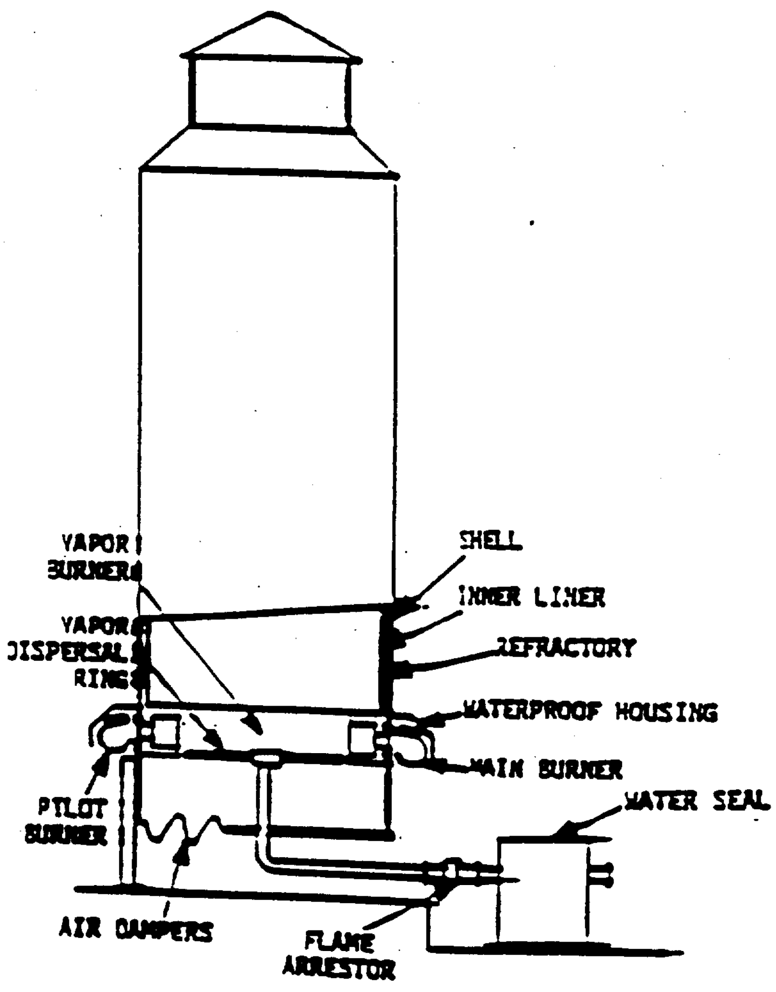


Figure 4-6. A Typical Temperature Controlled Flare and Simplified Flow Diagram
(Diagram Courtesy of the John Zink Company)

Figure 4-7 illustrates a simplified diagram of a refrigeration condenser system.

Controlling emissions from railcar loading racks is very similar to control at truck racks. The vapor processors discussed above for truck loading racks are suitable for controlling emissions from railcar loading.

4.1.2.3 Effectiveness of Control Techniques. Vapor processors for controlling loading rack emissions at bulk terminals have been in place for about 20 years for the control of VOC. The CTG level of control for ozone nonattainment areas was set at 80 mg VOC/liter in 1977.[3] Processors have not experienced difficulty meeting this level. In addition, the NSPS level of control for new, modified, and reconstructed sources was set at 35 mg/liter in 1983 (40 CFR 60, Subpart XX). Control device manufacturers have also not experienced difficulty designing and manufacturing devices to meet this level. In the Bay Area and Sacramento Air Quality Management Districts of California, the limit is set at 10 mg/liter. While the types of control devices that meet this level may be limited, sources are able to comply with these limits for VOC control. Additionally, afterburners may be retrofitted to existing vapor recovery units that can no longer meet these specific emission levels. These combustors are somewhat different from flares in that they are designed to destruct an air and hydrocarbon mixture, while flares are designed to burn only hydrocarbons. Several plants in California have undergone this retrofitting operation (Texaco, Arco, and Santa Fe pipeline) and now meet the required emission limitations.[4]

Table 4-1 contains a summary of test data obtained from various State agencies including the California Air Resources Board and the American Petroleum Institute, as well as data previously gathered by the EPA. The data are presented in emission limitation order, from lowest to

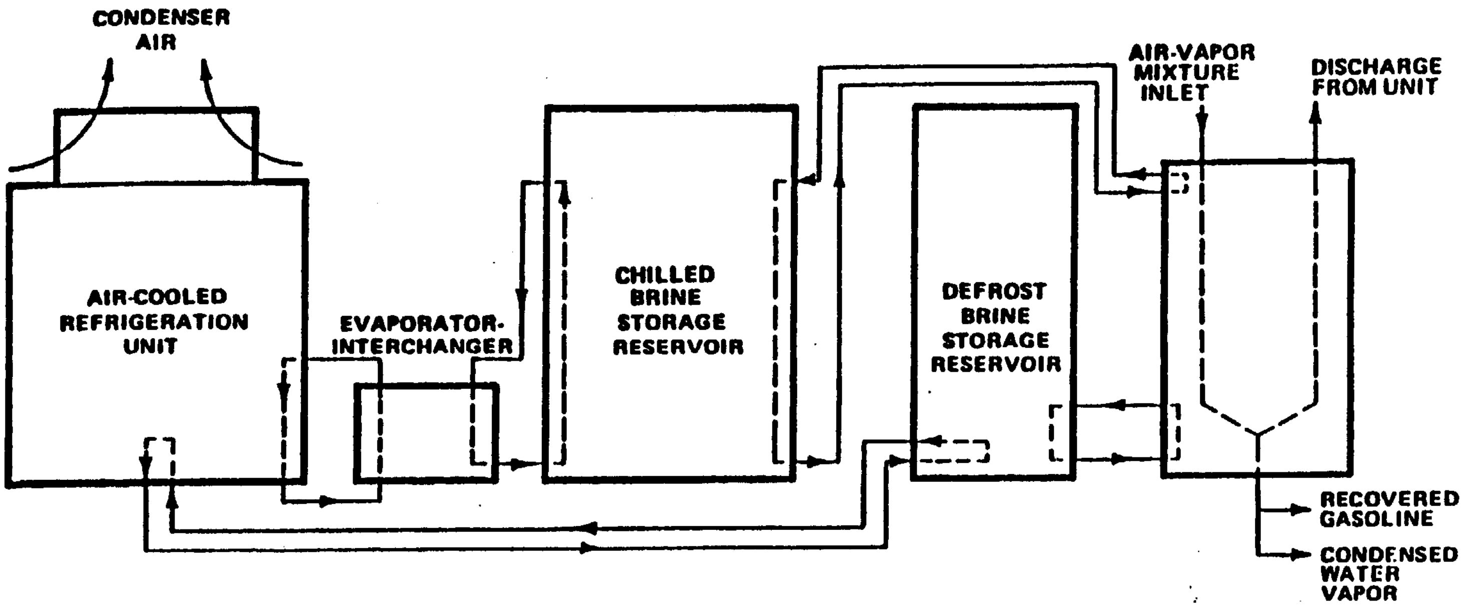


Figure 4-7. A Simplified Diagram of a Refrigeration System
(Diagram Courtesy of Edwards Engineering Corp.)

TABLE 4-1. SUMMARY OF EMISSION TEST DATA FOR BULK GASOLINE TERMINAL VAPOR PROCESSORS

Control Type	Date of Test	Allowable Emissions (mg/l)	Actual Emissions (mg/l)		Source of Data
TO	08/22/90	10	0.006		2
CA	06/01/90	10	0.06		2
TO	09/29/89	10	0.11		2
CA	09/20/90	10	0.6		2
TO/VRU	11/30/89	10	1.1		2
TO	08/30/89	10	1.2		2
CA	07/12/89	10	1.6		2
TO/REF	06/29/90	10	1.7		2
CA	05/24/89	10	1.9		2
CA	03/08/89	10	1.9		2
REF	09/06/90	10	2.4		2
CA	08/10/89	10	3.6		2
CA	08/09/89	10	4	1.552[a]	2
TO/CRA	07/26/89	35	0.12		2
CA	01/30/90	35	0.33		1
CA	10/23/90	35	0.45		1
CA	09/08/89	35	0.5		1
CA	12/15/89	35	0.7		4
CA	03/13/90	35	0.75		1
CA	12/20/89	35	0.9		4
CA	01/04/90	35	1.1		4
CRA	06/20/90	35	1.6		1
CA	11/29/88	35	1.6		1
CA	06/13/90	35	1.8		1
CA	08/08/81	35	1.97		1
CA	12/07/89	35	2.1		4
REF	04/12/90	35	2.6		2
CA	06/04/89	35	2.6		1
CA	06/15/90	35	2.9		1
VRU[b]	09/19/90	35	2.9		1
CA	10/26/81	35	3		1

TABLE 4-1. (Continued)

Control Type	Date of Test	Allowable Emissions (mg/l)	Actual Emissions (mg/l)	Source of Data
CA	04/09/87	35	3.1	2
TO	03/07/89	35	3.1	1
CA	07/03/90	35	3.2	1
CA	02/28/89	35	3.4	1
CA	07/10/91	35	3.5	1
CA	NA	35	3.5	1
TO	09/11/89	35	3.7	1
CA	06/28/90	35	4.3	1
VRU[b]	06/26/90	35	4.4	1
CA	05/20/87	35	4.8	1
CA	02/27/91	35	5	1
CA	03/01/91	35	5.1	1
CA	05/16/91	35	5.2	1
CA	03/10/88	35	5.3	1
CA	02/12/89	35	5.5	1
CA	10/11/89	35	5.5	1
CA	07/25/90	35	5.7	1
CA	06/25/90	35	5.8	1
VRU[b]	07/25/90	35	6.1	1
CA	03/07/89	35	7.35	1
CA	06/22/89	35	8.5	2
CA	06/20/90	35	9.3	1
CA	09/15/89	35	9.4	1
TO	07/29/87	35	9.5	1
TO	03/22/91	35	9.5	1
CA	05/17/91	35	10.8	1
CA	02/07/90	35	11	2
CA	06/08/90	35	11.4	1
CA	12/16/88	35	13.8	1
TO	10/24/90	35	13.9	1
CA	05/10/91	35	14.4	1
CA	06/29/90	35	15.2	1
REF	09/21/89	35	15.6	2

TABLE 4-1. (Continued)

Control Type	Date of Test	Allowable Emissions (mg/l)	Actual Emissions (mg/l)	Source of Data
CA	06/21/89	35	18	2
CA	07/11/90	35	18.2	1
REF	03/28/90	35	19.7	1
CA	05/05/89	35	20.8	1
REF	06/29/88	35	25.7	1
TO	07/20/89	35	27	1
REF	03/02/90	35	29.8	1
REF	03/25/87	35	30	2
REF	05/11/88	35	33.6	2
CA	12/05/89	35	34	2
CA	07/20/90	60	0.22	2
TO	12/16/80	80[c]	0.2	3
TO	01/20/81	80[c]	0.22	3
CA	09/17/80	80[c]	0.65	3
CA	09/22/80	80[c]	0.66	3
CA	02/04/81	80[c]	1.2	3
TO/COM	05/14/80	80[c]	1.2	3
CA	01/22/81	80[c]	1.5	3
CA	02/02/81	80[c]	1.6	3
CA	02/06/81	80[c]	1.6	3
CA	10/01/80	80[c]	1.8	3
CA	10/06/80	80[c]	2.3	3
CA	12/02/83	80[c]	3.5	1
CA	11/14/80	80[c]	4.5	3
CA	09/26/80	80[c]	4.5	3
CA	11/12/80	80[c]	4.8	3
CA	10/10/80	80[c]	5	3
CA	02/11/81	80[c]	5.2	3
CA	11/13/80	80[c]	5.6	3
CA	06/06/79	80[c]	5.9	3
CA	10/01/80	80[c]	6.3	3
CA	07/10/80	80[c]	6.7	3
CA	04/30/80	80[c]	6.9	3

TABLE 4-1. (Concluded)

Control Type	Date of Test	Allowable Emissions (mg/l)	Actual Emissions (mg/l)	Source of Data
CA	01/08/81	80[c]	7.5	3
CA	12/09/80	80[c]	7.7	3
CA	06/28/90	80	7.8	1
CA	05/22/80	80[c]	7.9	3
VRU[b]	07/11/91	80	8.4	1
CA	10/03/80	80[c]	11	3
CA	09/29/80	80[c]	15.6	3
CA	10/02/80	80[c]	17.9	3
CA	05/26/89	80	21.2	1
REF	05/30/80	80[c]	21.9	3
REF	03/26/81	80[c]	22.6	3
CA	07/31/90	80	30.9	1
REF	02/20/81	80[c]	41.8	3
REF	11/07/90	80	46.6	1
TO	10/31/84	80	60.5	1
REF	12/19/89	80	69.6	4
CRA	04/25/84	80	69.8	1
CA	10/31/89	108	0.18	2

Sources

1 Test reports obtained from requests made to State Agencies. Data obtained from Georgia, Kansas, Kentucky, Maryland, New Jersey, New Mexico, Oklahoma, Tennessee, Texas, Virginia, Washington, and Wisconsin, October 1991.

2 CARB Bulk Gasoline Terminal Vapor Recovery System Certifications, October 23, 1990.

3 Bulk Gasoline Terminal Background Information Document, Volume II (EPA-450/3-80-038b), August 1983.

4 American Petroleum Institute study, "Determining the Benzene Emission Factor of Existing Marketing Terminal Vapor Recovery Units," June 1990.

Notes

(a) Arithmetic average emission rate for units subject to 10 mg/l standard.

(b) Vapor recovery unit (VRU) type not specified.

(c) Allowable emissions not reported. Assumed that allowable emissions were equal to 80 mg/l since most of the tests reported from Source 4 were performed prior to the proposal of the NSPS for bulk terminals (December 1980).

NA = Not available.

highest. Also provided are the dates the tests were performed, the vapor control system types (CA = carbon adsorber, TO = thermal oxidizer, REF = refrigeration unit, VRU = vapor recovery unit, CRA = compression/refrigeration/ absorption unit, COM = compression unit), and the emission rate determined during the tests. Insufficient information was available in the test data that were submitted to determine the type of flare system tested (elevated, enclosed or temperature controlled with or without a vapor holder, etc.). The test data indicate that control systems of all three types discussed above easily meet the appropriate emission limitations and that emission rates less than 10 mg/liter can be achieved.

As discussed in Appendix D, it is assumed that 94 percent of uncontrolled loading at terminals occurs by submerged fill and 6 percent by splash fill. Using the submerged fill (658 mg/l) and splash fill (1,590 mg/l) emission factors calculated from the national weighted average RVP (11.4 psi) and the selected temperature (60°F), the weighted average emission factor for uncontrolled loading at terminals is calculated to be 715 mg/l. Therefore, the levels of control discussed above represent control efficiencies of total VOC of slightly less than 90 percent at 80 mg/liter, 95 percent at 35 mg/liter, and 99 percent at 10 mg/liter.

The focus of this report is the control of HAPs. It is possible that these vapor processors could control HAPs at a different percent reduction than total VOC. Therefore, the effectiveness of each of the three major types of control devices is discussed below.

Initially, the effectiveness of controlling HAPs relative to total gasoline vapors can be considered from a theoretical standpoint. As discussed in Section 3.2.2.1, the major part of gasoline vapors is made up of alkanes with four or five carbon atoms. However, most of the HAPs contained in gasoline vapor are aromatic compounds. There are several properties of aromatics that allow their control effectiveness to be higher than for the alkanes.

First, it would be expected that both carbon adsorption and refrigeration/condensation type control systems would control these aromatics to a level slightly greater than that for total VOC. This is because of the higher molecular weights and lower boiling points and volatilities of the aromatics. Conversely, due to the increased bond strength in aromatic compounds, incineration may control the more volatile and lighter compounds slightly better than the aromatics.

Specific tests have been conducted to determine the control device efficiency for HAPs. Several test reports from the late 1970's and early 1980's were analyzed to estimate benzene emissions from various types of vapor processors.[5] This analysis showed that carbon adsorption and refrigeration systems significantly reduced VOC and benzene in the vapor stream.

In a report entitled "Determining the Benzene Emission Factor of Existing Marketing Terminal Vapor Recovery Units", dated June 4, 1990, AmTest, Inc. (for API) described emissions testing and liquid and vapor sample analyses for five terminals in the Pacific Northwest.[6] The intent of this test program was to make a rapid determination of the ability of existing vapor recovery units at bulk terminals to meet the EPA proposed benzene emission standard (1989) of 0.2 mg/liter. One control system was a refrigeration system designed to meet the 80 mg/liter VOC standard and the other four were carbon adsorption systems designed for the 35 mg/liter VOC standard. Hydrocarbon emissions from the adsorption systems ranged from 0.7 to 2.1 mg/liter, while emissions from the refrigeration system were 69.6 mg/liter. The average benzene concentration in both regular (leaded) and unleaded liquid gasolines was 2.2 percent, while the concentration in super grade averaged 2.5 percent. The benzene emissions averaged less than 0.01 mg/liter, and the concentration in the system outlet vapors was less than 3 ppm.

The report also summarized test results from an independent study conducted by an API member company in southeastern Pennsylvania. This testing was conducted November 14-17, 1989, on four systems described in the report as charcoal, refrigeration, lean oil charcoal, and compression. Hydrocarbon emission rates were 11 to 14 mg/liter for the charcoal systems, and 45 and 152 mg/liter, respectively, for the refrigeration and compression systems. Control efficiency for benzene was well over 99 percent for all systems except the compression type, which controlled benzene at 72 percent.

Inlet and outlet vapor samples were also analyzed for toluene and xylene content. Toluene control efficiencies were approximately 99 percent for all systems except the compression system, which controlled toluene at about 75 percent. Xylene was controlled at 85 to 98 percent for the three systems and at about 76 percent by the compression system.

4.1.3 Storage Tanks at Terminals and Pipeline Facilities

4.1.3.1 Locations and Applicability. Gasoline storage tanks are located at all of the gasoline marketing facilities with the exception of pipeline pumping stations. However, the type of storage tank varies considerably among the gasoline storage and distribution facilities. This variation ranges from large external floating roof tanks having capacities of up to 5 million gallons at pipeline breakout stations and bulk terminals to underground storage tanks with capacities of around 10,000 gallons at service stations.

The control techniques discussed in this section are specifically related to the larger storage tanks at pipeline breakout stations and bulk terminals. Control techniques for bulk plant and service station storage tanks are discussed later in this chapter.

4.1.3.2 Description of Control Techniques. Storage tank emissions arise from breathing losses and from filling and emptying losses (working losses). There are two major types of storage vessels, fixed-roof tanks and external floating roof tanks. Fixed roof tanks may have internal floating roofs as well. Each tank type has its own associated emission rate.

Storage tank control requirements for gasoline storage tanks have been made by the EPA through control technique documents.[7,8] As discussed in Appendix D, many States have promulgated regulations in response to these CTGs for storage tanks. In addition, EPA has promulgated NSPS regulations for petroleum storage tanks (40 CFR 60 Subparts K, Ka, and Kb) that apply to gasoline storage tanks at terminals and pipeline facilities.

A fixed-roof tank is the original, traditional vessel used for the storage of gasoline. Working losses (filling and emptying losses) and breathing losses normally incurred from the storage of gasoline in fixed-roof tanks can be reduced in the following ways:

- by the installation of an internal floating roof with rim seals; or
- by the installation and use of a vapor processing system (e.g., carbon adsorption, incineration, or refrigerated condensation); or
- a vapor balance system.

Fixed-roof tank emissions at bulk terminals and pipeline breakout stations are most readily controlled by the installation of internal floating roofs. An internal floating roof, regardless of design, reduces the area of exposed liquid surface to air in the tank. Reducing the area of exposed liquid surface, in turn, decreases the evaporative losses which are the largest source of emissions for this piece of equipment. The presence of the floating roof vapor barrier precludes direct contact between a large portion of the liquid surface and the atmosphere, thus reducing emissions. All internal floating roofs share this design benefit. The relative effectiveness of one internal floating roof design over another is a function of how well the floating roof can be sealed.

From an emissions standpoint, the most basic internal floating roof design is the bolted, aluminum, internal floating roof with a single vapor-mounted wiper seal. The four types of losses from this roof design are: (1) rim or seal losses, (2) fitting losses, (3) deck seam losses, and (4) withdrawal losses. Rim or seal losses and fitting losses constitute the largest percentage contribution to the total loss from an internal floating roof tank.

External floating roof tanks do not experience the fitting losses or deck seam losses that occur with most internal floating roof tanks. External floating roof tanks are constructed almost exclusively of welded steel, thus assuring the absence of the deck seam losses. Further, because of the roof design, few if any deck penetrations are necessary to accommodate fittings.

Rim seal losses and withdrawal losses do occur with external floating roof tanks. The only difference between external floating roof tanks and internal floating roofs is that the external floating roof seal losses are believed to be dominated by wind induced mechanisms.[9] Withdrawal losses in external floating roof tanks, as with internal floating roof tanks, are entirely a function of the turnover rate and inherent tank shell characteristics. No control measures have been identified that are applicable to withdrawal losses from floating roof tanks.

4.1.3.3 Effectiveness of Control Techniques. Available emissions test data[10] suggest that the location of the seal (i.e., vapor- or liquid-mounted) and the presence of a secondary seal are the primary factors affecting the effectiveness of seal systems. A liquid-mounted primary seal has a lower emission rate and thus a higher control efficiency than a vapor-mounted seal. A secondary seal, whether in conjunction with a liquid- or vapor-mounted primary seal, provides an additional level of control.[11] Table 4-2 shows these control efficiencies.

Rim seal losses from external floating roof tanks vary depending on the type of seal system employed. As with internal floating roof rim seal systems, the location of the seal (i.e., vapor- or liquid-mounted) is the most important factor affecting the effectiveness of resilient seals for external floating roof tanks. The relative effectiveness of the various types of seals can be evaluated by analyzing the seal factors. These seal factors were developed on the basis of emission tests conducted on a pilot scale tank. From such an analysis it is clear that liquid-mounted seals are more effective than vapor-mounted seals at reducing rim seal losses. Metallic shoe seals, which commonly are employed on only external floating roof tanks, are more effective than vapor-mounted resilient seals but less effective than liquid-mounted resilient seals. Table 4-3 presents these control efficiencies.

4.1.4 Tank Truck Leakage

4.1.4.1 Locations and Applicability. Just as there are several loading methods and types of rack equipment at terminals and bulk plants to fill tank trucks with gasoline, there are several compatible truck loading systems. Gasoline tank trucks are normally divided into compartments with a hatchway at the top of each compartment. Top loading can be accomplished by opening the hatch cover and dispensing product directly through the hatch by splash or submerged fill. A top loading vapor system, compatible with the hatch, permits loading through the hatch while vapors are collected. A better vapor-tight seal is realized when bottom loading is used. A 1979 survey[12] covering approximately 1,900 tank vehicles, or about 2 percent of the gasoline tank truck population at that time, indicated that 22.8 percent of tank trucks had only top loading, while the

TABLE 4-2. TANK SEAL CONTROL EFFICIENCIES - INTERNAL FLOATING ROOF TANKS[a]

Tank & Seal Type	% Reduction From Least Control	Incremental % Reduction
Fixed-Roof Uncontrolled "Least Control"	-	-
Internal Floating Roof		
Primary Seal only (Vapor-mounted)	93.5%	93.5%
Primary Seal only (Liquid-mounted)	94.9%	1.4%
Primary Seal (Vapor-mounted) w/Secondary Seal	95.1%	0.2%
Primary Seal (Liquid-mounted) w/Secondary Seal	95.5%	0.4%

[a] Calculated with equations from Section 4.3 of AP-42 using the nationwide weighted average RVP of 11.4 and a temperature of 60°F.

TABLE 4-3. TANK SEAL CONTROL EFFICIENCIES - EXTERNAL FLOATING ROOF TANKS[a]

Tank & Seal Type	% Reduction From Least Control	Incremental % Reduction
External Floating Roof		
Primary Seal only (Vapor-mounted) "least control"	-	-
Primary Seal (Vapor-mounted) w/weather shield	38.7%	38.7%
Primary Seal (Vapor-mounted) w/Rim-mounted secondary	63.8%	25.1%
Primary Seal only (Mechanical)	80.5%	16.7%
Primary Seal (Mechanical) w/Shoe-mounted secondary	90.6%	10.1%
Primary Seal only (Liquid-mounted)	91.2%	0.6%
Primary Seal (Liquid-mounted) w/weather shield	93.1%	1.9%
Primary Seal (Mechanical) w/Rim-mounted secondary	94.8%	1.7%
Primary Seal (Liquid-mounted) w/Rim-mounted secondary	94.9%	0.1%

a Calculated with equations from Section 4.3 of AP-42 using the nationwide weighted average RVP of 11.4 and a temperature of 60°F.

remaining 77.2 percent could be either top or bottom loaded. Although no more recent definitive information is available, the trend is toward more trucks using bottom loading, due to State vapor recovery regulations and the advantages cited in Section 3.2.3.1.

Tank trucks become a separate source of emissions when fugitive leakage occurs from the truck-mounted vapor collection systems and truck compartment dome covers. This vapor leakage has been observed to be as high as 100 percent, with an average loss of 30 percent when no regular leak testing and repair program was in effect.[13]

4.1.4.2 Description of Control Techniques. There are two basic control methods for reducing emissions from tank truck leakage. Vapor leakage can be minimized by ensuring that the tank trucks are vapor tight or a vacuum can be generated to draw the vapors from the tank truck to the vapor processor. Figure 4-8 illustrates the tank truck vapor collection-equipment.

There are two methods of ensuring vapor tightness for trucks, both involving the periodic leak-testing of the tanks. The CTG for gasoline tank trucks recommends pressure limits for an annual test on the tanks and their vapor collection equipment.[14] The CTG recommendations for vapor tight tank trucks are that 1) the tank truck must pass an annual leak-tight test that requires having less than 3" H_2O pressure change under 18" H_2O pressure or 6" H_2O vacuum; 2) there will be no leaks greater than 100 percent of the lower explosive limit (LEL) when monitored at any time with a portable combustible gas analyzer; and 3) vapor collection systems back pressure not exceed 18" H_2O pressure when measured at the truck.

In addition to the CTG level, many districts in the State of California require an annual leak-tight test with less than 1" or 2" H_2O pressure change rather than the CTG

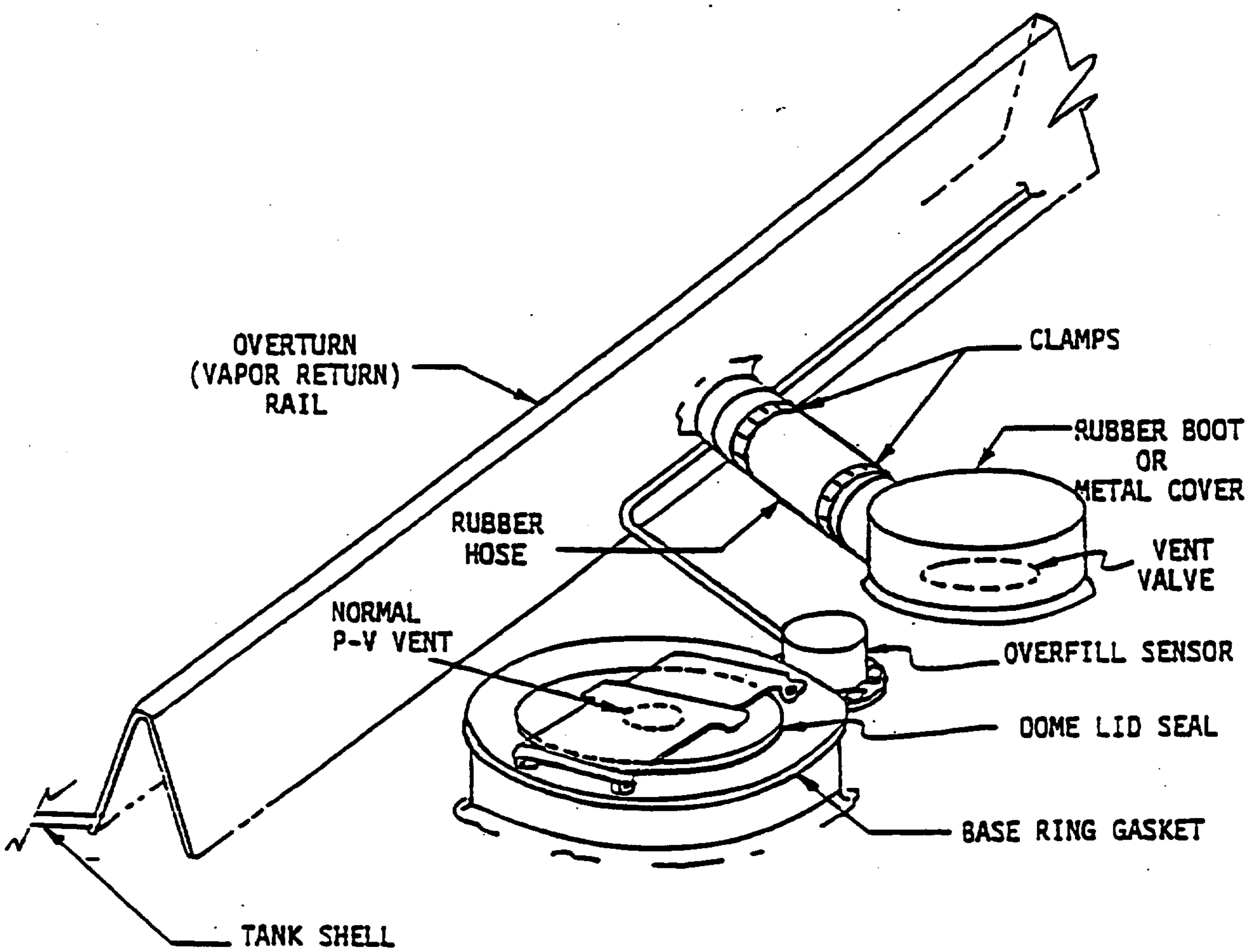


Figure 4-8. Tank Truck Vapor Collection Equipment for Bottom Loading Operations

recommendation of 3" H_2O. In addition to this difference, there are enforcement programs in California that actively monitor trucks using portable gas analyzers or equivalent methods. The combination of this more stringent test and increased enforcement, results in a control level slightly more effective than the CTG level.

Recently, the U.S. Department of Transportation (DOT) has also required an annual leak tightness test for cargo tank trucks. According to 49 CFR Part 180 §407 (c), the DOT test requires all cargo tanks, except cryogenic tanks, to have an annual leakage test. The test specifies that the cargo tank should be pressurized to at least 80% of the maximum allowable working pressure (MAWP), which is approximately 2-3 psi for a typical gasoline tank truck. Once pressurized, the cargo tank must maintain the test pressure for at least 5 minutes. Any valves or vents set at a release pressure lower than the test pressure are either rendered inoperative or capped off prior to testing. Such valves include the P-V vent under the dome plate assembly and the vent valve which is connected to the overturn rail. The DOT leakage test does not include a vacuum test as specified in EPA's Method 27. However, the DOT considers EPA's Method 27 test an acceptable alternative. The P-V vents under the dome covers that are capped off during the DOT test are potential emission points, thus Method 27 testing is needed to make certain that the tanks are vapor-tight at loading (less than 14 inches of water) and unloading (less than 6 inches of water) pressures.

Vapor leakage can also be minimized through the use of a vacuum assisted vapor collection system. The system employs a vacuum source in the vapor return line and maintains a slight negative pressure at the tank truck during loading. The system is designed, through permissive interlocking, to prevent loading from occurring unless an adequate vacuum is created and maintained in the system. This system is in use at a few bulk terminals in Texas[15,16,17] and one of the systems has been operating for over 2 years. At that terminal, the negative pressure is created at the tank truck and in the vapor return line by means of a 15 horsepower (hp) blower.[17] This system application for truck loading racks is relatively new technology and although it is now employed at only a few terminals, apparently others are planned.

4.1.4.3 Effectiveness of Control Techniques. The effectiveness of vapor control systems at bulk terminals and bulk plants is dependent upon the absence of leaks in the vapor-containing equipment on the tank truck. In EPA-sponsored tests, the average vapor loss due to tank truck leakage was determined to be 30 percent in areas having no tank truck vapor tightness regulations.[18] In June 1978 the EPA conducted a series of vapor leak tests on 27 tank trucks that were required to undergo an annual leak tightness test.[19] Tests were conducted on the tank trucks before any maintenance was performed to establish the truck leakage rate since the last certification. Evaluation of these data indicated that the average vapor leak rate for those tanks tested prior to maintenance was approximately 10 percent, meaning that, on the average, approximately 10 percent of the air-vapor mixture exhausted from a regulated gasoline tank truck during product loading would leak to the atmosphere without reaching the vapor processor.[20]

The design of the vacuum assist system suggests that tank truck leakage should be reduced nearly to zero. Although leakage at the truck is reduced or eliminated, the vacuum system introduces additional air into the vapor collection system requiring additional processing by the vapor processing system. To the Agency's knowledge, the systems that are in operation have not experienced any significant problems either at the processor or at the tank truck. However, test data on this system are not yet available for effectiveness analysis. Additionally, these systems are not designed for use without a vapor processor; therefore, they would not be appropriate at a bulk plant where a processor is not in use.

4.1.5 Tank Truck Unloading and Loading at Bulk Plants

4.1.5.1 Location and Applicability. Bulk plants are a secondary facility in the gasoline distribution system and are typically located in more rural areas. Bulk plants have fixed-roof tanks for storing gasoline and have loading racks that do the same job as those at terminals, only on a smaller scale. Control of gasoline working and breathing losses resulting from storage and handling of gasoline at bulk plants can be accomplished through submerged fill and a vapor balance system. The EPA developed CTG guidelines for bulk plants in 1977[21] recommending control alternatives of 1) submerged fill of outgoing tank trucks, 2) submerged fill of outgoing tank trucks and vapor balance for incoming transfer, and 3) submerged fill and vapor balance for outgoing transfer and vapor balance for incoming transfer.

4.1.5.2 Description of Control Techniques. The vapor balance system consists of a pipeline between the vapor spaces of the truck and the storage tank which essentially creates a closed system allowing the vapor spaces of the storage tank and the truck to balance with each other. Figure 4-9 shows the balance system at a bulk plant. The net effect of the system is to transfer vapor displaced by liquid in the storage tank into the transport truck during transfer of gasoline into the storage tank. This prevents the compression and expansion of vapor spaces which would otherwise occur in a filling operation. If a system is leak-tight, very little or no air is drawn into the system, and venting, due to compression, is also substantially reduced. Also, vapor balancing of storage tanks and outgoing account trucks reduces account truck filling losses and virtually eliminates emptying losses from storage tanks (i.e., displaced vapors are returned to the storage tank in this closed balance system).

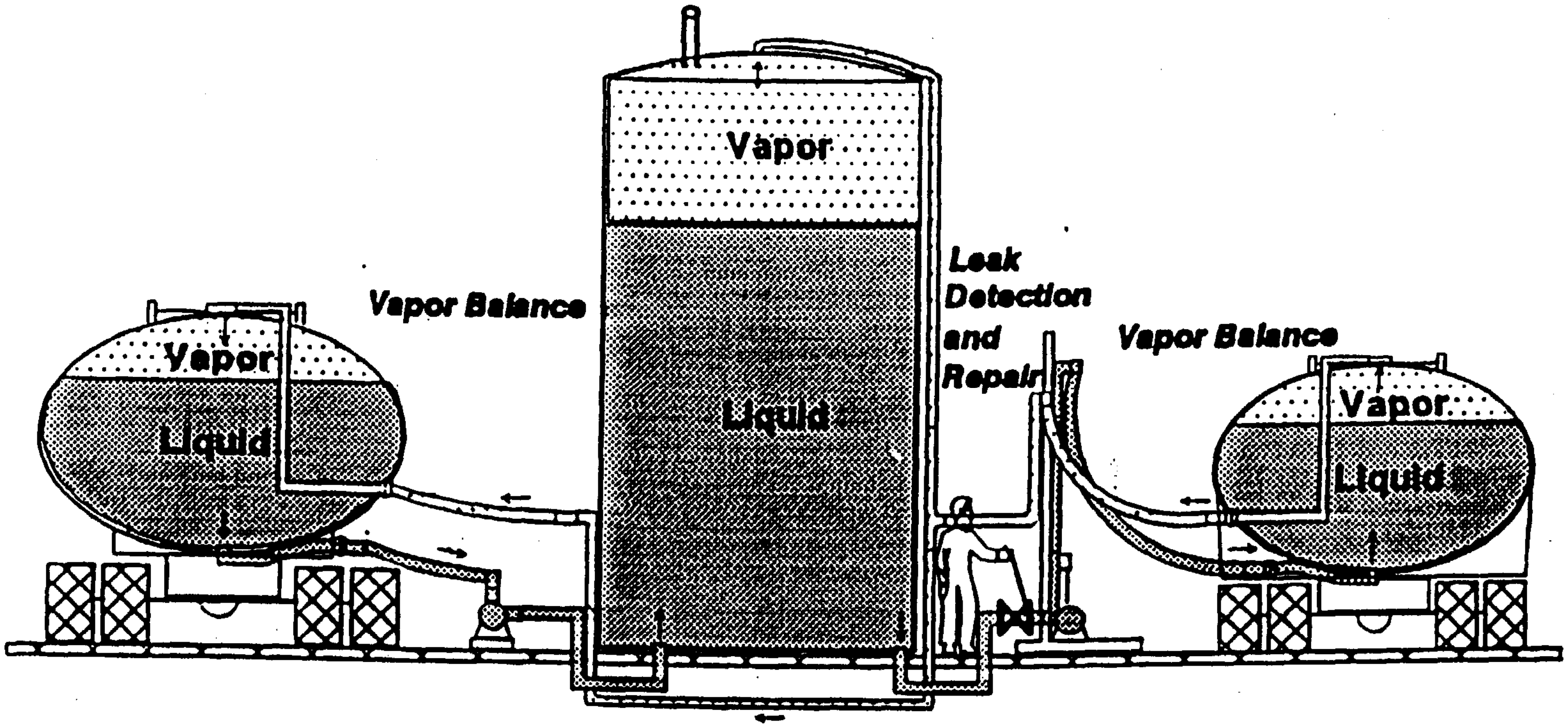


Figure 4-9. Vapor Balance System at a Bulk Gasoline Plant

4.1.5.3 <u>Effectiveness of Control Techniques</u>. As discussed earlier, submerged filling of tank trucks can reduce vapor loss by almost 60 percent when compared to splash loading.

The balance system has proven to be effective in bulk plant applications for both the delivery of gasoline by transport trucks to the bulk plant and for the loading of account trucks. Based upon test data, controls on bulk plant storage tanks can reduce filling and working/breathing losses and tank truck loading losses by greater than 95 percent.[22,23,24]

Based on the uncontrolled emission rates discussed in Chapter 3 (see Table 3-9), an emission factor of 54.0 mg/liter was used to represent the balance system control technology for tank filling losses based upon 95 percent control of the uncontrolled emissions (1,081 mg/liter). Emission factors for storage tank working losses and tank truck loading losses were assumed to be 21.7 mg/liter and 49.0 mg/liter respectively, based upon 95 percent control of the respective uncontrolled emission factors (tank working losses - 432 mg/liter, truck loading losses (balance service) - 980 mg/liter). High efficiencies are achieved by maintaining the integrity of the storage tanks, tank trucks, and associated vapor collection systems, and ensuring that proper connections are made.

4.1.6 <u>Service Stations</u>

4.1.6.1 <u>Location and Applicability</u>. Service stations are numerous and located virtually everywhere. Vapor balance and submerged fill controls for service station underground storage tanks were recommended in a CTG issued by the EPA in the mid 1970's.[25]

4.1.6.2 <u>Description of Control Techniques</u>. Emissions from underground tank filling operations at service stations have been demonstrated to be reduced by the use of vapor balance systems (Stage I control). In the service station balance system, vapors which would normally be vented to the atmosphere are routed back to the delivery truck during unloading through a vapor collection system. The truck transfers the vapors to the terminal or bulk plant for ultimate treatment by the vapor processor at the terminal.

Gasoline is loaded by gravity into the underground storage tanks via a flexible hose. Liquid gasoline displaces a nearly equal volume of air partially saturated with gasoline vapors. The vapor is routed through a pipe and flexible hose connected to a vapor collection system (i.e., a manifolded pipe) on the transport truck. Liquid transfer creates a slight pressure in the storage tank and a slight vacuum in the truck compartment. These pressure differences effectively cause the transfer of displaced vapor to the truck. Because of a phenomenon known as vapor growth (caused by liquid temperature differences), the truck volume cannot always accommodate all of the vapors. Any excess vapor is released through the vapor vent line as shown in Figure 4-10. To prevent this excess vapor from escaping into the atmosphere, a pressure-vacuum (P-V) valve may be installed on the vapor vent line. Not only would the P-V valve prevent leakage caused by vapor growth during underground tank loading, but such a device would also prevent breathing losses due to diurnal fluctuations in temperature and barometric pressure.[26,27]

4.1.6.3 Effectiveness of Control Techniques. The effectiveness of the Stage I vapor balance system is adversely affected by leaks. Truck hatches must be closed and hose connections should be tight during loading. Tests demonstrate balance systems to be greater than 95 percent efficient for reducing underground storage tank filling losses.[28,29,30] Note that breathing and emptying losses are not controlled by this method. These two sources account for 5 percent of total station losses. However, by installing a P-V vent some of this vapor loss can be stopped. According to one source, an average 90,000 gallon per month facility will save 8.3 gallons of gasoline per

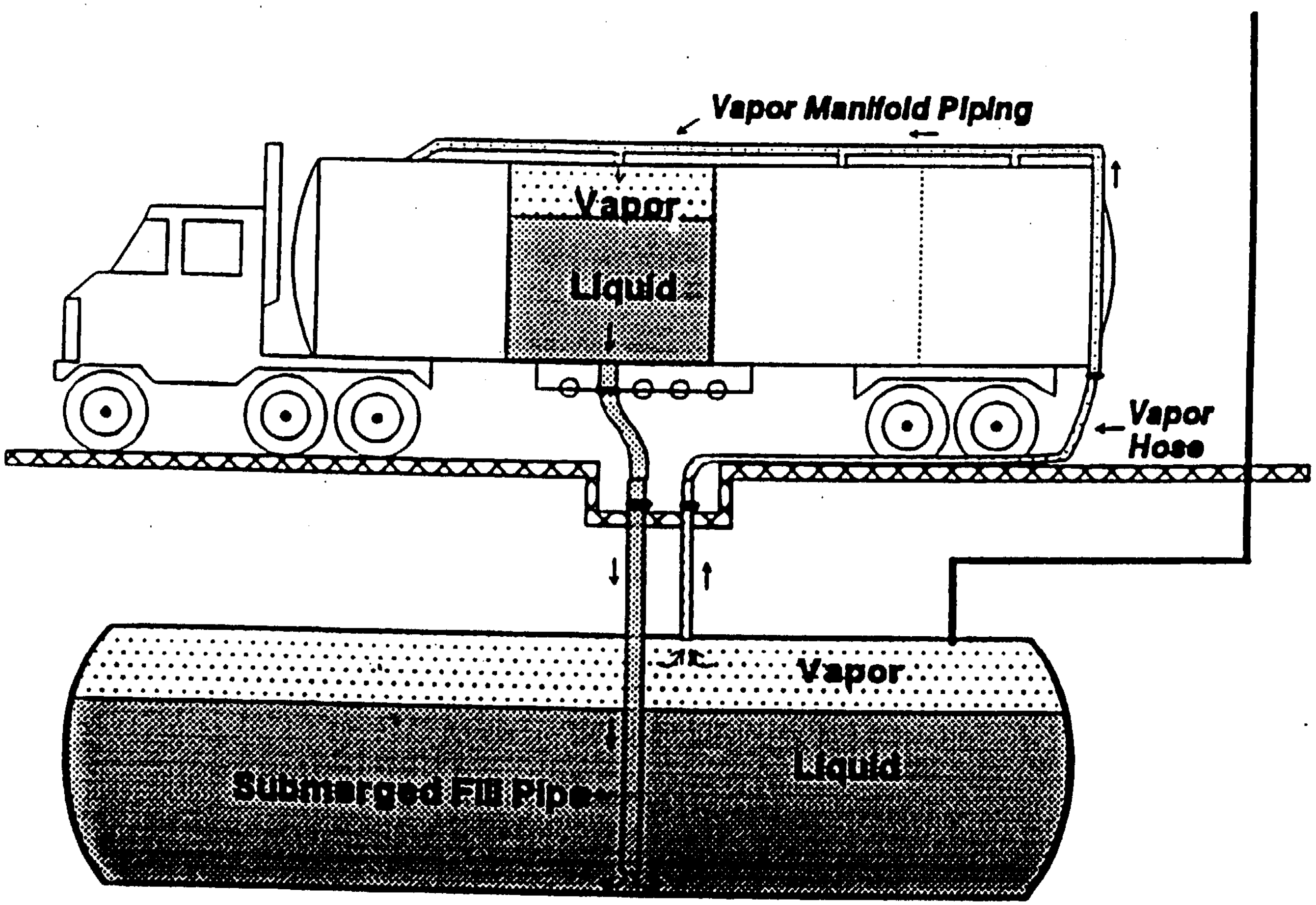


Figure 4-10. Vapor Balance System at a Service Station

month by installing P-V valves on service station storage vents.[31]

In order for the vapor balance system's performance to be maintained at design efficiency levels, the following objectives must be met:

- assure that the vapor return line will be connected during tank filling;
- assure that there are no significant leaks in the system or tank truck which reduce vacuum in the truck or otherwise inhibit vapor transfer;
- assure that the vapor return line and connectors are of sufficient size (minimum 3 inches in diameter) and sufficiently free of restrictions to allow transfer of vapor to the tank truck and achieve the desired recovery; and
- assure that gasoline is discharged below the gasoline surface in the storage tanks (submerged filling).

4.1.7 Fugitive Emissions

4.1.7.1 Locations and Applicability. Pumps, valves, and other components capable of leaking and producing fugitive HAP emissions are present at pipeline pumping stations, pipeline breakout stations, bulk terminals, and bulk plants. The control techniques discussed in this section could be applied at any of these facilities. CTG recommendations and NSPS and NESHAP regulations have been developed to control fugitive emissions from pumps, valves, and compressors in both liquid and vapor service, but not at these specific facilities.

4.1.7.2 Description of Control Techniques. There are basically two approaches to the control of fugitive emissions from pumps, valves, and other components. The first entails a leak detection and repair program in which fugitive sources are located and repaired at certain intervals. The second is a preventive approach whereby potential fugitive sources are controlled either by installing specified controls or leakless equipment.

Leak detection and repair programs use various monitoring techniques in a leak detection program to identify leaking equipment. These methods include individual component surveys, area surveys, and fixed point monitoring systems.

Each component is surveyed on a periodic basis. There are two common methods of conducting this survey. These include 1) leak detection by spraying each component with a soap solution and observing bubble formation, and 2) leak detection by measuring VOC concentration with a portable VOC detector. Another method is to perform visual inspections of each component to detect the evidence of liquid leakage.

The area survey entails walking through the area measuring the ambient VOC concentration within a given distance of all equipment located on ground and other accessible levels. This is conducted using a portable VOC detection instrument utilizing a strip chart recorder. Fixed point automatic hydrocarbon sampling and analysis monitors can also be placed at various locations. The instruments may sample the ambient air intermittently or continuously. Elevated hydrocarbon concentrations indicate one or more leaking components.

The detection of a leak is only the first step in reducing emissions from leaking equipment. The emission reduction depends on prompt and proper repair of the leak or replacement of the component.

An alternative approach to controlling fugitive emissions from these components is to replace them with leakless equipment. There are various types of so-called leakless equipment. These include dual mechanical seal pumps, sealless or canned-motor pumps, and closed-vent systems with control devices.

4.1.7.3 Effectiveness of Control Techniques. The control efficiency achieved by a leak detection and repair program is dependent on several factors, with the most critical being the inspection interval. This interval is related to the type of equipment and service conditions, and different intervals should be specified for different pieces of equipment. Monitoring may be scheduled on an annual, quarterly, monthly, or even weekly basis. Monitoring may also be scheduled for a skip-period approach where less frequent monitoring is allowed for components that achieve a specified level of performance. Estimated control effectiveness for leak detection and repair programs for pumps and valves is shown in Table 4-4.[32]

The installation of improved shaft sealing mechanisms can reduce emissions to a negligible level, and can be eliminated entirely by installing sealless pumps. Also, the installation of closed-vent systems with control devices can be expected to achieve efficiencies of greater than 90 percent.[32]

TABLE 4-4. ESTIMATED CONTROL EFFECTIVENESS FOR LEAK DETECTION AND REPAIR PROGRAMS FOR VALVES AND PUMPS

Monitoring Interval	Control Effectiveness (percent)	
	Valves Light Liquid	Pumps
Monthly	59	61
Monthly/Quarterly	46	-
Quarterly	44	33

Source: Reference 30.

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5.0 MODEL PLANTS AND REGULATORY ALTERNATIVES

This chapter presents a description of the model plants used in the analysis to represent facility populations in the United States in the 1998 base year. These model plants are used in the estimation of the impacts of implementating the regulatory alternatives developed to reduce hazardous air pollutant emissions. Section 5.1 presents the model plants for pipeline facilities, bulk terminals, bulk plants, and service stations. Section 5.2 discusses the regulatory alternatives for each emission source.

5.1 MODEL PLANTS

This section presents model plants for each of the gasoline distribution industry sectors. Varying sizes of facilities within each source category were selected to represent a cross-section of the total industry. For each source category, model plant characteristics are provided with a description of the design parameters for each. Also, a nationwide profile using the model plants is presented by distributing the total number of facilities across the various model plants.

5.1.1 Pipeline Facilities

The pipeline facility model plant parameters for pipeline pumping stations and breakout stations are based on information collected from industry representatives,[1] and a search of the literature.[2,3,4]

5.1.1.1 Pumping Stations. As discussed in Chapter 3, pipeline facilities are a major element in the distribution of gasoline between the refinery and the bulk terminal. The emissions at pipeline pumping stations are attributed solely to leaking pumps and valves. The emission factors (Section 3.2.2.1) and control costs for these components (Section 7.1.2) are based on the number of components at the facility and are not related to facility throughput. Therefore, the only parameters necessary to define for the model plants are the number of pumps and valves at the facility that are in gasoline service, and the operating schedule. Any pump or valve that will handle gasoline is considered to be in gasoline service. The pump or valve does not have to handle gasoline on a continuous or dedicated basis to be considered to be in gasoline service. Therefore, any pump or valve at a pumping station that periodically handles gasoline will be considered in gasoline service.

Pipelines may occur as single pipes or in clusters of two or three pipes. The smallest pipeline pumping station model plant represents a single pipeline facility and has two pumps and 25 valves. As with all pipeline pumping stations, the facility operates 24 hours a day, 365 days per year. The second model plant represents a facility with two pipelines and has five pumps (two of which operate on one pipeline and three that operate on the other) and 50 valves. The largest model plant represents a facility handling three pipelines and has nine pumps (three per pipeline) and 100 valves. The model plant parameters for pipeline pumping stations are shown in Table 5-1.

The 1998 baseline estimate for the pipeline pumping station population is 1,989 facilities (as discussed in Section 8.2). Data reviewed indicated that it was not unique to have a facility handling one, two, or three pipelines. However, no specific information was available to determine relative percentages of single, double, or triple pipeline facilities. Therefore, an equal distribution of pumping stations across the three model plants was assumed.

5.1.1.2 Breakout Stations. As noted above, pipelines often occur in clusters. At some point along the path, one,

TABLE 5-1. PIPELINE PUMPING STATION MODEL PLANT PARAMETERS

Design Value	Model Plant Number 1	2	3
Number of Pipelines	1	2	3
Number of Pumps[a]	2	5	9
Number of Valves[a]	25	50	100
Operating Schedule			
hrs/day	24	24	24
days/year	365	365	365
Percentage of Total Facilities	33%	33%	33%
Number of Facilities	663	663	663

[a] In gasoline service.

two, or all three of the lines branch off in different directions. When this occurs, the throughput to any one line is altered. Breakout stations are used at these points to temporarily store gasoline or other products until compensation can be made for the altered flow. As discussed in Section 8.2, the baseline population of facilities where lines branch in different directions is estimated at 120 facilities.

At times, the diameter of connected pipes in the pipeline will be reduced or increased. This causes a change in product flow rate between the different sized pipes. Breakout stations are again used to store gasoline in these situations. The baseline predicted population for this type of facility is 150. Combining both types of facilities results in an estimated 270 total breakout stations in the United States in the base year.

These two situations dictate the sizes of the two model plants used to develop pipeline breakout stations. The model plant to represent break-out stations that occur when two or three pipelines split has 15 storage tanks, 35 pumps, and 400 valves. As discussed above, there are an estimated 120 of this type station, or 45 percent of the total.

The model plant developed to represent breakout stations where the throughput is affected by changes in pipeline diameter includes 10 storage tanks, 20 pumps, and 250 valves. This model plant represents approximately 150 facilities, or 55 percent of the total.

It is important to note that products other than gasoline are sent through pipelines and stored at breakout stations. Product is stored temporarily and the tanks may not have product in them all the time. Therefore, all tanks, pumps, and valves are not in constant gasoline service.

Since the emission factors for storage tanks, pumps, and valves are on a per-tank or per-component basis in constant gasoline service, utilizing the numbers of tanks and components cited above would overstate emissions and emission reductions attributed to gasoline operations. Consequently, adjustments were made to reflect the number of tanks that are in gasoline service. This was accomplished by assuming a certain number of "equivalent dedicated tanks" for gasoline service. This does not signify that specific tanks are dedicated to gasoline and never used for other products. Rather, the "equivalent dedicated tank" reflects the equivalent number of tanks that would be in constant year round gasoline service. These equivalent tanks were determined by multiplying the number of tanks by the percent of time gasoline is stored.

A fraction of the total number of pumps and valves at a breakout station is associated with the pipeline itself and functions in the same manner as those pumps and valves at pumping stations; i.e., pumping product down the pipeline. There is also another fraction of pumps and valves associated with storage tanks. For those associated with storage tanks, the "equivalent dedicated" concept was again applied. The bases for the "equivalent" dedicated value concept were observations made during a site visit to a facility[5] and subsequent conversations with industry representatives. The parameters for pipeline breakout station model plants are shown in Table 5-2.

The tanks typically used at breakout facilities are external floating roof tanks (76 percent of the total; see Section D.1.2.1) with capacities ranging from 1,600 to 16,000 m^3 (10,000 to 100,000 bbl). The tank size assumed in the analysis for gasoline storage tanks at breakout stations was 8,000 m^3 (50,000 bbl) with a diameter of 30 meters (100 ft) and a height of 12 meters (40 ft).

5.1.2 <u>Bulk Terminals</u>

5.1.2.1 <u>Tank Truck Loading</u>. The bulk terminal source category has been studied for over a decade by EPA. Model plants for bulk terminals were originally developed during preparation of the bulk terminal CTG document and were further investigated and conclusions documented in the development of the new source performance standards (NSPS)

TABLE 5-2. PIPELINE BREAKOUT STATION MODEL PLANT PARAMETERS

Design Value	Model Plant Number[a] 1	2
Breakout Station Information		
Total Number of Storage Tanks	10	15
Total Number of Pumps	20	35
Total Number of Valves	250	400
Number of Storage Tanks	10	15
Storage Tank Volume		
m^3	8,000	8,000
bbl	50,000	50,000
Number of Turnovers/tank/year[b]	150	150
Operating Schedule		
hrs/day	24	24
days/year	365	365
Percentage of Total Facilities	55%	45%
Number of Facilities	150	120
Parameters Used to Estimate Emissions		
Number of "Equivalent Dedicated Storage Tanks" in Gasoline Service	4	5
Number of "Equivalent Dedicated Pumps" for Storage Tanks in Gasoline Service	3	4
Number of Pumps Associated with Pipeline	5	6
Number of "Equivalent Dedicated Valves" for Storage Tanks in Gasoline Service	160	200
Number of Valves Associated with Pipeline	50	100

[a] Model Plant 1 represents those stations at pipeline branches and Model Plant 2 those stations at pipeline diameter changes.

[b] Turnovers per year based upon assuming three turnovers per week for 50 weeks per year.

for bulk terminals (promulgated as 40 CFR Part 60, Subpart XX). In addition to the NSPS rulemaking, the same model plant sizes were used in subsequent regulatory development programs.[6,7,8] During these regulatory development programs, EPA received no significant comments citing problems with these parameters. Therefore, after evaluating the industry in 1990, this document will continue to use these historical model plant sizes. However, while the parameters have remained the same, the population and distribution of these model plants were modified to reflect 1998 base year conditions (see Chapter 8, Section 8.2).

The data base for determination of the original model plant parameters was derived primarily from operating data on 40 terminals of various ages. Data presented in reports of EPA-sponsored terminal source tests, data from plant visits, data from EPA's National Emissions Data System (NEDS), and data from information requests submitted under authority of section 114 of the Clean Air Act were used as further input for the selection of model plant parameters.[9]

5.1.2.2 Storage Tanks. As discussed in a previous bulk terminal model plant analysis,[10] a typical terminal has four or five aboveground storage tanks for gasoline, each with a capacity ranging from 1,500 to 15,000 m^3 (9,400 to 94,000 bbl). Most tanks in gasoline service have a floating roof to prevent the loss of product from tank "breathing and working." The fixed-roof tank is the least expensive to construct and is generally considered as the minimum acceptable tank for the storage of petroleum products. Emissions from existing fixed-roof tanks are most readily controlled by the installation of an internal floating roof. A set of model plant parameters was developed to describe the physical characteristics of a typical fixed-roof tank at a bulk terminal. This typical storage tank has a volume of 2,680 m^3 (16,750 bbl), a value based on available EPA data on fixed-roof tanks at terminals. A diameter of 15.2 meters (50 feet) and a height of 14.6 meters (48 feet) were assumed as typical values for a tank of this capacity.[11] In addition, it was assumed that storage tanks at terminals were subjected to 13 product turnovers per year (based on previous analyses).[12]

The model plant parameters are shown in Table 5-3. This table also provides the 1998 base year characterization of the bulk terminal industry as distributed across these model plant sizes.

5.1.2.3 Railcar Loading. Information was sought from industry representatives, literature, and trade associations concerning railcar loading of gasoline. Little information was obtained; however, one facility that loaded gasoline into railcars was visited.[13] In addition, railcar loading of chemicals was studied to determine the applicability of filling technology.[14] This information was used to develop a single model plant based on the parameters at the single gasoline loading facility, although it is estimated in the model plant analysis that there will be 20 such facilities in the base year. The model, or typical, plant parameters are described in Table 5-4.

It is assumed that a terminal that loads gasoline into railcars also has truck loading racks. Therefore, no separate storage tanks or pumps were attributed to railcar loading racks, which avoided double counting emissions. In addition, it was assumed that the railcar loading racks were located at a significant distance from the truck loading racks and that separate vapor piping and vapor processing equipment would be required.

A very small portion of the total gasoline transported is moved by rail and this occurs at only a few facilities. As discussed in Section 8.2, it is estimated that there are 20 terminals in the United States that load railcars. Due to the lack of information on additional facilities and the small number of total estimated facilities, all are assumed to be represented by the single model plant.

TABLE 5-3. BULK GASOLINE TERMINAL MODEL PLANT PARAMETERS

Design Value	Model Plant Number 1	2	3	4
Throughput				
(liters per day)	380,000	950,000	1,900,000	3,800,000
(gallons per day)	100,000	250,000	500,000	1,000,000
Number of Rack Positions	2	3	3	4
Number of Loading Arms	6	9	9	12
Loading Method	Submerged (Top or Bottom)	Submerged (Top or Bottom)	Submerged (Top or Bottom)	Submerged (Top or Bottom)
Pumping Rate/Loading Arm				
(lpm)	2,270	2,270	2,270	2,270
(gpm)	(600)	(600)	(600)	(600)
Tank Truck Capacity				
(liters)	32,200	32,200	32,200	32,200
(gallons)	(8,500)	(8,500)	(8,500)	(8,500)
Tank Truck Loading Time (minutes)	20	20	20	20
Maximum Instantaneous Loading Rate				
(lpm)	13,600	20,400	20,400	27,300
(gpm)	(3,600)	(5,400)	(5,400)	(7,200)
Operating Schedule (days/year)	340	340	340	340
Gasoline Storage Capacity				
(m^3)	10,340	23,880	43,670	95,400
(bbl)	(65,000)	(150,000)	(275,000)	(600,000)
Number of Tanks for Gasoline	3	4	5	6
Number of Turnovers per Year per Tank	13	13	13	13
Number of Terminal-Owned Trucks	3	6	9	20
Number of Components				
Pumps	10	10	10	10
Valves	90	115	130	160
Number of Facilities per Model Plant (1,024 total terminals)	410	230	280	100
Percent of Total Facilities	40	23	27	10
Percent of Total Throughput	12	17	41	30

TABLE 5-4. RAILCAR LOADING BULK GASOLINE TERMINAL MODEL PLANT PARAMETERS

Design Value	Model Plant Parameter
Throughput	
(million liters per year)	322
(million gallons per year)	85
Number of Loading Arms	3
Loading Method	Submerged (Top or Bottom)
Pumping Rate/Loading Arm	
(lpm)	3,800
(gpm)	1,000
Railcar Capacity	
(liters)	110,000
(gallons)	29,000
Number of Railcars Owned/Leased by Facility[a]	30
Maximum Instantaneous Loading Rate	
(lpm)	11,350
(gpm)	3,000
Number of Facilities	20
Total Throughput	
(billion liters)	6.2
(billion gallons)	1.6

[a] It is assumed that all railcars are dedicated to gasoline service and owned/leased by their terminal owners.

5.1.3 Bulk Plants

As described in Section 3.2.4, bulk gasoline plants are secondary distribution facilities within the gasoline distribution network. Model bulk plant parameters were developed and utilized in connection with earlier guidance[15] and environmental impact studies.[16,17,18] An analysis of the conditions of the industry in 1990 indicates that these basic parameters still adequately represent the industry, with one exception. Bulk plants that store and transport aviation gasoline were not included in earlier EPA studies. These facilities are generally located at airports, and store and move gasoline by truck to aircraft located in various parts of the air terminal. Information obtained from the National Air Transportation Association[19] indicates that the basic parameters described for gasoline bulk plants are generally representative of these aviation gasoline facilities, except that the estimated average throughput for an aviation bulk plant (1,500 liters/day) is considerably less than that designated for the smallest model bulk plant (11,350 liters/day). Therefore, an additional model plant was added to represent aviation gasoline bulk plants. All of these model bulk plant parameters are shown in Table 5-5.

As delineated in Table 5-5, the typical bulk plant facility includes tanks for storage of gasoline, loading racks, and incoming and outgoing tank trucks (account trucks). Regardless of throughput, it is assumed that all bulk plants have the same numbers of tanks, loading racks, and account trucks.[20] Larger model plants simply load more trucks per day than the smaller model plants. The typical bulk plant utilizes two relatively small aboveground storage tanks ranging in capacity between 50,000 to 75,000 liters for gasoline storage. Usually, a plant will have one loading rack using top filling by either the top-splash method or a top-entry submerged fill pipe. Since the number of pumps and valves is usually determined by the number of storage tanks and loading racks, the estimated number of

TABLE 5-5. BULK GASOLINE PLANT MODEL PLANT PARAMETERS

Design Value	Model Plant Number 1	2	3	4	5
Average Throughput					
(liters/day)	1,500	11,350	24,600	47,300	64,350
(gallons/day)	400	3,000	6,500	12,500	17,000
Throughput Range					
(liters/day)	0-2,500	2,500-15,140	15,140-30,280	30,280-64,350	64,350-75,700
(gallons/day)	0-650	650-4,000	4,000-8,000	8,000-17,000	17,000-20,000
Number of Storage Tanks	2	2	2	2	2
Number of Loading Racks	1	1	1	1	1
Number of Private Tank Trucks	2	2	2	2	2
Operating Schedule (days/year)	300	300	300	300	300
Number of Components					
Pumps	4	4	4	4	4
Valves	50	50	50	50	50
<u>Gasoline Bulk Plants</u>					
Number of Facilities	-	2,900	3,800	2,100	600
Percent of Gasoline Facilities	-	31	40	22	7
Throughput					
(million liters/year)	-	9,900	28,000	29,600	11,700
(million gallons/year)	-	2,600	7,400	7,800	3,100
<u>Aviation Gasoline Bulk Plants</u>					
Number of Facilities	3,200	-	-	-	-
Throughput					
(million liters/year)	1,400	-	-	-	-
(million gallons/year)	370				
Percentage of Total Facilities	25	23	30	17	5
Percentage of Total Throughput	2	12	35	36	15

these components is also constant for all model plants. Therefore, the only difference among the model plants is the volume of gasoline handled by each facility.

Transport trucks supply bulk plants with gasoline from bulk terminals, while account trucks are used to deliver gasoline to bulk plant customers. Bulk plants typically average two account trucks. These two trucks are usually privately owned by the bulk plant owner. While the basic specifications of the model plants have remained constant, the distribution of the bulk plant population across the industry has been updated to reflect 1998 base year conditions (see Chapter 8, Section 2). This distribution is also shown in Table 5-5.

5.1.4 Independent Tank Truck Facilities

The trucking industry generally consists of two major groups, private and for-hire. Private carriers are defined as those firms that transport their own goods in their own trucks. An example of a private carrier is an oil company that uses its own tank trucks to move gasoline from its terminals or bulk plants. For-hire carriers transport freight that belongs to others, renting out the hauling services of their trucks.

As discussed and documented in Section 8.2, it is estimated that 81,300 tank trucks will be used for the movement of motor vehicle gasoline in 1998. This estimate is based on an earlier EPA study of tank trucks[21] and was adjusted to reflect the expected 1998 base year population. While adjustment of the population was necessary, no more recent information was located concerning the category distribution of tank trucks, either private or for-hire (independent ownership). This earlier study assumed that about 31 percent of the gasoline tank trucks were used at bulk terminals. The remaining 69 percent were therefore assumed to be associated with bulk plants. However, there has been a significant decrease in the percentage of gasoline handled by bulk plants from the time period of the 1979 tank car study (27 percent) to the 1998 base year (18 percent). To attribute the same fraction of tank trucks to bulk plants probably overstates this portion greatly. Therefore, the percentage of tank trucks estimated for the 1998 base year associated with bulk plants was decreased from the 1979 study by a proportion equal to the decrease in throughput for bulk plants (18/27). Consequently, the updated percentage of bulk plant trucks is estimated to be 46 percent of the total tank truck population.

The remaining 54 percent of the total tank truck population is attributed to bulk terminals, which represents 43,900 vehicles in 1998. This number comprises only tank trucks of greater than 15,100 liter (4,000 gallon) capacity in order to avoid the inclusion of small tank trucks operating from bulk plants. The remainder, 37,400 vehicles, are smaller tank trucks used primarily to transport motor vehicle gasoline from bulk plants.

As shown in Tables 5-3 and 5-5, parameters for the model bulk terminals and bulk plants are predicated on the fact that a certain number of tank trucks are owned by the model plant owners. Based on this information, it is estimated that of the total number of terminal tank trucks, 7,200 are bulk terminal trucks and 18,800 of the total bulk plant trucks are owned by the model plant owners. The remaining 36,700 bulk terminal trucks and 18,600 bulk plant trucks are assumed to be "independents." This information is summarized in Table 5-6.

In addition, there are account trucks associated with aviation bulk plants not included in the earlier estimates. As shown in Table 5-6, it is estimated that there are 6,400 of these vehicles. It is also assumed that all of these vehicles are privately owned. Therefore, the total 1998 nationwide tank truck population is projected to be 87,700.

5.1.5 Service Stations

Service stations, as defined in this document, include motor vehicle refueling operations that receive revenue from

TABLE 5-6. CHARACTERIZATION OF NATIONWIDE TANK TRUCK POPULATION

Type/Owner of Tank Truck	Population
Total Nationwide Tank Trucks[a]	87,700
Bulk Terminal Trucks[b]	43,900
Private	7,200
For-Hire (Independent)	36,700
Bulk Plant Trucks	43,800
Private[c]	18,800
For-Hire (Independent)[c]	18,600
Aviation Bulk Plant Trucks[d]	6,400

[a] All trucks are assumed to have four compartments.

[b] 71 percent of the trucks assumed to have vapor collection equipment installed (see Appendix C).

[c] 60 percent of the trucks assumed to have vapor collection equipment installed (see Appendix C).

[d] Assumed no trucks have vapor collection or bottom loading equipment.

either the sale of gasoline (public retail outlets) or that service government, commercial, and industrial fleet operations (private outlets), excluding agricultural refueling operations. As opposed to counts made by the U.S. Census Bureau that include only those outlets that derive 50 percent or more of their dollar business from petroleum products, miscellaneous retail outlets that were considered service stations for this study include convenience stores, mass merchandisers, marinas, parking garages, and others that obtain less than 50 percent of their revenue from gasoline sales.

In addition to "public" outlets, there are a significant number of "private" facilities included in this subcategory. These outlets are maintained by government, commercial, and industrial consumers for their own fleet operations. Government agencies with central garages typically consist of regional locations for the U.S. Postal Service, Federal government agencies, and State and county agencies. Other miscellaneous facilities include utility companies, taxi fleets, rental car fleets, school buses, and corporate fleets. As noted previously, the agricultural sector of private outlets which includes farms, nurseries, and landscaping firms, etc. was not included in the study.

As for bulk terminals and bulk plants, there have been model plants developed for service stations in connection with previous EPA studies.[22,23,24] While recent data indicate that facility distributions may be different in metropolitan areas, the distribution used in previous EPA studies is believed to be representative of the nationwide facility distribution.[25] The service station model plant category parameters were originally derived from size ranges used by the Bureau of the Census, total facilities reported for 1977[26] and 1982[27], and the total consumption of gasoline (excluding agricultural) for each year.[28]

Based on information from Arthur D. Little, Inc. and the U.S. Census Bureau, it was estimated that approximately 90 percent of "private" outlets have throughputs of less than 37,850 liters/month (10,000 gallons/month).[29,30] The remaining 10 percent of private facilities which had throughputs greater than these amounts were distributed among model plants 3 through 6 in proportions representative of the public service station distribution.

The model plant parameters developed for EPA's 1984 model plant scenarios were basically well received by industry during the associated comment period. However, there was one alteration made in the 1987 analysis document in the service station model plant section that was based on comments received from the industry.[31] The pertinent comments were related to the throughput amount of gasoline at private stations; i.e., that the 5,000 gallons per month average used in the 1984 document to represent approximately 190,000 private stations in model plant 1 overestimated the nationwide throughput that would be exempted by a 10,000 gallon per month cutoff. Therefore, model plant 1 was split into two separate model plants with different average throughputs. These revised model plants and their design parameters are retained in this analysis.

Design characteristics for the six model plants are presented in Table 5-7. The 1998 base year nationwide distribution discussed in Section 8.2 is also provided in this table. In addition to the private facilities that are represented by the smallest model plant, this analysis also includes 1,600 aviation facilities that fit the description of service stations (i.e., private airplanes pull up to a dispenser and fill their tanks). The monthly throughput for these aviation facilities places them in the model plant 1 category. However, the average monthly throughput for these aviation facilities is slightly higher than the 7,600 liters indicated.

TABLE 5-7. SERVICE STATION MODEL PLANT PARAMETERS

Design Value	Model Plant Number 1	2	3	4	5	6	Totals
Average Throughput							
(10^3 l/mo)	7.6	23.0	76.0	132.0	246.0	700.0	-
(10^3 gal/mo)	2	6	20	35	65	185	
Throughput Range							
(10^3 l/mo)	0-19	19-38	38-95	95-189	189-379	>379	-
(10^3 gal/mo)	0-5	5-10	10-25	25-50	50-100	>100	
"Public" Service Stations							
Population	650	35,500	44,100	43,400	32,100	21,100	175,850
Percent of Public Stations	<1	20	25	25	18	11.4	100
Portion of Annual Throughput (10^6 liters)	60	9,800	40,200	68,800	94,800	168,800	382,400
"Private" Service Stations							
Population	189,200	-	8,600	7,400	4,200	800	210,300
Percent of Private Stations	90	-	4	3	2	1	100
Portion of Annual Throughput[a] (10^6 liters)	17,200		7,900	11,700	11,800	9,300	57,900
Aviation Service Stations							
Population	1,600	-	-	-	-	-	1,600
Annual Throughput (10^6 liters)	172						172
Total Facilities							
Population	191,450	35,500	52,700	50,800	36,300	20,900	387,750
Percent	49	9	14	13	9	6	100
Throughput (% of total consumption)	4	3	11	18	24	40	100

[a] Average throughput for aviation service stations is 9,200 liters/month (2,400 gallons/month).

5.2 REGULATORY ALTERNATIVES

The purpose of this section is to describe and develop regulatory alternatives from the emission source and control information presented earlier in Chapters 3 and 4. The purpose of this development is the establishment of alternatives to present the evaluation of the environmental, energy, and cost impacts.

In the formulation of regulatory alternatives for the gasoline distribution industry, the determination of those facilities that would be classified as "major" is paramount. Using the emission factors and HAP to VOC ratios discussed and documented in Chapter 3 (Section 3.2.1.1), the uncontrolled emissions for normal, average type, and reformulated gasoline at each model plant were calculated and are presented in Table 5-8. These uncontrolled annual emissions as well as MTBE emissions from reformulated and oxygenated gasoline (presented in Table 5-9) were used to make the major/area source estimations for each subcategory facility. These annual emissions were based upon model plant average throughputs and a range of total HAP contents from normal to reformulated gasoline (4.8 percent minimum to 16.3 percent for reformulated and oxygenated gasoline with MTBE) as described in Tables 3-1 and 3-2. To test for individual HAP criteria, MTBE was chosen for analysis because it makes up the greatest individual component portion of the HAP vapor profile for reformulated and oxygenated gasolines. As shown in these tables (Tables 5-8 and 5-9), only bulk gasoline terminals and pipeline breakout stations would be classified as encompassing major HAP sources. All of the other subcategories of the gasoline distribution network would be considered area sources.

Various combinations of control options were examined, ranging from control of all emission sources at both major and area facilities to control of only major source facilities. A cost effectiveness analysis was then performed to eliminate the inferior options (those with

TABLE 5-8. MODEL PLANT POTENTIAL TOTAL HAP EMISSIONS

	POTENTIAL EMISSIONS FROM MODEL PLANTS (Tons/year)								
	MODEL PLANT 1 HAP/VOC%			MODEL PLANT 2 HAP/VOC%			MODEL PLANT 3 HAP/VOC%		
	4.8	11.0	16.0	4.8	11.0	16.0	4.8	11.0	16.0
PIPELINE FACILITIES									
Pumping Stations	0.3	0.7	1.1	0.8	1.8	2.6	1.4	3.3	4.8
Breakout Stations									
Storage Tanks	3.9	9.0	13.0	4.9	11.2	16.3			
Fugitive Emissions	1.9	4.3	6.3	2.6	5.8	8.5			
Total Emissions	5.8	13.3	19.3	7.5	17.0	24.8			
BULK TERMINALS									
Truck Loading Racks	5.0	11.6	16.8	12.6	28.9	42.1	25.3	57.8	84.2
Storage Tanks	2.3	5.3	7.7	3.1	7.0	10.2	3.8	8.8	12.8
Fugitive Emissions	1.4	3.2	4.6	1.5	3.5	5.0	1.6	3.6	5.3
Total Emissions	8.7	41.1	29.1	17.2	39.4	57.3	30.7	70.2	102.3
BULK PLANTS									
Truck Loading	0.0	0.1	0.1	0.1	0.3	0.5	0.3	0.7	1.0
Storage Tanks	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.2	0.3
Fugitive Emissions	0.6	1.8	1.8	0.6	1.3	1.8	0.6	1.3	1.8
Total Emissions	0.6	1.9	1.9	0.7	1.7	2.4	1.0	2.2	3.1
SERVICE STATIONS									
Tank Filling Losses	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	0.1	0.2	0.3

TABLE 5-8. (Concluded)

	POTENTIAL EMISSIONS FROM MODEL PLANTS (Tons/year)								
	MODEL PLANT 4 HAP/VOC%			MODEL PLANT 5 HAP/VOC%			MODEL PLANT 6 HAP/VOC%		
	4.8	11.0	16.0	4.8	11.0	16.0	4.8	11.0	16.0
PIPELINE FACILITIES									
Pumping Stations									
Breakout Stations									
Storage Tanks									
Fugitive Emissions									
Total Emissions									
BULK TERMINALS									
Truck Loading Racks	50.5	115.6	168.2						
Storage Tanks	4.6	10.6	15.4						
Fugitive Emissions	1.7	3.9	5.8						
Total Emissions	56.8	130.1	189.4						
BULK PLANTS									
Truck Loading	0.6	1.3	1.8	0.8	1.7	2.5			
Storage Tanks	0.2	0.4	0.5	0.2	0.5	0.7			
Fugitive Emissions	0.6	1.3	1.8	0.6	1.3	1.8			
Total Emissions	1.4	3.0	4.1	1.6	3.5	5.0			
SERVICE STATIONS									
Tank Filling Losses	0.1	0.3	0.4	0.2	0.6	0.8	0.7	1.6	2.3

TABLE 5-9. MODEL PLANT MAXIMUM INDIVIDUAL HAP EMISSIONS

	POTENTIAL EMISSIONS FROM MODEL PLANTS USING REFORMULATED AND OXYGENATED GASOLINE WITH MTBE* (Tons/year)					
	MODEL PLANT 1 MTBE Emissions	MODEL PLANT 2 MTBE Emissions	MODEL PLANT 3 MTBE Emissions	MODEL PLANT 4 MTBE Emissions	MODEL PLANT 5 MTBE Emissions	MODEL PLANT 6 MTBE Emissions
PIPELINE FACILITIES						
Pumping Stations	0.8	1.9	3.6			
Breakout Stations						
Storage Tanks	9.6	12.1				
Fugitive Emissions	4.7	6.3				
Total Emissions	14.3	28.4				
BULK TERMINALS						
Truck Loading Racks	12.4	31.2	62.3	124.5		
Storage Tanks	5.7	7.5	9.5	11.4		
Fugitive Emissions	3.4	3.7	3.9	4.3		
Total Emissions	21.5	42.4	75.7	140.2		
BULK PLANTS						
Truck Loading	0.1	0.4	0.7	1.3	1.9	
Storage Tanks	0.0	0.1	0.2	0.4	0.5	
Fugitive Emissions	1.3	1.3	1.3	1.3	1.3	
Total Emissions	1.4	1.8	2.2	3.0	3.7	
SERVICE STATIONS						
Tank Filling Losses	<0.1	<0.1	0.2	0.3	0.6	1.7

* MTBE is 74 percent of total HAP emissions for this category (See Table 3-2)

higher costs for the same or lesser emission reductions). The alternatives that remain are termed Alternatives IV-Q, IV-M, III, II, and I. Alternatives IV-Q and IV-M are variations of Alternative IV. Alternative IV-Q includes a quarterly monitored leak detection and repair (LDAR) program for equipment leaks (either pumps or valves) at major source pipeline breakout stations and bulk terminals. Alternative IV-M specifies a more stringent monthly monitored LDAR program for equipment leaks, as well as other equipment leak requirements (same as requirements in 40 CFR 60 Subpart V) at these same sources. (There are additional provisions for reducing the monitoring frequency of valves to quarterly).

Alternative III includes control at all bulk terminals and pipeline breakout stations. Finally, the remaining two alternative control levels (II and I) require control of all subcategory facilities within the network. Tables 5-10 through 5-16 summarize the regulatory alternatives developed for each industry sector.

TABLE 5-10. NEW PIPELINE FACILITIES REGULATORY ALTERNATIVES

Emission source	Baseline Control Level	I	II	III	IV	IV-Q	IV-M
Pumping Stations							
Equipment Leaks	Periodic visual checks	Quarterly LDAR	Same as Alternative I				
Breakout Stations							
Storage Tanks	External floating roof tank with primary and secondary seals (NSPS & CTG)	External floating roof tank with primary and secondary seals at major and area sources	Same as Alternative I	Same as Alternative I	External floating roof tank with primary and secondary seals at major sources	Same as Alternative IV	Same as Alternative IV
	Fixed-roof tank with internal floating roof and primary seals (NSPS & CTG)	Fixed-roof tank with internal floating roof and primary seals at major and area sources	Same as Alternative I	Same as Alternative I	Fixed-roof tank with internal floating roof and primary seals at major sources	Same as Alternative IV	Same as Alternative IV
Equipment Leaks	Periodic visual checks	Monthly LDAR at major sources and Quarterly LDAR at area sources	Same as Alternative I	Same as Alternative I	Monthly LDAR at major sources	Same as Alternative IV	Same as Alternative IV

TABLE 5-11. EXISTING PIPELINE FACILITIES REGULATORY ALTERNATIVES

Emission source	Baseline Control Level	I	II	III	IV	IV-Q	IV-M
<u>Pumping Stations</u>							
Equipment Leaks	Periodic visual checks	Quarterly LDAR	Same as Alternative I				
<u>Breakout Stations</u>							
Storage Tanks	External floating roof tank with primary and secondary seals (NSPS & CTG)	External floating roof tank with primary and secondary seals at major and area sources (controls phased-in for area sources)	Same as Alternative I	Same as Alternative I	External floating roof tank with primary and secondary seals at major sources	Same as Alternative IV	Same as Alternative IV
	Fixed-roof tank with internal floating roof and primary seals (NSPS & CTG)	Fixed-roof tank with internal floating roof and primary seals at major and area sources (controls phased-in for area sources)	Same as Alternative I	Same as Alternative I	Fixed-roof tank with internal floating roof and primary seals at major sources	Same as Alternative IV	Same as Alternative IV
Equipment Leaks	Periodic visual checks	Quarterly LDAR at major and area sources	Same as Alternative I	Same as Alternative I		Quarterly LDAR at major sources	Monthly LDAR at major sources

TABLE 5-12. NEW BULK TERMINAL REGULATORY ALTERNATIVES

Emission source	Baseline Control Level	I	II	III	IV	IV-Q	IV-M
Bulk Gasoline Terminals							
Loading Racks	35 mg/l (NSPS) 10 mg/l California District rules	5 mg/l for major sources and 10 mg/l for area sources	5 mg/l for major sources and 35 mg/l for area sources	Same as Alternative II	5 mg/l for major sources	Same as Alternative IV	Same as Alternative IV
Storage Tanks	External floating roof tank with primary and secondary seals (NSPS & CTG)	External floating roof tank with primary and secondary seals at major and area sources	Same as Alternative I	Same as Alternative I	External floating roof tank with primary and secondary seals at major sources	Same as Alternative IV	Same as Alternative IV
	Fixed-roof tank with internal floating roof and primary seals (NSPS & CTG)	Fixed-roof tank with internal floating roof and primary seals at major and area sources	Same as Alternative I	Same as Alternative I	Fixed-roof tank with internal floating roof and primary seals at major sources	Same as Alternative IV	Same as Alternative IV
Tank Truck Leakage	Annual tightness test (NSPS)	Vacuum assist for major, annual test for area sources	Same as Alternative I	Same as Alternative I	Vacuum assist for major sources	Same as Alternative IV	Same as Alternative IV
Equipment Leaks	Periodic Visual Checks	Monthly LDAR at major, quarterly LDAR at area sources	Same as Alternative I	Same as Alternative I	Monthly LDAR at major sources	Same as Alternative IV	Same as Alternative IV

TABLE 5-13. EXISTING BULK TERMINAL REGULATORY ALTERNATIVES

Emission source	Baseline Control Level	I	II	III	IV	IV-Q	IV-M
<u>Bulk Gasoline Terminals</u>							
Loading Racks	80 mg/l -existing sources/nonattainment areas (CTG) 35 mg/l (NSPS) 10 mg/l California District rules	10 mg/l for major and area sources	10 mg/l for major sources and 35 mg/l for area sources (controls phased-in for area sources)	Same as Alternative II	10 mg/l for major sources	Same as Alternative IV	Same as Alternative IV
Storage Tanks	External floating roof tank with primary and secondary seals (NSPS & CTG)	External floating roof tank with primary and secondary seals at major and area sources (controls phased-in for area sources)	Same as Alternative I	Same as Alternative I	External floating roof tank with primary and secondary seals at major sources	Same as Alternative IV	Same as Alternative IV
	Fixed-roof tank with internal floating roof and primary seals (NSPS & CTG)	Fixed-roof tank with internal floating roof and primary seals at major and area sources (controls phased-in for area sources)	Same as Alternative I	Same as Alternative I	Fixed-roof tank with internal floating roof and primary seals at major sources	Same as Alternative IV	Same as Alternative IV
Tank Truck Leakage	Annual tightness test (CTG)	Annual vapor tightness test for major and area sources	Same as Alternative I	Same as Alternative I	Annual vapor tightness test for major sources	Same as Alternative IV	Same as Alternative IV
Equipment Leaks	Periodic visual checks	Quarterly LDAR at major and area sources	Same as Alternative I	Same as Alternative I		Quarterly LDAR at major sources	Monthly LDAR at major sources

TABLE 5-14. NEW BULK PLANT REGULATORY ALTERNATIVES

Emission source	Baseline Control Level	I	II	III	IV	IV-Q	IV-M
Incoming loads	Balance system equipment standard (no exemptions) (CTG)	Vapor balance without exemptions	Same as Alternative I				
Outgoing loads	Balance system equipment standard (exempt sources < 4,000 gal/day (CTG))	Vapor balance with exemptions	Same as Alternative I				
Tank Truck Leakage	Annual tightness test (CTG)						
Equipment Leaks	Periodic Visual Checks	Quarterly LDAR	Same as Alternative I				

TABLE 5-15. EXISTING BULK PLANT REGULATORY ALTERNATIVES

Emission source	Baseline Control Level	I	II	III	IV	IV-Q	IV-M
Incoming loads	Balance system equipment standard (no exemptions) (CTG)	Vapor balance without exemptions	Same as Alternative I				
Outgoing loads	Balance system equipment standard (exempt sources < 4,000 gal/day (CTG))	Vapor balance with exemptions	Same as Alternative I				
Tank Truck Leakage	Annual tightness test (CTG)						
Equipment Leaks	Periodic Visual Checks	Quarterly LDAR	Same as Alternative I				

TABLE 5-16. NEW AND EXISTING SERVICE STATION REGULATORY ALTERNATIVES

Emission source	Baseline Control Level	I	II	III	IV	IV-Q	IV-M
New Service Stations							
Underground Tank filling	Balance system equipment standard (no exemptions) (CTG)	Vapor balance with submerged fill exemption	Same as Alternative I				
	Balance system equipment standard with submerged fill exemption (CTG)						
Existing Service Stations							
Underground Tank Filling	Balance system equipment standard (no exemptions) (CTG)	Vapor balance with submerged fill exemption	Same as Alternative I				
	Balance system equipment standard with submerged fill exemption (CTG)						

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6.0 ENVIRONMENTAL AND ENERGY IMPACTS

The purpose of this chapter is to discuss the environmental and energy impacts associated with the gasoline distribution regulatory alternatives presented in Chapter 5, Section 5.2. Although most of the discussion will be concerned with the methodology used to generate the quantitative analysis of air pollution emission impacts, an analysis of other environmental and energy impacts of the regulatory strategies is also included.

6.1 AIR POLLUTION EMISSION IMPACTS

Estimates of the HAP and VOC emission reductions that could be achieved under each of the regulatory alternatives were made and are discussed in this section. The potential emission reductions achievable in the base year (1998) were calculated for each industry sector.

6.1.1 Methodology

Methods used for calculating emission reductions for all sectors of the industry were basically the same. As discussed in Chapter 3 (Section 3.3) and Appendix C, the nationwide gasoline throughput and/or facility population were apportioned to categories representing the 1998 baseline control level. Nationwide baseline parameters (throughput or facility population) were presented by control level for all emission sources in Table 3-11. These parameters were then multiplied by the appropriate emission factors to estimate baseline VOC emissions. HAP emissions were calculated by applying HAP to VOC ratios. (Differences between the HAP percent reduction and the VOC percent reduction come about due to differences in vapor pressures and consequent evaporation rates in the individual compounds that make up each chemical population).

In order to estimate the air pollution impacts of the regulatory alternatives, the facilities that would be affected by each of the alternatives were identified. Then the control level associated with each alternative was chosen, and its associated controlled emission factor multiplied by facility throughput was used to estimate the VOC emissions that would occur under that particular alternative. For example, the nationwide throughput at bulk terminal loading racks was divided into six categories: those having controls at (1) 80 mg VOC/liter, (2) 35 mg/l, (3) 10 mg/l, and (4) 5 mg/l; and uncontrolled loading racks that utilize (5) splash or (6) submerged loading. The baseline emissions were calculated by multiplying the throughput for each of these control levels by the emission factor for that level. The emission reductions were determined by subtracting the emissions calculated for each alternative from the baseline emissions. Emission reductions would occur from all of the baseline control level groups except those already at levels specified by each particular alternative.

Numbers of "new" facilities in each subcategory were estimated based on industry sector growth, facility trends, and estimated equipment life as discussed in Section 8.2.5. Table 8-27 provides a detailed listing of new, replacement, and existing facilities in the gasoline distribution network. For purposes of this analysis, a replacement facility is one that will be built or rebuilt during the period from 1993 to 1998 for replacement of worn-out or obsolete equipment. Furthermore, it is assumed that one-half of these replacement facilities will qualify as "existing" while the other half will be classified as "new" units.

The HAP emission reductions were determined by multiplying the VOC emission level and resulting emission reduction by the appropriate HAP to VOC ratio. As discussed in Chapter 3 and Appendix C, there are seven area HAP/VOC scenarios that show varying total HAP vapor contents. This analysis is discussed in Appendix C, page C-14, and is summarized in Table 6-1. Gasoline throughput and facility populations were analyzed separately so that the appropriate profile could be utilized. This discussion appears in Appendix D. As an example, the VOC emission reductions achieved in an area expected to utilize normal gasoline were multiplied by the normal total HAP to VOC ratio, 4.8 percent, while those VOC reductions in an area expected to use reformulated gasoline were multiplied by profiles representing reformulated gasoline (assuming 70 percent with MTBE at 12.9 percent, and 30 percent without MTBE at 4.2 percent).

6.1.2 Emission Reductions By Subcategory

The air pollution impacts will be discussed for each subcategory in the gasoline distribution network in the following paragraphs. For each subcategory, the baseline emission level will be defined along with the regulatory alternatives and their effect on emissions for each type of area. Baseline emissions and regulatory alternative emission reductions are shown in Tables 6-2, 6-3, and 6-4. Table 6-2 shows emission reductions at existing facilities, Table 6-3 delineates emission reductions at new facilities, and Table 6-4 provides a summary for all facilities.

6.1.3 Pipeline Pumping Stations.

Emissions from pumping stations consist entirely of fugitive emissions from leaking pumps and valves. As shown in Table 3-11, it was assumed that all emissions at pipeline pumping stations were uncontrolled at the baseline and that there are 1,989 facilities. Furthermore, it can be seen from an examination of Table 8-27 that 27.9 percent of these stations will be new (555 facilities) and 72.1 percent will qualify as existing (1,434 facilities). The number of facilities times the estimated model plant emissions, as

TABLE 6-1. SUMMARY OF HAP VAPOR PROFILES USED IN ANALYSIS[a]

Description of Fuel Type	Applicable Areas for Fuel Types	Total HAP to VOC ratio (percent by weight)[b]
Typical, or "Normal" Gasoline	Ozone and CO attainment	4.8
Reformulated Gasoline	Ozone nonattainment	
with MTBE		12.9
without MTBE		4.2
Oxygenated Gasoline	CO nonattainment	
with MTBE		16.3
without MTBE		4.4
Reformulated and Oxygenated Gasoline	CO and Ozone nonattainment	
with MTBE		16.0
without MTBE		4.2

a Data collected from various sources used to calculate normal gasoline vapor profiles which were adjusted to represent possible compositions of reformulated and oxygenated gasolines.

b As calculated in vapor profiles and shown in Table 3-2.

TABLE 6-2. SUMMARY OF REGULATORY ALTERNATIVE EMISSION REDUCTIONS FOR EXISTING FACILITIES IN THE BASE YEAR (1998)

	BASELINE EMISSIONS (Mg/yr)		EMISSION REDUCTIONS (Mg/yr and percentage reduction from baseline)											
			Alternative I				Alternative II				Alternative III			
			HAP		VOC		HAP		VOC		HAP		VOC	
	HAP	VOC	Mg/yr	%	Mg/yr	%	Mg/yr	%	Mg/yr	%	Mg/yr	%	Mg/yr	%
PIPELINE PUMPING STATIONS														
Fugitive Emissions from Equipment Leaks	1,710	22,800	620	36	8,310	36	620	36	8,310	36				
PIPELINE BREAKOUT STATIONS														
Storage Tanks	6,320	83,370	5,720	91	75,470	91	5,720	91	75,470	91	5,720	91	75,470	91
Fugitive Emissions from Equipment Leaks	780	10,410	310	40	4,110	39	310	40	4,110	39	310	40	4,110	39
BULK TERMINALS														
Loading Racks	2,690	43,680	2,470	92	42,110	96	2,160	81	41,280	95	2,160	81	41,280	95
Storage Tanks	4,910	80,310	2,850	58	52,670	66	2,850	58	52,670	66	2,850	58	52,670	66
Tank Truck Leakage	2,890	41,840	210	7	6,600	16	210	7	6,600	16	210	7	6,600	16
Fugitive Emissions from Equipment Leaks	3,130	40,740	1,140	37	14,900	37	1,140	37	14,900	37	1,140	37	14,900	37
BULK PLANTS														
Storage Tank Filling	1,680	30,550	1,420	85	26,970	88	1,420	85	26,970	88				
Tank Truck Loading Racks	2,050	35,350	1,270	62	23,760	67	1,270	62	23,760	67				
Tank Truck Leakage	760	11,340	0	0	0	0	0	0	0	0				
Fugitive Emissions	7,890	112,190	2,900	37	41,310	37	2,900	37	41,310	37				
SERVICE STATIONS														
Underground Tank Filling	10,970	197,460	8,300	76	159,940	81	8,300	76	159,940	81				
TABLE TOTALS	45,780	710,040	27,230		456,150		26,900		455,310		12,400		195,020	

TABLE 6-2. (Concluded)

	EMISSION REDUCTIONS (Mg/yr and percentage reduction from baseline)											
	Alternative IV				Alternative IV-Q				Alternative IV-M			
	HAP		VOC		HAP		VOC		HAP		VOC	
	Mg/yr	%	Mg/yr	%	Mg/yr	%	Mg/yr	%	Mg/yr	%	Mg/yr	%
PIPELINE PUMPING STATIONS												
Fugitive Emissions from Equipment Leaks												
PIPELINE BREAKOUT STATIONS												
Storage Tanks	420	7	5,590	7	420	7	5,590	7	420	7	5,590	7
Fugitive Emissions from Equipment Leaks					20	3	310	3	40	4	470	4
BULK TERMINALS												
Loading Racks	670	25	11,370	26	670	25	11,370	26	670	25	11,370	26
Storage Tanks	770	16	15,510	18	770	16	15,510	18	770	16	15,510	18
Tank Truck Leakage	100	4	2,700	6	100	4	2,700	6	100	4	2,700	6
Fugitive Emissions from Equipment Leaks					310	10	4,020	10	510	16	6,620	16
BULK PLANTS												
Storage Tanks												
Tank Truck Loading Racks												
Tank Truck Leakage												
Fugitive Emissions from Equipment Leaks												
SERVICE STATIONS												
Underground Tank Filling												
TABLE TOTALS	1,950		35,170		2,290		39,500		2,500		42,260	

TABLE 6-3. SUMMARY OF REGULATORY ALTERNATIVE EMISSION REDUCTIONS FOR NEW FACILITIES IN THE BASE YEAR (1998)

	BASELINE EMISSIONS (Mg/yr)		EMISSION REDUCTIONS (Mg/yr and percentage reduction from baseline)											
			Alternative I				Alternative II				Alternative III			
			HAP		VOC		HAP		VOC		HAP		VOC	
	HAP	VOC	Mg/yr	%	Mg/yr	%	Mg/yr	%	Mg/yr	%	Mg/yr	%	Mg/yr	%
PIPELINE PUMPING STATIONS														
Fugitive Emissions from Equipment Leaks	660	8,810	240	36	3,210	36	240	36	3,210	36				
PIPELINE BREAKOUT STATIONS														
Storage Tanks	60	740	0	0	0	0	0	0	0	0	0	0	0	0
Fugitive Emissions from Equipment Leaks	80	1,030	30	41	420	41	30	41	420	41	30	41	420	41
BULK TERMINALS														
Loading Racks	270	4,350	200	75	3,270	75	60	23	1,010	23	60	23	1,010	23
Storage Tanks	600	9,900	0	0	0	0	0	0	0	0	0	0	0	0
Tank Truck Leakage	840	12,120	170	20	2,540	21	170	20	2,540	21	170	20	2,540	21
Fugitive Emissions from Equipment Leaks	1,210	15,710	520	43	6,750	43	520	43	6,750	43	520	43	6,750	43
BULK PLANTS														
Storage Tank Filling	280	5,060	240	85	4,470	88	240	85	4,470	88				
Tank Truck Loading Racks	340	5,850	210	62	3,930	67	210	62	3,930	67				
Tank Truck Leakage	130	1,880	0	0	0	0	0	0	0	0				
Fugitive Emissions from Equipment Leaks	1,310	18,570	480	37	6,840	37	480	37	6,840	37				
SERVICE STATIONS														
Underground Tank Filling	920	16,510	690	76	13,370	81	690	76	13,370	81				
TABLE TOTALS	6,700	100,530	2,780		44,800		2,640		42,530		780		10,720	

TABLE 6-3. (Concluded)

	EMISSION REDUCTIONS (Mg/yr and percentage reduction from baseline)											
	Alternative IV				Alternative IV-Q				Alternative IV-M			
	HAP		VOC		HAP		VOC		HAP		VOC	
	Mg/yr	%	Mg/yr	%	Mg/yr	%	Mg/yr	%	Mg/yr	%	Mg/yr	%
PIPELINE PUMPING STATIONS												
Fugitive Emissions from Equipment Leaks												
PIPELINE BREAKOUT STATIONS												
Storage Tanks	0	0	0	0	0	0	0	0	0	0	0	0
Fugitive Emissions from Equipment Leaks	3	4	50	4	3	4	50	4	3	4	50	4
BULK TERMINALS												
Loading Racks	60	23	1,010	23	60	23	1,010	23	60	23	1,010	23
Storage Tanks	0	0	0	0	0	0	0	0	0	0	0	0
Tank Truck Leakage	180	21	2,610	22	180	21	2,610	22	180	21	2,610	22
Fugitive Emissions from Equipment Leaks	200	16	2,550	16	200	16	2,550	16	200	16	2,550	16
BULK PLANTS												
Storage tanks												
Tank Truck Loading Racks												
Tank Truck Leakage												
Fugitive Emissions from Equipment Leaks												
SERVICE STATIONS												
Underground Tank Filling												
TABLE TOTALS	440		6,210		440		6,210		440		6,210	

TABLE 6-4. SUMMARY OF REGULATORY ALTERNATIVE EMISSION REDUCTIONS FOR ALL FACILITIES IN THE BASE YEAR (1998)

	EMISSION REDUCTIONS (Mg/yr reduction from baseline)							
	Baseline Control		Alternative I		Alternative II		Alternative III	
	HAP	VOC	HAP	VOC	HAP	VOC	HAP	VOC
PIPELINE PUMPING STATIONS								
Fugitive Emissions from Equipment Leaks	2,370	31,610	860	11,520	860	11,520		
PIPELINE BREAKOUT STATIONS								
Storage Tanks	6,370	84,110	5,720	75,470	5,720	75,470	5,720	75,470
Fugitive Emissions from Equipment Leaks	860	11,450	340	4,540	340	4,540	340	4,540
BULK TERMINALS								
Loading Racks	2,960	48,020	2,670	45,380	2,230	42,280	2,230	42,280
Storage Tanks	5,510	90,210	2,850	52,670	2,850	52,670	2,850	52,670
Tank Truck Leakage	3,730	53,960	390	9,140	390	9,140	390	9,140
Fugitive Emissions from Equipment Leaks	4,340	56,450	1,660	21,640	1,660	21,640	1,660	21,640
BULK PLANTS								
Storage Tanks	1,960	35,600	1,660	31,440	1,660	31,440		
Tank Truck Loading Racks	2,390	41,200	1,480	27,700	1,480	27,700		
Tank Truck Leakage	890	13,210						
Fugitive Emissions from Equipment Leaks	9,190	130,760	3,390	48,150	3,390	48,150		
SERVICE STATIONS								
Underground Tank Filling	11,880	213,970	9,000	173,310	9,000	173,310		
TABLE TOTALS	52,450	810,550	30,010	500,990	29,570	497,840	13,190	205,740

TABLE 6-4. (Concluded)

	EMISSION REDUCTIONS (Mg/yr reduction from baseline)					
	Alternative IV		Alternative IV-Q		Alternative IV-M	
	HAP	VOC	HAP	VOC	HAP	VOC
PIPELINE PUMPING STATIONS						
Fugitive Emissions from Equipment Leaks						
PIPELINE BREAKOUT STATIONS						
Storage Tanks	420	5,590	420	5,590	420	5,590
Fugitive Emissions from Equipment Leaks	3	50	30	350	40	510
BULK TERMINALS						
Loading Racks	730	12,370	730	12,370	730	12,370
Storage Tanks	770	15,510	770	15,510	770	15,510
Tank Truck Leakage	280	5,310	280	5,310	280	5,310
Fugitive Emissions from Equipment Leaks	200	2,550	510	6,570	700	9,170
BULK PLANTS						
Storage Tanks						
Tank Truck Loading Racks						
Tank Truck Leakage						
Fugitive Emissions from Equipment Leaks						
SERVICE STATIONS						
Underground Tank Filling						
TABLE TOTALS	2,390	41,390	2,720	45,710	2,930	48,470

discussed in Section 3.2.2, were used to calculate baseline emissions. The baseline emission levels for leaking pumps and valves at pipeline pumping stations are shown in Tables 6-2 and 6-3.

Regulatory Alternatives I and II specify an LDAR program for pipeline pumping stations. As discussed in Chapter 4 (Table 4-2), it is estimated that a quarterly leak detection and repair program will reduce emissions from leaking valves by 44 percent and from leaking pumps by 33 percent. These efficiencies were applied to all baseline emissions from area source pipeline pumping stations to estimate the VOC emission reductions shown in Tables 6-2 and 6-3.

6.1.4 Pipeline Breakout Stations.

The emissions at pipeline breakout stations consist of those from tanks used for the storage of gasoline and fugitive emissions from pumps and valves. As discussed for pipeline pumping stations, it is assumed that fugitive emissions are uncontrolled at the baseline. The baseline emissions and regulatory alternative reductions of fugitive emissions from these equipment leaks were calculated by multiplying the number of equipment components estimated in the model plant analysis by the component emission factors that were shown in Table 3-5. The resulting emission reductions for Alternatives I, II, and III (quarterly LDAR at new and existing area sources and existing major source facilities, monthly LDAR at new major sources) are 340 Mg HAP/yr and 4,540 Mg VOC/yr. It was estimated that 7.4 percent of pipeline breakout stations are major source facilities (92.6 percent will be area source sites) and that 9.3 percent will be classified as being "new" (consequently, 90.7 percent will be existing) in the base year of 1998 (see Table 8-27).

The baseline assumptions for breakout station storage tanks were 143 uncontrolled fixed-roof tanks, 88 fixed-roof tanks with internal floating roofs, 476 external floating roof tanks with primary seals, and 272 external floating roof tanks with primary and secondary seals (see Table 3-10). Baseline emissions from breakout station storage tanks were calculated by multiplying the number of dedicated storage tanks by the throughput estimated in the model plant analysis.

Regulatory Alternatives I, II, and III for storage tanks require that all fixed-roof tanks be equipped with an internal floating roof with primary seals and that all external floating roof tanks be fitted with secondary seals. The installation of an internal floating roof on a previously uncontrolled fixed-roof tank would result in VOC emission reductions of 95 percent, as shown in Table 4-2. Upgrading external floating roof storage tanks with primary seals to secondary seals would result in emission reductions of 50 percent, using factors from the same table. Therefore, the emission reductions attributable to Alternatives I, II, and III are the 95 percent reduction achieved for the installation of an internal floating roof for the 143 uncontrolled fixed-roof tanks and the 50 percent reductions achieved with the addition of a secondary seal for the 476 storage tanks with only primary seals. This results in an overall emission reduction from breakout station storage tanks utilizing the controls specified by Alternatives I, II, or III of 90 percent.

Regulatory Alternatives IV, IV-Q, and IV-M require that fixed-roof tanks at major sources be equipped with internal floating roofs and that external floating roof tanks (again at major sources) be fitted with secondary seals. Consequently, the emission reductions associated with these alternatives would result from the addition of internal floating roofs on the estimated 11 uncontrolled fixed-roof tanks and the installation of secondary seals on the estimated 35 external floating roof tanks associated with major sources. This results in an overall emission reduction of 4 percent. Emission reductions at new facilities will be zero since the storage tank NSPS already requires the same control levels.

6.1.5 Bulk Terminals

The emission points at bulk terminals consist of truck or railcar loading racks, storage tanks, tank truck leakage, and fugitive emissions from leaking pumps and valves. As can be seen from Table 8-27, 28 percent of the bulk terminals (287 facilities) will be classified as new in the base year of 1998, while 72 percent of these sources (737 facilities) will be classified as existing sources. Each is addressed separately in this section.

6.1.5.1 Loading racks. The levels of control at loading racks range from uncontrolled loading racks (splash or submerged fill) to those loading racks with vapor collection and processing systems that meet or surpass an emission limitation of 10 milligrams of VOC emitted per liter of gasoline loaded (mg/l). Using the control levels for the consumption rates shown in Table 3-11, the baseline emissions were calculated by associating each throughput with the number of estimated facilities.

Regulatory Alternative I requires that loading racks at new major source bulk terminals lower emissions to 5 mg/l and that area bulk terminal racks and loading racks at existing major sources lower emissions to 10 mg/l. Therefore, the uncontrolled emissions from existing truck loading sources would be reduced from the uncontrolled level to 10 mg/l (nearly a 99 percent reduction for splash and submerged fill operations) and other existing sources would need to reduce their emissions an incremental amount as well. This amounts to an 87 percent reduction for sources operating at 80 mg/l and a 29 percent reduction for sources operating at 35 mg/l. To obtain the emission reduction gained by implementing the 5 mg/l standard at new major source facilities, the entire baseline throughput (446 billion liters) was multiplied by 5 mg/l to obtain emissions if all facilities were regulated at 5 mg/l. To obtain the emission level at new major sources, the resulting number was multiplied by the estimated percentage of major sources (27 percent) and by the estimated number of new sources (28 percent). The resulting emission level for this alternative was estimated to be 292 Mg HAP/yr and 2,642 Mg VOC/yr. This results in an overall emission reduction from bulk terminal loading racks of about 90 percent.

Similarly, Regulatory Alternatives II and III require that area source loading racks meet 35 mg/l and major sources meet the same levels as Alternative I (5 mg/l at new facilities, 10 mg/l at existing sources). Alternatives IV, IV-Q, and IV-M propose to regulate major source bulk terminal loading racks only, and these must meet 5 mg/l for new facilities and 10 mg/l for existing ones. Emissions for these alternatives were calculated in a manner similar to the others. Emission reductions for these alternatives would be about 25 percent.

6.1.5.2 Storage Tanks. The baseline emissions from storage tanks at bulk terminals were calculated in basically the same manner as discussed for breakout station storage tanks. Baseline storage tank population was separated by tank type for the analysis. The storage tank population has been characterized previously in Table 3-11.

The emission reductions attributable to Alternatives I, II, and III for the installation of an internal floating roof on the 1,072 uncontrolled fixed-roof tanks and the reductions achieved with the addition of a secondary seal on the 2,426 storage tanks with only primary seals are 2,850 Mg HAP/yr (54 percent reduction) and 52,670 Mg VOC/yr (58 percent reduction). The emission reductions attributable to Alternatives IV, IV-Q, and IV-M, which require (at major source facilities only) installation of internal floating roofs on fixed-roof tanks and addition of secondary seals on external floating roof tanks with only primary seals, are approximately 15 percent.

6.1.5.3 Tank Truck Leakage. The baseline regulatory levels for controlling leakage from tank trucks during gasoline loading include leak-tight inspection programs, usually required annually. The baseline emissions from the 446 billion liters loaded into tank trucks and railcars are 3,730 Mg HAP/yr and 53,950 Mg VOC/yr. The baseline assumptions were that approximately 317 billion liters were loaded into trucks regulated by the annual leak tightness program and 129 billion liters were loaded uncontrolled.

Regulatory Alternatives I, II, and III require that a vacuum assist vapor collection system be installed at each new major source terminal (existing major sources and all area sources would be required to implement annual vapor tightness testing). It is estimated that implementation of vacuum assist loading would affect approximately 3,300 trucks at new major source facilities. This number is derived from a calculation based on facility population characteristics (28 percent of bulk terminals are "new" and 27 percent of those are estimated to be major sources). The vacuum assist system, as discussed in Section 4.1.4.3, is expected to reduce tank truck leakage emissions at the loading racks nearly to zero (estimated 98 percent reduction). Therefore, the emission reductions for these regulatory alternatives entail reducing tank truck leakage VOC emissions at new major source facilities to 2 percent of the previous levels. Under these alternatives, trucks loading at all other bulk terminals (approximately 40,600) would have to undergo annual leak tightness testing according to EPA Method 27.

Regulatory Alternatives IV, IV-Q, and IV-M require that the same vacuum assist system be installed at new major source bulk terminals, and also require annual vapor tightness testing, as specified above, of trucks and railcars that load at new and existing major source facilities. It is estimated that these alternatives would affect approximately 8,500 trucks (72 percent of facilities are classified as existing and 27 percent of those will be classified as major sources).

6.1.5.4 Fugitive Emissions. The fugitive emissions at bulk terminals occur from leaking pumps and valves that are components of the piping that transfers gasoline and gasoline vapors. The baseline emissions (4,340 Mg HAP/yr and 56,460 Mg VOC/yr) were calculated on a per-component basis and as such 330 Mg HAP and 4,290 Mg VOC are attributed to new major sources, 840 Mg HAP and 10,940 Mg VOC to existing major sources, 890 Mg HAP and 11,500 Mg VOC to new area sources, and 2,280 Mg HAP and 29,700 Mg VOC to existing area sources. The levels of control for the regulatory alternatives for fugitive emission reductions at bulk terminals are the same as those discussed for pipeline breakout facilities.

6.1.6 Bulk Plants

There are four sources of emissions at bulk plants. Emissions occur during the filling of the storage tanks, during the loading of tank trucks at loading racks, from tank truck leakage during loading, and as fugitive emissions from leaking pumps and valves. Under existing criteria, there are no major source bulk plants; all qualify as area sources. As can be calculated from data in Table 8-27, 14.2 percent (approximately 1,790 facilities) of these sites qualify as new and 85.8 percent (10,800 facilities) fall into the existing site category.

6.1.6.1 Storage Tank Filling. The current control method for bulk plant storage tank filling consists of vapor balance piping that transfers gasoline vapors from the storage tank to the tank truck unloading gasoline. As discussed in Section 4.1.5.3, this technology has been demonstrated to reduce emissions by 95 percent. Approximately 45 percent of the estimated 25,200 storage tank loading facilities (approximately 3,600 new and 21,600 existing as calculated using the data in Table 8-27) use this method. The remaining 55 percent are uncontrolled.

Baseline emissions were calculated by multiplying throughput identified in Table 3-11 by these facility populations.

Alternatives I and II would require implementation of the above mentioned vapor balance system at area source bulk plants (both new and existing). As a result, emissions under these alternatives are reduced approximately 85 percent from baseline.

6.1.6.2 Tank Truck Loading Racks. As discussed in Section 4.1.5, the control technology for loading racks at bulk plants consists of the installation of vapor balance piping that transfers gasoline vapors from the tank truck being loaded back to the storage tank. This technology has been demonstrated to achieve a 95 percent reduction in VOC emissions. The baseline analysis assumes that approximately 49 billion liters is loaded into trucks using vapor balance methods, 30 billion liters using submerged fill, and almost 9 billion liters using splash fill (Table 3-10).

Regulatory Alternatives I and II require that new and existing area source bulk plants install vapor balance piping on their loading racks, but allow a 15,000 liters/day (4,000 gallon/day) exemption. Submerged fill is required for plants with throughputs below this level. Therefore, emission reductions calculated for these alternatives would arise from plants with previously uncontrolled throughputs (an estimated 14 percent of the total of 12,600 facilities, or 1,750 loading sites). Throughputs associated with this segment of the population were multiplied by the controlled emission factor to obtain emission quantities. This results in an overall emission reduction from tank truck loading at bulk plants of about 65 percent.

6.1.6.3 Tank Truck Leakage. None of the presented alternatives requires additional controls or control procedures for tank trucks loading at area source bulk plants. As a result, none of the alternatives would yield an emission reduction for this emission point. Baseline leadage emissions are 890 Mg HAP/yr and 13,220 Mg VOC/yr.

6.1.6.4 Fugitive Emissions from Equipment Leaks. The fugitive emissions at bulk plants occur from leaking pumps and valves that transport gasoline and gasoline vapors. Baseline emissions of 9,190 Mg HAP/yr and 130,757 Mg VOC/yr were calculated on a per-component basis. Alternatives I and II specify the implementation of a quarterly LDAR program at both new and existing facilities. This level of control is the same as that specified for area source bulk terminals.

6.1.7 Service Stations (Storage Tank Filling)

The emissions from service stations considered in this regulatory development result during the filling of the storage tank, which is typically underground. The control technique used to reduce emissions from this operation is vapor balance. The vapors being forced out of the storage tank by the incoming liquid gasoline are collected and returned to the tank truck. This has been demonstrated to reduce VOC emissions by at least 95 percent. The baseline assumptions for service stations are that approximately 289 billion liters are loaded into service station storage tanks using vapor balance, about 86 billion liters loaded using submerged fill, and the remaining 71 billion liters loaded using splash fill (Table 3-11). As can be calculated after an examination of Table 8-27, the majority of this throughput can be attributed to existing service stations (97.3 percent). It is estimated that only a minor amount (2.7 percent) will be attributed to new service stations in the base year of the analysis.

Regulatory Alternatives I and II require the installation of vapor balance systems nationwide (all service stations meet area source criteria), but each contains an exemption for stations with throughputs less than 10,000 gallons/month (about 7 percent of the throughput, see Table 5-7). Submerged fill will be required for stations with throughputs below this level. Therefore, the emission reductions for these alternatives would come entirely from previously uncontrolled areas (approximately 9 percent of the 387,750 stations or approximately 35,000 service stations). This results in an overall emission reduction for each of these alternatives of a little more than 75 percent.

6.2 WATER POLLUTION IMPACTS

The overall impact of the alternatives on water resources is negligible. None of the emission control technologies creates a significant water discharge. Only if refrigeration systems, which cool and condense the vapors from the loading operation for liquid recovery, are used for bulk terminal control, would a potential water pollution impact be created. In a refrigeration system the vapor-air mixture collected at the loading rack is cooled to very low temperatures (as low as -180°F). Along with the gasoline vapors, moisture in the air is condensed. The amount condensed is dependent upon the humidity of the entering process stream flow. As a consequence, a small amount of a liquid gasoline-water mixture is generated. This mixture is then passed through a gasoline-water separator, with the gasoline returning to storage and the water being discharged. It is estimated that this will produce only a negligible impact on water quality since gasoline is essentially insoluble in water[1].

6.3 SOLID WASTE IMPACTS

The only solid waste that may be generated by any of the control systems being evaluated would be spent activated carbon used in a bulk terminal carbon adsorption system. For this scenario, the assumption would be that the carbon could not be reactivated and would have to be discarded after its useful life. Table 6-5 summarizes calculations of this potential solid waste impact. This analysis assumes that approximately one-third of the terminals requiring control would choose carbon adsorption. This estimate is slightly higher than the estimated national average of emissions processed at bulk terminals using vapor recovery devices (25 percent) but this impact analysis is intended to be conservative. Consequently, the average annual solid waste impact is averaged over the 10-year life of the carbon, which results in a total environmental impact of 260 tons per year or an average of 0.73 ton per terminal. To put this impact in perspective, the average person generates almost 2 Mg of solid waste per year[2] (10 pounds per day, 365 days per year = 1.6 Mg per year). Therefore, this solid waste impact could be considered negligible.

6.4 ENERGY IMPACTS

Energy impacts for the regulatory alternatives were estimated in the form of gallons of gasoline saved. Energy savings were derived by determining the liquid gasoline equivalent of the emission reductions presented in Table 6-5. Liquid gasoline is saved from equipment leaks and storage tanks since less product is allowed to evaporate and escape. Gasoline is recovered at terminals when carbon adsorption or refrigeration systems are used to control emissions. Gasoline is recovered, or not lost to evaporation, at bulk plants where vapor recovery is used on outgoing loads. When gasoline is pumped from storage to fill the trucks, vapors are returned to the tank, thereby reducing evaporation and saving gasoline.

Table 6-6 summarizes the liquid gasoline saved. For bulk terminals, it was assumed that 25 percent of the emission reductions would be processed using recovery devices (carbon adsorption, refrigeration). Although these control devices use energy for their operation, the amount is relatively small and has been subtracted from the gross savings at bulk terminals shown in Table 6-6. Savings ranged from 68 million gallons per year for underground storage tank filling at existing service stations under

TABLE 6-5. ESTIMATED SOLID WASTE IMPACTS FROM CARBON DISPOSAL AT BULK GASOLINE TERMINALS

Bulk Terminal Model Plant	Carbon Capacity[c], lbs	Regulated[a] Facilities	Annual Solid Waste[b], Mg
1	10,000	123	56
2	14,000	69	44
3	18,000	84	69
4	25,000	30	34
Total		306	203

[a] Regulated facilities determined by assuming 30 percent of all facilities require control. Number of facilities by model plant determined by using 30 percent of facilities presented in Table 5-3.

[b] Annual solid waste impact determined by assuming one third of all facilities will use carbon adsorption and carbon must be disposed of after end of useful life (10 years). Annual solid waste impact averaged over 10 years life.

[c] Reference 3.

TABLE 6-6. ESTIMATED NET ENERGY SAVINGS (GASOLINE SAVED) FROM GASOLINE DISTRIBUTION CONTROL ALTERNATIVES

	Alternative I		Alternative II		Alternative III	
	VOC Em. Red., Mg/yr	Gasoline Savings, 10^6 Gal/yr[a]	VOC Em. Red., Mg/yr	Gasoline Savings, 10^6 Gal/yr[a]	VOC Em. Red., Mg/yr	Gasoline Savings, 10^6 Gal/yr[a]
Pipeline Pumping Stations						
Fugitive Emissions	11,500	4.5	11,500	4.5		
Pipeline Breakout Stations						
Storage Tanks	75,500	29.8	75,500	29.8	75,500	29.8
Fugitive Emissions	4,500	1.8	4,500	1.8	4,500	1.8
Bulk Terminals						
Loading Racks[b]	45,400	4.5	42,300	4.2	42,300	4.2
Storage Tanks	52,700	20.8	52,700	20.8	52,700	20.8
Tank Truck Leakage	9,100	3.6	9,100	3.6	9,100	3.6
Fugitive Emissions	21,600	8.5	21,600	8.5	21,600	8.5
Bulk Plants						
Storage Tank Filling	31,400	12.4	31,400	12.4		
Tank Truck Loading Rack	27,700	10.9	27,700	10.9		
Tank Truck Leakage						
Fugitive Emissions	48,100	19.0	48,100	19.0		
Service Stations						
Underground Tank Filling	173,300	68.3	173,300	68.3		
TABLE TOTALS	500,900	197.5	497,800	196.3	205,700	81.1

[a] Gallons/yr = (Mg/yr)(10^3 kg/Mg)(liter/0.67 kg)(gal/3.785 liter).

[b] Assumes only 25 percent of emissions controlled by recovery type devices, other emission reduction by vapor destruction devices.

TABLE 6-6. (Concluded)

	Alternative IV		Alternative IV-Q		Alternative IV-M	
	VOC Em. Red., Mg/yr	Gasoline Savings, 10^6 Gal/yr[a]	VOC Em. Red., Mg/yr	Gasoline Savings, 10^6 Gal/yr[a]	VOC Em Red., Mg/yr	Gasoline Savings, 10^6 Gal/yr[a]
PIPELINE PUMPING STATIONS						
Fugitive Emissions from Equipment Leaks						
PIPELINE BREAKOUT STATIONS						
Storage Tanks	5,600	2.2	5,600	2.2	5,600	2.2
Fugitive Emissions from Equipment Leaks	50	0.02	400	0.14	500	0.2
BULK TERMINALS						
Loading Racks[b]	12,400	1.22	12,400	1.2	12,400	1.2
Storage Tanks	15,500	6.1	15,500	6.1	15,500	6.1
Tank Truck Leakage	5,300	2.1	5,300	2.1	5,300	2.1
Fugitive Emissions from Equipment Leaks	2,600	1.0	6,600	2.6	9,200	3.6
BULK PLANTS						
Storage Tank Filling						
Tank Truck Loading Racks						
Tank Truck Leakage						
Fugitive Emissions from Equipment Leaks						
SERVICE STATIONS						
Underground Tank Filling						
TABLE TOTALS	41,400	16.3	45,700	18.0	48,500	19.1

[a] Gallons/yr = (Mg/yr)(10^3 kg/Mg)(liter/0.67 kg)(gal/3.785 liter)
[b] Assumes only 25 percent of emissions controlled by recovery type devices, other emission reduction by vapor destruction devices

Alternatives I and II to 0.02 million gallons per year savings for equipment leaks at new breakout stations under Alternative IV.

6.5 OTHER ENVIRONMENTAL IMPACTS

Other potential environmental impacts include noise impacts. The relative impacts of the regulatory alternatives on this environmental concern are expected to be insignificant. An EPA test[4] showed that the noise level from terminal vapor processing devices, which created significantly more noise to the unprotected ear than any other system considered, was less than 70 db at 7 meters from the noise source.

If incinerators/combustors/flares are utilized to control loading rack emissions at bulk terminals, the combustion of the gasoline vapor will create secondary air emissions of other compounds, specifically particulate, SO_x, and NO_x. Assuming a worst-case situation that one third of all terminals install a destruction device that burns the gasoline vapor, the estimated particulate, SO_x, and NO_x emissions are shown in Table 6-7. These estimates were calculated using AP-42 emission factors for natural gas fired boilers of 3.0 lb/million ft^3, 0.6 lb/million ft^3, and 100 lb/million ft^3, for particulate, SO_x, and NO_x, respectively. Consequently, the total impact would apply under Alternatives I, II, and III, but only 27 percent of total impacts would apply (27 percent of sources are major sources) if Alternative IV, IV-Q, or IV-M were implemented.

TABLE 6-7. ESTIMATED PARTICULATE, NO_x, AND SO_x EMISSIONS FROM INCINERATION AT BULK GASOLINE TERMINALS

Bulk Terminal Model Plant	Regulated[a] Facilities	Annual Emissions (Mg/year)		
		Particulate	NO_x	SO_x
1	123	0.8	28.4	0.2
2	69	1.2	39.4	0.3
3	84	2.9	96.5	0.5
4	30	2.1	68.9	0.5
Railcar	19	0.3	9.4	0.1
Total	325	7.3	242.6	1.5

a Regulated facilities determined by assuming 30 percent of all facilities require control. Numbers of facilities by model plant determined by using 30 percent of facilities presented in Table 5-3.

b Calculated using emission factors for natural gas-fired boilers less than 10 mmBTu/hr.

6.6 REFERENCES

1. The Merck Index. Eleventh edition. Merck & Co., Inc. 1989. p. 4269.

2. "Procedures for the Preparation of Emission Inventories for Carbon Monoxide and Precursors of Ozone." U.S. Environmental Protection Agency. Research Triangle Park, NC. Publication No. EPA-450/4-91-016. March 1991.

3. Telecon. Hawes, T., Pacific Environmental Services, Inc., to Keller, D., IT McGill, Inc. February 26, 1991. Carbon adsorber cost estimates.

4. Betz Environmental Engineers, Inc. Gasoline Vapor Recovery Efficiency Testing at Bulk Transfer Terminals Performed at Pasco-Denver Products Terminal. Prepared for U.S. Environmental Protection Agency. Research Triangle Park, NC. Contract No. 68-02-1407. Project No. 76-GAS-17. September 1976.

7.0 CONTROL COSTS

This chapter presents a discussion of the costs of implementing HAP and VOC emissions control at gasoline distribution facilities. Using the model plant parameters previously described in Chapter 5, costs have been developed for each of the six regulatory alternative arrays. Section 7.1 presents model plant costs for each facility type to be regulated: pipeline facilities, bulk terminals, bulk plants, and service stations. Costs associated with storage tanks and leak detection and repair programs are discussed separately since they will be incurred at facilities in more than one category. Section 7.2 presents an analysis of the control costs for each of the regulatory alternatives. Tabular costs are provided along with a discussion of the sources of data and the assumptions used in deriving the costs.

7.1 MODEL PLANT COSTS

7.1.1 Storage Tanks

This section addresses the cost of controls for storage tanks present at pipeline breakout stations and bulk terminals. Storage tank control techniques have been discussed in Section 4.1.3 and include the installation of internal floating roofs on fixed-roof storage tanks and the addition of secondary seals on external floating roof storage tanks.

The annual costs associated with installation of an internal floating roof within an existing fixed-roof tank structure were derived from costs developed in previous EPA studies for the third quarter of 1991.[1] The capital costs are based on a model tank with a capacity of 2,680 m^3 and a diameter of 15.2 m for bulk terminals, and a capacity of 8,000 m^3 and a diameter of 30 m for pipeline breakout stations, and are summarized in Table 7-1. According to estimates from vendors[2], degassing and cleaning costs for tanks at terminals and breakout stations, shown in Table 7-1, as well as the floating roof tanks detailed in Table 7-2, are approximately $9,000 and $13,000, respectively. The waste disposal cost averages approximately $3,000 for all the tanks. The roof and seal costs were based on figures and formulas given in the draft 1991 floating and fixed-roof tank CTG. The deck fitting costs also were taken from the CTG. The annualized costs for maintenance; taxes, insurance, and general and administrative charges; and inspections were estimated using the same percentages as presented in the draft 1991 CTG. A recovery credit was calculated to reflect the amount of gasoline that would no longer be lost through evaporation, breathing loss, etc. after this control measure was implemented. Note that the price per liter of gasoline used to calculate recovery credits is different at bulk terminals than at pipeline breakout stations. This is due to the fact that some federal tax is actually collected at the bulk terminal, thus raising the price slightly. Additionally, the concept of equivalent dedicated storage tanks (number in use as opposed to the total number at the facility) was used to calculate emissions as presented in the tables. However, the recovery credits should be distributed among the actual number of tanks at each model plant. Since there are a different number of storage tanks and dedicated storage tanks at each model plant, the recovery credits calculated for Tables 7-1 and 7-2 are presented as weighted averages. The combined annualized "costs" result in a net annual savings (recovery credit - annualized cost) of $13,540 at bulk terminals and $66,080 at pipeline breakout stations. Emission reduction (storage tank emission factors from Tables 3-6 and 3-7 times

TABLE 7-1. COSTS OF INSTALLING A BOLTED INTERNAL FLOATING ROOF ON AN EXISTING FIXED-ROOF TANK (THIRD QUARTER 1990 DOLLARS)

BULK TERMINALS	BREAKOUT STATIONS
Assumptions: Tank Capacity = 2,680 m^3 Tank Diameter = 15.2 m Tank Height = 14.6 m Emission Reduction = 45.9 Mg	Assumptions: Tank Capacity= 8,000 m^3 Tank Diameter= 30 m Tank Height = 12 m Emission Reduction = 497 Mg

	BULK TERMINAL	BREAKOUT STATION
Capital Cost & Installation		
Degassing, Cleaning, & Waste Disposal[a]	$9,000	$13,000
Roof with Liquid-Mounted Seal[b]	$19,900	$41,550
Controlled Deck Fittings[b]	$200	$200
Total Capital Cost	$29,100	$54,750
Annualized Costs ($/yr)		
Maintenance (5%)[b]	$1,460	$2,740
Taxes, Insurance, G&A (4%)[b]	$1,160	$2,190
Inspections (1%)[b]	$290	$550
Annual Capital Charges (11.76%, 20 yrs. @ 10%)	$3,420	$6,440
Total Annualized Cost	$6,330	$11,920
Product Recovery Credit	$19,870[c]	$78,000[d]
Net Annualized Cost ($/yr)[e]	($13,540)	($66,080)
Cost Effectiveness ($/Mg)	($295)	($133)

[a] Based on vendor estimations of $6,000 - $11,000 for degassing and cleaning, and about $3,000 for waste disposal.[3]

[b] Reference 1.

[c] Based on a calculation which subtracts losses from internal floating roof tanks from uncontrolled losses at fixed-roof tanks and a cost of gasoline at bulk terminals of $0.290/liter.[4]

[d] Based on the same loss calculation as specified in footnote "c" and $0.285/liter of gasoline at a breakout station.[5]

[e] Net annualized cost (savings).

TABLE 7-2. COSTS OF INSTALLING A SECONDARY SEAL ON AN EXISTING EXTERNAL FLOATING ROOF TANK (THIRD QUARTER 1990 DOLLARS)

BULK TERMINALS

Assumptions: Tank Capacity = 2,680 m^3
Tank Diameter = 23.8 m
Tank Height = 12 m
Emission Reduction = 7.5 Mg

BREAKOUT STATIONS

Assumptions: Tank Capacity= 8,000 m^3
Tank Diameter= 30 m
Tank Height = 12 m
Emission Reduction = 9.6 Mg

	BULK TERMINAL	BREAKOUT STATION
Capital Cost & Installation		
Degassing, Cleaning, & Waste Disposal[a]	$9,000	$13,000
Secondary Seal Cost[b]	$13,200	$16,960
Controlled Deck Fittings[b]	$680	$680
Total Capital Cost	$22,880	$30,640
Annualized Costs ($/yr)		
Maintenance (5%)[b]	$1,140	$1,530
Taxes, Insurance, G&A (4%)[b]	$920	$1,230
Inspections (1%)[b]	$230	$310
Annual Capital Charges (11.76%, 20 yrs. @ 10%)	$3,730	$4,990
Total Annualized Cost	$6,020	$8,060
Product Recovery Credit	$3,250[c]	$1,510[d]
Net Annualized Cost ($/yr)	$2,770	$6,550
Cost Effectiveness ($/Mg)	$370	$682

[a] Based on Vendor estimations of $6,000 - $11,000 for degassing and cleaning and about $3,000 for waste disposal.[3]

[b] Reference 1.

[c] Based on a calculation which subtracts secondary seal losses on an external floating roof tank from primary seal losses on an external floating roof tank and a cost of gasoline at bulk terminals of $0.290/liter.[4]

[d] Based on the same loss calculation as specified in footnote "c" and $0.285/liter of gasoline at a breakout station.[5]

control efficiencies from Tables 4-2 and 4-3) and overall cost effectiveness (annualized cost divided by emission reduction) reflect this same trend. As discussed previously for installation of seals on a fixed-roof tank, the net annual cost to install a secondary seal on an external floating roof tank (annualized cost - recovery credit) at a pipeline breakout station is $8,060 and at a bulk terminal is $6,020. Emission reduction and cost effectiveness were calculated in the same manner as noted for fixed-roof tanks.

7.1.2 Leak Detection and Repair

As discussed in Chapter 3, leaking pumps and valves are sources of emissions at pipeline facilities, bulk terminals, and bulk plants. Vapor leakage from tank trucks will be discussed later. The basic control technology discussed in Chapter 4, Section 4.1.7, involves LDAR programs with varying frequencies of inspections. Tables 7-3 and 7-4 present model plant costs as well as cost effectiveness for quarterly and monthly LDAR as implemented at pipeline pumping and breakout stations, bulk terminals, and bulk plants. Table 7-5 provides costs per monitoring event. Capital costs do not appear in the tables as there are none assumed to be associated with the implementation of LDAR (no equipment purchase, only annual monitoring and maintenance costs).

According to an estimate by a company providing this service[9], a technician can monitor approximately 300-600 components (i.e., pumps and valves) per day. Model plant 2 for pipeline breakout stations has 470 components; therefore, this analysis assumes that all monitoring can be performed in one day for all model plants. According to another company's estimate, the minimum charge for a technician to perform LDAR is $600/day. The model plants for the pipeline pumping stations have the fewest number of components, so this analysis assumes that a technician can monitor two facilities in one day for $600 or monitor one facility for $300. Extra charges for repair cost are

TABLE 7-3. ANNUAL COST FOR QUARTERLY LEAK DETECTION AND REPAIR

	Monitoring Cost ($/Monitoring)[a]	Repair Cost[a] ($/Monitoring)	Travel Cost[b] ($/Monitoring)	Total Cost ($/Monitoring)	Recovery Credit ($/yr)	Annual Cost ($/yr)	Emission Reduction (Mg/yr)	Annual Cost Effectiveness ($/Mg)
Pipeline Pumping Stations								
MP1	300	5	86	391	987	577	9.32	62
MP2	300	5	86	391	2,246	(682)	21.16	credit
MP3	300	10	86	396	4,237	(2,653)	39.76	credit
Pipeline Breakout Stations								
MP1	600	22.50	--	622.50	5,904	(3,414)	55.56	credit
MP2	600	37.50	--	637.50	8,048	(5,498)	75.72	credit
Bulk Terminals								
MP1	600	10	--	610	4,103	(1,663)	37.88	credit
MP2	600	10	--	610	4,519	(2,079)	41.76	credit
MP3	600	12.50	--	612.50	4,779	(2,329)	44.08	credit
MP4	600	12.50	--	612.50	5,281	(2,831)	48.76	credit
Bulk Plants								
MP1-MP5	600	5	--	605	1,731	689	15.28	45

( ) denotes a negative cost.

a Based on a vendor estimate (see Reference 2).

b Additional travel cost due to remotely located facility is estimated as follows: 120 miles at $.25/mile and 1 technician's travel time for approximately 2.5 hours @ $22.50/hr.

TABLE 7-4. ANNUAL COST FOR MONTHLY LEAK DETECTION AND REPAIR

	Monitoring Cost ($/Monitoring)[a]	Repair Cost[a] ($/Monitoring)	Travel Cost[b] ($/Monitoring)	Total Cost ($/Monitoring)	Recovery Credit ($/yr)	Annual Cost ($/yr)	Emission Reduction (Mg/yr)	Annual Cost Effectiveness ($/Mg)
Pipeline Pumping Stations								
MP1	300	5	86	391	1,633	3,059	45.6	67
MP2	300	5	86	391	3,726	966	105.48	9
MP3	300	10	86	396	6,993	(2,241)	196.56	(11)
Pipeline Breakout Stations								
MP1	600	22.50	--	622.50	9,086	(1,616)	256.2	(6)
MP2	600	37.50	--	637.50	12,251	(4,601)	345.36	(13)
Bulk Terminals								
MP1	600	10	--	610	6,856	464	28.44	16
MP2	600	10	--	610	7,428	(108)	31.32	(3)
MP3	600	12.50	--	612.50	7,791	(441)	33.12	(13)
MP4	600	12.50	--	612.50	8,466	(1,106)	36.6	(30)
Bulk Plants								
MP1-MP5	600	5	--	605	2,813	4,447	74.88	59

( ) denotes a negative cost.
a Based on a vendor estimate (see Reference 2).
b Additional travel cost due to remotely located facility is estimated as follows: 120 miles at $.25/mile and 1 technician's travel time for approximately 2.5 hours @ $22.50/hr.

TABLE 7-5. SUMMARY OF LEAK DETECTION AND REPAIR NET COSTS PER MONITORING EVENT (THIRD QUARTER 1990 DOLLARS)

Model Plant[a]	Cost ($/component) Quarterly LDAR[a]	Monthly LDAR[a]
Pipeline Pumping Stations		
Model Plant 1 2 pumps[c], 25 valves	4.97	8.79
Model Plant 2 5 pumps[c], 50 valves	(2.84)	1.34
Model Plant 3 9 pumps[c], 100 valves	(5.62)	(1.58)
Pipeline Breakout Stations		
Model Plant 1 20 pumps[c], 250 valves	(2.94)	(0.46)
Model Plant 2 35 pumps[c], 400 valves	(2.92)	(0.81)
Bulk Terminals		
Model Plant 1 10 pumps[c], 90 valves	(3.78)	.36
Model Plant 2 10 pumps[c], 115 valves	(3.85)	(.06)
Model Plant 3 10 pumps[c], 130 valves	(3.88)	(.25)
Model Plant 4 10 pumps[c], 160 valves	(3.93)	(.52)
Bulk Plants		
Model Plants 1-5 4 pumps[c], 50 valves	2.97	6.39

[a] Model plants and parameters from Table 5-1.
[b] ( ) Indicates a negative cost or net savings.
[c] Assuming two pump seals per pump.

estimated at $2.50/component. An extra charge for travel is added to the costs at pipeline pumping stations due to their often remote locations. The total cost for monitoring includes extra repair and travel cost. Since quarterly LDAR occurs four times a year, the "Total Cost" per monitoring is multiplied by four to obtain the "Annual Total Cost" for quarterly LDAR in Table 7-3. Similarly, monthly LDAR occurs 12 times a year. As a result, the "Total Cost" per monitoring is multiplied by 12 to obtain the "Annual Total Cost" for monthly LDAR. (Costs can be scaled back or scaled up accordingly, for components that are allowed to drop back to a quarterly monitoring period or for those that must be monitored monthly for a time.)

Annual baseline emissions were calculated for each model plant by multiplying the leakage rates for pumps and valves (see Table 3-5) by the number of pumps and valves at the model plant over the annual operating schedule. Annual emission reductions were calculated using the efficiencies associated with quarterly and monthly LDAR as shown in Table 4-4. The emission reductions were used to calculate a product recovery credit to reflect the amount of gasoline that would no longer be lost through evaporation or leaking at the pumps or valves. The "Annual Cost Effectiveness" was calculated by dividing the difference between the "Annual Total Cost" and the "Recovery Credit" by the "Emission Reduction." In several model plants, implementation of quarterly or monthly LDAR results in a net savings or negative cost, due to the recovery credit. This occurs primarily at the model plants which have the most pumps and valves. Since these model plants have a greater emission reduction when LDAR is applied, they also have a greater recovery credit.

7.1.3 Bulk Terminals

7.1.3.1 Truck loading racks. Capital expenditures and annualized costs for the control of emissions from bulk gasoline terminal loading operations were estimated for the four model plant sizes presented in Section 5.1.2. Three types of vapor processing systems have been included in the analysis: carbon adsorption (CA), thermal oxidation (TO), and refrigeration (REF) systems. Based on conversations with terminal operators and control equipment manufacturers, these are the most common types of systems in use today. Varying estimates were prepared based on assumed processor outlet emissions (35 mg/liter, 10 mg/liter, and 5 mg/l) and whether the installed system was a new unit or, in the case of thermal oxidizers, an add-on system. The costs presented include capital investment, annualized costs, and cost effectiveness for each type of control device for four different throughput levels. Table 7-6 presents the estimated costs for a new unit designed to meet a 35 mg/liter outlet emission limit; Table 7-7 provides cost estimates for a control device designed to meet a 10 mg/liter limit; and Table 7-13 gives cost estimates for a new unit designed to meet a 5 mg/l standard. Tables 7-8 through 7-14 present costs associated with upgrading existing terminal loading racks to limits imposed by the alternatives developed in this analysis. Table 7-8 details costs for upgrade of uncontrolled facilities to a 35 mg/l standard; Table 7-9 provides costs for converting existing 80 mg/l units to meet a 35 mg/l standard; Table 7-10 shows costs of upgrading uncontrolled facilities to a 10 mg/l emission limit; Table 7-11 gives costs for retrofit of 80 mg/l units that will allow them to meet a 10 mg/l standard; Table 7-12 presents costs for upgrading 35 mg/l units to 10 mg/l; Table 7-13 provides costs for upgrading 35 mg/l units to meet a 5 mg/l limit; and Table 7-14 shows costs for retrofit of 10 mg/l units such that they will meet a 5 mg/l standard. Finally, Table 7-15 presents the costs of adding on a thermal oxidizer to an existing system in order to obtain improved emission control (from 35 mg/l to 10 mg/l). Manufacturers were contacted and previous EPA cost information was reviewed to obtain the purchase costs

TABLE 7-6. BULK TERMINAL LOADING RACK COSTS - NEW 35 mg/l UNIT

(THOUSANDS OF THIRD QUARTER 1990 DOLLARS)

Gasoline Throughput	380,000 l/day			950,000 l/day			1,900,000 l/day			3,800,000 l/day		
Vapor Processor	CA[a]	TO[b]	REF[c]	CA	TO	REF	CA	TO	REF	CA	TO	REF
Capital Investment												
Unit purchase cost[d]	174	83	218	181	94	287	189	94	287	218	112	362
Unit installation cost[e]	147	70	185	154	80	244	161	80	244	185	95	308
Annual Operating Costs												
Electricity	9	1	3.3	12	6	8.3	16	8	16.6	25	18	38.2
Pilot gas[f]		2			3.4			6.3			8.3	
Carbon replacement[g]	2.1			2.9			3.8			5.2		
Maintenance[h]	6	3.5	11.6	6	3.5	11.6	6	3.5	11.6	6	3.5	11.6
Operating labor[i]	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8
Subtotal (Direct Operating Costs)	23.9	13.3	21.7	27.7	19.7	26.7	32.6	24.6	35	43	36.6	56.6
Capital charges[j] (16.3%)	52.3	25	65.7	54.7	28.4	86.5	57.1	28.4	86.5	65.8	33.6	109.2
Taxes and Insurance (4%)	12.8	6.1	16.1	13.4	7	21.2	14	7	21.2	16.1	8.3	26.8
Gasoline rec. credit[k]	56	0	56	140.1	0	140.1	280.2	0	280.2	560.3	0	560.3
Net Annualized Cost	33	44.4	47.5	(44.3)	55.1	(5.6)	(176.4)	60	(137.4)	(435.4)	78.5	(367.8)
Total VOC Controlled, Mg VOC/yr[l]	129.5	129.5	129.5	323.6	323.6	323.6	647.3	647.3	647.3	1294.6	1294.6	1294.6
Cost Effectiveness, $/Mg VOC	255	343	367	(137)	170	(17)	(273)	93	(212)	(336)	61	(284)

TABLE 7-7. BULK TERMINAL LOADING RACK COSTS - NEW 10 mg/l UNIT

(THOUSANDS OF THIRD QUARTER 1990 DOLLARS)

Gasoline Throughput	380,000 l/day			950,000 l/day			1,900,000 l/day			3,800,000 l/day		
Vapor Processor	CA[a]	TO[b]	REF[c]	CA	TO	REF	CA	TO	REF	CA	TO	REF
Capital Investment												
Unit purchase cost[d]	237.9	108	318	245.9	119	387	254.8	119	387	297.4	137	462
Unit installation cost[e]	202.2	92	270.3	209	101	329	216.6	101	329	252.8	116	392.7
Annual Operating Costs												
Electricity	9	1	4.3	12	6	10.8	16	8	21.6	25	18	43.2
Pilot gas[f]		7.3			16.7			33			61.6	
Carbon replacement[g]	2.1			2.9			3.8			5.2		
Maintenance[h]	6	3.5	11.6	6	3.5	11.6	6	3.5	11.6	6	3.5	11.6
Operating labor[i]	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8
Subtotal (Direct Operating Costs)	23.9	18.6	22.7	27.7	33	29.2	32.6	51.3	40	43	89.9	61.6
Capital charges[j] (16.3%)	71.7	32.5	95.9	74.2	35.9	116.7	76.8	35.9	116.7	89.7	41.2	139.3
Taxes and Insurance (4%)	17.6	8	23.5	18.2	8.8	28.6	18.9	8.8	28.6	22	10.1	34.2
Gasoline rec. credit[k]	57.4	0	57.4	143.6	0	143.6	287.2	0	287.2	574.3	0	574.3
Net Annualized Cost	55.8	59.1	84.7	(23.5)	77.8	31	(158.9)	96	(101.8)	(419.6)	141.2	(339.2)
Total VOC Controlled, Mg VOC/yr[l]	132.7	132.7	132.7	331.7	331.7	331.7	663.4	663.4	663.4	1,326.9	1,326.9	1,326.9
Cost Effectiveness, $/Mg VOC	420	445	638	(71)	235	93	(240)	145	(153)	(316)	106	(256)

TABLE 7-8. BULK TERMINAL LOADING RACK COSTS - UNCONTROLLED TO 35 mg/l UNIT WITH LOADING RACK CONVERSION

(THOUSANDS OF THIRD QUARTER 1990 DOLLARS)

Gasoline Throughput	380,000 l/day			950,000 l/day			1,900,000 l/day			3,800,000 l/day		
Vapor Processor	CA[a]	TO[b]	REF[c]	CA	TO	REF	CA	TO	REF	CA	TO	REF
Capital Investment												
Unit purchase cost[d]	174	83	218	181	94	287	189	94	287	218	112	362
Unit installation cost[e]	147	70	185	154	80	244	161	80	244	185	95	308
Rack Conversion	426	426	426	639	639	639	639	639	639	852	852	852
Annual Operating Costs												
Electricity	9	1	3.3	12	6	8.3	16	8	16.6	25	18	38.2
Pilot gas[f]		2			3.4			6.3			8.3	
Carbon replacement[g]	2.1			2.9			3.8			5.2		
Maintenance[h]	6	3.5	11.6	6	3.5	11.6	6	3.5	11.6	6	3.5	11.6
Operating labor[i]	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8
Subtotal (Direct Operating Costs)	23.9	13.3	21.7	27.7	19.7	26.7	32.6	24.6	35	43	36.6	56.6
Capital charges[j] (16.3%)	121.8	94.4	135.2	158.9	132.6	190.7	161.3	132.6	190.7	204.6	172.5	248
Taxes and Insurance (4%)	29.9	23.2	33.2	39	32.5	46.8	39.6	32.5	46.8	50.2	42.3	60.9
Gasoline rec. credit[k]	56	0	56	140.1	0	140.1	280.2	0	280.2	560.3	0	560.3
Net Annualized Cost	119.5	130.9	134	85.5	184.8	124.1	(46.7)	189.7	(7.7)	(262.5)	251.4	(194.8)
Total VOC Controlled, Mg VOC/yr[l]	129.5	129.5	129.5	323.6	323.6	323.6	647.3	647.3	647.3	1,294.6	1,294.6	1,294.6
Cost Effectiveness, $/Mg VOC	923	1,011	1,035	264	571	383	(72)	293	(12)	(203)	194	(150)

TABLE 7-9. BULK TERMINAL LOADING RACK COSTS- UPGRADE OF 80 mg/l TO 35 mg/l UNIT

(THOUSANDS OF THIRD QUARTER 1990 DOLLARS)

Gasoline Throughput	380,000 l/day			950,000 l/day			1,900,000 l/day			3,800,000 l/day		
Vapor Processor	CA[a]	TO[b]	REF[c]	CA	TO	REF	CA	TO	REF	CA	TO	REF
Capital Investment												
Unit purchase cost[d]	174	83	218	181	94	287	189	94	287	218	112	362
Unit installation cost[e]	147	70	185	154	80	244	161	80	244	185	95	308
Annual Operating Costs												
Electricity	9	1	3.3	12	6	8.3	16	8	16.6	25	18	38.2
Pilot gas[f]		2			3.4			6.3			8.3	
Carbon replacement[g]	2.1			2.9			3.8			5.2		
Maintenance[h]	6	3.5	11.6	6	3.5	11.6	6	3.5	11.6	6	3.5	11.6
Operating labor[i]	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8
Subtotal (Direct Operating Costs)	23.9	13.3	21.7	27.7	19.7	26.7	32.6	24.6	35	43	36.6	56.6
Capital charges[j] (16.3%)	52.3	25	65.7	54.7	28.4	86.5	57.1	28.4	86.5	65.8	33.6	109.2
Taxes and Insurance (4%)	12.8	6.1	16.1	13.4	7	21.2	14	7	21.2	16.1	8.3	26.8
Gasoline rec. credit[k]	2.5	0	2.5	6.3	0	6.3	12.6	0	12.6	25.2	0	25.2
Net Annualized Cost	86.5	44.4	101.1	89.5	55.1	128.2	91.1	60	130.2	99.7	78.5	167.4
Total VOC Controlled, Mg VOC/yr[l]	5.8	5.8	5.8	14.5	14.5	14.5	29.1	29.1	29.1	58.1	58.1	58.1
Cost Effectiveness, $/Mg VOC	14,914	7,655	17,431	6,172	3,800	8,841	3,131	2,062	4,474	1,716	1,351	2,881

TABLE 7-10. BULK TERMINAL LOADING RACK COSTS - UNCONTROLLED TO 10 mg/l UNIT WITH RACK CONVERSION

(THOUSANDS OF THIRD QUARTER 1990 DOLLARS)

Gasoline Throughput	380,000 l/day			950,000 l/day			1,900,000 l/day			3,800,000 l/day		
Vapor Processor	CA[a]	TO[b]	REF[c]	CA	TO	REF	CA	TO	REF	CA	TO	REF
Capital Investment												
Unit purchase cost[d]	238	108	318	246	119	387	255	119	387	297	137	462
Unit installation cost[e]	202	92	270	209	101	329	217	101	329	253	116	393
Rack Conversion	426	426	426	639	639	639	639	639	639	852	852	852
Annual Operating Costs												
Electricity	9	1	43	12	6	10.8	16	8	21.6	32	18	43.2
Pilot gas[f]		7.3			16.7			33			61.6	
Carbon replacement[g]	2.1			2.9			3.8			5.2		
Maintenance[h]	6	3.5	11.6	6	3.5	11.6	6	3.5	11.6	6	3.5	11.6
Operating labor[i]	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8
Subtotal (Direct Operating Costs)	23.9	18.6	22.7	27.7	33	29.2	32.6	51.3	40	50	89.9	61.6
Capital charges[j] (16.3%)	141.2	101.9	165.3	178.3	140.1	220.9	181	140.1	220.9	228.6	180	278.2
Taxes and Insurance (4%)	34.6	25	40.6	43.8	34.4	54.2	44.4	34.4	54.2	56.1	44.2	68.3
Gasoline rec. credit[k]	57.4	0	57.4	143.6	0	143.6	287.2	0	287.2	574.3	0	574.3
Net Annualized Cost	142.3	145.6	171.2	106.2	207.5	160.7	(29.2)	225.7	27.9	(239.7)	314.2	(166.3)
Total VOC Controlled, Mg VOC/yr[l]	132.7	132.7	132.7	331.7	331.7	331.7	663.4	663.4	663.4	1,326.9	1,326.9	1,326.9
Cost Effectiveness, $/Mg VOC	1,072	1,097	1,290	320	626	484	(44)	340	42	(181)	237	(125)

TABLE 7-11. BULK TERMINAL LOADING RACK COSTS - UPGRADE OF 80 mg/l TO 10 mg/l UNIT

(THOUSANDS OF THIRD QUARTER 1990 DOLLARS)

Gasoline Throughput	380,000 l/day			950,000 l/day			1,900,000 l/day			3,800,000 l/day		
Vapor Processor	CA[a]	TO[b]	REF[c]	CA	TO	REF	CA	TO	REF	CA	TO	REF
Capital Investment												
Unit purchase cost[d]	238	108	318	246	119	387	255	119	387	297	137	462
Unit installation cost[e]	202	92	270	209	101	329	217	101	329	253	116	393
Annual Operating Costs												
Electricity	9	1	4.3	12	6	10.8	16	8	21.6	25	18	43.2
Pilot gas[f]		7.3			16.7			33			61.6	
Carbon replacement[g]	2.1			2.9			3.8			5.2		
Maintenance[h]	6	3.5	11.6	6	3.5	11.6	6	3.5	11.6	6	3.5	11.6
Operating labor[i]	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8
Subtotal (Direct Operating Costs)	23.9	18.6	22.7	27.7	33	29.2	32.6	51.3	40	43	89.9	61.6
Capital charges[j] (16.3%)	71.7	32.5	95.9	74.2	35.9	116.7	76.8	35.9	116.7	89.7	41.2	139.3
Taxes and Insurance (4%)	17.6	8	23.5	18.2	8.8	28.6	18.9	8.8	28.6	22	10.1	34.2
Gasoline rec. credit[k]	3.9	0	3.9	9.8	0	9.8	19.6	0	19.6	39.1	0	39.1
Net Annualized Cost	109.3	59.1	138.2	110.3	77.8	164.8	108.7	96	165.8	115.5	141.2	196
Total VOC Controlled, Mg VOC/yr[l]	9	9	9	22.6	22.6	22.6	45.2	45.2	45.2	90.4	90.4	90.4
Cost Effectiveness, $/Mg VOC	12,144	6,567	15,356	4,881	3,442	7,292	2,405	2,124	3,668	1,278	1,562	2,168

TABLE 7-12. BULK TERMINAL LOADING RACK COSTS - UPGRADE OF 35 mg/l TO 10 mg/l UNIT

(THOUSANDS OF THIRD QUARTER 1990 DOLLARS)

Gasoline Throughput	380,000 l/day			950,000 l/day			1,900,000 l/day			3,800,000 l/day		
Vapor Processor	CA[a]	TO[b]	REF[c]	CA	TO	REF	CA	TO	REF	CA	TO	REF
Capital Investment												
Unit purchase cost[d]	238	108	318	246	119	387	255	119	387	297	137	462
Unit installation cost[e]	202	92	270	209	101	329	217	101	329	253	116	393
Annual Operating Costs												
Electricity	9	1	4.3	12	6	10.8	16	8	21.6	25	18	43.2
Pilot gas[f]		7.3			16.7			33			61.6	
Carbon replacement[g]	2.1			2.9			3.8			5.2		
Maintenance[h]	6	3.5	11.6	6	3.5	11.6	6	3.5	11.6	6	3.5	11.6
Operating labor[i]	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8
Subtotal (Direct Operating Costs)	23.9	18.6	22.7	27.7	33	29.2	32.6	51.3	40	43	89.9	61.6
Capital charges[j] (16.3%)	71.7	32.5	95.9	74.2	35.9	116.7	76.8	35.9	116.7	89.7	41.2	139.3
Taxes and insurance (4%)	17.6	8	23.5	18.2	8.8	28.6	18.9	8.8	28.6	22	10.1	34.2
Gasoline rec. credit[k]	1.4	0	1.4	3.5	0	3.5	7	0	7	14	0	14
Net Annualized Cost	111.8	59.1	140.7	116.6	77.8	171	121.3	96	178.3	140.7	141.2	221.1
Total VOC Controlled, Mg VOC/yr[l]	3.2	3.2	3.2	8.1	8.1	8.1	16.2	16.2	16.2	32.3	32.3	32.3
Cost Effectiveness, $/Mg VOC	34,938	18,469	43,969	14,395	9,605	21,111	7,488	5,926	11,006	4,356	4,372	6,845

TABLE 7-13. BULK TERMINAL LOADING RACK COSTS - UPGRADE OF 35 mg/l TO 5 mg/l UNIT OR NEW 5 mg/l UNIT

(THOUSANDS OF THIRD QUARTER 1990 DOLLARS)

Gasoline Throughput	380,000 l/day			950,000 l/day			1,900,000 l/day			3,800,000 l/day		
Vapor Processor	CA[a]	TO[b]	REF[c]	CA	TO	REF	CA	TO	REF	CA	TO	REF
Capital Investment												
Unit purchase cost[d]	273.6	133	365.7	282.7	144	445.1	292	144	445.1	342	162	531.3
Unit installation cost[e]	232.6	113	310.8	240.3	123	378.3	248	123	378.3	290.7	137	451.6
Annual Operating Costs												
Electricity	16	1	4.6	21.4	6	11.6	28.5	8	23.2	57	18	46.5
Pilot gas[f]		8.7			20.1			39.6			75.0	
Carbon replacement[g]	2.1			2.9			3.8			5.2		
Maintenance[h]	6	3.5	11.6	6	3.5	11.6	6	3.5	11.6	6	3.5	11.6
Operating labor[i]	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8
Subtotal (Direct Operating Costs)	30.9	20	23	37.1	36.4	30	45.1	57.9	41.6	75	103.3	64.9
Capital charges[j] (16.3%)	82.5	40	110.3	85.2	43.5	134.2	88	43.5	134.2	103.1	48.7	160.2
Taxes and Insurance (4%)	20.2	9.8	27.1	20.9	10.7	32.9	21.6	10.7	32.9	25.3	12	39.5
Gasoline rec. credit[k]	1.7	0	1.7	4.2	0	4.2	8.4	0	8.4	16.8	0	16.8
Net Annualized Cost	132	69.8	158.7	139	90.5	193	146.3	112.1	200.4	186.7	163.9	247.7
Total VOC Controlled, Mg VOC/yr[l]	3.9	3.9	3.9	9.7	9.7	9.7	19.4	19.4	19.4	38.8	38.8	38.8
Cost Effectiveness, $/Mg VOC	33,846	17,897	40,692	14,330	9,330	19,897	7,541	5,151	10,330	4,812	4,224	6,384

TABLE 7-14. BULK TERMINAL LOADING RACK COSTS - UPGRADE OF 10 mg/l TO 5 mg/l UNIT

(THOUSANDS OF THIRD QUARTER 1990 DOLLARS)

Gasoline Throughput	380,000 l/day			950,000 l/day			1,900,000 l/day			3,800,000 l/day		
Vapor Processor	CA[a]	TO[b]	REF[c]	CA	TO	REF	CA	TO	REF	CA	TO	REF
Capital Investment												
Unit purchase cost[d]	273.6	133	365.7	282.7	144	445.1	292	144	445.1	342	162	531.3
Unit installation cost[e]	232.6	113	310.8	240.3	123	378.3	248	123	378.3	290.7	137	451.6
Annual Operating Costs												
Electricity	16	1	4.6	21.4	6	11.6	28.5	8	23.2	57	18	46.5
Pilot gas[f]		8.7			20.1			39.6			75	
Carbon replacement[g]	2.1			2.9			3.8			5.2		
Maintenance[h]	6	3.5	11.6	6	3.5	11.6	6	3.5	11.6	6	3.5	11.6
Operating labor[i]	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8
Subtotal (Direct Operating Costs)	30.9	20	23	37.1	36.4	30	45.1	57.9	41.6	75	103.3	64.9
Capital charges[j] (16.3%)	82.5	40	110.3	85.2	43.5	134.2	88	43.5	134.2	103.1	48.7	160.2
Taxes and Insurance (4%)	20.2	9.8	27.1	20.9	10.7	32.9	21.6	10.7	32.9	25.3	12	39.3
Gasoline rec. credit[k]	0.3	0	0.3	0.7	0	0.7	1.4	0	1.4	2.8	0	2.8
Net Annualized Cost	133.4	69.8	160.1	142.5	90.5	196.5	153.3	112.1	207.4	200.6	163.9	261.6
Total VOC Controlled, Mg VOC/yr[l]	0.6	0.6	0.6	1.6	1.6	1.6	3.2	3.2	3.2	6.5	6.5	6.5
Cost Effectiveness, $/Mg VOC	222,333	116,333	266,833	89,063	56,563	122,813	47,906	35,031	64,813	30,862	25,215	40,246

TABLE 7-15. BULK TERMINAL LOADING RACK COSTS - THERMAL OXIDIZER ADD-ON

(THOUSANDS OF THIRD QUARTER 1990 DOLLARS)

Model Plant	1	2	3	4
Vapor Processor	TO[b]	TO[b]	TO[b]	TO[b]
Capital Investment				
Unit purchase cost[d]	35	35	35	35
Unit installation Cost[e]	29.8	29.8	29.8	29.8
Annual Operating Costs ($/yr)				
Electricity	1	1	1	1
Pilot gas[f]	2.0	3.4	6.3	8.3
Carbon replacement[g]				
Maintenance[h]	3.5	3.5	3.5	3.5
Operating labor[i]	6.8	6.8	6.8	6.8
Subtotal (Direct Operating Costs)	13.3	14.7	17.6	19.6
Capital charges[j] (16.3%)	10.4	10.4	10.4	10.4
Taxes and Insurance (4%)	2.6	2.6	2.6	2.6
Gasoline rec. credit[k]	0.0	0.0	0.0	0.0
Net Annualized Cost	26.3	27.7	30.6	32.6
Total VOC Controlled, Mg VOC/yr[m]	1.0	8.0	16.0	32.0
Cost Effectiveness, $/Mg VOC	26,300	3,463	1,912	1,019

FOOTNOTES FOR TABLES 7-6 THROUGH 7-15

[a] Carbon adsorption unit.

[b] Thermal oxidation unit - enclosed flame.

[c] Refrigeration unit.

[d] Costs for MP1, MP2, and MP3 are based on same units for CA system. Differences are due to the amount of carbon in each system.

[e] Estimated at 85 percent of control unit cost.

[f] Estimated that 50 percent TO units used propane and 50 percent used natural gas; price of propane was $1.03 per gallon and pilot burner was estimated to burn 2 gallons per hour. Burning an equivalent amount of natural gas was estimated at $0.80. Final estimate is the average cost for propane and natural gas.

[g] Estimated activated carbon replacement period is 10 years, at $2.09 per pound carbon cost. Estimated carbon in each unit:

MP1 - 10,000 lbs.
MP2 - 14,000 lbs.
MP3 - 18,000 lbs.
MP4 - 25,000 lbs.

[h] Telecon with John F. Jordan Co. (Reference 22).

[i] Daily system inspections at 1 hour per day. Labor rate is $20/hr.

[j] Total capital investment x (capital recovery factor + 0.04), where interest rate = 10 percent, equipment economic life = 10 years (0.163 capital recovery factor).

[k] Amount recovered per year, at $0.342 per liter assuming a density of 0.67 kg/liter.

[l] Calculated assuming baseline uncontrolled loading (see Table 3-11); i.e., 94 percent times the submerged loading factor, 658 mg/l, and 6 percent times the splash loading factor, 1,590 mg/l (see Table 3-8). These factors are based on an RVP of 11.4 psi and 60°F, as discussed in Section 3.2.1.2 of Chapter 3. Emission reductions are the difference between this weighted average factor, 713 mg/l, and each controlled level, multiplied by the model plant throughput.

[m] Assuming existing control device meets 35 mg/l emission limit and VOC controlled calculated using emission reduction factor of 25 mg/l (35 mg/l to 10 mg/l).

presented in these tables for carbon adsorption,[10,11] thermal oxidation,[12,13] and refrigeration type[14] vapor control systems.

For the carbon adsorption system, one manufacturer stated that essentially the same unit could be designed to handle the throughputs of the first three model plants. The only difference in these systems would be the amount of activated carbon needed for each system.[15] This same manufacturer estimated the amount of carbon for a 10 mg/l unit for MP1 at 10,000 lbs., MP2 at 14,000 lbs., and MP3 at 18,000 lbs.[16] MP4 would require a larger design to handle the throughput, and a separate estimate was provided for this system. The price of carbon is estimated at $2.09 per pound, and the carbon is assumed to have a working life of 10 years.[17] These sources also indicated that retrofitting a carbon adsorption system to comply with lower emission limits increases the capacity of the system by at least 20 percent; and feasibility studies indicate that in most cases, installation of a new unit is more cost-effective.[18] Therefore, retrofit was not considered to be an option for carbon systems.

Similarly, for thermal oxidation systems, the same unit could be designed to handle the throughputs of MP2 and MP3, and the unit price estimate for those two systems is the same. Installation costs were assumed to be 85 percent of the unit purchase cost, which is consistent with the findings in earlier EPA studies.[19,20]

Annual operating costs include electricity to power compressors, pumps, and blowers, routine maintenance and operating labor (daily inspections), pilot gas for the thermal oxidizers, and activated carbon replacement for the carbon units. Operating labor consists of a routine 1-hour inspection per day at a labor rate of $20 per hour. For carbon systems, the estimated maintenance cost is $6,000 per year, including parts and labor. The annual cost for thermal oxidation units is $3,500, while refrigeration units are approximately $11,600 yearly.[21] Thermal oxidizers require a pilot fuel source and, based on conversations with manufacturers, it is estimated that half use propane and the other half use natural gas.[22] The current cost for propane is approximately $1.03 per gallon.[23] Control systems are assumed to burn about 2 gallons per hour. The cost of burning a comparable amount of natural gas is about $0.80. The estimate in the tables is the average of these two figures.

Other costs include capital charges, administration, taxes and insurance, and the gasoline recovery credit. Capital charges are assumed to be 16.3 percent of the capital investment, while administration, taxes, and insurance charges are 4 percent of capital investment. The gasoline recovery credit is the amount recovered per year at $0.342 per liter (see Chapter 8), assuming a density of 0.67 kg/liter. The total VOC controlled is the difference between the uncontrolled and the controlled emission level. The cost effectiveness is defined as the total net annualized cost divided by the total emissions controlled per year ($/Mg VOC controlled).

7.1.3.2 Railcar loading racks. Table 7-16 presents costs of installation and operation of three vapor control systems, all achieving an emission rate of 10 mg/liter for a railcar loading operation. Based on observations of a railcar loading facility,[24] it was concluded that railcar loading occurs at a rack with similar operating characteristics to that of model plant 2 for tank trucks. The yearly throughput for the railcar loading rack model plant is estimated at 85 million gal/yr with a maximum instantaneous loading rate of 3,000 gal/min.

7.1.3.3 Tank Truck Leakage. As discussed in Section 4.1.4, there are two basic options for controlling vapor emissions from tank trucks during loading. These include installation of a vacuum assist vapor collection system at

TABLE 7-16. RAILCAR VAPOR CONTROL COSTS FOR 10 mg/l (THIRD QUARTER 1990 DOLLARS)

Cost Item	Carbon Adsorption (1,000 $)	Thermal Oxidation (1,000 $)	Refrigeration (1,000 $)
Capital Investment			
Equip Purchased	246	106	387
Equip Installed	209	90	329
Rack Converted	639	639	639
Railcar Converted	21	21	21
Total Capital	1,115	856	1,376
Annual Costs ($/yr)			
Electricity	12	6	11
Propane	-	3	-
Carbon Replacement	3	-	-
Maintenance	6	4	16
Operating Labor	7	7	7
Tank Test	-	-	-
Taxes, Insurance, and Admin. (4%)	45	34	55
Total	73	54	89
Recovery Credit	130	0	130
Capital Recovery (16.3%)	182	139	224
Net Annualized Cost	125	194	279
Total VOC Controlled, Mg VOC/yr	332	332	332
Cost Effectiveness, $/Mg VOC	377	585	841

the loading rack and implementation of a periodic vapor tightness testing program for the trucks. The total costs to design, purchase, and install a vacuum assisted system were estimated by Fina Oil and Chemical Company to be approximately $320,000.[25] (These costs may differ markedly from what another facility would have to spend for a similar system, due in part to engineering resource expense involved for site specific parameters and refining of the system.) The estimated breakdown of costs is as follows:

<u>Equipment</u>	
blower/motor	$25,000
control valves/actuators	40,000
air compressor/drier	15,000
PLC modules (computer)	18,000
electrical equipment	15,000
<u>Contractors</u>	
design	60,000
installation	120,000
facility refinements	27,000

Contacts with various tank truck manufacturers indicated that, on average, the cost to install vapor collection equipment on bottom loading tank trucks is $3,500 per truck.[26,27] Also, any gasoline tank trucks or railcars operating at bulk terminals affected by the proposed regulation will be required to have annual vapor tightness testing performed using the EPA Method 27 test found in 40 CFR 60, Appendix A. Method 27 contains both pressure and vacuum tests to be performed on the cargo tank. The annual DOT test, which consists of only a pressure test, considers the pressure portion of the EPA Method 27 test as an acceptable alternative test. Contacts with various vendors that perform these tests indicated that the DOT test costs approximately $200 for a 4-compartment tank truck, while the complete Method 27 test costs approximately $350. As a result of this proposed regulation, tank truck owners who were paying $200 per year for a tank truck inspection would now have to pay $350 per year. Consequently, the cost impact of this proposed regulation is the difference between these two costs, or $150 per year per cargo tank (tank truck or railcar).[28]

7.1.4 Bulk Plants

In order to obtain up-to-date cost estimates for retrofitting bulk plants, a wide variety of organizations was contacted. These included petroleum marketers trade organizations, oil companies, State environmental agencies that have recently adopted Stage I regulations, bulk plant owners, and installation contractors. Information received[29,30,31] showed that the costs of installing controls at a bulk plant are very close to the costs presented in the Draft Regulatory Impact Analysis: Proposed Refueling Emission Regulations for Gasoline-Fueled Motor Vehicles, July 1987 report. Since the costs from 1987 provided detailed cost breakdowns, the costs given in Tables 7-17 and 7-18 are from the 1987 report updated to 1990 dollars, using the CE Index.[32]

7.1.5 Service Stations

The same organizations contacted concerning bulk plant control costs were contacted to obtain current information regarding service station Stage I costs. In addition, several service station owners were contacted.

Additionally, industrial contractors were asked to provide cost estimates for retrofitting service stations with Stage I vapor recovery equipment. Several of these contractors responded with estimated costs.[33,34,35] Based on these estimates and an analysis of catalogued costs, the average capital cost given for retrofitting a service station with a coaxial system is approximately $1,524.[36] Also, the contractor estimated cost for installation of a dual point system ranged from $800 to $3,500 per tank, with an average of $2,323.[37] Since facilities examined in this analysis typically have three tanks, costs would be $6,969

TABLE 7-17. AVERAGE CONTROL COSTS FOR BULK PLANTS (NO EXEMPTIONS) (THIRD QUARTER 1990 DOLLARS)

Model Plant No.	1	2	3	4	5
Throughput (liters/day)	1,500	11,400	24,600	47,300	64,400
Weighted Average Top & Bottom Loading Costs					
<u>Balance Incoming & Outgoing Loads on Uncontrolled Plants</u>[a]					
Capital Costs[b,c]	31,208	31,208	31,208	31,208	31,208
Annual O & M (3%)	936	936	936	936	936
Capital Charges (13.1%)	4,088	4,088	4,088	4,088	4,088
Taxes, Ins. (4%)	1,248	1,248	1,248	1,248	1,248
Recovery Credit[d]	200	1,512	3,277	6,301	8,572
Net Annualized Cost ($/yr)	6,073	4,761	2,996	28	(2,300)
Emission Reduction (Mg/yr)	<1	3	7	14	19
Cost Effectiveness ($/Mg)	6,073	1,587	428	2	-[e]
<u>Balance Outgoing Loads on Plants with Incoming Load Balanced</u>[a]					
Capital Costs[b,c]	23,227	23,227	23,227	23,227	23,227
Annual O & M (3%)	697	697	697	697	697
Capital Charges (13.1%)	3,043	3,043	3,043	3,043	3,043
Taxes, Ins. (4%)	929	929	929	929	929
Recovery Credit[d]	200	1,512	3,277	6,301	8,572
Net Annualized Cost ($/yr)	4,469	3,157	1,392	(1,632)	(3,904)
Emission Reduction (Mg/yr)	<1	3	7	14	19
Cost Effectiveness ($/Mg)	4,469	1,052	199	6-[e]	-[e]

[a] Includes the cost of retrofitting two account trucks for use in vapor balance service.

[b] Top Load Cost - $21,310 (91%), Bottom Load Cost - $42,610 (9%), Incoming Load Cost - $7,981.

[c] References 2 and 19.

[d] Recovery credits are based on a control efficiency of 95 percent on outgoing loads from a balance system (or storage tank emptying losses), and a product cost of $0.30 per liter.

[e] Cost effectiveness not calculated because net annualized cost is a negative quantity (cost credit).

TABLE 7-18. ESTIMATED CONTROL COSTS FOR BULK PLANTS (EXEMPT < 4,000 GAL/DAY) (THIRD QUARTER 1990 DOLLARS)

Model Plant No.	1	2	3	4	5
Throughput (liters/day)	1,500	11,400	24,600	47,300	64,400
Weighted Average Top & Bottom Loading Costs					
Balance Incoming Loads and Install Outgoing Submerged Fill on Uncontrolled Plants with < 4,000 gal day[a]					
Capital Costs[b,c]	0	4,270	31,208	31,208	31,208
Annual O & M (3%)	0	278	936	936	936
Capital Charges (13.1%)	0	1,214	4,088	4,088	4,088
Taxes, Ins. (4%)	0	371	1,248	1,248	1,248
Recovery Credit[d]	0	1,313[d]	3,277[e]	6,301[e]	8,572[e]
Net Annualized Cost ($/yr)	0	550	2,996	(28)	(2,300)
Emission Reduction (Mg/yr)	0	4.4	7	14	19
Cost Effectiveness ($/Mg)	0	1,587	428	2	-[f]
Balance Outgoing Submerged Fill on Plants with Incoming Load Balanced < 4,000 gal/day[a]					
Capital Costs[b,c]	0	1,308	23,227	23,227	23,227
Annual O & M (3%)	0	39	697	697	697
Capital Charges (13.1%)	0	171	3,043	3,043	3,043
Taxes, Ins. (4%)	0	52	929	929	929
Recovery Credit[d]	0	358	3,277	4,358	5,970
Net Annualized Cost ($/yr)	0	(96)	1,392	311	(1,301)
Emission Reduction (Mg/yr)	0	1.2	7	14	19
Cost Effectiveness ($/Mg)	0	-[f]	199	22	-[f]

[a] Includes the cost of retrofitting two account trucks for use in vapor balance service.

[b] Top Load Cost - $21,310 (91%), Bottom Load Cost - $42,616 (9%), Incoming Load Cost - $7,981.

[c] References 2 and 19.

[d] Recovery credit based on control efficiency of 58% for conversion from top splash loading to submerged fill.

[e] Recovery credits are based on a control efficiency of 95 percent on outgoing loads from a balance system (or storage tank emptying losses), and a product cost of $0.30 per liter.

[f] Cost effectiveness not calculated because net annualized cost is a negative quantity (cost credit).

per station. More recently acquired information has reinforced these results.[38]

Information on the owner preference of a coaxial versus a dual point system was not available, although each system has its advantages (coaxial - low cost, dual point - ability to drop two products at the same time). For purposes of cost estimation, an average of the dual point and coaxial costs was used. There is no vapor recovery credit associated with service stations due to the fact that no vapor recovery devices are used and if vapor balance piping is used, vapors are returned to the truck tank for recovery or process at other subcategory facilities in the network. Table 7-19 provides a comprehensive analysis of the costs associated with the service station subcategory.

7.2 COST ANALYSIS OF REGULATORY ALTERNATIVES

The costs of control for each facility emission source's control option(s) were calculated by multiplying the facility number or gasoline throughput shown in Tables 3-11 and 8-27 by the appropriate model plant costs. The model plant costs used in the calculations are those discussed previously in Section 7.1. Cost effectiveness ratios ($/Mg HAP, $/Mg VOC) were calculated by dividing the control option net annualized cost by the HAP or VOC emission reductions achieved under each control option as discussed in Chapter 6. The capital and annualized control costs, HAP and VOC emission reductions, and cost effectiveness estimated for each control option at both new and existing pipeline facilities, bulk terminals, bulk plants, and service stations are presented in the following tables: Tables 7-20 and 7-21 for pipeline facilities, Tables 7-22 and 7-23 for bulk terminals, Tables 7-24 and 7-25 for bulk plants, and Table 7-26 for service stations.

TABLE 7-19. SERVICE STATION STAGE I CAPITAL AND ANNUALIZED COST ESTIMATES[a,b] (THIRD QUARTER 1990 DOLLARS)

Capital Cost and Installation[c]	$4,250
Annualized Costs ($/yr)	
Maintenance (3%)	127
Taxes, Insurance, and G&A (4%)	170
Capital Charges[b] (0.131)	557
Annualized Cost	854
Recovery Credit	NA
Net Annualized Cost	854

Throughput	Emission Reductions	Cost Effectiveness ($/Mg VOC)
MP1 (7,600 l/mo.)	0.138 Mg/yr	6,188
MP2 (23,000 l/mo.)	0.407 Mg/yr	2,098
MP3 (76,000 l/mo.)	1.343 Mg/yr	636
MP4 (132,000 l/mo.)	2.341 Mg/yr	365
MP5 (246,000 l/mo.)	4.347 Mg/yr	196
MP6 (700,000 l/mo.)	12.370 Mg/yr	69

[a] Since the number of underground storage tanks at service stations does not vary considerably with throughput (storage capacity would vary more), costs to comply with Stage I at affected facilities were assumed to be independent of facility size.

[b] Capital charges are based on a 10 percent interest rate and equipment life of 15 years.

[c] Average of rounded costs for coaxial ($1,500) and dual point ($7,000) systems. References 25, 26, 28, 33, 34.

TABLE 7-20. EXISTING PIPELINE FACILITIES NATIONWIDE CONTROL LEVEL COSTS

TYPE OF FACILITY/ CONTROL OPTION	HAP BASELINE EMISSIONS (Mg/yr)	HAP EMISSION REDUCTION (Mg/yr)	% HAP RED	CAPITAL COST (1000 $)	ANNUAL COST (1000 $)	AVERAGE $/Mg HAP	INCREMENT $/Mg HAP	AVERAGE $/Mg VOC	INCREMENT $/Mg VOC
Pipeline Pumping Stations									
Equipment Leaks	1,710								
Monthly LDAR		1030	60%	0[a]	3,400	3,300	9,500	250	710
Quarterly LDAR		620	36%	0[a]	(460)	(740)	(740)	(55)	(55)
Pipeline Breakout Stations									
Storage Tanks	6,320								
External-SS[b]-PI[d] Internal-PS[c]-PI[d]		5,720	91%	39,900	(21,240)	(3,900)	(3,700)	(280)	(280)
Major only		423	7%	4,400	(1,200)	(2,800)	(2,800)	(210)	(210)
Equipment Leaks	780								
Monthly LDAR		470	60%	0[a]	(700)	(1,400)	2,500	(110)	180
Quarterly LDAR		310	40%	0[a]	(1,100)	(3,400)	(3,800)	(260)	(290)
Majors only- Monthly LDAR		35	4%	0[a]	(50)	(1,400)	2,400	(110)	180
Majors only- Quarterly LDAR		23	3%	0[a]	(79)	(3,400)	(3,400)	(260)	(260)

[a] No capital costs associated with leak detection and repair programs.
[b] Secondary Seal.
[c] Primary Seal.
[d] Controls phased-in for area sources only.

TABLE 7-21. NEW PIPELINE FACILITIES NATIONWIDE CONTROL LEVEL COSTS

TYPE OF FACILITY/ CONTROL OPTION	HAP BASELINE EMISSIONS (Mg/yr)	HAP EMISSION REDUCTION (Mg/yr)	% HAP RED	CAPITAL COST (1000 $)	ANNUAL COST (1000 $)	$/Mg HAP	INCREMENT $/Mg HAP	$/Mg VOC	INCREMENT $/Mg VOC
Pipeline Pumping Stations									
Equipment Leaks	660								
Monthly LDAR		400	60%	0[a]	1,300	3,300	9,500	250	710
Quarterly LDAR		240	36%	0[a]	(180)	(740)	(740)	(60)	(60)
Pipeline Breakout Stations									
Storage tanks	60	b	b	b	b	b	b	b	b
Equipment Leaks	80								
Monthly LDAR		50	60%	0[a]	(70)	(1,500)	2,500	(110)	180
MM/QA LDAR[c]		30	40%	0[a]	(100)	(3,300)	3,000	(250)	190
Quarterly LDAR		30	40%	0[a]	(100)	(3,500)	(3,700)	(270)	(280)
MM only[c]		3	4%	0[a]	(5)	(1,700)	(1,700)	(110)	(110)

[a] No capital costs associated with leak detection and repair programs.
[b] New facilities subject to NSPS, which requires same level of control; therefore, no impacts on new facilities for these options.
[c] MM = monthly/major, QA = quarterly/area.

TABLE 7-22. EXISTING BULK TERMINALS NATIONWIDE CONTROL LEVEL COSTS

TYPE OF FACILITY/ CONTROL OPTION	HAP BASELINE EMISSIONS (Mg/yr)	HAP EMISSION REDUCTION (Mg/yr)	% HAP RED	CAPITAL COST (1000 $)	ANNUAL COST (1000 $)	$/Mg HAP	INCREMENT $/Mg HAP	$/Mg VOC	INCREMENT $/Mg VOC
Loading Racks	2,690								
All at 10 mg/l		2,500	92%	233,000	34,300	13,900	13,900[f]	330	820
Major-10/Area-10-PI[e]		2,500	92%	161,000	14,300	5,800	2,800[f]	140	170
Major-10/Area-35-PI[e]		2,200	81%	118,000	5,000	2,300	(2,800)[f]	60	(140)
Major-10/Area-None		670	25%	63,000	9,300	13,900	13,900	810	810
Storage Tanks	4,910								
External-SS[a] Internal-PS[b]		2,850	58%	63,000	(5,600)	(1,980)	NC[g]	(110)	NC[g]
External-SS[a]-PI[e] Internal-PS[b]-PI[e]		2,850	58%	46,000	(9,800)	(3,400)	(4,000)	(190)	NC[g]
Major only		770	16%	16,900	(1,520)	(1,980)	(1,980)	(170)	(170)

TABLE 7-22. (Concluded)

TYPE OF FACILITY/ CONTROL OPTION	HAP BASELINE EMISSIONS (Mg/yr)	HAP EMISSION REDUCTION (Mg/yr)	% HAP RED	CAPITAL COST (1000 $)	ANNUAL COST (1000 $)	$/Mg HAP	INCREMENT $/Mg HAP	$/Mg VOC	INCREMENT $/Mg VOC
Tank Truck Leakage	2,890								
Vacuum Assist		2,400	81%	254,000	56,600	24,000	26,900	1,600	2,000
Semi-Annual		1,000	35%	32,100	20,600	20,200	15,000	1,200	1,100
Annual		210	7%	32,100	8,500	39,900	39,900	1,300	1,300
Equipment Leaks	3,130								
Monthly LDAR		1,900	60%	0[d]	11	0	2,100	0	160
Quarterly LDAR		1,100	37%	0[d]	(1,500)	(1,300)	(2,400)	(100)	(180)
Majors only Monthly LDAR		500	16%	0[d]	3	0	2,100	0	160
Majors only Quarterly LDAR		300	10%	0[d]	(400)	(1,300)	(1,300)	(100)	(100)

[a] Secondary Seal.
[b] Primary Seal.
[c] Cost Effectiveness not calculated because annual cost is a net savings.
[d] No capital costs associated with leak detection and repair programs.
[e] Controls phased-in for area sources only.
[f] Increment from Major-10/Area-None.
[g] NC = Not Calculated.

TABLE 7-23. NEW BULK TERMINALS NATIONWIDE CONTROL LEVEL COSTS

TYPE OF FACILITY/ CONTROL OPTION	HAP BASELINE EMISSIONS (Mg/yr)	HAP EMISSION REDUCTION (Mg/yr)	% HAP RED	CAPITAL COST (1000 $)	ANNUAL COST (1000 $)	$/Mg HAP	INCREMENT $/Mg HAP	$/Mg VOC	INCREMENT $/Mg VOC
Loading Racks	270								
All at 5 mg/l		230	86%	53,000	13,300	58,000	54,700[c]	3,600	3,400[c]
Major-5/Area-10		200	77%	38,000	9,400	46,800	38,600[c]	2,900	2,400[c]
All at 10 mg/l		190	72%	33,000	7,700	40,100	28,500[c]	2,500	1,800[c]
Major-5/Area-35		60	23%	14,000	3,600	57,800	57,800	3,600	3,600
Major-5/Area-None		60	23%	14,000	3,600	57,800	57,800	3,600	3,600
Major-10/Area-None		56	21%	8,900	2,300	41,400	41,100	2,700	2,700
Storage Tanks	600	b	b	b	b	b	b	b	b
Tank Truck Leakage	840								
Vacuum Assist (All)		630	76%	86,000	19,100	30,100	28,000	2,000	5,300
Vacuum Assist (Major only)		180	21%	23,000	5,100	29,200	8,600	2,000	NC[d]
Semi-Annual		120	14%	0	4,600	39,300	39,300	1,800	4,600
Annual		b	b	b	b	b	b	b	b

TABLE 7-23. (Concluded)

TYPE OF FACILITY/ CONTROL OPTION	HAP BASELINE EMISSIONS (Mg/yr)	HAP EMISSION REDUCTION (Mg/yr)	% HAP RED	CAPITAL COST (1000 $)	ANNUAL COST (1000 $)	$/Mg HAP	INCREMENT $/Mg HAP	$/Mg VOC	INCREMENT $/Mg VOC
Equipment Leaks	1,210								
Monthly LDAR		730	60%	0[a]	0	0	2,100	0	160
MM/QA LDAR[e]		520	43%	0[a]	(426)	(800)	2,100	(60)	160
Quarterly LDAR		440	37%	0[a]	(600)	(1,300)	(2,400)	(100)	(180)
MM only[e]		200	17%	0[a]	0	0	0	0	0

[a] No capital costs associated with leak detection and repair programs.
[b] New facilities subject to NSPS which requires same level of control; therefore, no impacts on new facilities for these options.
[c] Increment from Major-5/Area-35.
[d] NC = not calculated.
[e] MM = monthly/major, QA = quarterly/area.

TABLE 7-24. EXISTING BULK PLANTS NATIONWIDE CONTROL LEVEL COSTS

TYPE OF FACILITY/ CONTROL OPTION	HAP BASELINE EMISSIONS (Mg/yr)	HAP EMISSION REDUCTION (Mg/yr)	% HAP RED	CAPITAL COST (1000 $)	ANNUAL COST (1000 $)	AVERAGE $/Mg HAP	INCREMENT $/Mg HAP	AVERAGE $/Mg VOC	INCREMENT $/Mg VOC
Storage Tank Loading	1,680								
Vapor balance		1,400	85%	47,700	9,600	6,700	6,700	360	360
Tank Truck Loading	2,050								
Vapor balance-no exemptions		1,700	81%	159,000	12,500	7,500	16,700	420	1,100
Vapor balance-with exemptions		1,300	62%	76,200	5,900	4,600	4,600	250	250
Tank Truck Leakage	760								
No exempt loading racks									
Semi-Annual		370	48%	64,100	31,300	85,800	84,500	3,900	6,000
Annual		200	26%	64,000	17,100	87,000	87,000	5,100	5,100
Exempt loading racks									
Semi-Annual		310	41%	40,000	22,200	70,900	74,100	5,200	8,400
Annual		160	20%	40,000	10,600	67,700	67,700	3,600	3,600
Equipment Leaks	7,890								
Monthly LDAR		4,740	60%	0[a]	48,100	10,100	22,100	710	1,600
Quarterly LDAR		2,900	37%	0[a]	7,400	2,600	2,600	180	180

[a] No capital costs associated with leak detection and repair programs.

TABLE 7-25. NEW BULK PLANTS NATIONWIDE CONTROL LEVEL COSTS

TYPE OF FACILITY/ CONTROL OPTION	HAP BASELINE EMISSIONS (Mg/yr)	HAP EMISSION REDUCTION (Mg/yr)	% HAP RED	CAPITAL COST (1000 $)	ANNUAL COST (1000 $)	AVERAGE $/Mg HAP	INCREMENT $/Mg HAP	AVERAGE $/Mg VOC	INCREMENT $/Mg VOC
Storage Tank Loading	280								
Vapor balance		236	85%	7,900	1,600	6,700	6,700	360	360
Tank Truck Loading	340								
Vapor balance-no exemptions		280	81%	22,900	2,100	7,500	16,500	420	1100
Vapor balance-with exemptions		210	62%	12,600	980	4,600	4,600	250	250
Tank Truck Leakage	130								
No exempt loading racks									
Semi-Annual		60	49%	0	2,800	45,500	81,500	3,000	6,000
Annual		30	26%	0	500	13,800	13,800	810	810
Exempt loading racks									
Semi-Annual		50	41%	0	2,200	42,400	74,000	2,700	5,400
Annual		30	21%	0	300	10,800	10,800	620	620
Equipment Leaks	1,310								
Monthly LDAR		780	60%	0[a]	8,000	10,100	22,100	710	1,550
Quarterly LDAR		480	37%	0[a]	1,200	2,600	2,600	180	180

[a] No capital costs associated with leak detection and repair programs.

TABLE 7-26. EXISTING AND NEW SERVICE STATIONS NATIONWIDE CONTROL LEVEL COSTS

TYPE OF FACILITY/ CONTROL OPTION	HAP BASELINE EMISSIONS (Mg/yr)	HAP EMISSION REDUCTION (Mg/yr)	% HAP RED	CAPITAL COST (1000 $)	ANNUAL COST (1000 $)	AVERAGE $/Mg HAP	INCREMENT $/Mg HAP	AVERAGE $/Mg VOC	INCREMENT $/Mg VOC
EXISTING SERVICE STATIONS									
Underground Tank Filling	10,970								
No exemptions		9,530	87%	758,000	152,000	16,000	84,200	850	5,700
With exemptions		8,300	76%	243,000	48,800	5,900	5,900	310	310
NEW SERVICE STATIONS									
Underground Tank Filling	920								
No exemptions		800	88%	23,000	4,600	5,700	30,200	310	2,000
With exemptions		690	77%	7,300	1,500	2,100	2,100	110	110

7.2.1 Pipeline Facilities

For equipment leaks at pumping and breakout stations, alternative control techniques are based on EPA's LDAR modelfor monthly and quarterly monitoring. The costs associated with monitoring pumps and valves in light liquid service have been described in Section 7.1.2 and are assumed to apply at these facilities. The total component populations (10,600 pumps and about 116,000 valves for pumping stations and 85,500 valves and 7,200 pumps for breakout stations) were multiplied by their appropriate associated costs to estimate the annual totals. These component totals can be arrived at through an analysis of the data presented in Tables 5-1 and 5-2. Additionally, further component breakdowns can be calculated by applying new/existing and major/area ratios to the above totals.

At pipeline pumping stations, it was estimated from data in Table 8-27 that 72.1 percent of the facilities would be classified as "existing" in the base year of 1998 (27.9 percent would therefore be "new") and all pipeline pumping stations are area sources. Under Alternatives I and II, a quarterly LDAR program is required at all of these facilities. The remainder of the alternatives do not require LDAR.

At pipeline breakout stations, 90.7 percent were estimated to be existing in the base year (9.3 percent would be classified as "new" as shown in Table 8-27) and it was further estimated that 7.4 percent of these sources would be classified as major sources of HAP emissions (92.6 percent would be area sources). Based on this analysis, at pipeline pumping stations, approximately 6,530 pumps and 77,500 valves would be found at existing sources, while 670 pumps and 7,950 valves would be located at new sources. Further breakdowns for valves are as follows: 590 major source new, 7,360 area source new, 5,740 major source existing, and 71,810 area source existing. The analysis of number of pumps follows similarly with the following results: 50 major source new, 620 area source new, 480 major source existing, and 6,050 at area source existing sites. Alternative IV requires a monthly LDAR program at new major source sites (590 valves and 50 pumps). Alternative IV-Q requires a quarterly LDAR program for the equipment at existing major source sites as well (5,740 valves and 480 pumps). Alternative IV-M requires that monthly LDAR be implemented at these sites. Alternatives I, II, and III provide for implementation of area source control in addition to the major source control as specified in Alternative IV-Q. These alternatives all require quarterly LDAR for all area source facilities (approximately 79,200 valves and 6,700 pumps).

Alternatives I, II, and III for storage tanks at breakout stations require the retrofit of all fixed-roof tanks with an internal floating roof and require installation of secondary seals on internal floating roof tanks as well. Therefore, under Regulatory Alternatives I, II, and III the cost of retrofitting internal and external floating decks can be applied to the entire uncontrolled fixed-roof tank population (143) and internal floating roof tanks with only primary seals (476).

Alternatives IV, IV-Q, and IV-M require that controls be implemented at major source facilities only. Consequently, these controls would apply to 11 fixed-roof and 35 internal floating roof tanks.

7.2.2 Bulk Terminals

7.2.2.1 Truck Loading Racks. Alternative I requires new major source terminal loading racks to meet an emission limit of 5 mg/liter, while all other terminals are required to meet a 10 mg/l limit (existing major and area sources would be allowed to phase-in controls). Of the 1,024 facilities (see Table 3-11), it is estimated that there are 76 sites that fall into the new major source category (27 percent of the total number of loading racks are major sources and 28 percent of those are classified as new [see Table 8-27]). Of these 76, it was further determined that 2 of these new source facilities were designed to meet the 10 mg/l standard and 74 were designed to meet the 35 mg/l NSPS standard. Therefore, all 76 sources must upgrade to the 5 mg/l limit. Tables 7-13 and 7-14 provide the necessary cost information for this category.

The remaining 948 sites must all meet the 10 mg/l emission limit specified by this alternative. Two hundred of these sources are classified as existing major (approximately 19 percent of the total number of facilities [72 percent are existing, 27 percent are classified as major]), 207 are new area sources (28 percent are new and 73 percent are area), and 541 fall in the existing area category (approximately 53 percent of the total population). Using the facility numbers and the percentages from Appendix D, Table D-3, it was determined that 485 of these facilities must upgrade their level of control to meet this standard (194 from 80 mg/l to 10 mg/l, and 291 from 35 mg/l to 10 mg/l) and that 213 of the previously uncontrolled sources must undergo rack conversions besides. Tables 7-10, 7-11, and 7-12 provide this cost information.

Alternatives II and III require the same levels of control at major sources as under Alternative I (phase-in controls at existing major sources). However, at both new and existing area sources, each of these alternatives allows an emission rate of 35 mg/l (again with phase-in control). Since all new sources must meet the NSPS standard of 35 mg/l, none of the new area sources was required to modify its loading racks. However, of the 541 existing area sources, 151 will be required to upgrade from 80 mg/l to the 35 mg/l limit, and 131 previously uncontrolled facilities must undergo rack conversion as well. Cost data for these categories are provided in Tables 7-8 and 7-9.

Alternatives IV, IV-Q and IV-M require control at major sources only, and at the same levels previously specified (5 mg/l at new sources, 10 mg/l at existing sources). As previously stated, the cost data are contained in Tables 7-10, 7-11, 7-12, 7-13, and 7-14.

For railcar loading, it was assumed that none of the facilities can meet either a 5 mg/l or a 10 mg/l level. As a consequence, all facilities with railcar loading racks would need rack conversions. Therefore, the costs in Table 7-14 were applied to all 20 railcar loading racks and added to the overall cost for terminal loading racks.

7.2.2.2 Storage Tanks. Alternatives I, II, and III for storage tanks require the conversion of all 1,072 uncontrolled fixed-roof tanks to internal floating roof tanks with phase-in allowed at area sources (incurring those costs in Table 7-1). Also, all 2,426 external floating roof tanks with only primary seals would be required to install secondary seals (phase-in at area sources), incurring the costs in Table 7-2. Alternatives IV, IV-Q, and IV-M require storage tank control at major source facilities only. Consequently, the number of fixed-roof and internal floating roof tanks requiring control would be reduced to 289 and 655, respectively (27 percent of all tanks are located at major source sites). Table 7-23 shows that there are no costs associated with implementation of these controls for new sources. This is due to the fact that the storage tank NSPS already requires these controls for new sources.

7.2.2.3 Tank Truck Leakage. For tank truck vapor leakage, Alternatives I, II, and III require the installation of a vacuum assist vapor collection system at new major sources (estimated to be a total of 76 sources (27 percent major and 28 percent of those are new as has been calculated from Table 8-27)) and mandate annual vapor tightness testing at all bulk terminal facilities. Consequently, the cost of installation of a vacuum assist system (see Section 7.1.3.3) involved with these alternatives would be incurred by 76 bulk terminals, excluding the very few that already have this system. The estimated cost of annual truck testing is $150 per truck plus downtime. This cost was applied to the 12,731 uncontrolled bulk terminal tank trucks.

Alternatives IV, IV-Q, and IV-M require controls at major sources only and, as such, the number of tank trucks requiring annual vapor tightness testing would be reduced to 3,437 (27 percent of the previously uncontrolled tank truck population).

7.2.2.4 Equipment Leaks. The costs for controlling equipment leaks were calculated in the same manner as those discussed for pipeline facilities. The control option programs (quarterly and monthly LDAR) are the same and the component inspection costs are also the same as have been discussed for pipeline facilities. It is assumed that there are approximately 10,000 pumps and 116,000 valves at bulk terminals (component populations summed across model plant facility numbers as presented in Table 5-3). Of this number, it is estimated that approximately 800 pumps and 9,000 valves will be found at the 76 new major source terminals and would therefore require monthly LDAR. The remaining equipment components (those found at existing major source and all area source terminals) would be subject to a quarterly LDAR program. All of these components are considered to be uncontrolled at the baseline and, as a consequence, they would incur the total costs.

7.2.3 Bulk Plants

For incoming loads (from tank trucks into storage tanks), Alternatives I and II require all bulk plants to install a vapor balance system. Implementing costs for these alternatives would therefore apply to the 13,857 facilities that were uncontrolled at the baseline, using the costs in Table 7-17. The remaining alternatives require no controls for storage tank filling and bulk plants would therefore incur no costs under these alternatives.

For outgoing loads, Alternatives I and II again require all bulk plants to utilize a balance system, but with an exemption. These alternatives require all bulk plants with a daily gasoline throughput greater than 15,000 liters (4,000 gallons) to install a vapor balance system and all bulk plants with a throughput of 15,000 liters (4,000 gallons) per day or less to install submerged fill equipment.

It was estimated in Table 5-5 that approximately 48 percent of the facilities have daily throughputs less than 15,000 liters (4,000 gallons) per day. Applying this percentage to the baseline breakdown presented in Appendix D, Table D-10, it was calculated that 1,082 facilities of the 2,256 currently in areas with exemptions would therefore continue to be exempt. Also, 48 percent of the remaining 3,826 motor gasoline terminals (1,836) and all 3,200 aviation gasoline bulk plants would be exempt. Consequently, under these alternatives, it was estimated that 5,036 of the newly subject facilities (1,836 + 3,200) would be exempt, and that 1,990 would be required to install vapor balance. The costs of implementation of these controls were taken from Table 7-18.

Alternatives III, IV, IV-Q, and IV-M require no additional controls on outgoing loads. Likewise, none of the alternatives includes controls for tank trucks loading at bulk plants. Consequently, there are no costs associated with tank trucks for any of these alternatives.

The costs for controlling equipment leaks were calculated as have been previously described for pipeline facilities and bulk terminals, and were added to the overall costs of Alternatives I and II. These calculations were based on the assumption that there are 100,800 pumps and 629,900 valves at bulk plants nationwide. All of these components were again considered to be uncontrolled at the baseline and as a result would incur the total control costs.

7.2.4 <u>Service Stations</u>

Alternatives I and II require the installation of a vapor balance system for all facilities with throughputs greater than 38,000 liters (10,000 gallons) per month. As shown in Appendix D, Table D-13, 123,562 stations are currently in areas with a 38,000 liter (10,000 gallon) per month exemption. Also, Table 5-7 indicates that approximately 58 percent of all service stations (public and private) have throughputs less than 38,000 liters/month (10,000 gallons per month). Therefore, 71,666 facilities in these areas would continue to be exempt under this alternative. Of the remaining 129,042 facilities without vapor balance, it is assumed that 58 percent of the motor gasoline stations (74,844) and all of the aviation gasoline stations (1,620) would have throughputs less than 38,000 liters/month (10,000 gallons per month). This leaves a total number of 104,474 stations, approximately 2,800 new and 101,650 existing (the service station population is characterized as 2.7 percent new and 97.3 percent existing as shown in Table 8-27), that would need to install vapor balance systems to comply with Alternative I or II. Costs for each of these alternatives were calculated by multiplying this number by the costs in Table 7-19.

7.2.5 Summary of National Alternative Impacts

Table 7-27 presents an overall summary for each of the regulatory alternatives developed and analyzed for this study. Note that Alternatives IV, IV-Q, and IV-M are variations on the same theme in that all of these alternatives propose controls for major sources only. The remaining alternatives propose controls for area sources as well as major sites, hence the break line in the center of Table 7-27.

Of the negative increments appearing in the table, both favor Alternative IV-Q over Alternative III (both are calculated in increments from Alternative IV). These increments fall under the headings of HAP cost effectiveness and VOC cost effectiveness. In this analysis, the smaller the number, the greater the cost effectiveness of the alternative. In this regard, Alternative IV-Q is not only very cost-effective, it provides a net cost benefit over Alternative IV while providing a greater emission reduction.

Table 7-27 presents the alternatives discussed earlier (including 5 mg/l for new facilities). Table 7-28 has been added to show the impacts of having both new and exisiting bulk terminal loading rack controls at 10 mg TOC/l.

TABLE 7-27. SUMMARY OF ALTERNATIVE IMPACTS (5 mg/l for New Terminals)

Alternative	HAP Emission Reduction (Mg/yr)	Percent Reduction Total	Percent Reduction Sub Cats	Capital Cost (1000$)	Annual Cost (1000$)	HAP Cost Effectiveness ($/Mg)	Incremental HAP Cost Effectiveness ($/Mg)	VOC Emission Reduction (Mg/yr)	VOC Cost Effectiveness ($/Mg)	Incremental VOC Cost Effectiveness ($/Mg)
I	30,000	64%	64%	734,500	79,200	2,600	33,200	500,900	160	4,700
II	29,600	63%	63%	668,100	64,500	2,200	4,700	497,800	130	260
III	13,200	28%	72%	273,800	(11,800)	(900)	(900)	205,500	(60)	(60)
IV-M	2,900	5%	14%	130,200	17,500	6,000	2,100	47,200	370	160
IV-Q	2,700	5%	13%	130,200	17,100	6,300	(1,500)	44,400	380	(110)
IV	2,400	5%	13%	130,200	17,600	7,300	7,300	40,100	440	440

IV-Q - Alternative IV with Quarterly LDAR at Major Sources

IV-M - Alternative IV with Monthly LDAR at Major Sources

TABLE 7-28. SUMMARY OF ALTERNATIVE IMPACTS
(10 mg/l for New Terminals in Alternatives IV, IV-Q, and IV-M)

Alternative	HAP Emission Reduction (Mg/yr)	Percent Reduction Total	Percent Reduction Sub Cats	Capital Cost (1000$)	Annual Cost (1000$)	HAP Cost Effectiveness ($/Mg)	Incremental HAP Cost Effectiveness ($/Mg)	VOC Emission Reduction (Mg/yr)	VOC Cost Effectiveness ($/Mg)	Incremental VOC Cost Effectiveness ($/Mg)
I	30,000	64%	64%	734,500	79,200	2,600	33,200	500,900	160	4,700
II	29,600	63%	63%	668,100	64,500	2,200	4,700	497,800	130	260
III	13,200	28%	72%	273,800	(11,800)	(900)	(900)	205,500	(60)	(60)
IV-M	2,900	5%	14%	124,800	16,300	5,500	2,100	47,100	350	160
IV-Q	2,700	5%	13%	124,800	15,800	5,800	(1,500)	44,300	360	(110)
IV	2,400	5%	13%	124,800	16,300	6,800	6,800	40,000	410	410

IV-Q - Alternative IV with Quarterly LDAR at Major Sources

IV-M - Alternative IV with Monthly LDAR at Major Sources

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CHAPTER 8
ECONOMIC IMPACT ANALYSIS

8.1 PROFILE OF THE U.S. GASOLINE DISTRIBUTION INDUSTRY

This chapter profiles elements of the U.S. gasoline distribution industry most affected by the proposed regulation. This industry includes:

- bulk terminals,
- bulk plants,
- service stations (both public and private),
- railroad tank cars,
- pipelines, and
- tank trucks.

Because motor gasoline constitutes approximately 99 percent of all gasoline consumed in the United States, the vast majority of available gasoline industry data pertains to motor gasoline-related operations.

8.1.1 Description Of The U.S. Gasoline Distribution Industry

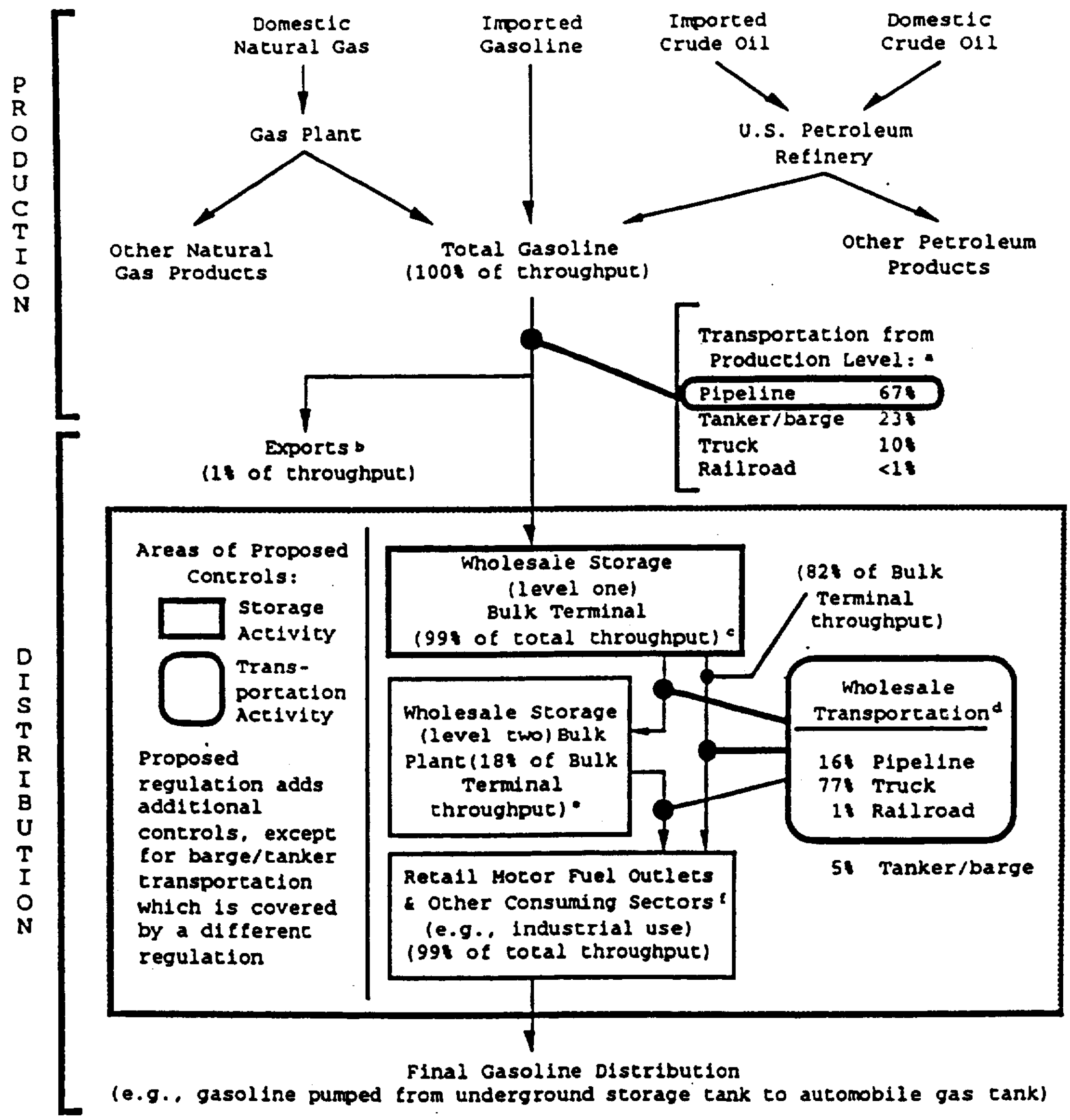
Gasoline is the major petroleum product produced from crude oil at refineries. A small quantity, less than one percent in 1987, is produced from natural gas liquids at gas processing plants.[1] Finished gasoline accounted for approximately 47 percent of the volume of total finished petroleum products supplied. The next largest petroleum product supplied in 1990 was distillate fuel oil, accounting for 20 percent of the total volume of petroleum products.[2] Table 8-1 displays trends in U.S. gasoline production and distribution.

Figure 8-1 depicts the flow and storage of gasoline through the U.S. distribution system. Gasoline is distributed from approximately 224 refineries owned by about 115 companies.[4]

TABLE 8-1. TRENDS IN GASOLINE MARKETING: U.S. GASOLINE PRODUCTION AND DISPOSITION (IN MILLIONS OF LITERS)[2, 3]

	Motor Gasoline									
	Production			Disposition						
Year	Domestic Production	Imports	Total Produced	Stock Change	Exports	Total Consumption	Percentage Unleaded of Total Quantity Consumed	Percentage Consumption from Imports	Aviation Gasoline Consumption	Total Gasoline Consumption
1990[a]	403,267	19,148	422,415	754	3,423	418,237	94.7	4.6	1,452	419,698
1989	404,021	21,411	425,432	(2,031)	2,263	425,200	88.8	5.0	1,499	426,699
1988	403,615	23,500	427,115	174	1,277	425,664	81.7	5.5	1,478	427,143
1987	396,943	22,281	419,224	(870)	2,031	418,063	75.9	5.3	1,447	419,510
1986	391,778	18,916	410,694	638	1,915	408,141	69.0	4.6	1,860	410,001
1985	372,456	22,107	394,564	(2,379)	580	396,362	64.5	5.6	1,478	397,841
1984	374,429	17,349	391,778	3,133	348	388,297	59.6	4.5	1,447	389,744
1983	367,872	14,332	382,204	(2,611)	580	384,235	55.1	3.7	1,463	385,698
1982	367,756	11,431	379,187	(1,451)	1,160	379,477	52.1	3.0	1,415	380,892
1981	371,644	9,110	380,754	(1,625)	116	382,262	49.5	2.4	1,828	384,091
1980	377,504	8,123	385,628	3,830	58	381,740	46.6	2.1	2,035	383,775
1979	397,581	10,502	408,083	(116)	0	408,199	39.8	2.6	2,178	410,377
1978	415,974	11,025	426,999	(3,133)	58	430,074	34.0	2.6	2,210	432,284
1977	408,083	12,591	420,674	4,178	116	416,381	27.5	3.0	2,257	418,638
1976	396,943	7,601	404,544	(580)	174	404,950	21.6	1.9	2,114	407,064
1975	378,317	10,676	388,993	1,625	116	387,253	N/A	2.8	2,178	389,430
1974	369,033	11,837	380,870	1,393	116	379,361	N/A	3.1	2,528	381,889

[a]1990 data for aviation gasoline were estimated based on consumption in the first 11 months of 1990.



[a] Figures from 1977 Commodity Transportation Survey for "gasoline and jet fuels." only pipeline shipments would be regulated by the proposed standard.

[b] Assumed all exports are taken from the refinery-level and that none go through terminals.

[c] Assumed all refinery shipments other than exports go through a terminal (i.e., there are no refinery-to bulk-plant shipments).

[d] Transportation mode figures from an unpublished Bureau of Census source for shipments from SIC 5171 (this source's data are used to estimate mode of transport for all wholesale shipments of gasoline; non-truck transportation apparently results from terminal-to terminal shipments).

[e] The percentage has varied over time; the 18 percent figure represents the estimate for 1998 (see Section 8.2.3 for description of estimation procedure).

[f] For detail on consuming sectors, see Table 8-2.

Figure 8-1. The U.S. Gasoline System

Most gasoline goes first to one of over 1,000 large bulk terminals, located generally along a pipeline or on the coastline of a navigable body of water, where companies can take barge or tanker delivery. Most of these bulk terminals are owned by refiners. A significant, but declining, proportion of gasoline is transported by truck from the bulk terminal to another storage facility, the bulk plant, which is generally smaller than the terminal and nearer the final customer. Bulk plants are located in areas with smaller volume requirements that do not justify the additional investment required for a bulk terminal. EPA defines a bulk gasoline terminal as having gasoline throughput of at least 75,700 liters (20,000 gallons) per day; bulk plants have an average throughput of less than 75,700 liters per day.

Increasingly, gasoline bypasses the bulk plant and is shipped directly to service stations because of the construction of large-volume retail outlets and the use of more efficient truck carriers.[5] Gasoline wholesalers often distribute additional petroleum products, especially home heating oil, and may also operate retail gasoline outlets. Gasoline is transported through the wholesale distribution chain by railroad cars, tank trucks, pipelines, and barges and tankers (two forms of water transport covered by a separate EPA regulation).

The gasoline distribution industry consists of three broad entities:

- "major" oil companies,
- independent marketers with refineries, and
- all other entities, which include distributors (jobbers) and retailers.

Major oil companies, such as Exxon, Shell, and Texaco, account for a large percentage of total refinery capacity. Major companies are vertically integrated; that is, besides gasoline and other petroleum product production, they own wholesale distribution facilities and retail outlets. Independent marketers with refineries are similar to major oil companies in that they are vertically integrated and have refinery capacity. However, independent refiners hold a much smaller percentage of the market. The remainder of the gasoline industry comprises independent wholesale distributors (jobbers) and retailers that do not own refinery capacity. Some of these smaller firms specialize in one phase of the industry such as providing transportation services. These firms obtain gasoline from the major and independent oil companies.

8.1.2 Complexities and Problems Affecting the Industry Profile.

Two major problems arise in attempting to profile the gasoline distribution industry:

- general deficiencies in the available data and
- the complexities involved in defining and characterizing ownership of industry establishments given the presence of significant industry vertical and horizontal integration.

8.1.2.1 Data Deficiencies. Most of the available industry data comes from three major sources: previous EPA reports, the U.S. Department of Commerce's Bureau of the Census, and various petroleum industry associations such as the American Petroleum Institute (API). Unfortunately, data from these three sources are often collected using different definitions. For example, the Census Bureau data on public service stations, Standard Industrial Classification (SIC) 5541--Gasoline Service Stations, only describe stations that receive at least 50 percent of their revenue from sales of gasoline and automotive lubricants.

A significant shortcoming of much of the available data is the lack of specific data for gasoline distribution activities; most of the data that have been identified are provided for total petroleum products. For example, data are only provided for petroleum product employment; data are not available for employment in gasoline operations only.

Inconsistent use of terminology in industry data also causes problems. For example, the term "jobber" may refer to any petroleum product wholesaler, to wholesalers of fuel oil exclusively, or to petroleum product wholesalers with bulk plants, depending on the source.

8.1.2.2 Industry Integration. Many firms in the industry are also involved in other lines of business; they not only market other petroleum products, but have diversified into businesses as dissimilar as real estate and lobster distribution.[6] Unfortunately, detailed data for differentiating gasoline distribution from other activities are not available.

8.1.3 Data Characterizing the Gasoline Distribution Industry

8.1.3.1 Gasoline Production and Consumption. Table 8-1 shows that motor gasoline production peaked in 1978 at over 430 billion liters. In 1982, production reached its lowest level since 1974, at nearly 380 billion liters. With increased demand due to economic growth and falling gasoline prices, the level of gasoline produced has recently increased to near 1978 levels.

Table 8-2 presents consumption of gasoline by end-use sector for the years 1982, 1987, and 1989. These data show that the private and commercial transportation sector accounted for approximately 95 percent of total gasoline consumed in each year.

8.1.3.2 Prices and Margins. Table 8-3 presents nominal and real (in 1990 dollars) retail motor gasoline prices

TABLE 8-2. CONSUMPTION OF GASOLINE: 1982, 1987, 1989 (IN THOUSANDS OF LITERS)[7, 8, 9]

		Public Use		Private and Commercial Use						
					Non-Highway					
Year	Total Consumed	Federal	State, County, Municipal	Highway	Agricultural	Aviation	Industrial and Commercial	Construction	Marine	Misc.
1982	385,081	640	9,579	364,905	3,452	1,410	631	146	4,019	297
Percentage of Total	100.00	0.17	2.49	94.76	0.90	0.37	0.16	0.04	1.04	0.08
1987	426,988	902	11,170	402,159	3,489	1,363	1,777	1,055	4,462	612
Percentage of Total	100.00	0.21	2.62	94.19	0.82	0.32	0.42	0.25	1.04	0.14
1989	434,069	881	10,182	410,226	3,109	1,330	1,883	1,126	4,739	593
Percentage of Total	100.00	0.20	2.35	94.51	0.72	0.31	0.43	0.26	1.09	0.14

TABLE 8-3. TRENDS IN RETAIL MOTOR GASOLINE PRICES (IN CENTS PER GALLON, INCLUDING TAXES)[10, 11]

Year	Nominal		Real[a]	
	Leaded Regular	Unleaded Regular	Leaded Regular	Unleaded Regular
1990	115.0	117.0	115.0	117.0
1989	99.8	102.1	103.9	106.3
1988	89.9	94.6	97.5	102.6
1987	89.7	94.8	100.5	106.2
1986	85.7	92.7	98.9	107.0
1985	111.5	120.2	132.2	142.5
1984	112.9	121.2	137.8	148.0
1983	115.7	124.1	146.4	157.1
1982	122.2	129.6	160.7	170.4
1981	131.1	137.8	183.4	192.8
1980	119.1	124.5	182.7	191.0
1979	85.7	90.3	143.4	151.1
1978	62.6	67.0	114.0	122.0

TRENDS IN RETAIL MOTOR GASOLINE PRICES (IN CENTS PER LITER, INCLUDING TAXES)

Year	Nominal		Real[a]	
	Leaded Regular	Unleaded Regular	Leaded Regular	Unleaded Regular
1990	30.4	30.9	30.4	30.9
1989	26.4	27.0	27.5	28.1
1988	23.8	25.0	25.7	27.1
1987	23.7	25.0	26.5	28.1
1986	22.6	24.5	26.1	28.3
1985	29.5	31.8	34.9	37.7
1984	29.8	32.0	36.4	39.1
1983	30.6	32.8	38.7	41.5
1982	32.3	34.2	42.5	45.0
1981	34.6	36.4	48.5	50.9
1980	31.5	32.9	48.3	50.5
1979	22.6	23.9	37.9	39.9
1978	16.5	17.7	30.1	32.2

[a]In 1990 prices, (adjusted by GNP implicit price deflator).

(including gasoline taxes) for regular leaded and unleaded gasoline over the period 1978-1989. In real terms, the price of motor gasoline declined each year during the period 1982-1988. The Persian Gulf crisis caused much of the large price increase between 1989 and 1990.

Gasoline producers distribute their products through both direct and indirect channels. Each channel represents about half the volume sold in the United States.[12] Direct supply means that the refiner retains ownership of the gasoline throughout the wholesale distribution process. Directly supplied gasoline is delivered to retail stations at "dealer tank wagon" prices. In the indirect method, distributors buy gasoline from refiners at terminal prices (discounted from the tank-wagon price). They may then deliver it to other distributors and to their own or other retail outlets, hoping to cover costs and make a profit on the spread between terminal and resale prices. Distributors using the indirect method are referred to as "jobbers." All the major oil companies use both forms of wholesale distribution depending on whether refiners believe that their costs of distribution would be less than the jobber discount.

By using both forms of distribution, refiners can reduce their investment and operating costs, and can compare the costs of directly supplied and distributor-supplied product. This serves as a check on the economic efficiency of refiners' distribution systems.[12] Refiners usually choose direct distribution in densely populated areas where station representation is good; jobbers are used to distribute gasoline to areas where the refiners' stations are few and widely dispersed.[13]

Table 8-4 presents estimates of average margins at each point in the gasoline distribution chain. These margins represent the total dollar value per liter added to the cost of gasoline by each sector in the distribution chain to cover that

TABLE 8-4. ESTIMATES OF MARGINS AT VARIOUS POINTS IN THE GASOLINE DISTRIBUTION CHAIN[10,11]

Sector	Margin ($/gallon)	Margin ($/liter)
Pipeline	0.030	0.008
Bulk Terminal	0.020	0.005
Truck Transportation	0.025	0.007
Bulk Plant	0.020	0.005
Total Wholesale	0.095	0.025
Service Station	0.05	0.013
Total Retail	0.05	0.013

sector's costs and profit. Other data compiled by EIA support these estimates.[14-18]

8.1.3.3 <u>Margins and Product Differentiation</u>. Attempts at product differentiation in retail trade have centered on extensive advertising campaigns extolling the virtues of various additive packages to protect engine parts, give better mileage, or reduce tailpipe emissions. As a result of similar attempts at differentiation during the years before the Organization of Petroleum Exporting Countries (OPEC) price hike, a majority of customers paid 2 or 3 cents a gallon more for major brand gasolines than for independent brands.[19] However, some analysts in the industry believe that little "brand loyalty" now exists because of the unprecedented price increases resulting from the gasoline shortages of the last two decades. The theory is that these increases have convinced consumers that "gasoline is gasoline" and should be bought on the basis of price rather than brand.

The market share of "regular" and "mid-grade" gasolines, which have lower retail margins than "premium" high octane gasoline, has also been affected by price increases. As a result of precipitous increases in retail gasoline prices during the Persian Gulf crisis, consumers have recently switched to cheaper, lower octane gasolines. The percentage of premium gasoline to total gasoline sold by refineries dropped from 24 percent to 16 percent between October 1989 and October 1990.[20] During the 1982-1989 period, the market share of premium-grade gasolines had increased substantially, despite the difference between average retail prices of premium and regular grades, which averaged approximately $0.04 per liter ($0.15 per gallon).[21]

The stability of prices within any marketing territory has depended on the presence or absence of aggressive independent marketers.[22] These independent marketers pioneered the building of retail outlets with large storage capacity. This enabled them to bypass bulk plants and resulted in lower costs. They also lowered margin requirements with direct-operated units, and further reduced per-gallon operating costs with high-volume retail outlets.

8.1.3.4 Total Industry Employment and Sales. Employment data for the U.S. gasoline distribution industry in 1989 are available on the following:

- pipeline transportation of petroleum products, excluding natural gas--17,825 employees
- wholesale services for petroleum products--201,957 employees
- retailing activities at "traditional" gasoline service stations--622,799 employees.[23] (Not included in this estimate is the number employed at "non-traditional" service stations such as convenience stores.)

By contrast, 1982 petroleum product employment in these sectors was approximately 34,842 less than in 1989. Approximately 20,514 people were employed in product pipelines and in product wholesaling activities. Service stations employed 561,172 in 1982, and it is the only sector that increased employment in 1989.

The Petroleum Marketers Association of America's (PMAA's) 1990 Marketer Profile Survey estimates 12,500 to 14,000 independent petroleum marketers nationwide in 1990. PMAA's current estimates represent a decline from an estimated 21,000 at the beginning of the 1980s:

> Continued declines in the number of marketers is no longer attributable to shrinking markets, as was the case during the early 1980s, when the highest rate of industry exits occurred. A PMAA long-range study committee estimated that roughly half of the present total will make it to the year 2000. In more recent years, factors external to the market have exerted a greater influence on competitive conditions; government regulation in the

> environmental arena has had a particularly marked impact on the nation's petroleum marketing businesses.[24]

National Petroleum News (NPN) estimates that the vast majority of jobbers are small jobbers located in small rural areas away from the large highly competitive markets that the majors and large chains fight over:

> Two current situations seem to favor those small jobbers still in business: the contraction of the 1980s has reduced competition in their small markets, providing in some cases for higher profit-margins; and the gallonage potential, generally speaking, is insufficient to attract either major or chain direct-retail operations.[25]

Also, NPN estimates that many small jobber's retail outlets are debt-free and that some larger but debt-burdened chains could have difficulty covering the cost of underground storage tank and vapor recovery regulations.

Only independent petroleum marketers are represented in the 1990 Marketer Profile Survey. Therefore, absolute values from the survey only apply to that segment of the marketing industry. However, figures from the survey can be used to illustrate trends for the industry as a whole. Table 8-5 shows employment data using PMAA's total independent petroleum marketing employment estimates for 1985, 1987, and 1989. The 12 percent increase in employment between 1987 and 1989 is consistent with an industry trend toward larger businesses. Much of this gain in employment has been due to an increase in part-time employment.

The Bureau of Labor Statistics' (BLS) Monthly Labor Review provides estimates of projected employment for wholesale trade in petroleum and petroleum products and gasoline service station retail trade. BLS estimates that wholesale trade will lose approximately 2,000 workers (or an annual rate of change in employment of -1.0 percent) in petroleum and petroleum products over the period 1988-2000. For gasoline service stations, BLS projects an increase of 74,000 workers over that same time frame for an annual rate increase of 0.9 percent.[26]

TABLE 8-5. ESTIMATED NUMBER OF PEOPLE EMPLOYED BY PMAA-MEMBER INDEPENDENT PETROLEUM MARKETERS, BY EMPLOYMENT TYPE AND JOB CATEGORY: 1985, 1987, AND 1989[6]

Job Category	Full-time			Part-time			Total		
	1989	1987	1985	1989	1987	1985	1989	1987	1985
Service Station	18,482	19,724	42,177	8,823	9,652	25,306	27,305	29,376	67,483
Convenience Store	75,414	68,831	19,682	41,811	21,661	19,683	117,225	90,492	39,365
Sales	10,161	8,855	11,201	506	122	46	10,667	8,977	11,247
Drivers	38,055	36,630	33,742	5,268	3,617	5,623	43,323	40,247	39,365
Service/ Maintenance	15,258	15,497	16,830	1,809	894	44	17,067	16,391	16,874
Office	40,002	38,844	28,118	2,281	2,885	11,247	42,283	41,729	39,365
Other	11,178	12,881	7,027	1,963	1,809	9,844	13,141	14,690	16,871
Total	208,550	201,262	158,777	62,461	40,640	71,793	271,011	241,902	230,570

Note: Employment figures shown are estimates for the independent petroleum marketing sector only. Data are presented to represent trends and for comparison of job category employment shares. Data are estimates representing PMAA's membership (approximately 11,000 members), not the 12,500-14,000 estimated total number of independent petroleum marketers.

Total sales for the gasoline distribution industry were estimated from 1987 Census data. These data provide a range of total gasoline sales between $173 and $200 billion. The $173 figure is the sum of gasoline sales by the dominant wholesale SICs 5171--Petroleum Bulk Stations and Terminals and 5172--Petroleum and Petroleum Products Wholesalers, except Bulk Stations and Terminals, and the predominant retail SIC 5541--Gasoline Service Stations). In 1987, service stations without payroll had total sales from all sources of revenue of approximately $2.8 billion. According to the National Association of Convenience Stores, gasoline sales at convenience stores totaled $20.5 billion in 1987. Convenience stores which have revenues from gasoline sales equaling at least 50 percent of their total sales, are included in the Census. Determining how many of these convenience stores are already included in the Census figures is not possible.

8.1.3.5 Ownership and Concentration. Table 8-6 presents concentration ratios for 1970-1987 for total wholesale and retail gasoline sales. This table shows that concentration in gasoline sales decreased slightly during this period.

8.1.4 Wholesale Gasoline Distribution

The wholesale gasoline distribution sector involves intermediate storage and transportation of gasoline.

8.1.4.1 Wholesale Distribution and Sales. The U.S. Department of Commerce's Bureau of the Census collects data on wholesale petroleum product sales using the SIC system. According to the Census' 1987 Census of Wholesale Trade--Commodity Line Sales--United States, 11 different four-digit wholesale SICs had sales of petroleum products in 1987.

TABLE 8-6. CONCENTRATION RATIOS FOR GASOLINE SALES (PERCENTAGE OF U.S. TOTAL)[27]

	1987	1986	1985	1980	1975	1970
Top 4 firms	28.9	29.5	29.8	28.5	29.5	30.7
Top 8 firms	48.7	49.6	50.3	49.5	50.3	54.6
Top 15 firms	65.0	66.4	67.7	66.3	68.6	74.9
Top 20 firms	70.2	70.5	71.8	72.1	74.7	80.0
Top 30 firms	76.4	76.6	71.2	77.9	—	—

However, 96 percent of total petroleum product wholesale sales were by SICs 5171--Petroleum Bulk Stations and Terminals and 5172--Petroleum and Petroleum Products Wholesalers, except Bulk Stations and Terminals. SIC 5172 comprises truck jobbers, packaged and bottled petroleum products distributors, and others marketing petroleum and its products wholesale, but without bulk liquid storage facilities.

Figure 8-2 and Table 8-7 present generalized sales data for petroleum products and gasoline available from the Census. Sales of petroleum products in 1987 were approximately $188 billion dollars, with SICs 5171 and 5172 accounting for approximately $181 billion of that total. Detailed data available from the Census in 1987 show that motor gasoline sales totaled $97.8 billion in these two SICs. Aviation gasoline sales from these two SICs amounted to approximately $750,000.

8.1.4.2 Employment. No figures were identified for employment in wholesale marketing activities specifically for gasoline. However, the data available for petroleum products show that 201,957 people were employed in wholesale activities as of January 1, 1989 (down from approximately 226,000 from January 1982).[29,30]

8.1.4.3 Economic Agents and Relationships. Industry analysts often refer to three categories of firms in the gasoline production and distribution industry. The "major oil companies" (most often referred to as Amoco, Atlantic Richfield, Chevron, Exxon, Mobil, Shell, and Texaco) and "semi-major oil companies" (often defined as American Petrofina, Ashland Petroleum, Citgo, Conoco,Crown Central Petroleum, Diamond Shamrock, Kerr-McGee Refining, Marathon Oil, Murphy, Phillips Petroleum, Standard Oil [now BP-America], Sun, Tenneco Oil [acquired by Amoco in 1987], and Union Oil of California) own a large percentage of refining capacity and have vertically

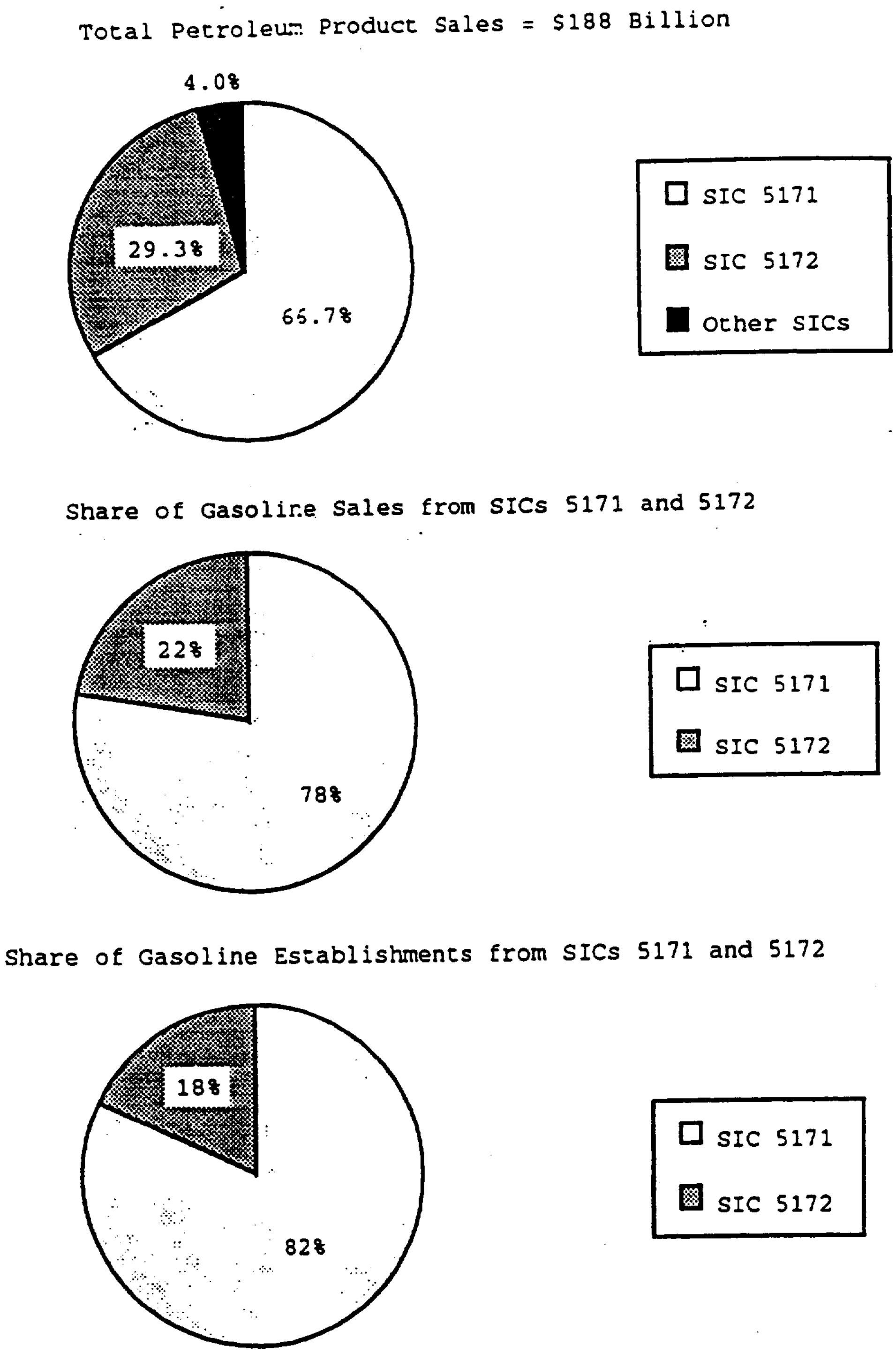


Figure 8-2. SIC 5171 and 5172 Characteristics[28]

Note: SIC 5171--Petroleum Bulk Stations and Terminals
SIC 5172--Petroleum and Petroleum Products, except Bulk Stations and Terminals

TABLE 8-7. GENERAL CENSUS DATA CHARACTERIZING THE WHOLESALE MARKET FOR GASOLINE: 1987[a] (SALES IN MILLIONS OF DOLLARS)

			Motor Gasoline			Aviation Gasoline		
SIC	Total Number of Estab- lishments	Total Sales	Number of Estab- lishments	Sales	Percent- age of Total Sales	Number of Estab- lishments	Sales	Percent- age of Total Sales
5171[b]	12,353	139,655	10,870	76,714	55	1,054	606	0.4
5172[c]	4,373	95,219	2,374	21,070	22	300	149	0.2
Total of Above	16,726	234,874	13,244	97,784	42	1,354	755	0.3

[a]In 1987, SICs 5171 and 5172 accounted for 96 percent of total wholesale petroleum product sales; percentage of total for gasoline is not available.

[b]SIC 5171--Petroleum Bulk Stations and Terminals.

[c]SIC 5172--Petroleum and Petroleum Products Wholesalers, except Bulk Stations and Terminals.

integrated operations from the refinery down to the retail service station level. Independents, also known as "jobbers," can be vertically integrated but often are integrated to a lesser degree than the majors or semi-majors.

Census data indicate that refining companies have the largest share of wholesale gasoline sales (approximately 55 percent in 1987), although the majority of establishments involved in wholesale gasoline (80 percent in 1987) are owned by companies that do not refine gasoline.

These economic entities are related to one another in a myriad of ways. For example, refiners typically operate bulk terminals with salaried personnel. Most bulk plants, however, are operated by independent wholesalers. Some bulk plants are operated by cooperative associations or by the refiners themselves using employees/agents who work on a salary or commission basis. Cooperative associations own a small number of bulk plants. These serve mostly farmers, and available data are limited.

Historical data are available for bulk plants and terminals (SIC 5171) describing recent trends in wholesale gasoline establishment ownership and sales. Figure 8-3 reveals that non-refinery firms' shares of total wholesale gasoline sales and total wholesale gasoline establishments increased between 1977-87.

<u>Establishment and firm size and concentration</u>. Data from the <u>1987 Census of Wholesale Trade--Establishment and Firm Size</u> on the size of establishments and firms classified in SICs 5171 and 5172 pertain to all company activities, not just gasoline sales. Because gasoline sales are a large percentage of their total sales, these data are assumed to be representative of gasoline wholesalers. Figures 8-4 and 8-5 show that refiner-owned establishments were substantially larger and more numerous than non-refiner-owned establishments. On average, refiner-

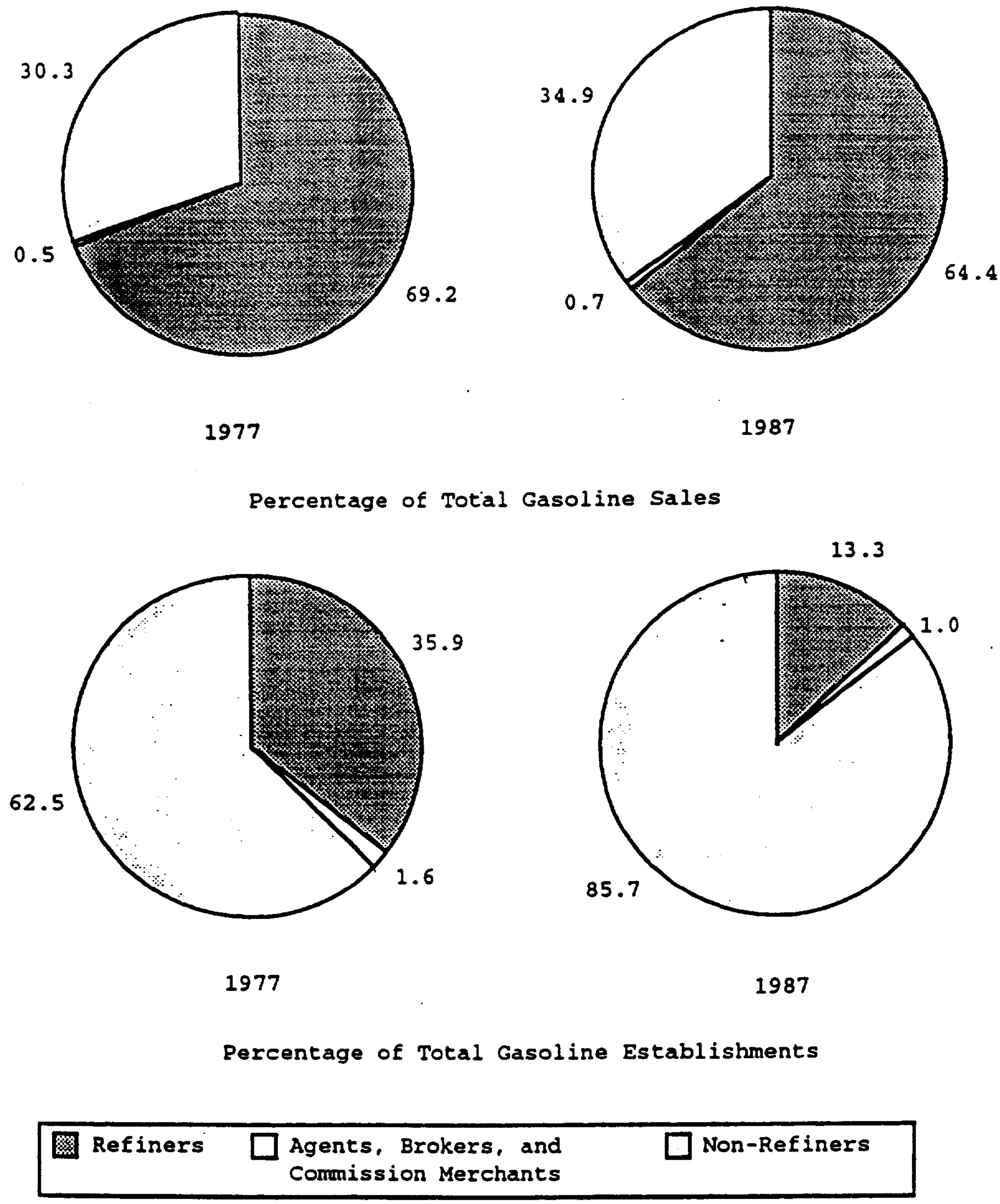


Figure 8-3. Wholesale Gasoline Establishment Ownership and Sales Trends: SIC 5171[31,32]

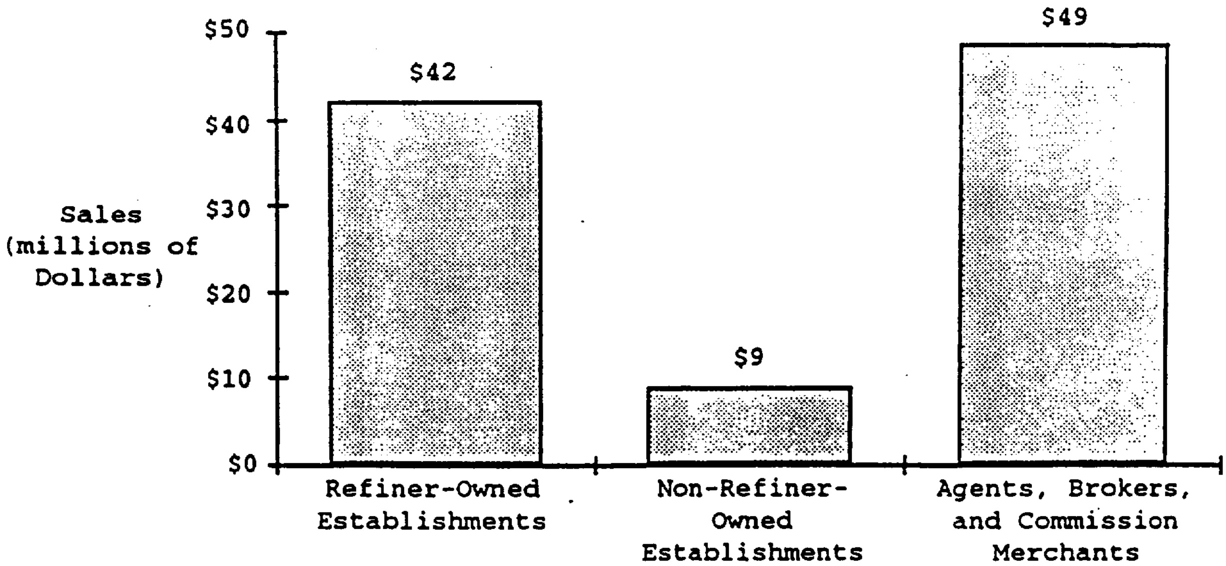


Figure 8-4. 1987 Sales Per Establishment for SICs 5171 and 517228

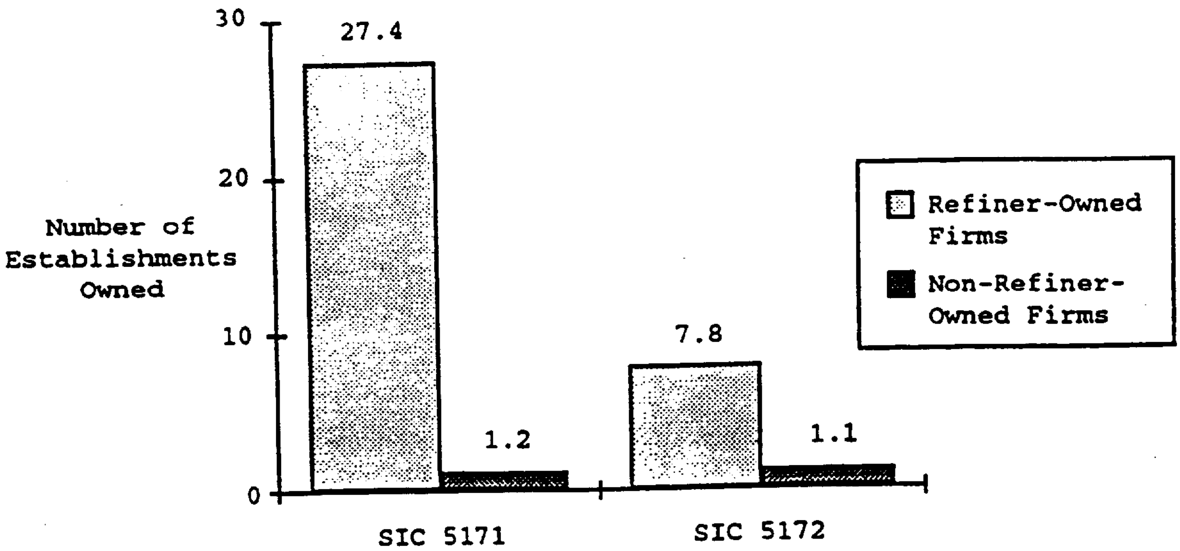


Figure 8-5. Refiner vs. Non-refiner Firm Ownership of Wholesaling Establishments[28]

owned establishments have substantially greater sales than non-refiner owned establishments. The 1987 Establishment and Firm Size data presented on Table 8-8 show concentration by the largest firms in the two SIC industries. This table shows that concentration is higher in refiner-owned firms than non-refiner-owned firms. Table 8-9 provides data characterizing trends in SIC 5171 concentration between 1977 and 1987. These data show that overall concentration declined between 1977 and 1987 in the overall bulk station/terminal market.

Financial ratios. Financial data and ratios are available from Dun and Bradstreet's Industry Norms and Key Business Ratios. This source presents "common-size" balance sheet and income statement data along with key business ratios on solvency, efficiency, and profitability.

Table 8-10 shows three commonly used profitability ratios for SICs 5171 and 5172 in 1987, 1989, and 1990. Financial analysts tend to look increasingly to the return on net worth as an absolute measure of a firm's profitability. The consensus among financial analysts is that a return of at least 10 percent is required to provide dividends plus adequate funds for future growth.[37]

8.1.5 Storage Facility-Specific Data

The EPA defines bulk plants and bulk terminals using gasoline throughput. Bulk plants have gasoline throughput of 75,700 liters (20,000 gallons) per day or less; bulk terminals have throughput of greater than 75,700 liters per day. "Bulk Station" is a Bureau of the Census term for bulk plant. Throughput is not the determining factor used by the Census for separating bulk stations from bulk terminals. Instead, the Census uses a combination of storage capacity and method of incoming product transportation to identify these facilities. Although most other sources use the term bulk plant rather than

TABLE 8-8. CONCENTRATION BY LARGEST FIRMS: 1987, SICs 5171, AND 5172[28]

SIC	Number of Estab-lishments	% of Total	Sales		Paid Employment, March 12, 1987	
			Amount ($10^6)	% of Total	Number	% of Total
5171	12,353	100.0	139,655	100.0	135,923	100.0
4 largest firms	341	2.8	23,655	16.9	4,552	3.3
8 largest firms	692	5.6	42,082	30.1	8,487	6.2
20 largest firms	1,327	10.7	72,841	52.2	15,385	11.3
50 largest firms	1,587	12.8	90,329	64.7	21,222	15.6
Non-Refiner-Owned	10,400	84.2	62,954	45.1	114,667	84.4
4 largest firms	31	0.3	6,913	11.0	1,672	1.5
8 largest firms	58	0.6	10,575	16.8	2,342	2.0
20 largest firms	104	1.0	16,134	25.6	4,231	3.7
50 largest firms	185	1.8	(W)	(W)	(W)	(W)
Refiner-Owned	1,781	14.4	75,219	53.9	19,227	14.1
4 largest firms	340	19.1	23,654	31.4	4,551	23.7
8 largest firms	688	38.6	42,035	55.9	8,424	43.8
20 largest firms	1,316	73.9	67,971	90.4	14,108	73.4
50 largest firms	1,715	96.3	74,976	99.7	18,530	96.4

(continued)

TABLE 8-8. CONCENTRATION BY LARGEST FIRMS: 1987, SICs 5171, AND 5172 (CONTINUED)[28]

SIC	Number of Establishments	% of Total	Sales: Amount ($\$10^6$)	Sales: % of Total	Paid Employment, March 12, 1987: Number	Paid Employment, March 12, 1987: % of Total
5172	4,373	100.0	95,219	100.0	39,265	100.0
4 largest firms	58	1.3	27,224	28.6	1,378	3.5
8 largest firms	112	2.6	39,600	41.6	1,945	5.0
20 largest firms	289	6:6	55,380	58.2	3,506	8.9
50 largest firms	429	9.8	70,227	73.8	5,989	15.3
Non-Refiner-Owned	3,701	84.6	61,945	65.1	34,106	86.9
4 largest firms	27	0.7	17,251	27.8	830	2.4
8 largest firms	34	0.9	24,901	40.2	1,111	3.3
20 largest firms	57	1.5	35,074	56.6	2,167	6.4
50 largest firms	140	3.8	44,496	71.8	3,813	11.2
Refiner-Owned	438	10.0	17,473	18.4	4,048	10.3
4 largest firms	103	23.5	11,510	65.9	952	23.5
8 largest firms	238	54.3	14,589.	83.5	1,716	42.4
20 largest firms	325	74.2	16,803	96.2	3,408	84.2
50 largest firms	431	98.4	17,469	100.0	4,032	99.6

(W)--Withheld to avoid disclosing data for individual companies; data are included in broader kind-of-business totals.
SIC 5171--Petroleum Bulk Stations and Terminals.
SIC 5172--Petroleum and Petroleum Products Wholesalers, except Bulk Stations and Terminals.

TABLE 8-9. TRENDS IN CONCENTRATION BY LARGEST FIRMS: 1977-1987 (SIC 5171)[28,33]

SIC	1977 Percentage of Total Establish-ments	1987 Percentage of Total Establish-ments	1977 Percentage of Total Sales	1987 Percentage of Total Sales
5171:	100.0	100.0	100.0	100.0
4 largest firms	7.6	2.8	28.7	16.9
8 largest firms	20.1	5.6	45.5	30.1
20 largest firms	27.9	10.7	61.4	52.2
50 largest firms	31.8	12.8	69.1	64.7
Non-Refiner-Owned:	64.4	84.2	35.7	45.1
4 largest firms	0.5	0.3	8.2	11.0
8 largest firms	0.7	0.6	12.0	16.8
20 largest firms	1.1	1.0	18.9	25.6
50 largest firms	3.1	1.8	25.7	(W)
Refiner-Owned:	34.1	14.4	63.9	53.9
4 largest firms	22.2	19.1	44.9	31.4
8 largest firms	58.9	38.6	71.2	55.9
20 largest firms	84.7	73.9	94.0	90.4
50 largest firms	95.3	96.3	99.0	99.7

(W)--Withheld to avoid disclosing data for individual companies; data are included in broader kind-of-business totals.

TABLE 8-10. TRENDS IN FINANCIAL PROFITABILITY RATIOS, 1987, 1989, 1990: SICs 5171 AND 5172[34-36]

		Return on Sales[a]			Return on Assets[b]			Return on Net Worth[c]		
SIC	Quartile	1990	1989	1987	1990	1989	1987	1990	1989	1987
5171	Upper	2.7	2.6	2.9	9.4	8.9	10.3	20.2	17.1	20.9
	Median	1.2	1.2	1.4	5.2	4.5	5.7	10.0	9.1	10.8
	Lower	0.4	0.4	0.5	1.8	1.4	2.1	3.9	3.0	4.0
5172	Upper	3.2	2.9	3.5	10.5	10.1	12.7	23.4	22.0	25.7
	Median	1.4	1.3	1.6	5.4	4.8	6.1	11.0	10.9	12.9
	Lower	0.4	0.4	0.6	1.7	1.5	2.4	4.2	3.4	5.5

[a]Profits earned per dollar of sales.

[b]Indicates how well a firm has used its assets for making a profit.

[c]Measures the rate of return of owner's equity (stockholder's investment).

bulk station, it is prudent to only compare the total number of facilities between the different sources.

8.1.5.1 Bulk Terminals. Table 8-11 shows that the number of gasoline bulk terminals operating in 1990 is only three-quarters the number operating in 1977. Table 8-12 shows time-series data on ownership of bulk terminals by major/semi-major oil companies versus all other entities.

8.1.5.2 Bulk Plants and Bulk Stations. Bulk plants receive approximately one-fifth of the total volume of gasoline that moves through the U.S. gasoline system. Figure 8-6 shows a 5 percent decline in the percentage of motor gasoline passing through bulk stations between 1977 and 1987.

Table 8-11, which showed bulk terminal estimates, also shows the estimated number of bulk plants for several years over the period 1977-1990. Non-Census sources of bulk plant data include PMAA's Marketer Profile Survey. Independent marketers reported to PMAA a 26 percent drop in average storage capacity from 616,955 liters in 1987 to 454,200 liters in 1989. PMAA believes that the capacity decline is related to selective scrapping of older tanks that do not warrant upgrading or investment, rather than closure of entire facilities. An April 1989 study by the National Petroleum Council found that total bulk plant storage capacity declined from 65 million to 50 million barrels between 1983 and 1988.[47]

8.1.6 Gasoline Transportation

Pipelines move the greatest volume of gasoline the greatest distance through the distribution system. Although, published data are not available on the total volume of gasoline that moves by pipeline, related data have been identified. Figure 8-7 presents data on the relative proportions of petroleum products moved by various transportation modes in 1974 and 1989.

TABLE 8-11. ESTIMATES OF THE TOTAL NUMBER OF WHOLESALE GASOLINE STORAGE FACILITIES: 1977-1990

Year	Bulk Plants	Bulk Terminals	Total
1990	11,000[38]	1,335[39]	12,335
1987[40]	15,000	1,500	16,500
1982[41]	15,000	1,500	16,500
1977[41]	17,850	1,751	19,601

TABLE 8-12. FACILITY OWNERSHIP: TERMINALS (PERCENTAGE OF TOTAL)[42-44]

Segment Category[a]	1990 Bulk Terminals	1987 Bulk Terminals	1982 Bulk Terminals
Major + Semi-Major	70	79	79
Independent/Other	30	21	20

[a]See Section 8.1.4.3 for list of companies that fall under each category.

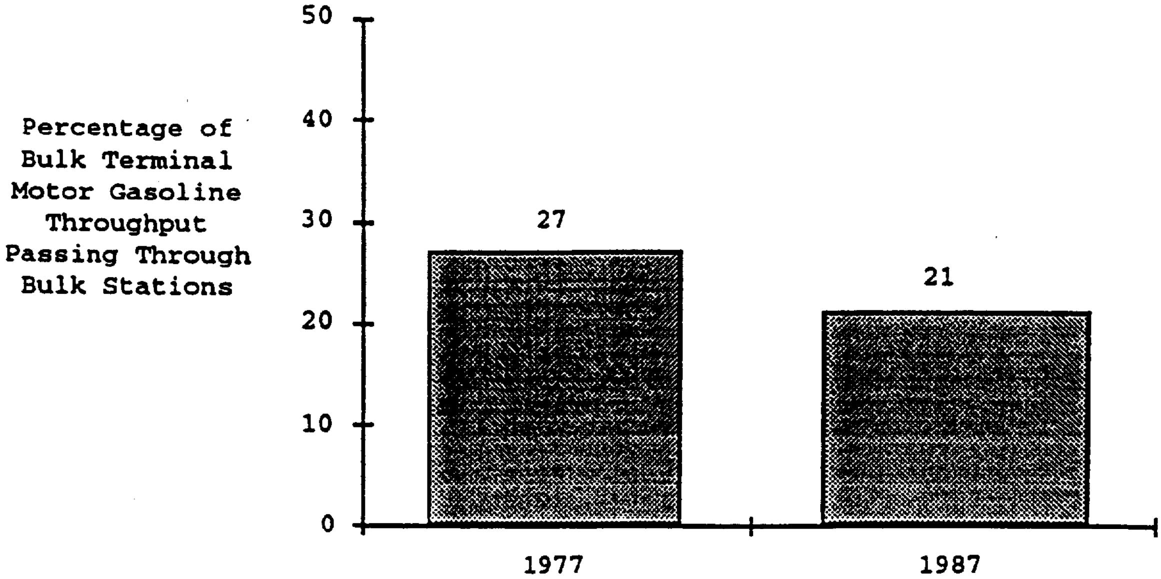


Figure 8-6. Trend in Bulk Station Throughput[45,46]

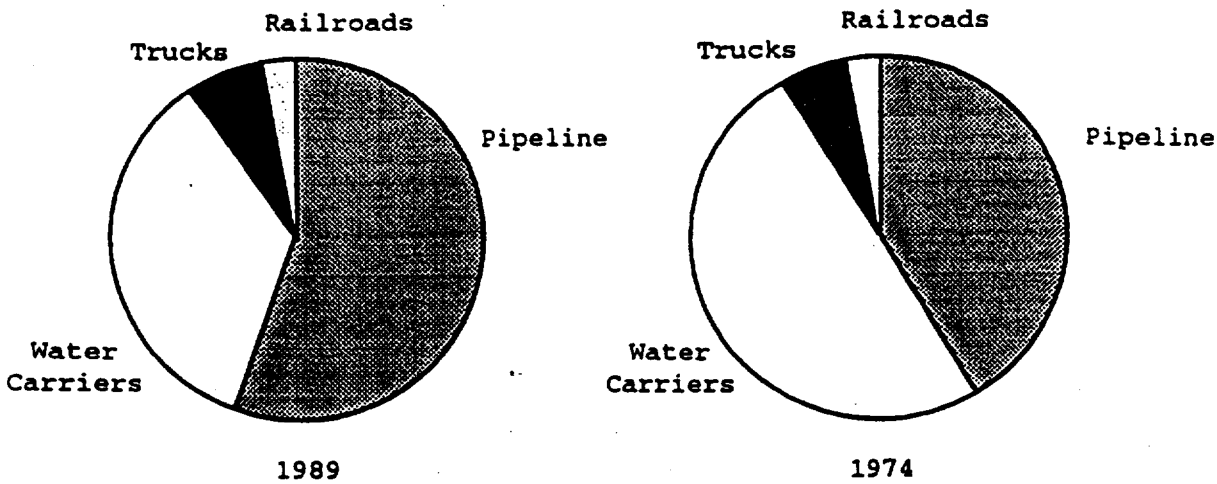


Figure 8-7. Transportation of Petroleum Products, 1974-1989 (Relative proportion of total ton-miles shipped by various modes)[48,49]

Data on the transportation of gasoline through the marketing chain show that shipments further upstream in the chain (closer to the refinery) are mostly made by pipeline or water carrier; shipments further downstream in the chain predominantly move by truck.

8.1.6.1 Trucking. Gasoline trucking firms can be separated into three categories: (1) "private carriage," major oil companies owning gasoline transport vehicles; (2) "common carriage," firms providing transportation services to major oil companies; and (3) "jobber entities," independent firms transporting petroleum products, but are also involved in some other aspect of the petroleum marketing business such as owning bulk plants or service stations. Data on trucking characteristics are available from the U.S. Census' Truck Inventory and Use Survey for two relevant categories: petroleum shipments and tank trucks (liquids or gases). Table 8-13 displays the Census data characterizing the liquid/gas tank truck fleet in both 1982 and 1987. The median age of tank trucks was 8-9 years in 1987, compared to 7-8 years in 1982.

Both the PMAA's Marketer Profile Survey and an unpublished 1983 Census study conclude that the primary means of moving gasoline from terminal to bulk plant to customer was by truck. The number of transport trucks owned by independent marketers rose from 14,593 in 1987 to 19,630 in 1989; the per-marketer average increased from 1.4 transports in 1987 to 1.8 in 1989.[50] PMAA's survey also found that independent marketer use of common carriers continued to increase in 1989, but that most marketers continue to transport the bulk of their own sales volume.[47]

8.1.6.2 Pipelines. Most of the available data for pipeline movement includes all petroleum products and crude oil. The Federal Energy Regulatory Commission (FERC) requires common carrier, interstate pipelines to file annual reports on total

TABLE 8-13. LIQUID/GAS TANK TRUCK CHARACTERISTICS IN 1982 AND 1987

	1987	1982
Total Number	213,000	241,600
	Percentage of Total	Percentage of Total
Major Use		
Retail Trade	24	25
For-hire Transportation	16	16
Wholesale Trade	15	14
Others	45	44
Range of Operation		
Local	63	65
Short-range (<200 miles)	22	19
Off-road	8	11
Long-range (>200 miles)	7	5
Model Year		
Approximate median	1978/1979	1974/1975
Operator Classification:		
Not for-hire	84	83
For-hire	16	17
Motor carrier	12	14
Owner/operator	4	3
Operator Classification: (continued)		
For-hire jurisdiction		
Interstate	46	53
Intrastate	41	30
Local	12	16
Products Carried:		
Petroleum	56	71
Chemicals	15	20
Others	29	10
Truck Fleet Size:		
1	16	18
2 to 5	25	23
6 to 19	34	28
20 or more	26	30

petroleum products deliveries and total product pipeline mileage. In 1989 these companies comprised 79,624 miles of products pipeline and 4.85 billion barrels (771 billion liters) of petroleum product deliveries. These figures represent declines from 1988, which showed 80,264 miles of products pipeline and 4.97 billion barrels (790 billion liters) of products deliveries.

Table 8-14 displays data on the top 10 pipeline companies in 1988 for two categories: petroleum product deliveries and products trunkline mileage owned and operated. Pipelines are joint ventures involving several (usually large and well-integrated) companies.

The FERC does collect limited data characterizing profitability in the overall liquids pipeline industry. In 1989, for only the second time since figures have been collected, net income as a percentage of operating income declined from the previous year from 36.5 percent in 1988 to 34.2 percent. In 1978 net income was 21.9 percent of operating income.

8.1.7 Gasoline Distribution Industry: Retail and Consuming Sectors

8.1.7.1 Industry Employment and Sales. There is no comprehensive source of employment data for gasoline retailing. The Bureau of the Census collects data only for payroll gasoline service stations that receive 50 percent or more of their revenue from automotive fuels or lubricants. Table 8-15 displays historical Census data on the number of stations, total sales, and employment in gasoline service stations that fit the Census definition. In addition to the 701,690 people employed by service stations, at least an additional 22,432 were employed in the non-payroll stations counted by the Census in 1987. The

TABLE 8-14. RANKINGS OF MAJOR PETROLEUM PRODUCTS PIPELINE COMPANIES[51]

The Top 10 Liquid Pipelines in Product Deliveries--1988		
Company	Product Deliveries (thousand of bbl)	Product Deliveries (thousand of liters)
Colonial Pipeline Co.	635,620	101,044,511
Santa Fe Pacific Pipeline Partners LP	315,300	50,123,241
Buckeye Pipeline Co. LP	284,536	45,232,688
Chevron Pipeline Co.	247,955	39,417,406
Marathon Pipeline Co.	238,129	37,866,367
Phillips Pipeline Co.	222,775	35,414,542
Plantation Pipeline Co.	189,000	30,045,330
Explorer Pipeline Co.	174,143	27,683,513
Williams Pipeline Co.	173,576	27,593,377
Mid-America Pipeline Co.	162,909	25,897,644

The Top 10 Liquid Pipelines in Miles of Products Pipeline Owned/Operated--1988	
Company	Mileage
Mid-America Pipeline Co.	8,082
Williams Pipeline Co.	6,775
Colonial Pipeline Co.	5,274
Phillips Pipeline Co.	4,192
Chevron Pipeline Co.	3,385
Texas Eastern Products Pipeline	3,373
Buckeye Pipeline Co. LP	3,289
Santa Fe Pacific Pipeline Partners LP	3,174
Plantation Pipeline Co.	3,146
ARCO Pipeline Co.	2,831

TABLE 8-15. TRENDS IN CENSUS BUREAU-DEFINED SERVICE STATIONS[a]

			Number of Stations					Sales		
Year	No. of Service Stations[b]	Percentage Decline from Previous Period	Percent Company-Owned	Percent Franchisee-Owned	Sales (in millions of $)	Percentage Increase from Previous Period	Sales Per Station ($)	Percent Company-Owned	Percent Franchisee-Owned	Employment
1972	226,459		20.0	80.0	31,880		140,774	20.2	79.8	747,668
1977	176,465	-22	19.1	80.9	56,468	77	319,996	20.0	80.0	672,673
1982	144,690	-18	18.0	82.0	106,200	88	733,983	18.0	82.0	604,286
1987	115,870	-20	18.1	81.9	89,200	-16	769,828	18.6	81.4	701,690
1990[c]	112,749	-3	18.0	82.0	115,145	29	1,021,252	18.0	81.1	N/A

[a]Census Bureau defines gasoline service stations as retail outlets receiving at least 50 percent of their revenues from automotive fuels and lubricants.

[b]Number of stations at end of year.

[c]Number of stations estimated based on 1987 to 1990 percentage change calculated from values in NPN Factbook for peak number of stations in business in both years. Sales data for 1990 are from International Franchising Association's Franchising in the Economy 1988-1990.

N/A: Not available.

U.S. has approximately 70,000 convenience stores, of which about 65 percent of them sell gasoline.[52]

8.1.7.2 Retail Motor Outlets and End Users. Retailing of gasoline takes place at traditional gasoline service stations, car washes, automobile dealers, and convenience grocery and liquor stores. Retail motor outlets provide a wide array of product and service mixes to consumers. MPSI Americas, Inc., divides the retail motor outlet population into four major categories: conventional stations, pumpers, convenience stores, and other. Conventional service stations have service bays for automobile maintenance and repairs. The other three categories do not have service bays. Pumpers are large-volume self-service sellers providing few, if any, of the traditional service station services. Convenience stores are differentiated from the other three types by the larger amount of floor space provided for the display of food and other convenience items. The "other" category includes outlets of any type that have other facilities, such as a car wash, or a quick oil change and tune-up facility.

Table 8-16 shows the 1987 and 1989 market share breakdowns of the number of outlets and gasoline volume by retail outlet type and U.S. region. One obvious trend that the data show is that average store volumes are increasing, which corroborates the Census data presented earlier. The data also show that service stations and "others" have decreased in market share in both numbers of stations and volume, while pumpers and convenience stores have increased in market share in numbers and volume.

Table 8-17 shows some of the trends in convenience store retailing of gasoline. Convenience store gasoline sales have increased from approximately $20.6 billion in 1987 to $27.1 billion in 1989. Various end users of gasoline, including industry, commercial and government fleets, agriculture,

TABLE 8-16. REGIONAL AND NATIONAL MARKET SHARES BY RETAIL OUTLET TYPE[a]: 1987 AND 1989[53,54]

	Total		Service Stations		Pumpers		C-Stores		Others	
	1989	1987	1989	1987	1989	1987	1989	1987	1989	1987
Northeast										
Percent of Outlets	100.0	100.0	61.0	58.7	21.7	24.4	6.2	5.2	11.1	11.7
Percent of Volume	100.0	100.0	55.9	52.4	38.5	41.7	3.4	2.9	2.2	3.0
Avg. Monthly Volume (gal)	69,996	63,375	64,132	58,914	123,818	124,883	38,591	37,808	14,252	16,766
Avg. Monthly Volume (L)	264,935	239,874	242,740	222,989	468,651	472,682	146,067	143,103	53,944	63,459
Midwest										
Percent of Outlets	100.0	100.0	36.0	39.0	44.2	39.9	8.3	8.6	11.5	12.5
Percent of Volume	100.0	100.0	27.9	32.6	62.5	58.1	6.8	6.0	2.8	3.3
Avg. Monthly Volume (gal)	76,256	72,751	59,197	59,152	107,771	105,714	43,077	46,202	18,327	19,059
Avg. Monthly Volume (L)	288,629	275,363	224,061	223,890	407,913	400,127	163,046	174,875	69,368	72,138
Sunbelt										
Percent of Outlets	100.0	100.0	24.4	27.2	32.6	30.0	32.2	30.2	10.8	12.6
Percent of Volume	100.0	100.0	23.5	26.8	57.1	54.0	16.0	15.2	3.4	4.0
Avg. Monthly Volume (gal)	58,173	57,916	55,943	57,045	101,915	N/A	28,934	28,995	18,176	18,646
Avg. Monthly Volume (L)	220,185	219,212	211,744	215,915	385,748	N/A	109,515	109,746	68,796	70,575
Western										
Percent of Outlets	100.0	100.0	45.8	52.9	34.1	31.9	11.9	7.1	8.2	8.9
Percent of Volume	100.0	100.0	45.2	45.1	47.5	48.3	5.3	4.3	2.0	2.3
Avg. Monthly Volume (gal)	81,352	69,515	65,056	56,100	120,367	114,870	38,188	36,850	20,987	20,907
Avg. Monthly Volume (L)	307,917	263,114	246,237	212,339	455,589	434,783	144,542	139,477	79,436	79,133
Total U.S.										
Percent of Outlets	100.0	100.0	39.8	43.7	32.3	29.6	17.4	15.2	10.5	11.5
Percent of Volume	100.0	100.0	37.7	40.9	51.2	48.7	8.5	7.2	2.6	3.2
Avg. Monthly Volume (gal)	70,023	65,079	61,669	56,983	110,898	112,106	33,948	31,780	17,631	18,656
Avg. Monthly Volume (L)	265,037	246,324	233,417	215,681	419,749	424,321	128,493	120,287	66,733	70,613

N/A-Not available

[a]Data are primarily from metropolitan areas of the U.S. where most gasoline is marketed; no attempt was made to count rural vendors or highway units, which do not add significantly to overall consumption.

TABLE 8-17. TRENDS IN CONVENIENCE STORE GASOLINE RETAILING[55,56]

Year	No. of C-Stores	Percentage of Stores Selling Gasoline	Gasoline Sales ($$10^6$)	Gasoline Sales Per Store ($$10^3$)	Gasoline Margin as a Percentage of Sales	Non-Gasoline Margin as a Percentage of Sales	Investment for New Store ($)	
							Urban	Rural
1982	50,000	49	9,865	197	4.5	30.1	417,200	272,200
1987	67,500	56	20,600	305	10.6	35.9	682,800	517,400
1988	69,200	N/A	22,000	318	11.5	36.4	773,300	532,700
1989	70,200	65	27,100	386	N/A	N/A	918,700	571,500

N/A: Not available.

aviation, and marine users, buy from the wholesale gasoline market. In 1989, less than 3 percent of gasoline was consumed by these sectors. Except for aviation gasoline facilities, no recent data are available for these "bulk-users" of gasoline, other than the data presented in Table 8-2 on the amount of gasoline consumed.

8.1.7.3 Economic Agents. As with the wholesale sector, a myriad of participants and relationships exist at the retail level. Retailers of gasoline may be single-site dealers, operators of retail chains, jobbers, small refiners, or large, integrated oil companies.

> Combinations of ownership may also occur. For example, a landowner may lease property to an oil company which then builds a station and subleases the property to a dealer. Also, a third party may lease a station to a wholesaler who in turn subleases to a dealer or operates the station directly. These are but a few of the more common combinations of ownership.[57]

Service station operation methods are also diverse. The operator of a retail outlet is typically an independent entrepreneur operating one or more outlets.

> The retail outlet operator is usually not an employee of an oil company; refiners typically operate terminals with salaried personnel, but contract with independent wholesalers and retailers to operate bulk plants and retail gasoline outlets.[57]

Many wholesalers own the land, buildings, and storage tanks at their bulk plants, and many also own retail outlets, which the wholesalers operate directly or lease to dealers.

8.1.7.4 Number of Retail Establishments. Figure 8-8 presents estimates from Lundberg Survey, Inc., of the total

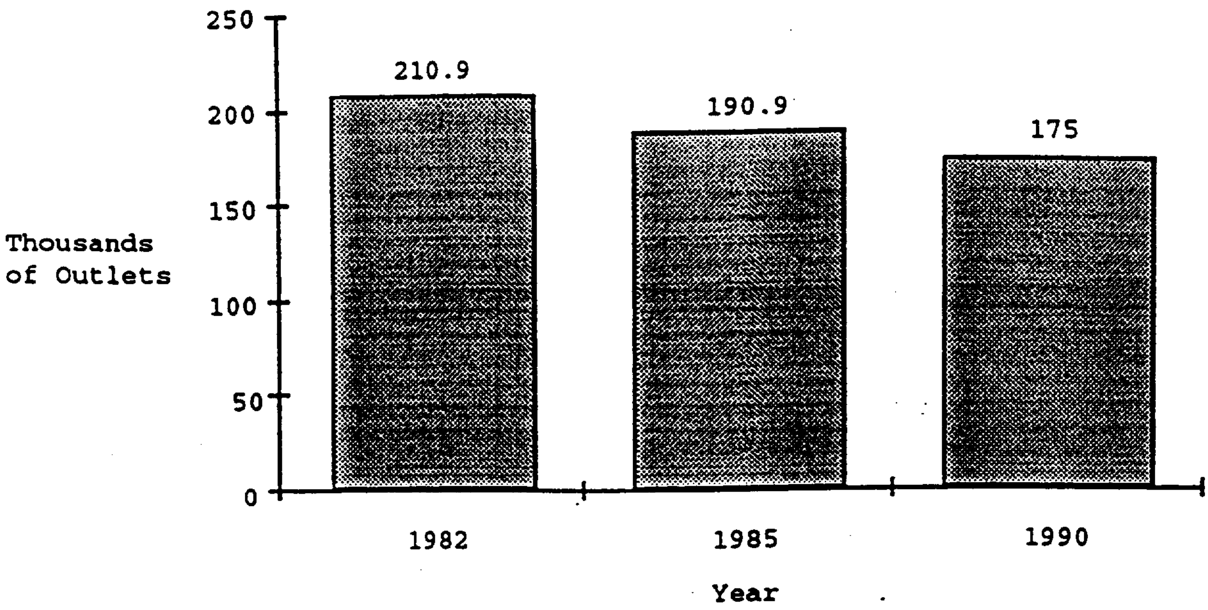


Figure 8-8. Estimated Number of Retail Gasoline Outlets--1982, 1985, 1990[58,59]

number of retail gasoline outlets for selected years. The Lundberg Letter estimated 210,900 outlets for 1982 and 190,900 outlets for 1985. API and Lundberg Survey, Inc. independently estimated the current number of retail gasoline outlets to be 175,000. A recent article from NPN estimates the total number of retail outlets at 210,000.[60]

A series of gasoline distribution changes have led to the decline in the number of stations over the past two decades:

- Changing consumer preferences and station cost increases have altered the economic scale of gasoline retailing. As a result, the market requires fewer gasoline stations to service demand.

- Gasoline demand growth has dropped substantially below the levels of the 1960s and early 1970s. As a result, the widespread retail gasoline distribution systems of many refiners, built in the expectation of strong growth, no longer seem likely to afford attractive returns on investment.

- Refiners have attempted to improve their levels of profitability and have moved to focus their resources in their most profitable business activities. As a consequence, many refiners have sold or closed stations, sometimes in groups containing all the stations owned by a particular refiner in a multistate region.[61]

8.1.7.5 Presentation of Census Data. The 1987 Census of Retail Trade's Merchandise Line Sales provides data on sales of "automotive fuels." These data show that nearly 93 percent (over $81 billion) of automotive fuel sales at the retail level are from gasoline service stations. The Census data show eight other detailed SIC industries that retail gasoline; however, only one, grocery stores, has more than 2 percent of all automotive fuel sales. Data available from the National Association of Convenience Stores 1990 State of the Convenience Store Industry show that gasoline sales alone at convenience stores in 1990 totalled $27.1 billion (total industry sales were $67.7 billion).[55] These 1990 figures show that gasoline sales made up 40 percent of total convenience store sales, up from 34 percent in 1987.[62]

8.1.7.6 Establishment and Firm Size. Table 8-15 shows total sales per Census-defined service station increasing from approximately $140,000 in 1972 to over $1 million in 1990. Other Census data presented in that table show that service stations owned and operated by oil companies represented a slightly smaller share of both total sales and total stations in 1990 than in 1972.

8.1.7.7 Ownership and Concentration. Table 8-18 shows recent trends in concentration for public service stations with payroll. These data show increased concentrations between 1982 and 1987 by the largest firms. Because these figures do not include non-payroll stations, they overrepresent the total market shares of the largest firms in the industry.

8.1.7.8 Financial Ratios. Financial data and ratios for gasoline service stations are also available from Dun and Bradstreet's Industry Norms and Key Business Ratios and Robert Morris Associates' Annual Statement Studies. "Common-size" balance sheet and income statement data are presented along with key business ratios on solvency, efficiency, and profitability. Table 8-19 shows three commonly used financial ratios for SIC 5541. For 1990, the median return on net worth was 15.3, or about 50 percent higher than the wholesale median firms' return on net worth.

TABLE 8-18. CONCENTRATION BY LARGEST FIRMS, 1982-1987: SIC 5541--PUBLIC SERVICE STATIONS[63,64]

Category	1982 Percentage of Establish-ments	1987 Percentage of Establish-ments	1982 Percentage of Total Sales	1987 Percentage of Total Sales
4 Largest Firms	3.3	3.9	6.4	7.1
8 Largest Firms	5.4	6.4	10.3	11.0
20 Largest Firms	8.9	11.2	17.5	18.5
50 Largest Firms	12.8	16.0	24.4	25.1
Total	116,188	114,748	$94,718,664	$101,997,440

Note: Data are only for service stations with payroll.

TABLE 8-19. TRENDS IN FINANCIAL PROFITABILITY RATIOS: 1987, 1989, 1990 SIC 5541--GASOLINE SERVICE STATIONS[34-36]

	Return on Sales[a]			Return on Assets[b]			Return on Net Worth[c]		
Quartile	1990	1989	1987	1990	1989	1987	1990	1989	1987
Upper	4.5	4.5	4.9	16.5	15.7	17.6	35.9	32.7	41.1
Median	2.0	1.9	2.4	7.5	6.8	8.3	15.3	13.3	15.9
Lower	0.5	0.6	0.8	1.7	2.2	2.8	4.1	5.3	5.5

[a]Profits earned per dollar of sales.
[b]Indicates how well a firm has used its assets for making a profit.
[c]Measures the rate of return on owner's equity (stockholder's investment).

8.2 ESTIMATES OF BASELINE YEAR CONDITIONS

The economic impact analysis represents conditions in the fifth year after promulgation of the regulation, or calendar year 1998. To determine the changes due to the regulation, baseline prices and quantities must first be estimated. The baseline is defined as those quantities and prices that would be expected in 1998 in the absence of the regulation.

8.2.1 Baseline Estimate of Gasoline Consumption

Estimating gasoline consumption in the baseline year is difficult because of the instability of crude oil supplies and the many institutional and technical changes occurring during this decade. The Department of Energy's Energy Information Administration (EIA) has made long-term forecasts of future gasoline prices and consumption.[65] In its consumption forecast, EIA allows for both increases and decreases in the demand for gasoline due to growth in the nation's incomes and population and to improved fuel efficiency and penetration of the transportation fuels market by alternatives to gasoline. EIA calculates gasoline consumption projections for four scenarios: low oil price, high economic growth, high oil price, and "reference."

Under these scenarios, projections for the annual percentage growth rate in gasoline consumption between 1989 and 2010 range from approximately 0.1 to 1.1 percent. The "reference" scenario represents a mid-range estimate of .5 percent per year. Applying the reference case's growth rate to 1989 consumption of 426.7 billion liters (112.7 billion gallons)[2] yields an estimate of baseline 1998 gasoline consumption of 446.3 billion liters (117.9 billion gallons). Nearly all of this, approximately 444.7 billion liters, is motor gasoline; only 1.6 billion liters are aviation gasoline.

8.2.2 <u>Baseline Estimates of Gasoline Price and Margins</u>

Gasoline prices at the retail level have varied a great deal during the 1980s, as previously shown in Table 8-3. EIA has forecast that over the period 1989-2010, the real price of gasoline (i.e., price with effect of inflation removed) should increase 43 percent, an annual percentage growth rate of 1.7 percent. Applying this 1.7 growth rate to the July 1990 price (adjusted for the 1990 federal tax increase) yields an estimated price of $.357 per liter ($1.35/gallon) of gasoline in 1998.

Wholesale and retail pricing margins are volatile and no forecasts of future wholesale or retail margins have been located. Most qualitative discussions of gasoline margins in the future have predicted tighter margins in the short run due to the cost of complying with environmental regulations (especially underground storage tank regulations). Ultimately, however, the margins must cover all costs of production and will probably increase in absolute terms. In the absence of additional quantitative data or estimates, however, the margins developed in Section 8.1.3.2 are assumed to be representative of the margins for gasoline in the baseline year.

Table 8-20 displays the estimated 1998 throughput levels and pricing margins for the key points in the U.S. gasoline distribution system. Data were not developed for particular entities in the marketing chain if they were unnecessary for the impact analysis.

8.2.3 <u>Estimation of Baseline Year (1998) Parameters</u>

Regulatory and economic forces have brought about significant changes in gasoline distribution and marketing over the last twenty years. For example, the number of bulk plants declined 57 percent between 1972 and 1982.[66] Therefore, estimating the number and distribution of facilities within an

TABLE 8-20. 1988 THROUGHPUT LEVELS AND PRICING MARGINS

Entity	Throughput (billion liters)			Margin ($/liter)
	Motor Gasoline	Aviation Gasoline	Total Gasoline	
Refinery	444.7	1.6	446.3	—
Exports	—	—	4.4	—
Pipeline from Refinery	—	—	—	0.008
Bulk Terminal	—	—	441.9	0.005
Rail from Terminal	—	—	6.2[a]	—
Truck from Terminal	—	—	441.9[b]	0.007
Bulk Plant	79.2	1.4	80.6	0.005
Truck from Bulk Plant	79.2	1.4	80.6	0.007
Service Station[c]:				
Public	382.4	0.2	382.6	0.013
Private	57.9	0.0	57.9	0.013
Total	440.3	0.2	440.4	0.013

— Value was not estimated because it is not necessary for regulatory analysis.

[a] Throughput by rail from terminal estimated based on unpublished 1983 Bureau of the Census study showing 1.4 percent of shipments from SIC 5171 using rail.

[b] Assumed all shipments eventually go by truck (i.e., rail shipments represent terminal to terminal shipments).

[c] For aviation gasoline facilities, these terms are defined as follows: "Bulk plants" are airport storage facilities that require trucks to dispense gasoline into planes; "service stations" are airport facilities that pump aviation gasoline into planes directly from underground tanks.

industry sector is challenging. No projections are publicly available, but historical data illustrate some of the trends.

The general method used to estimate the baseline number and distribution of facilities involved the following three steps:

1. Estimate the total number of baseline facilities in an industry sector by regressing historic facility data against time.

2. Estimate the number of facilities by facility size category in each industry sector using historic sales and capacity data while controlling to baseline levels of consumption.

3. Reconcile the differences in estimates of the total number of facilities made in steps 1 and 2 while maintaining the relative distribution of facilities by size estimated in step 2.

The Economic Impact Analysis contains a detailed description of the data and procedures used to complete steps 1 and 2 above for each industry sector.[67]

Tables 8-21, 8-22, and 8-23 present the results of the initial estimation (step 2) of facility populations and distribution of model plants within facility categories for the baseline year. Values in these tables have been rounded because these numbers are projections.

8.2.4 Final Estimates of the Number of Facilities in the Baseline Year.

Initial estimates of the total number of facilities in 1998 were adjusted to account for the throughput distributions and for total estimated 1998 consumption. The number of bulk terminal facilities calculated from the Census-derived model plant distribution and estimated 1998 throughput is approximately 1,020. This figure is comparable to the estimate of 1,174 terminals in 1998 derived from the regression estimate of Step 1.

TABLE 8-21. ESTIMATED DISTRIBUTION OF MODEL PLANTS FOR MOTOR GASOLINE BULK PLANTS, 1998[a]

Model Plant[b]	Average Model Plant Annual Throughput (liters)	Percentage of Throughput	Approximate Estimated Throughput (millions of liters)	Approximate Number of Facilities	Estimated Percentage of Facilities
2	3,405,000	13	9,900	2,900	31
3	7,380,000	35	28,000	3,800	40
4	14,190,000	37	29,600	2,100	22
5	19,305,000	15	11,700	600	7
Total		100	79,200	9,400	100

[a]Estimate of 1998 total gasoline throughput through motor gasoline bulk plants = total motor gasoline consumption in 1998 (444 billion liters) minus one percent of that total that is exported, multiplied by the percentage that approximates the number of bulk plants in 1998 (9,227). This calculation results in an estimate of 18 percent of total domestic consumption of motor gasoline passing through motor gasoline bulk plants in 1998.

[b]Model plant 1 for bulk plants represents all aviation gasoline bulk plants at airports.

TABLE 8-22. ESTIMATED DISTRIBUTION OF MODEL PLANTS FOR BULK TERMINALS, 1998

Model Plant	Average Model Plant Annual Throughput (liters)	Percentage of Total Number of Facilities	Approximate Number of Facilities[a]	Estimated Throughput (millions of liters)	Percentage of Total Throughput
1	129,200,000	40	410	53,000	12
2	323,000,000	23	230	74,600	17
3	646,000,000	27	280	179,800	41
4	1,292,000,000	10	100	134,400	30
Total		100	1,020	441,900	100

[a] Total number of bulk terminals estimated based on terminal throughput in 1998 and the percentage distribution of the number of terminals estimated from the Bureau of the Census storage capacity data.

TABLE 8-23. ESTIMATED DISTRIBUTION OF MODEL PLANTS FOR MOTOR GASOLINE SERVICE STATIONS, 1998[a]

	Public Service Stations					Private Stations[b]				
Model Plant	Average Model Plant Annual Through-put (liters)	Percent-age of Total Through-put[c]	Approx-imate Estimated Through-put (millions of liters)[d]	Approx-imate Number of Facili-ties[e]	Percent-age of Facili-ties	Percent-age of Facili-ties	Number of Facili-ties	Estimated Through-put (millions of liters)	Total Estimated Through-put (millions of liters)	Percent-age of Total Estimated Through-put
1	91,200	<1	60	650	<1	90.0	189,200	17,200	17,300	4
2	276,000	3	9,800	35,500	20	--	--	--	9,800	2
3	912,000	11	40,200	44,100	25	4.1	8,600	7,800	48,000	11
4	1,584,000	18	68,700	43,400	25	3.5	7,400	11,700	80,400	18
5	2,952,000	25	94,800	32,100	18	1.9	4,000	11,800	106,700	24
6	8,400,000	44	168,800	20,100	11	0.5	1,100	9,200	178,000	40
Total		100	382,400	175,850	100	100.0	210,300	57,900	440,300	100

[a]In addition to this distribution developed from Census data, 1,600 aviation gasoline service stations with total annual throughput of 172 million liters are estimated for 1998.

[b]Source of private service station data is A.D. Little, Inc.'s 1978 report, The Economic Impact of Vapor Recovery Regulations on the Service Station Industry.

[c]Distribution calculated from an average of the distribution calculated from Census sales data for 1987 for payroll stations, and a previous EPA public service station distribution (see Reference 101).

[d]Total throughput through public stations is estimated by subtracting total service station throughput (estimated to be 99% of total motor gasoline consumption) by the amount of gasoline passing through private stations.

[e]Distribution of total throughput by model plant is calculated by applying model plant throughput percentages to total public service station throughput.

The throughput-derived estimate of the number of public stations in 1998 is approximately 175,000, while the double-log regression estimate is approximately 145,000 public stations. There is a significant difference between the two projections. The 175,000 throughput-derived figure is used in this analysis because this represents a conservative estimate of the public service station population.[67] Use of this estimate will therefore tend to overestimate the costs of the regulation.

Over the past two decades, the percentage of terminal throughput that passes through bulk plants has declined significantly (see Figure 8-6). Because this trend is expected to continue into the near future, the percentage of terminal throughput passing through bulk plants in 1998 is estimated using the Census-derived distribution of model plants and the number of facilities estimated by the double-log regression of the number of bulk plants. A percentage of the terminal throughput figure was selected that most closely approximated the 9,227 bulk plants calculated from the regression (an 18 percentage throughput figure yields approximately 9,400 bulk plants in 1998).

Twenty railcar-loading terminals are estimated for the baseline year based on estimated 1998 throughput. Applying 1983 data representing the percentage of total shipments from SIC 5171 that go by rail (1.4 percent)[68] to total estimated terminal throughput in 1998 (441.9 billion liters), results in an estimate of 6.2 billion liters of gasoline moved by rail in the baseline year. The number of railcar-loading terminals was then estimated based on one identified railcar model plant.[69] Throughput for that plant was divided by 1998 estimated total railcar throughput to estimate 20 railcar loading terminals in 1998. Because only one model railcar plant represents this small sector of the gasoline marketing system, a model plant distribution is not required.

Delivery of gasoline in 1998 is expected to take place using an estimated 87,700 tank trucks. (Of these, 81,300 trucks deliver to bulk terminals and motor gasoline bulk plants; only 6,400 trucks deliver aviation gasoline. The 81,300 estimate is derived from a two-stage process. First, data available on the number of gasoline tank trucks (not including aviation gasoline trucks used at airports) from a 1979 report[70] were updated to 1987 using the 1977 to 1987 ratio of total "liquid/gas tank trucks" available from the Bureau of the Census (236,000:213,000).[71] This calculation results in an estimated 76,400 tank trucks used in gasoline service in 1987. Next, the ratio of 1987 gasoline tank trucks to total 1987 gasoline consumption was calculated and applied to 1998 estimated total gasoline consumption. This method results in an estimated 81,300 tank trucks used in gasoline delivery in 1998.

The distribution of these 81,300 tank trucks between private and common carriers and between bulk terminals and bulk plants is discussed in Section 5.1.4. The 1979 report characterizing gasoline tank trucks does not account for trucks used by airports for delivery of aviation gasoline into airplanes. An additional 6,400 tank trucks are estimated to deliver aviation gasoline into planes at airports based on the 1990 number of aviation gasoline bulk plants (3,200)[72] and an estimate of two tank trucks per aviation bulk plant.[73]

In addition to tank trucks owned by terminals and bulk plants, for-hire, or common carrier trucking companies transport gasoline. Section 5.1.4 discusses how the total number of for-hire tank trucks transporting gasoline in 1998 is estimated. A previously developed for-hire model firm characterization was used to develop the distribution of for-hire trucks between various size trucking firms.[74] This distribution provides a relationship between the number of trucks owned by firms and the number of people employed by those firms. The 1987 Census of

Wholesale Trade contains firm-level data characterizing employment and sales. The employment data from the Census for SIC 5172--Petroleum and Petroleum Wholesalers, except Bulk Stations and Terminals were matched with the data from the previously developed characterization to provide distributions of the number of for-hire gasoline trucking firms with particular fleet sizes and the distribution of throughput by truck fleet size. For-hire trucks used at terminals were estimated using Census data for "manufacturer sales branches," and data for "merchant wholesalers" were used to characterize trucks at bulk plants. The estimated distribution of for-hire gasoline trucking firms for 1998 is provided in Table 8-24.

The number of pipeline pumping stations in 1998 is estimated at 1,990. This estimate is derived from total products pipeline mileage (150,000)[75] and an estimate that a pumping station occurs about every 40 miles.[76] The number of pipeline break-out stations (270, of which 150 are located at points where the diameter of the pipe changes and 120 are located at pipeline branching areas) are estimated from a map displaying U.S. petroleum products' pipelines.[77] Because no data were available to trend these estimates to 1998, the number of these facilities is held constant between 1990 and 1998. For economic impact analysis purposes, pipeline facility throughput was apportioned across model plants based on the number of pipes for pumping stations and the number of storage tank "equivalent dedicated pumps" for break-out stations (see Tables 5-1 and 5-2).

Tables 8-25 and 8-26 display the final model plant throughput and model plant distributions estimated for each gasoline distribution entity in 1998.

8.2.5 New, Replacement, and Existing Capacity

The baseline conditions imply that changes in the industry sectors' capacity will occur over the period 1993-1998; industry

TABLE 8-24. 1998 FOR-HIRE GASOLINE TRUCKING FIRM CHARACTERISTICS[28,71,74]

	Terminal	Bulk Plant
Total Number of For-hire Tank Trucks	36,700	18,600
Throughput (million liters)	369,435	39,413
Throughput/Truck Ratio	10.1	2.1

Model Firm:	Firm 1	Firm 2	Firm 3	Firm 4	Total
Number of Tank Trucks per Model Firm	2	7	30	100	
Number of Employees per Model Firm	10	25	50	120	
Throughput Distribution for Terminals[a, b]	1.7%	9.4%	8.8%	80.1%	100.0%
Throughput Distribution for Plants[a, c]	16.4%	40.2%	16.9%	26.5%	100.0%
Terminals:					
Throughput (million liters)	6,373	34,656	32,460	295,947	369,435
Total Number of Model Firm Trucks	633	3,443	3,225	29,400	36,700
Number of Firms	317	492	107	294	1,210
Bulk Plants:					
Throughput (million liters)	6,476	15,838	6,657	10,442	39,413
Total Number of Model Firm Trucks	3,056	7,474	3,142	4,928	18,600
Number of Firms	1,528	1,068	105	49	2,750

[a]Census category of 10 to 19 employees is evenly divided between Model Firms 1 and 2.
[b]Based on distribution of firm sales per employment size for SIC 5172 manufacturer sales branches.
[c]Based on distribution of firm sales per employment size for SIC 5172 merchant wholesalers.

TABLE 8-25. MODEL PLANT THROUGHPUT BY FACILITY TYPE

Facility Type/Model Plant	Average Model Plant Throughput		Throughput Range Represented by Model Plant	
	Liters/Day	Gallons/Day	Liters/Day	Gallons/Day
Bulk Terminals:				
Model Plant 1	380,000	100,000	<757,000	<200,000
Model Plant 2	950,000	250,000	757,000-1,514,000	200,000-400,000
Model Plant 3	1900,000	500,000	1,514,000-2,271,000	400,000-600,000
Model Plant 4	3800,000	1,000,000	>2,271,000	>600,000
Bulk Plants:				
Model Plant 1	1,500	400	<2,500	<650
Model Plant 2	11,350	3,000	2,500-15,140	650-4,000
Model Plant 3	24,600	6,500	15,140-30,280	4,000-8,000
Model Plant 4	47,300	12,500	30,280-64,350	8,000-17,000
Model Plant 5	64,350	17,000	64,350-75,700	17,000-20,000
	Liters/Month	Gallons/Month	Liters/Month	Gallons/Month
Service Stations:				
Model Plant 1[a]	7,600	2,000	<19,000	<5,000
Model Plant 2	23,000	5,000	19,000-38,000	5,000-10,000
Model Plant 3	76,000	20,000	38,000-95,000	10,000-25,000
Model Plant 4	132,000	35,000	95,000-189,000	25,000-50,000
Model Plant 5	246,000	65,000	189,000-379,000	50,000-100,000
Model Plant 6	700,000	185,000	>379,000	>100,000

(continued)

TABLE 8-25. MODEL PLANT THROUGHPUT BY FACILITY TYPE (CONTINUED)

Facility Type/Model Plant	Average Model Plant Throughput		Throughput Range Represented by Model Plant	
	Million Liters/ Year	Million Gallons/ Year	Million Liters/ Year	Million Gallons/ Year
Railcar Loading at Bulk Terminals:				
Model Plant 1	322	85	--	--
	Billion Liters/ Year	Billion Gallons/ Year	Billion Liters/ Year	Billion Gallons/ Year
Pipeline Pumping Station:				
Model Plant 1	43.7	11.5	--	--
Model Plant 2	87.3	23.1	--	--
Model Plant 3	131.0	34.6	--	--
Pipeline Break-out Station:				
Model Plant 1	116.4	30.8	--	--
Model Plant 2	145.6	38.5	--	--

[a]Aviation gasoline facilities have average throughput of 9,200 liters/month (2,400 gallons/month).

TABLE 8-26. NUMBER OF FACILITIES BY MODEL PLANT

Facility Type	Model Plant Facilities						
	MP1	MP2	MP3	MP4	MP5	MP6	Total
Bulk Terminals	410	230	280	100	--	--	1,020
Bulk Plants:							
Aviation Gasoline	3,200	--	--	--	--	--	3,200
Motor Gasoline	--	2,900	3,800	2,100	600	--	9,400
Total	3,200	2,900	3,800	2,100	600	--	12,600
Service Stations:							
Motor Gasoline:	189,850	35,500	52,700	50,800	36,100	21,200	386,150
Private	189,200	--	8,600	7,400	4,000	1,100	210,300
Public	650	35,500	44,100	43,400	32,100	20,100	175,850
Aviation Gasoline	1,600	--	--	--	--	--	1,600
Total	191,450	35,500	52,700	50,800	36,100	21,200	387,750
Railcars Loading at Bulk Terminals:	20						20
Pipeline Pumping Stations:	1,250	1,250	1,250				3,750
Pipeline Break-out Stations:	150	120					270

growth implies that new capacity and new facilities will be constructed. At the same time, existing facilities will close as their equipment wears out and becomes obsolete. EPA has estimated the number of new, replacement, and existing facilities for 1998 based on industry sector growth, facility trends, and estimated equipment life.[69] A new facility is one that has been built to handle the increased output required of the industry over the impact period. A replacement facility is one that has been built or rebuilt during the period to replace worn-out or obsolete equipment. An existing facility is one that was operating in 1993 and continues to operate in 1998. The resulting estimates are shown in Table 8-27. These estimates provide a context for evaluating the economic impacts discussed in Section 8.3.

TABLE 8-27. ESTIMATED NUMBER OF NEW CAPACITY, REPLACEMENT CAPACITY, AND EXISTING FACILITIES

Sector	New Capacity	Replacement Capacity	Existing	Total
Pipeline Break-out Stations	10	30	230	270
Pipeline Pumping Stations	80	960	960	1,990
Bulk Terminals (loading racks)	40	490	490	1,020
Bulk Terminals (storage tanks)	40	110	880	1,020
Bulk Terminal Trucks	1,690	14,070	28,140	43,900
Bulk Plants (loading racks)	0	3,580	9,020	12,600
Bulk Plants (storage tanks)	0	570	12,030	12,600
Bulk Plant Trucks	0	12,440	31,360	43,800
Service Stations	9,540	40,740	337,450	387,730

Note: Figures may not add due to rounding.

8.3 ESTIMATION OF ECONOMIC AND FINANCIAL IMPACTS

Gasoline distribution in the United States represents a vertically integrated system that consists of several individual markets. Each market is affected by the supply and demand forces of interlinked markets. For example, refined gasoline combined with pipeline services provides "delivered gasoline" to the delivered gasoline market.

The cost of the additional equipment and services at several points in the distribution chain, creates incentives for producers and consumers in related markets to simultaneously adjust their production and consumption of gasoline marketing services. To evaluate the economic impacts requires an economic model that can estimate the price and quantity changes on all the distribution markets affected directly or indirectly by the regulation.

8.3.1 Market Interaction Model Summary

Figure 8-9 illustrates the key markets modeled to represent the gasoline distribution system. These particular markets are key for two reasons: they represent the different stages of the gasoline marketing system, and they reflect production activities that were considered for direct regulation during standard development. Markets in the model were also chosen to represent the major sectors involved in the marketing of gasoline in the U.S. The market interaction model assumes that all refinery gasoline moves by pipeline. This assumption may overstate market impacts because it prohibits substitution of other possible modes of transportation. Combining delivered gasoline and terminal equipment produces terminal storage services. Terminal storage services can, in turn, either be combined with terminal transportation services to provide retail-commercial gasoline for "large volume" (large throughput) outlets or gasoline for storage in bulk plants. The gasoline

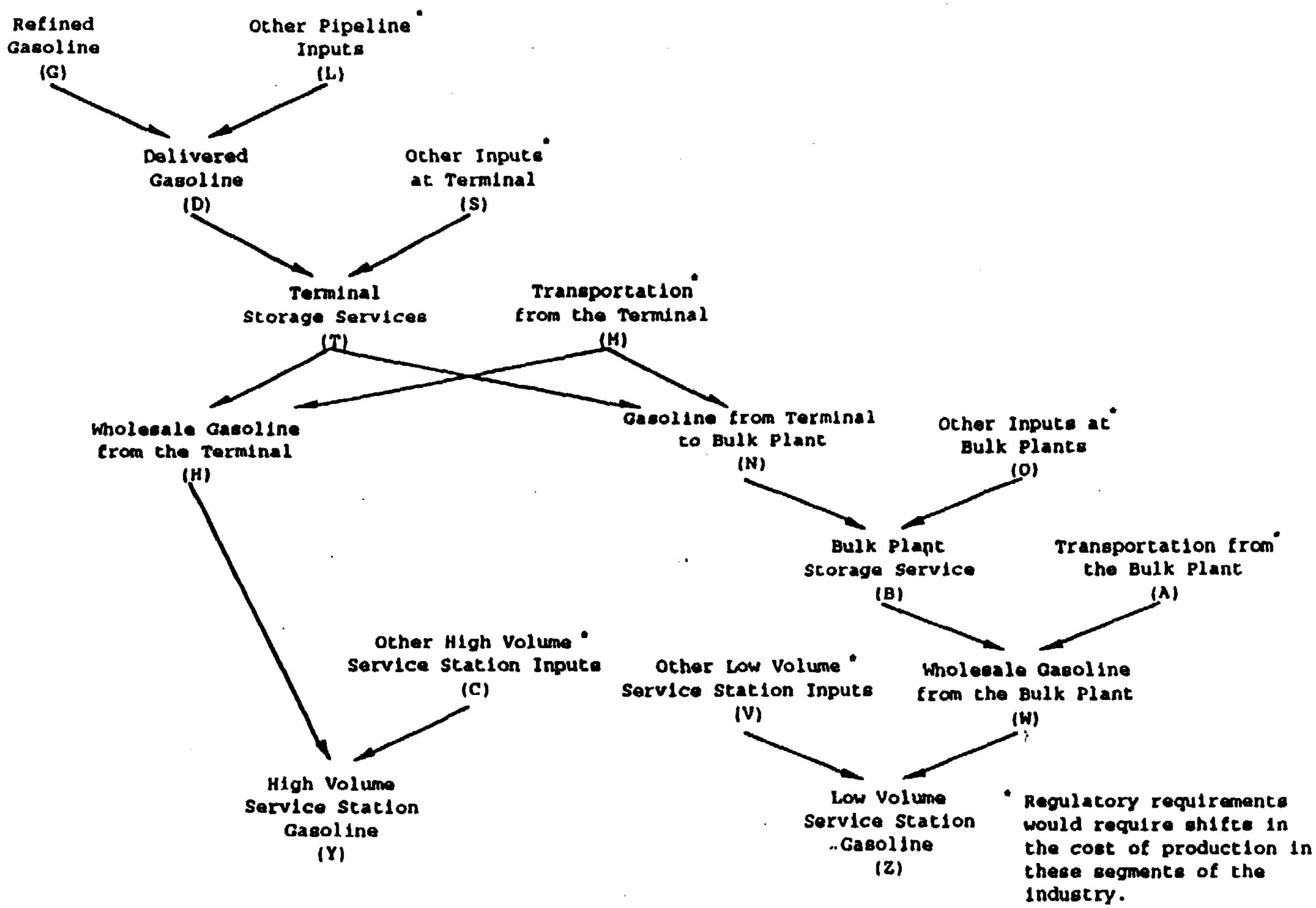


Figure 8-9. Gasoline Distribution: Factor and Product Flows

Note: Letters in parenthesis under each sector refer to the mathematical description in the Appendix of the Economic Impact Analysis. 67

from bulk terminals to be stored at bulk plants can be combined with bulk plant equipment to provide bulk plant storage services. Combining these services with bulk plant transportation services provides retail-commercial gasoline for small volume (small throughput) outlets.

These markets are represented mathematically as a system of thirty six linear equations based on Hicks' and Muth's work on specification of theoretically correct systems of demand and supply equations in linear form.[78,79] The coefficients of these equations represent the responsiveness of key product or service supply and demand schedules to shifts in the corresponding demand and supply, respectively. The variables of the model are proportionate changes in equilibrium prices and quantities of the markets modeled and the "right hand side" variables are the proportionate changes in market supply associated with the additional cost of meeting the requirements of the regulation. By specifying the supply shifts associated with the regulations, the model can be solved to find associated changes in price and quantity in all markets represented by the model. Applying these changes to baseline levels of price and quantity provides estimates of the market impacts of a proposed regulation. A detailed description of the model's structure and data is provided in the Economic Impact Analysis report.[67]

8.3.1.1 Estimation of Baseline Year Values and Model Parameters. Table 8-28 presents the estimated prices and quantities for the baseline year of analysis. As discussed in Section 8.2, baseline estimates of prices and quantities are forecasts and are subject to the usual forecasting uncertainties. Baseline year prices for each sector are estimated from the projected average retail price of gasoline in 1998 in 1990 price terms ($0.357 per liter; see Section 8.2.2 for the derivation of this price). Price margins for each sector are estimated in Section 8.1.3.2 from industry sources.

TABLE 8-28. ESTIMATED BASELINE YEAR PRICES AND QUANTITIES

Commodity	Quantity (in billions of liters)	Price (in $/liter)
Refined Gasoline	441.8	0.322
Other Pipeline Inputs	441.8	0.008
Delivered Gasoline	441.8	0.330
Other Inputs at Terminals	441.8	0.005
Terminal Storage Services	441.8	0.335
Terminal Storage Services--Input to Wholesale Gasoline from Terminal	362.3	0.335
Terminal Storage Services--Input to Gasoline from Terminal to Bulk Plant	79.5	0.335
Transportation Services from the Terminal	441.8	0.007
Transportation Services from the Terminal--Input to Wholesale Gasoline from Terminal	362.3	0.007
Transportation Services from the Terminal--Input to Gasoline from Terminal to Bulk Plant	79.5	0.007
Wholesale Gasoline from Terminal	362.3	0.342
Gasoline from Terminal to Bulk Plant	79.5	0.342
Other Inputs at Bulk Plants	79.5	0.005
Bulk Plant Storage Services	79.5	0.347
Transportation Services from the Bulk Plant	79.5	0.007
Wholesale Gasoline from the Bulk Plant	79.5	0.354
Other Low Volume Service Station Inputs	79.5	0.013
Low Volume Station Gasoline	79.5	0.367
Other High Volume Service Station Inputs	362.3	0.013
High Volume Station Gasoline	362.3	0.355

Commodity Market Shares	Percentage of Total Volume (%)
Terminal Transportation Services--Input to Wholesale Gasoline from Terminal	82
Terminal Transportation Services--Input to Gasoline from Terminal to Bulk Plant	18
Terminal Storage Service--Input to Wholesale Gasoline from Terminal to Bulk Plant	82
Terminal Storage Service--Input to Gasoline from Terminal to Bulk Plant	18

These margins are subtracted from the retail price of gasoline in 1998 (in 1990 dollars) to compute the price of gasoline as it leaves each sector. Because federal and state gasoline taxes are assessed at several different points in the system but primarily at the refinery (typically for federal taxes), no attempt was made to net taxes out with the other operating margins. Industry quantities for 1998 are estimated based on total projected gasoline consumption, calculated in Section 8.2.1, and on historical trends in shares for each of the industry sectors. The model requires certain "elasticity" parameters to represent the conditions and interrelationships in the U.S. gasoline market. For example, it is necessary to develop an estimate of how responsive gasoline consumers are to changes in the price of gasoline. That is, for a given price change, what is the effect on the quantity of gasoline consumed? This relationship is called the own-price elasticity of demand. The Economic Impact Analysis report presents the estimated values for these parameters.[67] The parameter values were selected to represent nonvolatile economic relationships. For example, it is assumed that producers are severely limited in their ability to alter the mix of each product's inputs (i.e., the elasticities of substitution are very small).

8.3.1.2 Impacts of Regulatory Supply Shifts. Shifts in market supply due to the proposed regulations will initially take place at three points in the gasoline distribution industry. These supply shifts are estimated based on the control costs presented in Chapter 7 for regulatory alternatives IV, IV Q, and IV M. These are the regulatory alternatives examined in this economic analysis because they control major emission sources only. The correct control costs to use depends on the level of control consistent with the regulatory alternative and the "marginal" facility being controlled.

The marginal facility is that establishment whose production costs (including a "normal" profit) equal the price that consumers are willing to pay for the last unit of gasoline consumed. Thus, the marginal facility provides the supply at the point where the supply and demand schedules intersect. This is depicted in Figure 8-10 for a hypothetical supply and demand schedule for the market for Other Inputs at Terminals. Before regulation, the supply of these services is S^0 and the demand is D^0. S^0 is a short run supply schedule (existing firms will produce so long as they cover their fixed costs), but it also reflects the willingness of new firms to enter the market and provide additional capacity at price P^0. The new firms comprise the marginal firms in this market over this period. If existing firms attempted to raise the price higher than P^0, new firms will enter the market and bid away the business of existing firms. Such market conditions are particularly likely in "transition" industries characterized by technical or institutional changes that affect the long run cost of production.[80] In this setting, then, the economic impact will depend on the minimum control cost needed to meet the regulation required of new firms.

The imposition of the regulation will cause facilities' production costs to rise equal to the additional cost of complying with the regulation. The market impact of the regulation is depicted in Figure 8-10 by a new supply curve such as S^1. Holding post-regulatory demand constant, the new price and quantity for retail gasoline is determined by the intersection of the post-regulatory supply function, S^1, and the demand function D^0. Given the perspective that the marginal firm is best represented by new firms, this analysis bases the relevant shift from S^0 to S^1 in this analysis on the cost of control at new facilities. To emphasize that this is likely to be different from the control costs of existing facilities, we show the downward sloping segment of the new supply schedule as

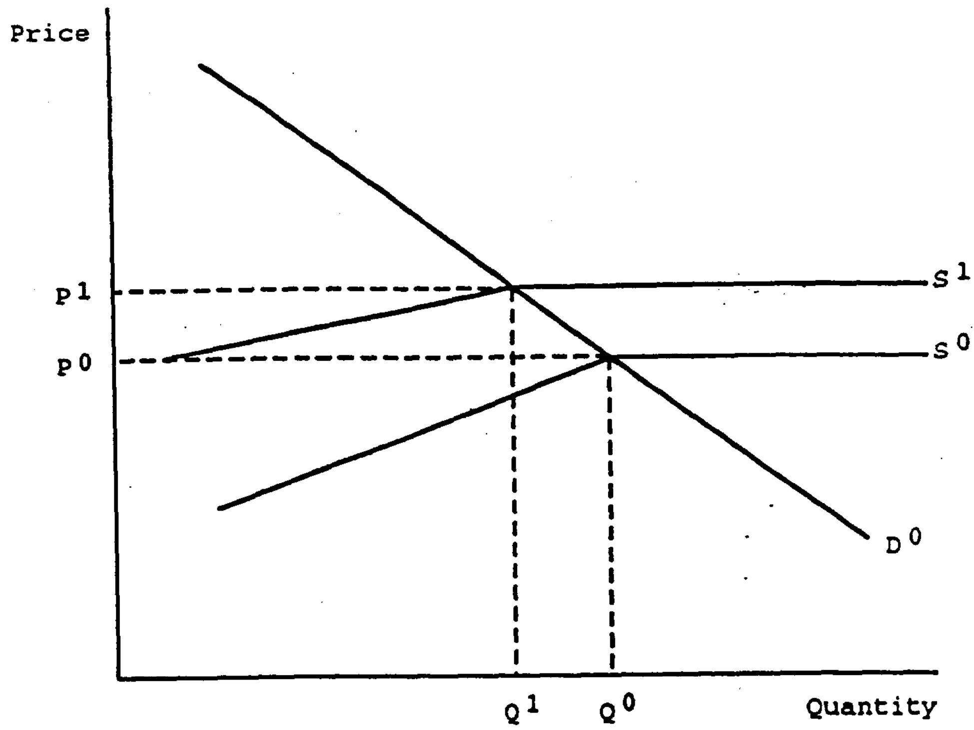


Figure 8-10. Hypothetical Bulk Terminal Services Other Inputs Market

having a different slope from S^0. This highlights the fact that the costs of regulation imposed on existing firms will vary with such circumstances as facility size, initial level of control, etc. A corollary observation is that regulation will impose distributional impacts (net financial gains or losses) on firms that are distinct from the market impacts identified in this section of the analysis.

8.3.1.3 Estimation of Marginal Facility Cost. As described in the industry profile, there are a wide variety of plant sizes in the gasoline distribution industry. Theory indicates that this is due to the fact that demand for wholesale and retail gasoline distribution varies considerably over space and/or that the cost of production varies considerably with distance. In both cases, this means that the markets for most gasoline distribution services are "local." Trends toward larger production facilities were identified in Section 8.1, but most markets are still geographically circumscribed, especially in the later stages of distribution.

Selecting a supply shift for marginal bulk terminal facilities in the market interaction model should therefore reflect the diversity of local markets. These range from larger metropolitan markets served by large capacity facilities to small rural markets served by small facilities. Consequently, EPA estimates the shift in the supply price of new bulk terminal facilities as the weighted average of the cost of compliance of all the relevant model plants. The weights are based on the amount of throughput attributed to each of the bulk terminal model plant size categories in the baseline.

Similarly, the supply shift in bulk terminal transportation inputs due to required monthly truck leak testing and repair at new plants is based on the weighted average of cost of these tests to the different model plants. The costs for each model plant varied in proportion to the number of trucks that served that plant (the weights included a 40 percent allowance for new plants in non-attainment areas where Control Technology Guidance already specified monthly leak testing of gasoline trucks). The supply shift for pipeline breakout stations is also based on the weighted average cost of monthly leak detection and repair at new model plants.

Table 8-29 describes each affected sector's marginal facility and the estimated increased cost per liter of throughput represented by that marginal facility. The cost shift for pipelines is negative because recovery credits anticipated from leak reduction are greater than the cost of the monthly inspection and repair.

Costs associated with required control at existing plants or in sectors where only existing plants are affected by the regulation are not included in this table because new plants are marginal facilities (see the discussion in Section 8.3.1.2). As discussed below, existing plant costs are reflected in the economic welfare effects of the regulation but they are not expected to have any significant influence on the market impacts.

8.3.2 Market Adjustments

The marginal facility cost increases per liter of output from Table 8-29 were entered into the model and solved for estimated market changes in price and quantity. The effects of the supply shifts for regulatory alternatives IV, IVQ, and IVM on all markets are shown in Table 8-30 and 8-30A. This table shows that the estimated market impacts of the proposed regulation will be relatively small, because the additional costs imposed are relatively small and buffered as they are passed through the market in the form of price and quantity changes. These estimates apply to all the regulatory

TABLE 8-29. REGULATORY ALTERNATIVES IV, IVQ, AND IVM: MARGINAL FACILITY CHARACTERISTICS

Facility Type	Marginal Facility	Cost Per Liter ($)
Pipelines	Weighted average cost of leak detection and repair at new model plants	-9.77818×10^{-7}[a]
Bulk Terminals	Weighted average cost of vacuum assist at new model plants.	4.9047185×10^{-4}
Bulk Terminal Transportation	Weighted average cost of leak detection and repair at new model plants.	7.2×10^{-6}

[a] For pipelines, the credits for detection and repair are greater than the costs resulting in a negative cost per liter.

TABLE 8-30. ESTIMATED EFFECTS OF REGULATORY ALTERNATIVE IV, IV-Q, AND IV-M ON THE GASOLINE MARKETING INDUSTRY (QUANTITIES IN BILLIONS OF LITERS; PRICES IN DOLLARS PER LITER)

	Baseline (1988)		Changes due to Policy		% Change		Post Policy	
COMMODITY	Quantity	Price	Quantity	Price	Quantity	Price	Quantity	Price
Refined Gasoline	441.8	0.322	-0.3	-0.000	-0.1	-0.0	441.5	0.322
Other Pipeline Inputs	441.8	0.008	-0.3	-0.000	-0.1	-0.1	441.5	0.008
Delivered, Refined Gasoline	**441.8**	**0.330**	**-0.3**	**-0.000**	**-0.1**	**-0.0**	**441.5**	**0.330**
Other Inputs at Terminals	441.8	0.005	-0.3	0.000	-0.1	9.8	441.5	0.005
Terminal Storage Services	441.8	0.335	-0.3	0.000	-0.1	0.1	441.5	0.335
Terminal Storage Services-Input to Wholesale Gas	**362.3**	**0.335**	**-0.3**	**0.000**	**-0.1**	**0.1**	**362.0**	**0.335**
Terminal Storage Services-Input to Bulk Plant Gas	**79.5**	**0.335**	**-0.0**	**0.000**	**-0.1**	**0.1**	**79.5**	**0.335**
Transportation Services from the Terminal	441.8	0.007	-0.3	0.000	-0.1	0.0	441.5	0.007
Terminal Transportation Services-Input to Wholesale Gas	362.3	0.007	-0.3	0.000	-0.1	0.0	362.0	0.007
Terminal Transportation Services-Input to Bulk Plants	79.5	0.007	-0.0	0.000	-0.1	0.0	79.5	0.007
Wholesale Gasoline from Terminal (non-bulk plant)	362.3	0.342	-0.3	0.000	-0.1	0.1	362.0	0.342
Gasoline from Terminal to Bulk Plant	79.5	0.342	-0.0	0.000	-0.1	0.1	79.5	0.342
Other Inputs at Bulk Plants	79.5	0.005	-0.0	-0.000	-0.1	-0.0	79.5	0.005
Bulk Plant Storage Services	**79.5**	**0.347**	**-0.0**	**0.000**	**-0.1**	**0.1**	**79.5**	**0.347**
Transportation Services from the Bulk Plant	79.5	0.007	-0.0	-0.000	-0.1	-0.1	79.5	0.007
Wholesale Gasoline from the Bulk Plant	79.5	0.354	-0.0	0.000	-0.1	0.1	79.5	0.354
Other Low Volume Service Station Inputs	79.5	0.013	-0.0	-0.000	-0.1	-0.0	79.5	0.013
Low Volume Station Gasoline	**79.5**	**0.367**	**-0.0**	**0.000**	**-0.1**	**0.1**	**79.5**	**0.367**
High Volume Service Station Inputs	362.3	0.013	-0.3	-0.000	-0.1	-0.0	362.0	0.013
High Volume Station Gasoline	**362.3**	**0.355**	**-0.3**	**0.000**	**-0.1**	**0.1**	**362.0**	**0.355**

Note: Percentage price changes may appear as zero due to rounding rather than a lack of price change. Commodities in bold indicate 4 wholesale and 2 retail sectors where changes in price and quantity will be reflected in market exchange prices.
Conversion rate: 1 gallon = 3.785 liters, $1.00/gallon= $0.26/liter

TABLE 8-30A. ESTIMATED EFFECTS OF REGULATORY ALTERNATIVE IV, IV-Q, AND IV-M ON THE GASOLINE MARKETING INDUSTRY (QUANTITIES IN BILLIONS OF GALLONS; PRICES IN DOLLARS PER GALLON)

COMMODITY	Baseline (1988) Quantity	Baseline (1988) Price	Changes due to Policy Quantity	Changes due to Policy Price	% Change Quantity	% Change Price	Post Policy Quantity	Post Policy Price
Refined Gasoline	116.7	1.22	-0.1	-0.000	-0.1	-0.0	116.7	1.22
Other Pipeline Inputs	116.7	0.03	-0.1	-0.000	-0.1	-0.1	116.6	0.03
Delivered, Refined Gasoline	**116.7**	**1.25**	**-0.1**	**-0.000**	**-0.1**	**-0.0**	**116.7**	**1.25**
Other Inputs at Terminals	116.7	0.02	-0.1	0.002	-0.1	9.8	116.6	0.02
Terminal Storage Services	116.7	1.27	-0.1	0.001	-0.1	0.1	116.7	1.27
Terminal Storage Services-Input to Wholesale Gas	**95.7**	**1.27**	**-0.1**	**0.001**	**-0.1**	**0.1**	**95.7**	**1.27**
Terminal Storage Services-Input to Bulk Plant Gas	**21.0**	**1.27**	**-0.0**	**0.001**	**-0.1**	**0.1**	**21.0**	**1.27**
Transportation Services from the Terminal	116.7	0.03	-0.1	0.000	-0.1	0.0	116.7	0.03
Terminal Transportation Services-Input to Wholesale Gas	95.7	0.03	-0.1	0.000	-0.1	0.0	95.7	0.03
Terminal Transportation Services-Input to Bulk Plants	21.0	0.03	-0.0	0.000	-0.1	0.0	21.0	0.03
Wholesale Gasoline from Terminal (non-bulk plant)	95.7	1.29	-0.1	0.001	-0.1	0.1	95.7	1.30
Gasoline from Terminal to Bulk Plant	21.0	1.29	-0.0	0.001	-0.1	0.1	21.0	1.30
Other Inputs at Bulk Plants	21.0	0.02	-0.0	-0.000	-0.1	-0.0	21.0	0.02
Bulk Plant Storage Services	**21.0**	**1.31**	**-0.0**	**0.001**	**-0.1**	**0.1**	**21.0**	**1.31**
Transportation Services from the Bulk Plant	21.0	0.03	-0.0	-0.000	-0.1	-0.1	21.0	0.03
Wholesale Gasoline from the Bulk Plant	21.0	1.34	-0.0	0.001	-0.1	0.1	21.0	1.34
Other Low Volume Service Station Inputs	21.0	0.05	-0.0	-0.000	-0.1	-0.0	21.0	0.05
Low Volume Station Gasoline	**21.0**	**1.39**	**-0.0**	**0.001**	**-0.1**	**0.1**	**21.0**	**1.39**
High Volume Service Station Inputs	95.7	0.05	-0.1	-0.000	-0.1	-0.0	95.7	0.05
High Volume Station Gasoline	**95.7**	**1.34**	**-0.1**	**0.001**	**-0.1**	**0.1**	**95.7**	**1.35**

Note: Percentage price changes may appear as zero due to rounding rather than a lack of price change. Commodities in bold indicate 4 wholesale and 2 retail sectors where changes in price and quantity will be reflected in market exchange prices.

Conversion rate: 1 gallon = 3.785 liters, $1.00/gallon = $0.26/liter alternatives (IV, IVQ, and IVM) since differences among them only affect controls required of existing plants.

The biggest price change will occur in the cost of other inputs to bulk terminal storage (9.8 percent). Since these other inputs constitute only a small share of costs, however, bulk terminal storage services are estimated to increase in price by only one tenth of a percent. While the rounding convention of the table obscures some differences in the change in quantity estimated for the proposed regulation, these are all in the neighborhood of one tenth of one percent for each industry sector. This amounts to a reduction in consumption of roughly 300 million liters of gasoline per year. Thus, while the relative changes in gasoline distribution markets are estimated to be small, the market is so large that some of the absolute market effects are non-trivial.

8.3.3 Employment Impacts.

If percentage changes in output due to the regulation are assumed to be perfectly reflected in percentage changes in employment, roughly 1,100 jobs will be lost from estimated baseline employment in the gasoline marketing sectors considered here. These results are put into perspective in Table 8-31. Nearly 80 percent of the jobs lost will be in the service station sectors due to the reduction in gasoline consumption occasioned by the rise in the retail price of gasoline. These jobs, however, constitute only five one-hundredths of a percent of baseline employment in the low volume service station sector and seven one-hundredths of a percent in the high volume service station sector. These job losses are also a very small percentage of the baseline job increases projected for most of these sectors in the five year period following proposal action, 1993-1998: just under 3 percent of increased employment in the

TABLE 8-31. ESTIMATED EMPLOYMENT IMPACTS

Distribution Sector	Total Employment	Employment Reductions	Employment Reductions: as % of total employment[a]	Employment Reductions: as % of anticipated growth
Refineries	106,000	72	0.07	
Pipelines	17,800	12	0.07	
Bulk Terminals	91,750	69	0.08	1.97
Bulk Terminal Transportation[b]	75,240	51	0.07	
Bulk Plants	16,500	8	0.05	--[c]
Bulk Plant Transportation[b]	16,500	8	0.05	
Low Volume Service Stations	235,600[d]	119	0.05	2.05
High Volume Service Stations	1,073,350[d]	775	0.07	2.93
Total	1,632,740	1114		

[a] Reflects the assumption that the percentage change in quality before and after the regulations is the same as percentage change in employment.

[b] Assumed for-hire firm for Bulk Terminal Transportation and captive for Bulk Plant Transportation because they have the smallest throughput (this creates a worst-case scenario).

[c] No growth expected for the bulk plant sector.

[d] For low volume service stations, multiplied total employment by 18% to estimate employment; for high volume, multiplied total employment by 82%.

high volume service station sector and just over 2 percent in the low volume service station sector.

For bulk terminals, the job losses constitute just under two percent of anticipated job growth. With the exception of the bulk plant sectors, where sixteen jobs are expected to be lost over the analysis period, the projected job losses due to the regulation are more accurately interpreted as reductions in job opportunities rather than terminations of existing jobs.

Loss of jobs also imposes some displacement or transaction costs on the economy. An examination of these costs showed that, in a statistical sense, workers would be willing to accept wage reductions equivalent to roughly $57,000 for an increase in job security equal to the statistical equivalent of one job.[81] Since most of the job reductions estimated here are changes in job opportunities, rather than actual losses in jobs, it is not clear that the estimated job displacement costs apply to any but the bulk plant and bulk plant transportation jobs. For these two sectors, job displacement costs estimated by the imputed value of job security are less than one million dollars.

8.3.4 Facility and Firm Impacts

8.3.4.1 Facility Closure Estimates. Although the reductions in quantity reflected in the market interaction model results discussed in Section 8.3.2 are not large in percentage terms, the scale of activity in the gasoline marketing industry makes them noteworthy. The quantity changes may reflect changes in output of existing facilities, closure of facilities, or both. Assuming in the extreme that all the quantity changes occur as a result of closing existing facilities or never opening new facilities, plant closure due to the regulation can be estimated. Further assuming that the smallest model plants in each sector are most vulnerable to closure, this analysis estimates the plant closures listed in Table 8-32.

TABLE 8-32. ESTIMATED FIRM IMPACTS

Distribution Sector	Total Facilities 1998	Potential Plant Closures[a]	% Reduction in new facilities[b]
Refineries	•	N/A	
Pipelines		N/A	
Bulk Terminals	1020	3	6.57
Bulk Term. Transportation[d].		15	
Bulk Plants	12600	12	--[c]
Bulk Plant Transportation[d].		12	
Low Vol. Service Station	279650	440	25.64
High Vol. Service Station	108100	165	2.11
Total	•	647	

Note: Potential plant closure figures are not applicable for refineries and pipelines because it is assumed that these types of facilities do not close, but rather reduce capacity or capacity utilization or postpone addition of new capacity.

a Potential plant closures are the absolute change in quantity of throughput divided by throughput of the smallest model plant.

b Percentage reduction in new facilities is facility closures as a percentage of anticipated facility growth.

c No growth anticipated for bulk plants.

d Assumed for-hire firm for Bulk Terminal Transportation and captive for Bulk Plant Transportation because they have the smallest throughput (this creates a worst-case scenario).

The total estimated number of closures is 647. Of all closures, more than 90 percent are in the service station sector. In this sector, 72 percent of closures are among Low Volume Service Stations, while the remaining 28 percent are among High Volume Service Stations. While the number of facility closures among service stations is in the hundreds, it should be kept in mind that the total number of stations in the country is over 380,000 and that the number of facilities closed constitutes less than one percent. While there are 647 total plant closures estimated across all sectors, the projected plant closures due to the regulation are more accurately interpreted as reductions in new facility openings rather than closures of existing facilities. Plant closures for refineries and pipelines are not applicable because it is assumed that these types of facilities do not close, but rather reduce capacity or capacity utilization, or postpone the addition of new capacity.

8.3.4.2 Firm Impacts and Financial Health. The EPA includes estimates of firm-level financial impacts in many of the economic impact analyses of its regulations. Identification of the firm-level impacts for the "gasoline distribution industry" involves two aspects: the size of the financial impacts and whether these impacts threaten the existence of firms in the industry. Chapter 7 presents cost data at the facility or establishment level using model plants for selected regulatory options for the pipeline, bulk terminal, and bulk terminal transportation sectors of the industry.

These data show that the cost of all the regulatory alternatives are relatively small when compared to current costs of production or current prices per liter. These data also show that small model plants will experience higher costs of control per unit of throughput than large model plants. These facility or model plant costs can be combined with firm level descriptions and financial information to provide estimates of the firm level financial impacts of the proposed regulations. Such impact estimates are reported in the Economic Impact Analysis report.[67]

Estimating firm financial impact estimates involved the following sequence of activities:

1. Characterize "model firms" based on available data on firm size and facility ownership in each industry sector. This characterization concluded with estimation of model firm sales.

2. Construct pro-forma balance sheets and income statements for model firms based on Dun and Bradstreet financial ratios for each industry sector. Three sets of ratios were used, each set representative of firms in either above average, average, or below average financial health.

3. Compute compliance costs for each model firm based on the control costs of facilities estimated to be owned by each of the model firms and the cost of capital based on industry sector and firm financial health.

4. Revise the model firms pro forma balance sheets and income statements based upon the estimated compliance costs for firms. Model firms with below average financial health were treated as financing purchases out of cash reserves.

5. Use the revised balance sheets and income statements to compute new financial ratios for model firms and assess the impact of the regulation on these ratios. Ratios used were the liquidity, activity, leverage, and profitability ratios.

This financial analysis reported in the Economic Impact Analysis report was conducted using the most stringent regulatory alternative, Regulatory Alternative I, as a basis for estimating firm compliance costs. In addition, the analysis assumed that each model plant would have the highest possible control costs i.e., existing plants with the lowest initial level of control. Under these extreme conditions, small model firms with below-average financial health still has enough cash in their pro-forma balance sheet to cover the cost of control.

At the same time, the financial ratios of model firms were hardly affected by the compliance costs.

No average or above average firms' ratios fell in the range of the less financially healthy firms' ratios after the regulation. Regulatory alternatives IV, IV-Q, and IV-M are substantially less stringent than Regulatory Alternative I and would result in considerably lower control costs. Consequently, even firms in below average financial health are expected to be able to cover the costs of complying with this regulation and firms in average or better financial health will not suffer serious financial affects.

8.3.5 Economic Welfare Changes

The results of the market impact model can be used to improve estimates of the costs of the regulation so that they more closely correspond to economic welfare measures. Even though the impact of the regulation directly affects only certain gasoline distribution markets, the interaction among the markets transmits these changes to upstream and downstream markets. The cumulative welfare impact, as well as the distributional effect of this regulation on consumers and producers, can be measured in the two "final" markets: High Volume Service Stations and Low Volume Service Stations.[82]

For this analysis, measures of producers and consumers surplus are used to approximate the theoretically correct willingness-to-pay measures of welfare change. If the income effects of the regulation are small, this approximation is quite good.[83] The Economic Impact Analysis report provides a more detailed discussion of the theory and procedures used to estimate these economic welfare and distribution estimates.[67]

Table 8-33 presents estimates of changes in producer and consumer surplus and economic welfare based on the quantity and

TABLE 8-33. ESTIMATED CHANGES IN ECONOMIC WELFARE ($\$10^6$ 1990 DOLLARS)

	ALT IV	ALT IV-Q	ALT IV-M
Transfers			
Consumer Surplus			
High Volume	-134.4	-134.4	-134.4
Low Volume	-29.2	-29.2	-29.2
Total	-163.6	-163.6	-163.6
Producer Surplus			
Total	145.3	145.8	145.4
Net Welfare Change			
Costs	-18.3	-17.8	-18.2

price changes of the market interaction model and the facility costs estimated in Chapter 7. All consumers lose some surplus (bear some cost) due to the increase in price and decrease in quantity of gasoline associated with the regulation. Although the price and quantity changes are themselves relatively small, the estimated loss amounts to about $163 million a year. The magnitude substantially exceeds aggregate control cost estimates because of the huge volume of gasoline across which the price increases apply. At the same time, some producers lose (those with high compliance and production costs) while others benefit from the higher prices more than they are damaged by the costs of compliance. On net, producers gain an estimated surplus of about $145 million per year. These estimates of producer surplus vary slightly across the three regulatory alternatives because the real resource costs borne by existing firms change with the alternatives.

The net difference in surplus changes is the economic welfare cost of the regulation after market adjustments. This figure is estimated to be roughly $18 million per year and varies slightly between regulatory alternatives IV, IVQ, and IVM. Note that this estimate does not reflect the environmental and health benefits that the regulation yields. Judging the merit of the regulation on grounds of economic efficiency is possible only if one weighs these economic welfare costs against the benefits they produce.

8.3.6 Small Business Impacts

The Economic Impact Analysis[67] develops estimates of the size distribution of firms in different segments of the gasoline distribution industry based on the number of establishments owned and assignment of model plant combinations to the firms owning multiple plants. As shown on Table 8-34, when the Small Business Administration's definition of small business is

TABLE 8-34. SBA DEFINITIONS OF SMALL BUSINESS AND CONCORDANCE WITH FIRM SIZE CATEGORIES FOR RELEVANT SECTORS OF THE GASOLINE DISTRIBUTION INDUSTRY

SECTOR	SIC CODE	SBA DEFINITION OF SMALL BUSINESS	LARGEST FIRM SIZE COMPATIBLE WITH THE SBA DEFINITION OF SMALL BUSINESSES	PERCENTAGE OF TOTAL FIRMS REPRESENTED BY THESE ESTAB-LISHMENTS	PERCENTAGE OF TOTAL THROUGHPUT (AND SALES) REPRESENTED BY THESE ESTAB-LISHMENTS
BULK TERMINALS	5171	<100 EMPLOYEES	1 - 9 ESTABLISHMENTS	56	7
BULK PLANTS	5171	<100 EMPLOYEES	1 - 4 ESTABLISHMENTS	99	94
BULK TERMINAL TRANSPORTATION[a]	5172	<100 EMPLOYEES	MODEL FIRMS 1 - 3	76	20
BULK PLANT TRANSPORTATION[a]	5172	<100 EMPLOYEES	MODEL FIRMS 1 - 3	98	74
PUBLIC SERVICE STATIONS	5541	<$4.5 MILLION ANNUAL REVENUES	1 - 9 ESTABLISHMENTS	99	57

[a] For bulk terminal transportation and bulk plant transportation there are four model firms with 2, 7, 30, and 100 trucks respectively. It is estimated that model firms 1 through 3 have fewer than 100 employees.

applied to these firms, the majority of firms are classified as small businesses in every industry segment examined. The percentage of firms classified as small ranges from 56 percent for bulk terminals to 99 percent for public service stations.

This striking result occurs in part because of the way in which these data were compiled: the firm size categories were coarse and the data did not allow for vertical or horizontal integration of firms. Finer, more complete data would probably result in a substantial reduction in the number of firms classified as small in each sector of the gasoline distribution industry. Even so, the evidence compiled in Table 8-34, when added to the information on industry organization compiled in Section 8.1, suggest that there are a substantial number of small firms distributing gasoline that will be affected by the regulation either directly or indirectly through increases in the cost of gasoline or reductions in gasoline consumption.

At the same time, however, there is little to suggest that any of the regulatory alternatives under consideration would result in financial impacts that would significantly or differentially stress the affected small businesses. This conclusion is based on three considerations:

- First, the sectors that are being directly regulated are the same sectors that are characterized by larger firms and vertical integration back through gasoline production: pipelines, bulk terminals, and bulk terminal transportation. Bulk plants, bulk plant transportation, and service stations are not affected directly by the regulation because they are not major emissions sources.

- Second, for all but the smallest facilities in directly affected industry segments, the costs of control associated with any of these alternatives are a minute fraction of production costs. More importantly, small scale facilities are likely to be serving small or specialized markets. This makes it unlikely that the differential in unit cost of control estimated between the smallest and largest model plants of an industry sector will seriously affect the competitive position of small firms, even assuming that the small firms own small facilities.

- Finally, the examination of firm financial impacts performed using pro forma balance sheets showed that even small firms in poor financial condition could fund estimated control costs with cash balances and that financial ratio of small firms were not significantly impacted by the regulation. The available data, while admittedly limiting the precision of the analysis, nevertheless suggest that only firms that are exceptionally vulnerable financially will be threatened by the cost of these controls. This threat appears to depend more on the financial condition of the firm that on its size.

While EPA expects that this regulation will slightly slow growth in facilities and jobs in most sectors and that, in the bulk plant and bulk plant transportation sectors, the closure of some existing firms will be hastened, small firms in the gasoline distribution industry would not be differentially affected by these regulations because of their size alone.

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APPENDIX A

EVOLUTION OF THE BACKGROUND INFORMATION DOCUMENT

The purpose of this study was to develop a basis for supporting proposed national emission standards for hazardous air pollutants (NESHAP) for the gasoline distribution (Stage I) network. To accomplish the objectives of this program, technical data were acquired on the following aspects of this industry: (1) facility types and emission sources, (2) the release of HAP and VOC emissions into the atmosphere by these sources, and (3) the types and costs of demonstrated emission control technologies. The bulk of the information was gathered from the following sources:

1. Technical literature;
2. State, regional, and local air pollution control agencies;
3. Plant visits;
4. Industry representatives; and
5. Equipment vendors.

Significant events relating to the evolution of the background information document are recorded in chronological order in Table A-1.

TABLE A-1. EVOLUTION OF THE BACKGROUND INFORMATION DOCUMENT

Date	Company, Consultant, or Agency/Location	Nature of Action
3/8/74	U.S. Environmental Protection Agency	Promulgated NSPS for New Petroleum Liquid Storage Tanks (40 CFR Part 60 Subpart K, 39 FR 9317).
11/1/76 to 6/1/77	U.S. Environmental Protection Agency	Section 114 letters sent to oil companies regarding specific bulk terminals.
6/8/77	U.S. Environmental Protection Agency	Benzene is listed as a hazardous air pollutant (HAP) under section 112 of the Clean Air Act.
10/77	U.S. Environmental Protection Agency	Bulk Gasoline Terminal Control Techniques Guideline issued (Control of Hydrocarbons from Tank Truck Gasoline Loading Terminals. EPA Publication No. EPA-450/2-77-026).
12/77	U.S. Environmental Protection Agency	Fixed-Roof Tank Control Techniques Guideline issued (Control of Volatile Organic Emissions from Storage of Petroleum Liquids in Fixed-Roof Tanks. EPA Publication No. EPA-450/2-77-036).
12/77	U.S. Environmental Protection Agency	Bulk Gasoline Plant Control Techniques Guideline issued (Control of Volatile Organic Emissions from Bulk Gasoline Plants. EPA Publication No. EPA-450/2-77-035).
6/78	U.S Environmental Protection Agency	Petroleum Refinery Equipment Leak Control Techniques Guideline issued (Control of Volatile Organic Compound Leaks from Petroleum Refinery Equipment. EPA Publication No. EPA-450/2-78-036).
1978	National Air Pollution Control Techniques Advisory Committee (NAPCTAC)	Review of draft Stage I Benzene Package.
12/78	U.S. Environmental Protection Agency	External Floating Roof Tank Control Techniques Guideline issued (Control of Volatile Organic Emissions from Petroleum Liquid Storage in External Floating Roof Tanks. EPA Publication No. EPA-450/2-78-047).

TABLE A-1. (Continued)

Date	Company, Consultant, or Agency/Location	Nature of Action
12/78	U.S. Environmental Protection Agency	Tank Truck/Vapor Collection System Control Techniques Guideline issued (Control of Volatile Organic Compound Leaks from Gasoline Tank Trucks and Vapor Collection Systems. EPA Publication No. EPA-450/2-78-051).
4/4/80	U.S. Environmental Protection Agency	Promulgated additional NSPS for New Petroleum Liquid Storage Vessels (40 CFR 60 Subpart Ka, 45 FR 23379).
12/17/80	U.S. Environmental Protection Agency	Proposed NSPS for new Bulk Gasoline Terminals (40 CFR 60 Subpart XX, 45 FR 83126) and issued draft background information document (EPA Publication No. EPA-450/3-80-038a).
8/18/83	U.S. Environmental Protection Agency	Promulgated NSPS for new Bulk Gasoline Terminals (40 CFR 60 Subpart XX, 48 FR 37590) and issued final background information document (EPA Publication No. EPA-450/3-80-038b).
5/30/84	U.S. Environmental Protection Agency	Promulgated NSPS for Equipment Leaks of VOC at Petroleum Refineries (40 CFR 60 Subpart GGG, 49 FR 22606).
6/84	U.S. Environmental Protection Agency	Draft For Risk Exposure issued (Estimation of the Public Health Risk from Exposure to Gasoline Vapor via the Gasoline Marketing System).
8/8/84	U.S. Environmental Protection Agency	Issuance of Evaluation of Air Pollution Regulatory Strategies for Gasoline Marketing Industry (EPA-450/3-84-012a).
2/7/87	Natural Resources Defense Council	NRDC lawsuit.
4/8/87	U.S. Environmental Protection Agency	Promulgated additional NSPS for New Petroleum Liquid Storage Vessels (40 CFR 60 Subpart Kb, 52 FR 11428).
7/87	U.S. Environmental Protection Agency	Issuance of "Draft Regulatory Impact Analysis: Proposed Refueling Emission Regulation for Gasoline-Fueled Motor Vehicles - Volume I: Analysis of Gasoline Marketing Regulatory Strategies." EPA-450/3-87-001a.
9/14/89	U.S. Environmental Protection Agency	Proposed Gasoline Marketing Benzene Standards (54 FR 38083).

TABLE A-1. (Continued)

Date	Company, Consultant, or Agency/Location	Nature of Action
12/20/90	Piedmont Aviation Services, Winston-Salem, NC	Plant visit to gather background information concerning airplane fueling and gasoline throughput.
3/7/90	U.S. Environmental Protection Agency	Withdrew Gasoline Marketing Benzene Standards (45 FR 8292).
11/15/90	U.S. Environmental Protection Agency	Additional compounds in gasoline listed as HAPs (1990 CAAA).
12/18/90	Fina Oil & Chemical Co., Port Arthur, TX	Plant visit to gather background information concerning vacuum assist technology for tank truck loading at terminals.
1/17/91	Puget Sound Air Pollution Control Agency, Seattle, WA	Letter requesting performance test reports for vapor control systems at bulk gasoline terminals.
	New Jersey State Department of Environmental Protection, Trenton, NJ	Letter requesting performance test reports for vapor control systems at bulk gasoline terminals.
2/4/91	American Petroleum Institute (API), Washington, DC	Letter requesting information concerning the composition of gasoline vapors.
2/21/91	Plantation Pipe Line, Gastonia, NC	Plant visit to gather background information concerning operations at pipeline pumping stations.
2/22/91	Service Distributing Company, Inc., Albemarle, NC	Letter requesting cost information concerning installing and retrofitting Stage I vapor recovery at service stations.
2/25/91	Braswell Equipment Co., Wilson, NC	Letter requesting information concerning bulk gasoline plant and service station costs.
2/26/91	Arnold Equipment Co., Greensboro, NC	Letter requesting information concerning bulk gasoline plant and service station costs.
	Southern Pump and Tank Co., Raleigh, NC	Letter requesting information concerning bulk gasoline plant and service station costs.
2/26/91	Braswell Equipment Co., Wilson, NC	Letter requesting information concerning bulk gasoline plant and service station costs.
4/22/91	Mobil Oil Corporation, Albany, NY	Plant visit to gather background information concerning railcar loading operations.
4/23/91	Powell Duffryn Terminals, Inc., Bayonne, NJ	Plant visit.

TABLE A-1. (Concluded)

Date	Company, Consultant, or Agency/Location	Nature of Action
6/21/91	U.S. Environmental Protection Agency	Federal Register notice announcing availability of preliminary draft list of categories of major and area sources of HAPs (56 FR 28548).
9/19/91	Maryland Department of Environment, Baltimore, MD	Letter requesting information concerning bulk gasoline plant and service station costs.
9/30/91	U.S. Environmental Protection Agency	Floating and Fixed-Roof Tank Control Techniques issued (Control of Volatile Organic Compound Emissions from Volatile Organic Liquid Storage in Floating and Fixed-Roof Tanks. Draft.)
11/91	Industry members, selected equipment vendors and consultants	Mailed draft BID Chapters 3-8.2 and Appendices B & C.
7/16/92	U.S. Environmental Protection Agency	Federal Register notice publishing initial list of categories of major and area sources of HAPs (57 FR 31576).
9/92	NAPCTAC	Received draft BID for comment.
11/17/92	U.S. EPA/NAPCTAC, Durham, NC	NAPCTAC meeting.
2/18/93	U.S. EPA/API, Durham, NC	Meeting to discuss issues and comments from NAPCTAC meeting.

APPENDIX B

INDEX TO ENVIRONMENTAL IMPACT CONSIDERATIONS

This appendix consists of a reference system which is cross-indexed with the October 21, 1974, Federal Register (39 FR 37419) containing the Agency guidelines concerning the preparation of environmental impact statements. This index can be used to identify sections of this document which contain data and information germane to any portion of the Federal Register guidelines.

TABLE B-1. CROSS-INDEXED REFERENCE SYSTEM TO HIGHLIGHT ENVIRONMENTAL IMPACT PORTIONS OF THE DOCUMENT

Agency guidelines for preparing regulatory action for environmental impact statements (39 FR 37419)	Location within the background information document
1. BACKGROUND AND SUMMARY OF REGULATORY ALTERNATIVES	
Summary of regulatory alternatives	The regulatory alternatives from which standards will be chosen for proposal are summarized in Chapter 1, Section 1.2.
Statutory basis for proposing standards	The statutory basis for proposing standards is summarized in Chapter 1, Section 1.1.
Relationship to other regulatory agency actions	The relationships between EPA and other regulatory agency actions are discussed in Chapters 3, 7, and 8.
Industries affected by the regulatory alternatives	A discussion of the industries affected by the regulatory alternatives is presented in Chapter 3, Section 3.1. Further details covering the business and economic nature of the industry are presented in Chapters 6, 7, and 8.
Specific processes affected by the regulatory alternatives	The specific processes and facilities affected by the regulatory alternatives are summarized in Chapter 1, Section 1.1. A detailed technical discussion of the processes affected by the regulatory alternatives is present in Chapter 4, Section 4.1.

TABLE B-1. (Concluded)

Agency guidelines for preparing regulatory action for environmental impact statements (39 FR 37419)	Location within the background information document
2. REGULATORY ALTERNATIVES	
Control techniques	The alternative control techniques are discussed in Chapter 4.
Regulatory alternatives	The various regulatory alternatives are defined in Chapter 5, Section 5.2. A summary of the major alternatives considered is included in Chapter 1, Section 1.2.
3. ENVIRONMENTAL IMPACT OF THE REGULATORY ALTERNATIVES	
Primary impacts directly attributable to the regulatory alternatives	The primary impacts on mass emissions and ambient air quality due to the alternative control systems are discussed in Chapter 6, Section 6.1. A matrix summarizing the environmental impacts is included in Chapter 1.
Secondary or induced impacts	Secondary impacts for the various regulatory alternatives are discussed in Chapter 6, Sections 6.2, 6.3, 6.4, 6.5, and 6.6.
4. OTHER CONSIDERATIONS	A summary of the potential adverse environmental impacts associated with the regulatory alternatives is included in Chapter 1, Section 1.3, and Chapter 6. Potential socio-economic and inflationary impacts are discussed in Chapter 8, Section 8.3.

APPENDIX C

CALCULATION OF HAP VAPOR PROFILES FOR GASOLINE

The purpose of this appendix is to present the methodology and results of the analysis to estimate the hazardous air pollutants (HAPs) in gasoline vapor. This appendix consists of two sections. The first section contains the information resulting from a search conducted to obtain data related to the composition of gasoline vapor, that was specific enough to allow the identification and quantification of those HAPs contained on the 1990 Clean Air Act Amendments list. Section C.1 discusses the information obtained from this search as well as the mathematical procedures used to develop a "typical" HAP vapor profile for normal gasoline.

Requirements in Title II of the 1990 CAAA will lead to the fuel composition being changed in many areas of the country. These programs are not yet in effect, so it was difficult to obtain any actual data related to the composition of gasoline vapors from reformulated or oxygenated gasoline. Therefore, adjustments were made to the normal gasoline profile to attempt to represent vapor compositions of possible reformulated or oxygenated gasoline. The methodology used to modify the normal profile forms the basis for the second section of this appendix and is discussed in Section C.2.

C.1 NORMAL GASOLINE

To locate information on gasoline vapor composition, literature searches were conducted and trade organizations, research organizations, regulatory agencies, and large and small oil companies were contacted. Overall, over 100 sources were contacted to attempt to obtain information on this subject. These included the American Petroleum Institute (API), Western States Petroleum Association (WSPA), the National Institute for Petroleum and Energy Research (NIPER), the Coordinating Research Council (CRC), the Society of Automotive Engineers (SAE), the Motor Vehicles Manufacturers Association (MVMA), all the major oil companies, the California Air Resources Board, and many others.

Information obtained during this search indicated that a great deal of research was being conducted related to the composition of tailpipe emissions from automobiles. However, information related to the composition of evaporative emissions from gasoline transfer and storage operations was limited.

A total of forty nine analyses of gasoline vapor were located that contained speciation of sufficient detail to identify the CAAA HAPs. These came from a variety of the sources listed above. In addition, EPA obtained a number of compositional analyses of liquid gasoline. Table C-1 summarizes the sources of the test data received.

For each vapor sample, the individual HAPs were identified and their weight percentage relative to the total VOC weight was noted or calculated (in cases where the fraction was reported as a volume or mole percent). In addition, the sum of all of the weight percentages of the HAPs was determined.

For the liquid samples, Raoult's law was used to estimate the vapor phase composition. Raoult's law describes the relationship between the partial pressure of a component in the gas phase and the mole fraction of that component in the liquid phase. Raoult's law is expressed as follows:

$$p_A = y_A P = x_A p^*_A \ (T)$$

TABLE C-1. SUMMARY OF SOURCES OF DATA RECEIVED REGARDING GASOLINE COMPOSITION

Data ID	Source of Test Data	Number of Samples	Form of Data
A	Memorandum, from Knapp, K.T., EPA AEERL, to Durham, J., EPA OAQPS, regarding speciation of components in gasoline with data attached. August 1, 1990.	2	liquid
B	Furey, R.L. and B.E. Nagel, Composition of Vapor Emitted from a Vehicle Gasoline Tank During Refueling. GM Research Laboratories, Warren, MI.(Presented at SAE International Congress and Exposition, Detroit Michigan)	2	vapor
C	Sisby, J.E., S. Tejada, W. Rau, J. Lang, and J. Duncan. Volatile Organic Compound Emissions from 46 In-Use Passenger Cars. (Reprinted from Environmental Science and Technology, May 1987)	2	vapor
D	Letter, from Woodward, P., National Institute for Petroleum and Energy Research, to Norwood, P., Pacific Environmental Services, Inc., regarding composition of gasoline with data. January 10, 1991	2	liquid
E	Halder, C., G. Van Gorp, N. Hatoum, and T. Warne. Gasoline Vapor Exposures. Part I. Characterization of Workplace Exposures. American Industrial Hygiene Association, 47(3):164-172 (1986).	4	vapor
F	Appendix to Northeast Corridor Regional Modeling Project - Determination of Organic Species Profiles for Gasoline Liquids and Vapors - Sampling and Analysis Data Sheets, EPA-450/4-80-036b. U.S. Environmental Protection Agency, Research Triangle Park, NC. December 1980.	20	vapor

TABLE C-1. (Concluded)

Data ID	Source of Test Data	Number of Samples	Form of Data
G	Information Obtained From Braddock, J., EPA:AEERL regarding vapor composition of refueling emissions.	14	vapor
H	Environ Corporation, Arlington, VA. Summary Report on Individual Exposures to Gasoline. Prepared for Gasoline Exposure Workshop Planning Group. November 28, 1990.	1	vapor
I	Passenger Car Hydrocarbon Emissions Speciation. EPA-600/2-80-085. U.S. Environmental Protection Agency, Research Triangle Park, NC. May 1980.	2	vapor
	TOTAL NUMBER OF DATA POINTS	49	

where, p^*_A is the vapor pressure of pure liquid A at temperature T and y_A is the mole fraction of A in the gas phase. Raoult's law is an approximation that is generally valid when the mole fraction of compound A in the liquid is approximately close to one and when the mixture is made up of similar substances, such as straight chain hydrocarbons of similar molecular weights. Gasoline was assumed to meet the second criteria based on general compositional data.

An example of the calculational procedure used to estimate vapor HAP composition from liquid composition is shown in Table C-2. All non-HAP components were grouped according to the number of carbons. All compounds within each carbon number were assumed to have the vapor pressure and molecular weight of certain compounds selected as representative for the carbon number. Those compounds selected are shown in parenthesis in Table C-2.

The weight fraction for each HAP was identified in the liquid data, and the weight fractions for each carbon number (excluding HAPs) totalled. The mole fraction of each HAP and carbon number group were calculated. The vapor pressure was then estimated using the Antoine equation (a common vapor pressure estimation technique) at 25 degrees F for each HAP or carbon number group.

Using the liquid mole fraction and the vapor pressure, and assuming one atmosphere total pressure the mole fraction in the vapor phase was calculated using Raoult's law. This was converted to mass fraction, after which the HAP to total VOC mass ratio was calculated.

After the individual and total HAP weight fractions were calculated for each individual sample, the data were combined and summarized. The results of all of the individual samples are shown in Table C-3. Also, Table C-4 presents the summary of the data for normal gasoline. The table shows the maximum and minimum percentage for each HAP and for total HAPs. The arithmetic average was also taken for each of these situations.

TABLE C-2. EXAMPLE OF VAPOR COMPOSITION CALCULATIONS FROM LIQUID DATA

CHEMICAL/CLASS	wt frac in liq	moles in liquid	liquid mole frac Xa	vapor mole frac Ya	wt frac in vap	HAP/VOC in vap
Hexane	1.8	0.021	0.021	0.0027	0.231	0.0108
Benzene	1.31	0.017	0.017	0.0013	0.103	0.0048
Toluene	6.19	0.067	0.067	0.0015	0.137	0.0064
2,2,4 trimethylpentane	3.02	0.026	0.026	0.0011	0.121	0.0056
Xylene	6.33	0.060	0.060	0.0003	0.030	0.0014
Ethyl benzene	1.27	0.012	0.012	0.0001	0.009	0.0004
Naphthalene	0.67	0.005	0.005	0.0000	0.000	0.0000
Methanol	0	0.000	0.000	0.0000	0.000	0.0000
MTBE	0	0.000	0.000	0.0000	0.000	0.0000
TOTAL HAPS	20.59		0.208			0.0294
c3 (propane)	0.02	0.000	0.000	0.0033	0.145	
c4 (n-butane)	4.83	0.086	0.086	0.1513	8.475	
c5 (iso-pentane)	14.85	0.212	0.212	0.1347	9.429	
c6 (2 methyl pentane)	11.45	0.136	0.136	0.0251	2.105	
c7 (2 methyl hexane)	8.5	0.087	0.087	0.0043	0.425	
c8 (iso-octane)	6.53	0.058	0.058	0.0023	0.262	
c9 (1 meth-3 eth benz)	12.45	0.099	0.099	0.0002	0.025	
c10 n-decane	9.74	0.070	0.069	0.0001	0.008	
c11 (n-undecane)	6.13	0.040	0.040	0.0000	0.001	
c12 (n-dodecane)	0.82	0.005	0.005	0.0000	0.000	
TOTAL VOC	95.91	1.001	1		21.508	

* other gasoline formulations may contain methanol or MTBE

TABLE C-3. INDIVIDUAL SAMPLE HAP PROFILES

	HAP/VOC RATIO BY WEIGHT													
TEST ID	A1	A2	B1	B2	C1	C2	D1	D2	E1	E2	E3	E4	F1	F2
HAP														
Hexane	0.0108	0.0110	0.0090	0.0110	0.0058	0.0053	0.0112	0.0110	0.0180	0.0310	0.0192	0.0170	0.0208	0.0095
Benzene	0.0048	0.0051	0.0145	0.0070	0.0047	0.0076	0.0186	0.0219	0.0220	0.0060	0.0081	0.0220	0.0029	0.0033
Toluene	0.0064	0.0049	0.0195	0.0100	0.0042	0.0222	0.0211	0.0228	0.0310	0.0400	0.0178	0.0220	0.0096	0.0202
2,2,4 trimethylpentane	0.0056	0.0044	0.0200	0.0030	0.0051	0.0041	0.0107	0.0260	0.0070	0.0180	0.0085		0.0090	0.0079
Xylenes	0.0014	0.0013			0.0011	0.0010	0.0042	0.0043	0.0090	0.0150	0.0079	0.0110	0.0013	0.0011
Ethyl benzene	0.0004	0.0003			0.0003	0.0003	0.0010							
Naphthalene														
Cumene (isopropylbenzene)														
MTBE														
TOTAL HAPS	0.0294	0.0270	0.0630	0.0310	0.0212	0.0405	0.0668	0.0860	0.0870	0.1100	0.0616	0.0720	0.0436	0.0420

TABLE C-3. (Continued)

TEST ID / HAP	HAP/VOC RATIO BY WEIGHT													
	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13	F14	F15	F16
Hexane	0.0293	0.0116	0.0129	0.0262	0.0099	0.0219	0.0134	0.0155	0.0432	0.0132	0.0134	0.0289	0.0091	0.0075
Benzene	0.0043		0.0085	0.0029	0.0032	0.0045	0.0073	0.0085	0.0085	0.0021	0.0041	0.0048	0.0032	0.0039
Toluene	0.0070	0.0178	0.0093	0.0056	0.0273	0.0044	0.0087	0.0108	0.0088	0.0078	0.0085	0.0065	0.0158	0.0066
2,2,4 trimethylpentane	0.0022	0.0084	0.0102		0.0079	0.0003		0.0005		0.0131	0.0054	0.0022	0.0039	0.0023
Xylenes	0.0005				0.0016		0.0013		0.0009	0.0018	0.0006		0.0015	
Ethyl benzene							0.0003			0.0005			0.0003	
Naphthalene														
Cumene (isopropylbenzene)														
MTBE														
TOTAL HAPS	0.0433	0.0378	0.0409	0.0347	0.0500	0.0311	0.0310	0.0353	0.0614	0.0385	0.0321	0.0424	0.0340	0.0203

TABLE C-3. (Continued)

	HAP/VOC RATIO BY WEIGHT													
TEST ID	F17	F18	F19	F20	G1	G2	G3	G4	G5	G6	G7	G8	G9	G10
HAP														
Hexane	0.0337	0.0118	0.0442	0.0032	0.0096	0.0078	0.0063	0.0084	0.0122	0.0116	0.0154	0.0217	0.0205	0.0202
Benzene	0.0029	0.0026	0.0031	0.0021	0.0085	0.0072	0.0076	0.0080	0.0080	0.0092	0.0117	0.0141	0.0158	0.0164
Toluene	0.0052	0.0073	0.0053	0.0233	0.0069	0.0068	0.0081	0.0070	0.0060	0.0059	0.0134	0.0105	0.0086	0.0102
2,2,4 trimethylpentane	0.0019	0.0107		0.0105	0.0055	0.0052	0.0055	0.0057	0.0065	0.0075	0.0093	0.0121	0.0143	0.0159
Xylenes	0.0005	0.0016	0.0011	0.0008	0.0071	0.0046	0.0046	0.0063	0.0102	0.0076	0.0079	0.0051	0.0058	0.0122
Ethyl benzene		0.0005	0.0006	0.0010	0.0009	0.0010	0.0020	0.0010	0.0008	0.0015	0.0020	0.0051		0.0019
Naphthalene					0.0004	0.0002	0.0006	0.0004	0.0015	0.0011	0.0003			0.0004
Cumene (isopropylbenzene)														
MTBE														
TOTAL HAPS	0.0442	0.0345	0.0543	0.0409	0.0389	0.0328	0.0347	0.0368	0.0452	0.0444	0.0600	0.0686	0.0650	0.0772

TABLE C-3. (Concluded)

TEST ID	HAP/VOC RATIO BY WEIGHT						
HAP	G11	G12	G13	G14	H1	I1	I2
Hexane	0.0126	0.0137	0.0169	0.0175	0.0192	0.0184	0.0186
Benzene	0.0127	0.0127	0.0113	0.0144	0.0081	0.0077	0.0158
Toluene	0.0135	0.0116	0.0099	0.0091	0.0247	0.0066	0.0211
2,2,4 trimethylpentane	0.0091	0.0095	0.0109	0.0029	0.0085	0.0049	
Xylenes	0.0136	0.0081	0.0090	0.0086	0.0079	0.0005	0.0107
Ethyl benzene	0.0004	0.0019	0.0019	0.0016		0.0004	0.0022
Naphthalene	0.0005	0.0003	0.0006	0.0006			0.0001
Cumene (isopropylbenzene)							0.0001
MTBE	0.1463	0.1393	0.1183	0.1631			
TOTAL HAPS	0.2087	0.1971	0.1788	0.2178	0.0684	0.0385	0.0686

TABLE C-4. VAPOR PROFILE OF NORMAL GASOLINE

HAZARDOUS AIR POLLUTANT[a]	HAP TO VOC RATIO (percentage by weight) MINIMUM	ARITHMETIC AVERAGE	MAXIMUM
Hexane	0.3	1.6	4.4
Benzene	0.2	0.9	2.2
Toluene	0.4	1.3	4.0
2,2,4 Trimethylpentane (iso-octane)	0.03	0.8	2.6
Xylenes	0.05	0.5	1.5
Ethylbenzene	0.03	0.1	0.5
TOTAL HAPS[b]	2.0	4.8	11.0

[a] Cumene and naphthalene were also identified in some of the data points in small quantities. They are not shown as their addition does not significantly change the analysis.

[b] The total HAP ratios shown in the table are not simply sums of the individual HAPs. Total HAPs were calculated for each individual sample in the data base and the values represented in the table reflect the maximum, minimum, and arithmetic average total HAPs of these samples.

C.2 REFORMULATED AND OXYGENATED GASOLINES

Title II of the 1990 Clean Air Act Amendments addresses emission standards for mobile sources. There are several elements in Title II that will affect gasoline composition in the 1998 base year, and thus affect HAP emissions from gasoline storage and transfer operations.

Section 219 of Title II amends the 1977 CAA by adding Section 211(k). This section requires reformulated gasoline in nonattainment areas with a 1980 population greater than 250,000 (a total of nine cities with the worst ozone problems). All other ozone nonattainment areas can "opt-in" to the program regardless of 1980 population. Beginning in 1995, "reformulated" gasoline must be sold and marketed in these nonattainment areas with the following limits: 1) benzene content cannot exceed 1 percent, 2) no heavy metals present, and 3) minimum oxygen content of 2.0 percent. Additionally the more stringent of the Formula Standard concerning aromatics (level of 25 percent or the Performance Standards concerned with VOC or toxic emissions (15 percent reduction from emissions using a 1990 baseline fuel) shall also apply.

Section 211(m) requires the purchasing and selling of fuels with higher levels of alcohols or oxygenates in the winter months in the areas exceeding the CO standard. Beginning in 1992, these "oxygenated" fuels must have at least 2.7 percent oxygen.

The reformulated gasoline requirements will cause reductions in the benzene and aromatic contents of the fuel sold in these areas classified as nonattainment. Since many of the HAPs in gasoline vapor are aromatic compounds, this alone would reduce the total HAP content of the gasoline liquid and vapors. However, the addition of oxygen containing compounds to both reformulated and oxygenated gasoline will significantly increase the HAP content, all other things being equal. Therefore, these measures will alter the HAP content, but in opposite directions.

Methyl tert-butyl ether, or MTBE, is a major source of oxygen that will be added to gasoline by the petroleum industry to meet these requirements. MTBE is also listed in the CAAA as a HAP. Traditionally, MTBE has been used as an octane booster in unleaded gasolines. If the octane was lower than expected, small allotments of MTBE would be added to reach the desired octane level. MTBE has many advantages as an octane enhancer. It has a high average blending octane rating, dissolves easily in the refinery streams, and will not precipitate out of solution when it comes into contact with water. Therefore, the quantity of gasoline in the nation which contains some MTBE is quite large, although the MTBE content is very low. If fact, none of the data received for normal gasoline showed measurable levels of MTBE. There were four samples that contained MTBE but these were intentionally spiked during laboratory analyses to estimate reformulated gasoline percentages.

It is expected that MTBE will be the most common oxygenate used to meet the oxygen requirements. Other octane boosters/ oxygenates in use are ethanol 113, ethyl tert-butyl ether (ETBE), and tertiary amyl methyl ether (TAME). ETBE has a lower RVP (3-5) compared to MTBE (8) and its blending octane rating is also higher. However, there are limits on ETBE and the other blending agents which will keep MTBE in the forefront. Ethanol 113 is not economical without government subsidies and ETBE is similarly affected since ethanol feedstock is needed to produce ETBE. Therefore, the amount of ethanol and ETBE available will always be limited by government subsidies. The lack of isoamylene feedstock will limit the use of TAME as well.

It requires approximately 15 volume percent of MTBE in liquid gasoline to meet the 2.7 weight percent oxygen limit, and 11 volume percent to meet the 2.0 weight percent oxygen limit. The effects of these large percentages in liquid gasoline are significant. The moderate volatility of MTBE would cause high concentrations in the vapor phase relative to the less volatile aromatics. It is therefore expected that the inclusion of MTBE in these percentages may increase the HAP/VOC ratio in gasoline vapor from approximately 5 weight percent to near 15 percent, with liquid concentrations of MTBE in the 15 percent range.

The drastic differences in the HAP content of gasoline vapor (depending on the type of fuel) necessitate the estimation of vapor phase composition (HAP to VOC ratios) for several different scenarios. There will be four basic types of fuels in use after full implementation of these programs. These are 1) normal fuels (ozone and CO attainment areas and those ozone nonattainment areas not opting into the reformulated program), 2) oxygenated fuels (CO nonattainment areas), 3) reformulated fuels (ozone nonattainment areas in the reformulated program), and 4) reformulated fuels with 2.7 percent oxygen, or reformulated and oxygenated (CO and ozone nonattainment areas that are in the reformulated program).

Therefore, HAP to VOC ratios were developed for each of these fuels. The situation is further complicated by the fact that two different ratios are required for reformulated, oxygenated, and reformulated/oxygenated fuels to account for MTBE. This results in a total of seven different HAP vapor profiles as shown in Table C-5. As discussed in Section 3.3 on baseline emissions, these profiles are used throughput the analysis.

Since these programs are not in effect at this time, HAP to VOC ratios were mathematically developed using the arithmetic average vapor profile for normal fuel as the starting point. For reformulated fuel, the benzene content in the vapor was calculated based on a 1.0 percent content in the liquid. This was calculated using the equation from EPA's 1984 study, "Evaluation of Air Pollution Regulatory Strategies for Gasoline Marketing Industry", EPA-450/3-84-012a (page 2-5). This equation coupled with the VOC emission rate equation predicted that the vapor phase

TABLE C-5. VAPOR PROFILES USED IN ANALYSIS (HAP to VOC percentage by weight)

	TYPE OF GASOLINE						
		Reformulated		Oxygenated		Reformulated/Oxygenated	
HAP	Normal	with MTBE	w/o MTBE	with MTBE	w/o MTBE	with MTBE	w/o MTBE
Hexane	1.6	1.4	1.4	1.4	1.4	1.4	1.4
Benzene	0.9	0.4	0.4	0.7	0.7	0.4	0.4
Toluene	1.3	1.1	1.1	1.1	1.1	1.1	1.1
2,2,4 Trimethylpentane	0.8	0.7	0.7	0.7	0.7	0.7	0.7
Xylenes	0.5	0.4	0.4	0.4	0.4	0.4	0.4
Ethyl Benzene	0.1	0.1	0.1	0.1	0.1	0.1	0.1
MTBE		8.7		11.9		11.9	
TOTAL HAPS	4.8	12.9	4.2	16.3	4.4	16	4.2

Source: Data collected from various sources used to calculate normal gasoline vapor profile which was adjusted to represent possible compositions of reformulated and oxygenated gasolines.

benzene to total VOC ratio would be 0.44 percent by weight. This value was used for the vapor phase benzene content of all reformulated and reformulate/oxygenated gasolines. As stated above, the total aromatic content must also be reduced for reformulated gasolines to 25 weight percent in the liquid. To determine the extent of reduction necessary, a baseline aromatic content of liquid data was calculated using data from the 1990 Motor Vehicle Manufacturers Association (MVMA) National Fuel Survey. The arithmetic average aromatic content for all fuels over all times of the year was 28.7 percent. Using this as representative of the average aromatic composition of gasoline, the percent reduction needed to meet the 25 percent level was calculated to be about 13 percent. Therefore, all of the aromatic HAPS (except benzene) would be reduced by this percentage. The resulting HAP to VOC weight percentages for toluene (1.1 %), ethyl benzene (0.1 %), and xylenes (0.4 percent) were held constant for all reformulated or reformulated/ oxygenated fuels.

As discussed in Chapter 3, data were received for gasolines containing MTBE. For some of these samples, vapor data and the corresponding liquid composition were available. Using these sample results, a ratio of liquid content to vapor content was derived. This ratio was then used (at the liquid percentages of 11 and 15 percent MTBE levels) to estimate the MTBE to VOC percentage in the vapor. These estimates of MTBE to VOC ratios were 8.8 weight percent for the 11 volume percent liquid and 12 weight percent for the 15 volume percent liquid.

The addition of these large amounts of MTBE would force a reduction in the relative percentages of other compounds simply due to the volume that would be occupied by the MTBE in the liquid. Therefore, to account for this fact, the nonaromatic HAPs (hexane and 2,2,4 trimethylpentane) were reduced by 11 percent. In order to simplify the analysis, it was also assumed that these same reductions would also occur if other oxygenates were used instead of MTBE.

The oxygenated fuel profiles were similarly developed. When approximately 15 percent MTBE (or other oxygenate) was added to the profile, all other components were reduced by 15 percent. For those reformulated/oxygenated gasoline, the benzene and aromatic levels were the same as discussed above, and 15 percent oxygenate was used instead of 11 percent.

APPENDIX D

BASELINE EMISSIONS ANALYSIS

The purpose of establishing an emissions baseline is to be able to estimate the impacts of reducing emissions from this baseline through the implementation of additional control measures. The baseline emissions must take into account the level of control already in place in the base year to get an accurate assessment of the impacts of the control alternatives. As noted in Chapter 3, the base year for the gasoline marketing source category was selected as 1998.

Generally, the approach for establishing the emissions baseline was the same for each sector of the industry. An important factor in the determination of baseline emissions is the level of control that would be in effect in the absence of any hazardous air pollution regulation.

Due to the various types of gasolines that will be in use in the 1998 base year, it was necessary to divide the parameters used to estimate emissions (source population and gasoline throughput) into groups according to the type of fuel expected to be used. This breakdown was made using nonattainment area designations since this is the determining factor for the type of fuel.

To aid in the presentation of the above mentioned factors, this appendix is separated into three sections. Section D.1 discusses the baseline regulatory coverage for all States. Section D.2 follows with a description of the separation of gasoline throughput and source population by nonattainment area, and Section D.3 presents the baseline emissions calculations for the various industry sectors.

D.1 Regulatory Coverage

There are two basic control levels in effect in the United States for gasoline marketing sources. Control techniques guideline (CTG) documents have been prepared for bulk terminals, bulk plants, service stations (underground tank filling), tank trucks, and storage tanks. Also, new source performance standards (NSPS) are applicable for new or reconstructed bulk terminal loading racks and large storage tanks such as those at terminals and pipeline breakout stations.

The purpose of the CTG documents is to outline what the EPA defines as the presumptive norm for reasonably available control technology (RACT) for existing sources. Some of the recommendations are in the form of emission limits and others are in the form of recommended control equipment to be installed. States with nonattainment areas for ozone are required to adopt regulations consistent with these CTG recommendations to provide for attainment of the national ambient air quality standards (NAAQS). The NSPS are national standards regulating new or reconstructed sources of criteria pollutants, including ozone (VOC sources).

To estimate how the States have implemented the CTG recommendations, State regulations were reviewed for Stage I gasoline marketing sources. The results of this survey were used to estimate the affected gasoline throughput on a State-by-State basis. In instances where regulations covered an entire State, it was assumed that all throughput for the State was covered by the regulation. Base year 1998 State gasoline throughputs were determined as follows. The State and national 1990 gasoline throughputs were obtained from the 1991 National Petroleum News (NPN) Factbook issue. The ratio of the 1998 national throughput discussed in Section 8.1 to the 1990 national throughput from NPN was determined and multiplied by the 1990 throughputs for each State to obtain 1998 State gasoline throughput.

However, many States have regulations that cover only ozone nonattainment areas. For these States, the counties that were covered were determined and the percentage of county throughput to State throughput was calculated using 1985 NEDS gasoline consumption. While these throughputs may not be applicable to the base year 1998, it was assumed that the relative county to State throughput percentages were acceptable approximations. Estimates were made regarding the percentage of the throughput and/or source population affected by NSPS regulations.

The following paragraphs address the CTG and NSPS control levels and the penetration of standards throughout the nation. The areas discussed are bulk terminal loading racks, storage tanks, bulk plants, tank trucks, and service stations (storage tank filling). While there are regulations for similar applications for the control of fugitive emissions from leaking pumps and valves, there are no regulations that specifically address these components for pipeline facilities, bulk terminals, and bulk plants (although a few bulk terminals apparently practice leak detection and repair). Therefore, for the purposes of this analysis, it is assumed that all fugitive emissions at gasoline marketing sources are uncontrolled.

D.1.1 Bulk Terminal Loading Racks

There is both a CTG and an NSPS regulation for loading racks at bulk terminals. The recommended CTG level of control is 80 mg VOC/liter of gasoline loaded. This limit is based on submerged fill and vapor recovery/control systems. The CTG also recommends that no leaks be allowed in the vapor collection system during operation. The NSPS level is similar, except that the numerical limit is 35 mg total organic compounds (TOC)/liter. State regulations were reviewed to determine the requirements for bulk terminals. Table D-1 lists the States that have implemented requirements for bulk terminals. The States listed in the first column require that all terminals within their boundaries achieve a level of control consistent with the CTG (80 mg/l). The second column includes States that require controls consistent with the CTG only for areas within the States that do not meet the ozone NAAQS (nonattainment areas).

An earlier study indicated that approximately 60 percent of the systems installed for the purpose of meeting the 80 mg/l limit routinely operate at the NSPS level of 35 mg/l. In conversations with equipment manufacturers in 1991, it was determined that control devices are no longer manufactured to meet 80 mg/l, but are typically designed to meet 35 mg/l. Therefore, unless otherwise specified, it was assumed that 60 percent of the terminals in the controlled areas listed in Table D-1 are operating at 35 mg/l, with the remainder operating at 80 mg/l (or 90 percent control in one instance). This 60 percent includes those new or reconstructed terminals that are required to meet the NSPS level. In addition, two districts in California (Bay Area and Sacramento) have loading rack emission limitations equivalent to 10 mg/l. Test data indicate that many terminals are operating at levels considerably below 10 mg/l (see Section 4.1.2.3).

Therefore, there are four basic control levels. These are 10 mg/l, 35 mg/l, 80 mg/l, and uncontrolled. The uncontrolled sources may be further divided into those loading with submerged fill and with splash fill. As discussed in the 1987 Response to Public Comments document, it is believed that 94 percent of uncontrolled terminals load using submerged fill and 6 percent by splash fill. These percentages were also used in this analysis. State gasoline throughput by control level is shown in Table D-2. Also, Table D-3 presents nationwide parameters by control level used in the baseline emissions analysis.

It was assumed that the breakdown of the bulk terminal population would be parallel to throughput. Therefore, the terminal population by control level shown in Table D-3 was calculated by multiplying the percentage of throughput in that control level category by the total nationwide terminal population.

TABLE D-1. STATE REGULATORY COVERAGE FOR BULK GASOLINE TERMINALS

Entire State Consistent With CTG Controls[a]	CTG Controls[a] Nonattainment Areas Only	No Control Regulations[d]
Alabama	Arkansas	Alaska
California	Colorado	Arizona
Connecticut	Delaware	Hawaii
District of Columbia	Florida	Idaho
Illinois	Georgia	Iowa
Kentucky	Indiana	Minnesota
Louisiana	Kansas	Mississippi
Maine	Maryland	Montana
Massachusetts	Missouri	Nebraska
Michigan	Nevada[b]	North Dakota[c]
New Hampshire	New Mexico	South Dakota
New Jersey	New York	Wyoming
North Carolina	Ohio	
Pennsylvania	Oklahoma[b]	
Rhode Island	Oregon	
South Carolina	Texas	
Tennessee	Utah	
Wisconsin	Virginia	
	Vermont	
	Washington	
	West Virginia	

a CTG Controls = 80 mg/liter standard or lower.

b Portion of State not covered by CTG controls is covered by submerged fill requirements.

c North Dakota has no nonattainment areas for ozone, but the entire State is covered by submerged fill requirements.

d Approximately 94 percent of total throughput is loaded by submerged fill.

TABLE D-2. STATE BULK TERMINAL THROUGHPUT BY LOADING RACK CONTROL LEVEL[a]
(1,000 gallons/year)

STATE	80 mg/l	90 % control	35 mg/l	10 mg/l	UNCONTROLLED
ALABAMA	858,258	0	1,287,387	0	0
ALASKA	0	0	27,739	0	249,652
ARIZONA	390,520	0	657,992	0	649,906
ARKANSAS	9,053	0	139,262	0	1,131,139
CALIFORNIA	4,038,743	0	6,058,115	3,365,619	0
COLORADO	338,180	0	579,290	0	648,179
CONNECTICUT	585,145	0	877,717	0	0
DELAWARE	140,460	0	210,690	0	0
DISTRICT OF COL.	0	71,155	106,733	0	0
FLORIDA	1,181,764	0	2,105,803	0	2,998,412
GEORGIA	622,024	0	1,138,936	0	1,853,104
HAWAII	0	0	39,339	0	354,050
IDAHO	0	0	49,751	0	447,756
ILLINOIS	2,114,729	0	3,172,093	0	0
INDIANA	490,485	0	885,944	0	1,351,945
IOWA	0	0	139,287	0	1,253,582
KANSAS	111,405	0	265,854	0	888,711
KENTUCKY	749,042	0	1,123,562	0	0
LOUISIANA	819,406	0	1,229,109	0	0
MAINE	160,852	0	262,931	0	194,878
MARYLAND	755,437	0	1,162,575	0	264,777
MASSACHUSETTS	985,152	0	1,477,728	0	0
MICHIGAN	979,093	0	1,666,167	0	1,777,741
MINNESOTA	0	0	210,227	0	1,892,045
MISSISSIPPI	10,241	0	140,811	0	1,129,045
MISSOURI	572,469	0	994,106	0	1,218,620
MONTANA	0	0	44,963	0	404,667
NEBRASKA	0	0	80,497	0	724,472
NEVADA	0	0	65,956	0	593,608
NEW HAMPSHIRE	146,601	0	234,871	0	134,728

TABLE D-2. (Concluded)

STATE	80 mg/l	90 % control	35 mg/l	10 mg/l	UNCONTROLLED
NEW JERSEY	1,435,664	0	2,153,497	0	0
NEW MEXICO	0	0	82,107	0	738,965
NEW YORK	1,664,553	0	2,699,889	0	1,827,538
NORTH CAROLINA	1,350,866	0	2,026,298	0	0
NORTH DAKOTA	0	0	35,639	0	320,747
OHIO	1,690,480	0	2,696,532	0	1,447,300
OKLAHOMA	110,902	0	311,912	0	1,310,030
OREGON	221,246	0	414,836	0	746,705
PENNSYLVANIA	1,916,045	0	2,874,067	0	0
RHODE ISLAND	154,234	0	231,351	0	0
SOUTH CAROLINA	654,910	0	982,364	0	0
SOUTH DAKOTA	0	0	39,858	0	358,720
TENNESSEE	1,057,880	0	1,586,820	0	0
TEXAS	1,683,407	0	3,000,737	0	4,280,640
UTAH	155,837	0	269,103	0	318,131
VERMONT	0	0	29,410	0	264,686
VIRGINIA	1,225,531	0	1,838,296	0	0
WASHINGTON	46,772	0	292,325	0	1,999,501
WEST VIRGINIA	90,751	0	197,961	0	556,513
WISCONSIN	859,352	0	1,289,027	0	0
WYOMING	0	0	26,523	0	238,705
NATIONWIDE	30,377,488	71,155	49,513,986	3,365,619	34,569,200
	26%	0%	42%	3%	29%

[a] The control levels represent the emission level. As an example, it is assumed that 49,513,986 thousand gallons per year of gasoline passes through terminals emitting VOCs at approximately 35 mg/liter of throughput.

TABLE D-3. NATIONWIDE BULK TERMINAL LOADING RACK - BASELINE PARAMETERS BY CONTROL LEVEL

Control Level	Annual Throughput (10^6 liters)	Percent of Total Throughput	Number of Facilities
10 mg VOC/liter	13,000	3%	29
35 mg VOC/liter	187,000	42%	430
80 mg VOC/liter and 90 percent control	115,000	26%	265
Submerged filling only	123,000	27%	282
Splash filling	8,000	2%	18

D.1.2 Storage Tanks

There are CTG documents for petroleum liquid storage in fixed-roof tanks and external floating roof tanks, and NSPS regulations covering fixed-roof and external floating roof petroleum liquid storage tanks. The CTGs recommend the installation of internal floating roofs on fixed-roof tanks and a continuous primary seal on external floating roofs. There are several NSPS standards (Subparts K, Ka, and Kb) for storage tanks with varying control level requirements. However, in order to simplify this analysis, it was assumed that the NSPS level of control of storage tanks was internal floating roofs for fixed-roof tanks, and primary and secondary seals for external floating roof tanks. A review of State regulations revealed that most States regulate emissions from storage tanks in their State implementation plans (SIPs) with CTG recommended controls. Based on information contained in an earlier tank survey and the results of this review of State regulations, the following assumptions were made.

In attainment areas with no storage tank regulations, 10 percent of the tanks would be external floating roof tanks subject to NSPS and have primary and secondary seals, with an additional 47 percent having external floating roofs with primary seals. The remaining 43 percent were assumed to be fixed-roof tanks, with 16 percent having internal floating roofs and the remaining 27 percent having no controls.

Many areas require the CTG level of control for fixed-roof tanks and primary seals on external floating roof tanks. For these areas, it was assumed that 78 percent of the tanks were external floating roof tanks, with 10 percent subject to NSPS and having secondary seals in addition to the primary seals and the remaining 68 percent being external floating roof tanks with primary seals. The remaining 22 percent were assumed to be fixed-roof tanks with internal floating roofs.

Finally, there are areas where both primary and secondary seals are required. For these areas, it was assumed that 75 percent of these tanks were external floating roof tanks and 25 percent fixed-roof tanks with internal floating roofs.

Working losses for both fixed-roof and external floating roof storage tanks are a function of gasoline throughput, and not the storage tank population. Storage tank throughputs were estimated for each of the control levels. However, these throughputs were arrived at in different fashions for bulk terminal storage tanks and pipeline breakout station storage tanks. The following describes in more detail how the storage tank populations and throughputs were derived.

D.1.2.1 Pipeline Breakout Station Storage Tanks.

As discussed in Chapter 8, the total nationwide population of breakout stations was estimated by counting observances of pipeline branches and diameter changes across the country. These branches and diameter changes were noted by State. The total number of breakout stations by State was then placed in the appropriate control level as discussed above. This is shown in Table D-4. Assuming an average of four "equivalent dedicated storage tanks" (see Chapter 5) per breakout station, the nationwide breakout station storage tank total (for emissions purposes) was calculated by control level. This calculated to a total of 748 external floating roof tanks, with 476 having primary seals and 272 having primary and secondary seals. It was also estimated that there were 231 fixed-roof tanks, with 88 having internal floating roofs and 143 being uncontrolled.

The throughput by control level was calculated assuming that each tank had a storage capacity of 50,000 bbls with 150 turnovers per year, for an annual throughput of 315,000,000 gallons. This individual tank throughput was multiplied by the number of tanks in each control level to give the throughput.

TABLE D-4. PIPELINE BREAKOUT STATION POPULATION BY STATE SEPARATED BY STORAGE TANK CONTROL LEVEL[a]

STATE	Total Number of Stations	STORAGE TANK CONTROL LEVEL Primary Seal Areas	Secondary Seal Areas	Uncontrolled
ALABAMA	4	4		
ALASKA	0			
ARIZONA	10			10
ARKANSAS	3		3	
CALIFORNIA	10		10	
COLORADO	2		2	
CONNECTICUT	1	1		
DELAWARE	0			
DISTRICT OF COL.	0		4	
FLORIDA	4	3		1
GEORGIA	8	3		5
HAWAII	0			
IDAHO	3	3		
ILLINOIS	17		17	
INDIANA	11	11		
IOWA	11			11
KANSAS	15		1	10
KENTUCKY	0			
LOUISIANA	13		13	
MAINE	0			
MARYLAND	3	3		
MASSACHUSETTS	3	2		1
MICHIGAN	7	7		
MINNESOTA	11	11		
MISSISSIPPI	2			2
MISSOURI	10			10
MONTANA	4			4
NEBRASKA	4			4
NEVADA	2	2		
NEW HAMPSHIRE	0			

TABLE D-4. (Concluded)

STATE	Total Number of Stations	STORAGE TANK CONTROL LEVEL Primary Seal Areas	Secondary Seal Areas	Uncontrolled
NEW JERSEY	2	2		
NEW MEXICO	4	4		
NEW YORK	8			8
NORTH CAROLINA	4		4	
NORTH DAKOTA	2			2
OHIO	13	5		8
OKLAHOMA	7	3		4
OREGON	4		1	3
PENNSYLVANIA	17	17		
RHODE ISLAND	0			
SOUTH CAROLINA	0			
SOUTH DAKOTA	7			7
TENNESSEE	2		2	
TEXAS	27		3	24
UTAH	2		2	
VERMONT	0			
VIRGINIA	9	1		8
WASHINGTON	8			8
WEST VIRGINIA	0			
WISCONSIN	1	1		
WYOMING	2			2
NATIONWIDE TOTALS	277	83	62	132
		30.0%	22.4%	47.7%

[a] The storage tank control levels shown in the column heading are defined as follows:
- Primary seal areas are those areas that require primary seals only on external floating roof tanks and internal floating roofs on fixed-roof tanks.
- Secondary seal areas are those areas that require primary and secondary seals on external floating roof tanks and internal floating roofs on fixed-roof tanks.
- Uncontrolled areas are those areas that do not have any storage tank emission control regulations.

D.1.2.2 Bulk Terminal Storage Tanks. The bulk terminal storage tank population and throughput were arrived at in a different manner from the breakout station parameters discussed above. The initial step was to divide each State's gasoline throughput into the various control levels applicable to the particular State. State gasoline throughput by control level for bulk terminal storage tanks is shown in Table D-5. The number of tanks per State was calculated the same for each control level using the following relationship:

$$\text{State capacity (bbl)} = \frac{\text{State Throughput (bbl)}}{\text{Number of Turnovers/year}}$$

$$\text{Number of Tanks/State} = \frac{\text{State Capacity (bbl)}}{\text{Storage Tank Capacity (bbl)}}$$

Storage tank capacities of 36,000 bbl and 16,750 bbl were assumed for floating roof and fixed-roof storage tanks, respectively, and 13 turnovers per year per tank. Baseline parameters for bulk terminal storage tanks are presented in Table D-6.

D.1.3 Bulk Plants

The CTG for bulk plants contains recommended control alternatives of 1) submerged fill of outgoing tank trucks, 2) submerged fill of outgoing tank trucks and vapor balance for incoming transfer, and 3) submerged fill and vapor balance for outgoing and incoming transfer. The CTG discusses exemptions from vapor balance on outgoing loads at bulk plants with daily throughputs of less than 4,000 gallons.

A review of all State regulations was also conducted to determine the regulatory coverage for bulk plants. States commonly responded to the recommended CTG alternatives by selecting Alternative 3 as the control level. However, some State regulations include an exemption from vapor balance for those plants with daily throughputs less than 4,000 gallons, requiring only submerged fill on outgoing transfers. Table D-7 shows a summary of State bulk plant

TABLE D-5. STATE BULK TERMINAL THROUGHPUT BY STORAGE TANK TYPE[a]

	THROUGHPUT BY TANK TYPE BY STATE (10^3 BBL/yr)			
STATE	PRIMARY SEALS	SECONDARY SEALS	FIXED WITH INTERNAL	UNCONTROLLED FIXED
ALABAMA	34,484	5,109	11,495	0
ALASKA	3,121	660	1,040	1,783
ARIZONA	23,775	4,044	7,925	4,695
ARKANSAS	0	22,847	7,616	0
CALIFORNIA	0	240,401	80,134	0
COLORADO	8,042	16,895	7,745	4,595
CONNECTICUT	23,510	3,483	7,837	0
DELAWARE	5,643	836	1,881	0
DISTRICT OF COL.	0	3,177	1,059	0
FLORIDA	85,476	14,967	28,492	20,731
GEORGIA	47,522	8,605	15,841	14,081
HAWAII	6,322	937	2,107	0
IDAHO	7,996	1,185	2,665	0
ILLINOIS	0	94,408	31,469	0
INDIANA	34,762	6,496	11,587	12,116
IOWA	15,670	3,316	5,223	8,954
KANSAS	11,539	6,733	5,277	6,594
KENTUCKY	30,095	4,459	10,032	0
LOUISIANA	0	36,581	12,194	0
MAINE	9,943	1,473	3,314	0
MARYLAND	31,172	5,197	10,391	5,211
MASSACHUSETTS	39,582	5,864	13,194	0
MICHIGAN	71,084	10,531	23,695	0
MINNESOTA	33,787	5,005	11,262	0
MISSISSIPPI	14,401	3,048	4,800	8,229
MISSOURI	21,871	19,649	12,297	12,498
MONTANA	5,058	1,071	1,686	2,890
NEBRASKA	9,056	1,917	3,019	5,175
NEVADA	10,600	1,570	3,533	0

TABLE D-5. (Concluded)

STATE	PRIMARY SEALS	SECONDARY SEALS	FIXED WITH INTERNAL	UNCONTROLLED FIXED
	THROUGHPUT BY TANK TYPE BY STATE (10^3 BBL/yr)			
NEW HAMPSHIRE	8,296	1,229	2,765	0
NEW JERSEY	57,683	8,546	19,228	0
NEW MEXICO	13,196	1,955	4,399	0
NEW YORK	83,412	14,743	27,804	21,469
NORTH CAROLINA	0	60,307	20,102	0
NORTH DAKOTA	4,009	849	1,336	2,291
OHIO	82,099	13,891	27,366	15,556
OKLAHOMA	20,797	4,126	6,932	9,403
OREGON	9,317	11,875	6,407	5,324
PENNSYLVANIA	76,984	11,405	25,661	0
RHODE ISLAND	6,197	918	2,066	0
SOUTH CAROLINA	0	29,237	9,746	0
SOUTH DAKOTA	4,484	949	1,495	2,562
TENNESSEE	0	47,237	15,742	0
TEXAS	59,901	77,682	41,635	34,229
UTAH	4,849	6,598	3,474	2,771
VERMONT	4,727	700	1,576	0
VIRGINIA	36,933	7,295	12,311	16,410
WASHINGTON	26,895	5,568	8,965	14,253
WEST VIRGINIA	13,584	2,012	4,528	0
WISCONSIN	34,528	5,115	11,509	0
WYOMING	2,984	631	995	1,705
	1,135,384	843,320	594,851	233,527
	40%	30%	21%	8%

[a] The tank types are external floating roof tanks and fixed-roof tanks. PRIMARY SEALS refers to external floating roof tanks with primary seals only. SECONDARY SEALS refers to external floating roof tanks with primary and secondary seals. FIXED WITH INTERNAL refers to fixed-roof tanks with internal floating roofs. UNCONTROLLED FIXED refers to fixed-roof tanks without an internal floating roof.

TABLE D-6. BASELINE PARAMETERS FOR BULK TERMINAL STORAGE TANKS

Control Level	Annual Thruput (10^6 bbls)	Percent of Thruput	Number of Tanks	Percent of Tanks
External Floating Roof Tanks				
with Primary Seals	1,135	40%	2,426	57%
with Primary and Secondary Seals	843	30%	1,802	43%
			4,228	100%
Fixed-Roof Tanks				
with Internal Floating Roofs	595	21%	2,732	72%
Uncontrolled	234	8%	1,072	28%
			3,804	100%

TABLE D-7. STATE REGULATORY COVERAGE FOR BULK PLANTS

Entire State Consistent With CTG Controls[a]	CTG Controls[a] Nonattainment Areas Only	No Control Regulations[b]
Alabama	Arkansas	Alaska
California[c]	Colorado	Arizona
Connecticut	Delaware[c]	Florida
District of Columbia	Georgia	Hawaii
Illinois	Indiana[c]	Idaho
Kentucky[c]	Maryland[c]	Iowa
Louisiana[c]	Missouri[c]	Kansas
Massachusetts	Nevada	Maine
Michigan	New York[c]	Minnesota
New Jersey	Ohio	Mississippii
North Carolina[c]	Oregon	Montana
Pennsylvania[c]	Texas[c]	Nebrasksa
Rhode Island[c]	Utah[c]	New Hampshire
South Carolina[c]	Washington	New Mexico
Tennessee		North Dakota
Virginia[c]		Oklahoma
Wisconsin		South Dakota
		Vermont
		West Virginia
		Wyoming

[a]CTG recommendations include the use of vapor balance, submerged fill, and pressure relief settings for storage tanks, and vapor balance for the loading racks.

[b]Loadings assumed to be 25 percent splash fill and 75 percent submerged fill at loading racks, unless otherwise specified.

[c]Regulations require vapor balance on all outgoing transfers. All other areas with CTG regulations exempt plants with daily throughputs less than 4,000 gallons/day from installing vapor balance equipment.

regulations in a manner similar to the bulk terminal table shown earlier.

Bulk plants are intermediate storage and distribution facilities. Therefore, all of the gasoline throughput for an area does not pass through a bulk plant. In order to estimate emissions from bulk plants, the throughput that travels through bulk plants was a necessary parameter. Information contained in the 1987 Census of Wholesale Trade was used to estimate the bulk plant throughput on an individual State basis. The State throughput for bulk stations contained in the Census information was divided by the total State throughput to obtain an estimate of the percentage for bulk plants. These percentages were applied to the estimated 1998 State throughput to calculate baseline bulk plant throughput. This is shown in Table D-8.

This throughput was then separated by State by control level. The four basic control levels were 1) vapor balance on incoming and outgoing loading operations with no exemptions, 2) vapor balance on incoming and outgoing loading operations with submerged fill requirements for bulk plants with throughputs less than 4,000 gallons per day, 3) vapor balance on incoming loads with submerged fill only on outgoing loads, and 4) no controls. The throughput by State by control level is shown in Table D-9. The uncontrolled throughput was further divided into splash and submerged fill. It was assumed that 75 percent of the uncontrolled plants load using submerged fill and 25 percent using splash fill. Table D-10 presents national parameters used in the baseline emissions analysis for bulk plants.

The populations in Table D-10 were basically derived using the throughput breakdowns by control level and applying those to the bulk plant population provided in Section 8.2. This was done except in the instance of aviation bulk plants. All of these were assumed to be uncontrolled with the percentage loading by submerged fill the same as for motor gasoline.

TABLE D-8. BULK PLANT THROUGHPUT BY STATE
(1,000 gallons/year)

STATE	1998 TOTAL THROUGHPUT	% THRU PLANTS	BULK PLANT THROUGHPUT
ALABAMA	2,145,645	23%	493,498
ALASKA	277,391	19%	52,704
ARIZONA	1,698,418	24%	407,620
ARKANSAS	1,279,454	33%	422,220
CALIFORNIA	13,462,477	18%	2,423,246
COLORADO	1,565,650	42%	657,573
CONNECTICUT	1,462,862	6%	87,772
DELAWARE	351,150	68%	238,782
DISTRICT OF COL.	177,888	18%	32,020
FLORIDA	6,285,978	12%	754,317
GEORGIA	3,614,063	30%	1,084,219
HAWAII	393,389	3%	11,802
IDAHO	497,506	37%	184,077
ILLINOIS	5,286,822	18%	951,628
INDIANA	2,728,374	21%	572,959
IOWA	1,392,869	36%	501,433
KANSAS	1,265,970	53%	670,964
KENTUCKY	1,872,604	28%	524,329
LOUISIANA	2,048,515	37%	757,951
MAINE	618,660	25%	154,665
MARYLAND	2,182,788	10%	218,279
MASSACHUSETTS	2,462,880	9%	221,659
MICHIGAN	4,423,002	12%	530,760
MINNESOTA	2,102,272	24%	504,545
MISSISSIPPI	1,280,097	43%	550,442
MISSOURI	2,785,195	30%	835,559
MONTANA	449,630	18%	80,933
NEBRASKA	804,969	56%	450,783
NEVADA	659,565	4%	26,383
NEW HAMPSHIRE	516,200	66%	340,692
NEW JERSEY	3,589,161	5%	179,458

TABLE D-8. (Concluded)

STATE	1998 TOTAL THROUGHPUT	% THRU PLANTS	BULK PLANT THROUGHPUT
NEW MEXICO	821,073	37%	303,797
NEW YORK	6,191,979	7%	433,439
NORTH CAROLINA	3,377,164	26%	878,063
NORTH DAKOTA	356,386	31%	110,480
OHIO	5,834,312	8%	466,745
OKLAHOMA	1,732,844	41%	710,466
OREGON	1,382,787	25%	345,697
PENNSYLVANIA	4,790,112	13%	622,715
RHODE ISLAND	385,586	3%	11,568
SOUTH CAROLINA	1,637,274	18%	294,709
SOUTH DAKOTA	398,577	18%	71,744
TENNESSEE	2,644,699	18%	476,046
TEXAS	8,964,784	17%	1,524,013
UTAH	743,071	18%	133,753
VERMONT	294,095	52%	152,929
VIRGINIA	3,063,827	13%	398,297
WASHINGTON	2,338,598	15%	350,790
WEST VIRGINIA	845,225	34%	287,377
WISCONSIN	2,148,379	21%	451,160
WYOMING	265,228	43%	114,048
NATIONWIDE	117,897,448	20%	23,061,106

TABLE D-9. STATE BULK PLANT THROUGHPUT BY CONTROL LEVEL[a]
(1,000 gallons/year)

STATE	VAPOR BALANCE NO EXEMPTIONS	VAPOR BALANCE WITH EXEMPTIONS	VAPOR BALANCE IN SUBMERG FILL OUT	UNCONTROLLED
ALABAMA	0	493,498	0	0
ALASKA	0	0	0	52,704
ARIZONA	0	234,312	0	173,308
ARKANSAS	0	7,469	0	414,751
CALIFORNIA	2,423,246	0	0	0
COLORADO	0	355,089	0	302,484
CONNECTICUT	0	87,772	0	0
DELAWARE	238,782	0	0	0
DISTRICT OF COL.	32,020	0	0	0
FLORIDA	0	354,529	0	399,788
GEORGIA	0	466,518	0	617,701
HAWAII	0	0	0	11,802
IDAHO	0	0	0	184,077
ILLINOIS	0	951,628	0	0
INDIANA	257,505	0	0	315,454
IOWA	0	0	0	501,433
KANSAS	0	147,612	0	523,352
KENTUCKY	524,329	0	0	0
LOUISIANA	757,951	0	0	0
MAINE	0	100,532	0	54,133
MARYLAND	188,859	0	0	29,420
MASSACHUSETTS	0	0	221,659	0
MICHIGAN	0	293,728	0	237,032
MINNESOTA	0	0	0	504,545
MISSISSIPPI	0	11,009	0	539,433
MISSOURI	429,352	0	0	406,207
MONTANA	0	0	0	80,933
NEBRASKA	0	0	0	450,783
NEVADA	0	0	0	26,383
NEW HAMPSHIRE	0	241,891	0	98,801

TABLE D-9. (Concluded)

STATE	VAPOR BALANCE NO EXEMPTIONS	VAPOR BALANCE WITH EXEMPTIONS	VAPOR BALANCE IN SUBMERG FILL OUT	UNCONTROLLED
NEW JERSEY	0	179,458	0	0
NEW MEXICO	0	0	0	303,797
NEW YORK	291,297	0	0	142,142
NORTH CAROLINA	878,063	0	0	0
NORTH DAKOTA	0	0	0	110,480
OHIO	0	338,096	0	128,649
OKLAHOMA	0	113,675	0	596,792
OREGON	0	138,279	0	207,418
PENNSYLVANIA	622,715	0	0	0
RHODE ISLAND	11,568	0	0	0
SOUTH CAROLINA	294,709	0	0	0
SOUTH DAKOTA	0	0	0	71,744
TENNESSEE	0	476,046	0	0
TEXAS	715,448	0	0	808,565
UTAH	70,127	0	0	63,626
VERMONT	0	0	0	152,929
VIRGINIA	398,297	0	0	0
WASHINGTON	0	17,539	0	333,250
WEST VIRGINIA	0	77,138	0	210,238
WISCONSIN	0	451,160	0	0
WYOMING	0	0	0	114,048
NATIONWIDE	8,134,266	5,536,979	221,659	9,168,201
	35%	24%	1%	40%

[a] VAPOR BALANCE NO EXEMPTIONS refers to those areas that have regulations requiring vapor balance on the incoming side for all bulk plants, regardless of throughput. VAPOR BALANCE WITH EXEMPTIONS refers to those areas that require vapor balance on the incoming side for all bulk plants, and vapor balance on the outgoing side for all plants with daily throughputs below this level. VAPOR BALANCE IN SUBMERG FILL OUT denotes the areas that require vapor balance on incoming loads, but only submerged fill on outgoing loads. UNCONTROLLED refers to those areas without any emission regulations covering bulk plants.

TABLE D-10. BASELINE PARAMETERS FOR BULK PLANTS

Control Level	Annual Throughput (10^6 liters)	Percent of Total Throughput	Number of Facilities
Vapor balance incoming and outgoing load, no exemptions	30,791	35%	3,315
Vapor balance incoming and outgoing load, submerged fill on outgoing loads at plants < 4,000 gal/day	20,960	24%	2,256
Vapor balance incoming, submerged fill outgoing	839	1%	90
Submerged fill incoming and outgoing	26,029	30%	5,202
Motor vehicle gasoline			2,802
Aviation gasoline			2,400
Submerged fill incoming and splash fill outgoing	8,676	10%	1,734
Motor vehicle gasoline			934
Aviation gasoline			800

D.1.4 <u>Tank Trucks</u>

In determining baseline regulatory coverage for tank trucks, two cases were considered: trucks in "normal" service and trucks in "collection" service (i.e., trucks equipped with vapor collection equipment). Normal service pertains to areas where no controls (or only submerged fill) are required at the terminal or bulk plant. In this situation there are no collection systems; therefore, there can be no leakage of vapors from the vapor collection system or the truck tank. "Collection" service pertains to loading when vapor balance systems are employed. For areas where vapor balance systems are used, the CTG recommendation is to have vapor-tight tank trucks. The CTG recommendations for vapor-tight tank trucks are that 1) the tank truck must pass an annual leak-tight test that requires it to have less than 3" H_2O pressure change under 18" H_2O pressure or 6" H_2O vacuum, 2) it have no leaks greater than 100 percent of the lower explosive limit (LEL) when monitored at any time with a portable combustible gas analyzer, and 3) the vapor collection system backpressure not exceed 18" H_2O when measured at the truck.

In addition to the CTG level, many districts in the State of California require an annual vapor tightness test with less than 1" or 2" H_2O pressure change rather than the CTG recommendation of 3" H_2O. In addition to this difference, there are enforcement programs in California that actively monitor trucks using portable gas analyzers or equivalent methods. The combination of this more stringent test and increased enforcement results in a control level slightly more effective than the CTG level.

It was assumed in this analysis that all areas requiring vapor collection and control at terminal loading racks require that tank trucks be vapor-tight. It was also assumed that all areas requiring vapor balance for the outgoing truck loading racks at bulk plants require that bulk tank trucks be vapor-tight.

Emissions from tank truck leakage are calculated using gasoline throughput. Therefore, gasoline throughput was separated into controlled and uncontrolled at bulk terminals and bulk plants to calculate tank truck leakage emissions. For both terminals and plants, the throughput in California was separated into an "enhanced" truck tightness category.

As discussed in Chapter 8, Section 8.2, the population of tank trucks may be divided into two groups within the overall categories of bulk plant trucks and bulk terminal trucks. These are private (owned by terminal or plant owner) and for-hire. In addition, bulk plant private trucks may be broken down into motor vehicle gasoline trucks and aviation gasoline trucks. In order to estimate the number of these trucks that already had controls installed, the throughput percentages discussed above for bulk terminals and bulk plants were applied to the populations of tank trucks to estimate the number controlled and uncontrolled (except for aviation gasoline trucks, which were all assumed to be uncontrolled).

Table D-11 shows the baseline gasoline throughput percentages and populations by control level for tank trucks. While this represents the baseline conditions, only the throughput is used in the emissions analysis.

D.1.5 Service Stations

The approach for determining the regulatory coverage for service stations was similar to that for bulk terminal loading racks and bulk plants. All gasoline, with the exception of agricultural accounts, was assumed to pass through service stations (including public and private outlets). The service station design criteria document contains emission limits in terms of equipment specifications. Recommended controls are submerged fill of storage tanks, vapor balance between truck and tank, and a leak-free truck and vapor transfer system. There are no exemptions noted in the design criteria document.

TABLE D-11. BASELINE PARAMETERS FOR TANK TRUCKS

Control Level	Percent of Total Throughput	Number of Trucks
Bulk Terminal Tank Trucks		
Enhanced leak tightness	11%	5,079
Annual leak tightness	60%	26,090
Uncontrolled	29%	12,731
Bulk Plant Tank Trucks		
Enhanced leak tightness	11%	4,818
Annual leak tightness	49%	17,622
Uncontrolled	40%	21,360
Motor vehicle gasoline		14,960
Aviation gasoline		6,400

State regulations were also reviewed to determine the regulatory coverage for storage tank filling at service stations. Although the design criteria document does not contain exemptions, there are various exemption levels contained in the State regulations. Many of these regulations contain exemptions with respect to tank size, which exempts most agricultural accounts. Other regulations specifically exempt agricultural dispensing facilities. Some States exempt dispensing facilities according to monthly throughput, with the common exemption level being 38,000 liters (10,000 gallons) per month.

For the purposes of this analysis, there were three basic control levels selected. These are 1) vapor balancing with no exemptions, 2) vapor balancing with a 38,000 liters (10,000 gallons) per month exemption, and 3) uncontrolled. Control level 1 includes areas with no exemptions as well as the areas with exemptions for very small tanks. This exemption affects very few public and private facilities except for agricultural accounts. Also, as with bulk terminals and bulk plants, the uncontrolled stations are divided into submerged and splash fill. Unless otherwise noted, uncontrolled throughput was split 50/50 between submerged and splash fill. It was assumed that all aviation service station type facilities were uncontrolled and operated with the same split between submerged and splash as stated above.

Gasoline throughput by State by control level is shown in Table D-12. Baseline population and throughput for service stations is summarized in Table D-13.

D.2 BASELINE ANALYSIS OF FUEL TYPES

As discussed in Chapter 3 and Appendix C, there are four basic fuel types that are expected to be in use in the base year of 1998. These are 1) normal, 2) reformulated, 3) oxygenated, and 4) a combination of oxygenated and reformulated. Since HAP emissions are calculated by multiplying the VOC emissions by a HAP to VOC ratio, the

TABLE D-12. STATE SERVICE STATION THROUGHPUT BY CONTROL LEVEL[a] (1,000 gallons/year)

STATE	NO EXEMPTIONS	WITH EXEMPTIONS	SUBMERGED FILL	UNCONTROLLED
ALABAMA	2,145,645	0	0	0
ALASKA	0	0	0	277,391
ARIZONA	0	0	0	1,698,418
ARKANSAS	0	22,634	0	1,256,821
CALIFORNIA	13,462,477	0	0	0
COLORADO	0	845,451	0	720,199
CONNECTICUT	0	1,462,862	0	0
DELAWARE	0	351,150	0	0
DISTRICT OF COL.	177,888	0	0	0
FLORIDA	0	2,954,410	0	3,331,569
GEORGIA	0	1,555,059	0	2,059,004
HAWAII	0	0	0	393,389
IDAHO	0	0	0	497,506
ILLINOIS	0	5,286,822	0	0
INDIANA	1,226,213	0	0	1,502,161
IOWA	0	0	0	1,392,869
KANSAS	0	278,513	0	987,457
KENTUCKY	1,872,604	0	0	0
LOUISIANA	2,048,515	0	0	0
MAINE	618,660	0	0	0
MARYLAND	0	1,888,592	0	294,196
MASSACHUSETTS	2,462,880	0	0	0
MICHIGAN	0	4,423,002	0	0
MINNESOTA	0	0	0	2,102,272
MISSISSIPPI	0	25,602	0	1,254,495
MISSOURI	0	1,431,173	0	1,354,023
MONTANA	0	0	0	449,630
NEBRASKA	0	0	0	804,969
NEVADA	0	0	0	659,565
NEW HAMPSHIRE	0	366,502	0	149,698

TABLE D-12. (Concluded)

STATE	NO EXEMPTIONS	WITH EXEMPTIONS	SUBMERGED FILL	UNCONTROLLED
NEW JERSEY	0	3,589,161	0	0
NEW MEXICO	0	0	0	821,073
NEW YORK	4,161,382	0	0	2,030,598
NORTH CAROLINA	3,377,164	0	0	0
	0	0	0	356,386
OHIO	4,226,201	0	0	1,608,112
OKLAHOMA	0	277,255	1,455,589	0
OREGON	553,115	0	0	829,672
PENNSYLVANIA	0	4,790,112	0	0
RHODE ISLAND	385,586	0	0	0
SOUTH CAROLINA	0	392,946	0	1,244,328
SOUTH DAKOTA	0	0	0	398,577
TENNESSEE	0	2,644,699	0	0
TEXAS	4,208,518	0	0	4,756,266
UTAH	389,592	0	0	353,479
VERMONT	0	0	0	294,095
VIRGINIA	0	3,063,827	0	0
WASHINGTON	0	116,930	0	2,221,668
WEST VIRGINIA	0	245,115	0	600,110
WISCONSIN	0	2,148,379	0	0
WYOMING	0	0	0	265,228
NATIONWIDE	41,316,439	38,160,196	1,455,589	36,965,224
	35%	33%	1%	31%

[a] NO EXEMPTIONS indicates those areas where the service station regulations do not contain exemptions related to throughput (i.e., 38,000 liters/month or 10,000 gallons/month). WITH EXEMPTIONS refers to those areas that do not have exemptions based on this throughput. SUBMERGED FILL refers to areas that require only submerged filling of storage tanks. UNCONTROLLED indicates those areas without Stage I service station regulations.

TABLE D-13. BASELINE PARAMETERS FOR SERVICE STATIONS

Control Level	Percent of Total Throughput	Number of Stations
Vapor balance with no exemptions	35%	135,146
Vapor balance with submerged fill for stations with less than 10,000 gal/month throughput	32%	123,562
Submerged fill	17%	33,621
Motor gasoline		32,821
Aviation gasoline		800
Splash fill	16%	30,970
Motor gasoline		30,170
Aviation gasoline		800

parameters used to calculate VOC emissions discussed in Section D.1 must be separated according to fuel type. The major criterion for this breakdown is the attainment designation.

Nine ozone nonattainment areas will be required to utilize reformulated gasoline throughout the year and all other ozone nonattainment areas may opt into this program. Also, all CO nonattainment areas will be required to distribute oxygenated gasoline during the winter months.

For this baseline emissions analysis, several assumptions were necessary. First, the areas that will opt into the reformulated gasoline program are not known at this time. It was assumed that all moderate and above ozone nonattainment areas will opt in and utilize reformulated gasoline. Another separation was by time of year. The year was divided into the winter season (November - February) and the nonwinter season (March - October). The rationale for this breakdown is that the oxygenated fuel requirements for CO nonattainment areas apply only in the winter period, which will affect the types of fuels used in this time period without affecting the remainder of the year.

Exceedances of the ambient CO standard occur during different months, depending on the geographical location. Therefore, the use of oxygenated fuels is not always required during the same months for all CO nonattainment areas. However, in order to simplify the analysis, it was assumed that all oxygenated fuel throughput occurs during the months of November through February. These are the most common months for exceedances.

Based on 1990 throughput as reported in the 1991 National Petroleum News Factbook, it is estimated that approximately 68 percent of the gasoline throughput occurs in the eight nonwinter months (March - October). During these months, there will be two types of fuels in use. These are reformulated and normal gasoline. The areas assumed to use reformulated fuel in this analysis are moderate and above ozone nonattainment areas. All other areas will utilize normal fuels.

For the winter, there are a greater number of fuels that will be used. In areas that are moderate and above ozone nonattainment areas and nonattainment for CO, the fuel used will be reformulated/oxygenated (i.e., reformulated with the higher oxygen content). Areas nonattainment for CO, but not also moderate or above for ozone, will utilize oxygenated fuels. Moderate and above ozone nonattainment areas that are not also CO nonattainment areas will utilize reformulated gasoline.

In response to these situations, the percentage of gasoline throughput for four nonattainment scenarios was determined. For the nonwinter period, the only necessary breakdown was the throughput for moderate and above ozone nonattainment areas. In the winter, throughput percentages were determined for moderate and above ozone nonattainment areas that are also CO nonattainment areas, moderate and above ozone nonattainment areas that are not also CO nonattainment areas, and CO nonattainment areas that are not also moderate or above ozone nonattainment areas. These percentages were determined using preliminary estimates of nonattainment area designations based on 1987-89 design values and 1988-90 design values for a few areas and the 1985 NEDS gasoline consumption report. Table D-14 shows the percentages of throughput by State for these nonattainment area (and resulting fuel type) designations.

The regulatory coverage was then applied by State for each attainment area designation in the analysis. An emission factor corresponding to the regulatory coverage, loading method, type of storage used, etc., was selected and VOC emissions were calculated by multiplying the corresponding throughput by the corresponding emission factor. The winter RVP, 14.0 psi, and nonwinter RVP, 10.2 psi, as discussed in Chapter 3, were used to calculate separate VOC emission factors for each time period. The resulting VOC emissions were multiplied by the total HAP to

TABLE D-14. STATE GASOLINE THROUGHPUT BY NONATTAINMENT AREA CLASSIFICATION

STATE	PERCENT >MOD OZONE NONATTAIN	PERCENT CO & >MOD NONATTAIN	PERCENT CO ONLY NONATTAIN
ALABAMA	0%	0%	0%
ALASKA	0%	0%	62%
ARIZONA	57%	57%	17%
ARKANSAS	0%	0%	0%
CALIFORNIA	94%	82%	1%
COLORADO	0%	0%	71%
CONNECTICUT	100%	86%	0%
DELAWARE	77%	59%	0%
DISTRICT OF COL.	100%	100%	0%
FLORIDA	31%	0%	0%
GEORGIA	40%	23%	0%
HAWAII	0%	0%	0%
IDAHO	0%	0%	0%
ILLINOIS	61%	37%	37%
INDIANA	19%	12%	0%
IOWA	0%	0%	0%
KANSAS	0%	0%	0%
KENTUCKY	26%	0%	0%
LOUISIANA	14%	0%	0%
MAINE	58%	0%	0%
MARYLAND	87%	87%	0%
MASSACHUSETTS	100%	100%	0%
MICHIGAN	55%	39%	0%
MINNESOTA	0%	0%	55%
MISSISSIPPI	0%	0%	2%
MISSOURI	34%	26%	0%
MONTANA	0%	0%	28%
NEBRASKA	0%	0%	0%
NEVADA	0%	0%	48%
NEW HAMPSHIRE	65%	61%	0%
NEW JERSEY	98%	97%	0%

TABLE D-14. (Concluded)

STATE	PERCENT >MOD OZONE NONATTAIN	PERCENT CO & >MOD NONATTAIN	PERCENT CO ONLY NONATTAIN
NEW MEXICO	0%	0%	26%
NEW YORK	49%	49%	5%
NORTH CAROLINA	28%	28%	4%
NORTH DAKOTA	0%	0%	0%
OHIO	50%	20%	1%
OKLAHOMA	0%	0%	0%
OREGON	0%	0%	0%
PENNSYLVANIA	49%	0%	0%
RHODE ISLAND	100%	0%	0%
SOUTH CAROLINA	0%	0%	0%
SOUTH DAKOTA	0%	0%	0%
TENNESSEE	16%	0%	0%
TEXAS	45%	2%	0%
UTAH	45%	0%	0%
VERMONT	0%	0%	0%
VIRGINIA	13%	0%	0%
WASHINGTON	0%	0%	0%
WEST VIRGINIA	27%	0%	0%
WISCONSIN	35%	0%	0%
WYOMING	0%	0%	0%
NATIONWIDE	43%	28%	5%

VOC ratio for the appropriate fuel type to obtain the total HAP emissions. These HAP to VOC ratios and the corresponding attainment area situation where they were used is summarized in Table D-15. The following sections describe the methodology for each of the industry sectors.

D.3 BASELINE EMISSIONS FOR INDIVIDUAL SUBCATEGORIES

In this section, baseline emissions are presented for the individual source subcategories within the gasoline marketing chain. For each subcategory, the breakdown of parameters into the different attainment designations is presented by control level. The VOC emission factors used to calculate VOC emissions are discussed, and baseline HAP and VOC emissions are presented.

D.3.1 Pipeline Facilities

D.3.1.1 Pipeline Pumping Stations. Emissions from pipeline pumping stations are attributed to fugitive emissions from pumps and valves. The emission factors used for pumps and valves were taken from AP-42, Section 9.1.3 for light liquid components at refineries, 0.26 kg/valve/day and 2.7 kg/pump seal/day. All pipeline pumping stations are assumed to be uncontrolled (i.e., not routinely monitoring for liquid and vapor leaks) in the 1998 base year. As discussed in Chapter 8, it is estimated that at the baseline there are 1,989 pumping stations in the United States. Using the model plant distribution shown in Table 5-1, this converts to a total component population of 10,600 pumps and 116,080 valves. The nationwide VOC emissions were calculated using these component populations.

The types and quantity of gasoline traveling through a pipeline will mirror the nationwide consumption. Therefore, the VOC emissions were separated by time of year (68 percent during nonwinter and 32 percent during winter) and by fuel type according to the attainment area designations shown in Table D-14. For example, it was assumed that about 43 percent of the nationwide throughput is in moderate and above ozone nonattainment areas. Therefore, 43 percent of

TABLE D-15. HAP VAPOR PROFILES USED IN ANALYSIS AND APPLICABILITY

Description of Fuel Type	Total HAP to VOC Ratio (percent by weight)	Applicability
Typical, or "Normal" Gasoline	4.8	Summer: All areas not moderate or above nonattainment for ozone Winter: All areas not moderate or above nonattainment for CO
Reformulated Gasoline[a]		Summer: All areas moderate or above nonattainment for ozone Winter: All areas moderate or above nonattainment for ozone not also nonattainment for CO
with MTBE	12.9	
without MTBE	4.2	
Oxygenated Gasoline[a]		Summer: None Winter: All CO nonattainment areas not also moderate or above ozone nonattainment areas
with MTBE	16.3	
without MTBE	4.4	
Reformulated and Oxygenated Gasoline[a]		Summer: None Winter: All moderate and above ozone nonattainment areas that are also nonattainment for CO
with MTBE	16.0	
without MTBE	4.1	

[a] For the purposes of this analysis, it is assumed that 50 percent of reformulated, oxygenated, and reformulated/oxygenated fuels will contain MTBE, with the remaining half using another oxygenate.

the nonwinter VOC emissions were multiplied by the reformulated vapor profiles to estimate HAP emissions. The baseline emissions from pipeline pumping stations are shown in Table D-16.

D.3.1.2 Pipeline Breakout Stations. There are two sources of emissions at pipeline breakout stations. These are fugitive emissions from leaking pumps and valves and emissions from gasoline storage.

The fugitive emissions were calculated based on the model plant information discussed in Chapter 5. The smaller station was assumed to have 8 "equivalent" pumps and 210 "equivalent" valves. The larger model plant was assumed to have 10 equivalent pumps and 300 equivalent valves. Using the distribution of facilities by model plant in Chapter 5, a total nationwide component population of 69,389 equivalent valves and 2,465 pumps was estimated. These were multiplied by the emission factors discussed above for pipeline pumping stations to determine nationwide baseline VOC emissions. It was also assumed that throughput for breakout stations is a representation of the nationwide throughput. Therefore, the VOC emissions were separated by the percentages for the time of year and attainment area, and multiplied by the corresponding HAP to VOC ratios to estimate baseline HAP emissions.

Emissions from storage tanks were calculated using the storage tank populations and throughputs by control level discussed in Section D.1.2.1 and multiplying these by the VOC emission factors. These VOC emission factors were derived assuming an RVP of 10.2 psi for summer and 14.0 psi for winter, and are presented in Table D-17. The HAP emissions were calculated using nationwide percentages of throughput as discussed above. Table D-18 presents baseline storage tank and fugitive emissions from pipeline breakout stations.

D.3.2 Bulk Terminals

There are three basic sources of emissions at bulk terminals. These are loading rack emissions (which include

TABLE D-16. BASELINE EMISSIONS FROM PIPELINE PUMPING STATIONS

Baseline Emissions	Fugitive Emissions (Mg/yr)	
	HAP	VOC
Existing	1,710	22,800
New	660	8,810
TOTAL	2,370	31,610

TABLE D-17. EMISSION FACTORS FOR PIPELINE BREAKOUT STATION STORAGE TANKS[a,b]

Type of Emission	VOC Emission Factor NonWinter	Winter	Units
Fixed-Roof Uncontrolled			
Breathing losses	27.0	37.7	Mg VOC/yr/tank
Working losses	431.3	559.6	Mg VOC/yr/tank
Internal Floating Roof[c]			
Rim Seal losses	1.0	1.5	Mg VOC/yr/tank
Fitting losses	1.1	1.6	Mg VOC/yr/tank
Deck Seam losses	2.3	3.3	Mg VOC/yr/tank
Working losses	7.33×10^{-8}		Mg VOC/bbl throughput
External Floating Roof			
Standing Storage losses			
Primary seal[d]	15.8	23.1	Mg VOC/yr/tank
Secondary seal[e]	7.4	10.8	Mg VOC/yr/tank
Working losses	4.61×10^{-8}		Mg VOC/bbl throughput

a Emission factors calculated with equations from Section 4.3 of AP-42 using a nonwinter RVP of 10.2 psi, a winter RVP of 14.0 psi, and a temperature of 60°F, as discussed in Section 3.2.1.2.

b Assumes storage tanks at pipeline breakout stations have a capacity of 8,000 m^3 (50,000 bbl), a diameter of 30 meters (100 feet), and a height of 12 meters (40 feet).

c Assumes that internal floating roof is equipped with a liquid-mounted resilient seal (primary only).

d Assumes that external floating roof is equipped with a primary metallic shoe seal.

e Assumes that external floating roof is equipped with a shoe-mounted secondary seal.

TABLE D-18. BASELINE EMISSIONS FROM PIPELINE BREAKOUT STATIONS

Baseline Emissions	Storage Tank Emissions (Mg/yr)		Fugitive Emissions (Mg/yr)	
	HAP	VOC	HAP	VOC
Existing	6,320	83,370	780	10,410
New	60	740	80	1,030
TOTAL	6,370	84,110	860	11,450

tank truck leakage at facilities controlled by vapor collection), storage tank emissions, and fugitive emissions from leaking pumps and valves. Baseline HAP and VOC emissions from bulk terminals are shown in Table D-19. Each will be addressed in the following subsections.

D.3.2.1 Loading Rack Emissions. The national baseline control levels shown in Table D-3 were separated according to the nonattainment designations shown in Table D-14. It was assumed that all throughput for ozone nonattainment areas was controlled at the control level for that particular State or part of that State. For example, it was estimated that 67 percent of the gasoline throughput occurred at terminals subject to New York's 80 mg/l standard. It was also estimated that 49 percent of New York's throughput occurred in moderate or above ozone nonattainment areas. This 49 percent of the State throughput was assumed to all be subject to the 80 mg/l standard and control levels set as discussed in Section D.1. Using this approach, throughput was divided into the various attainment designations according to control level. Table D-20 shows this breakdown that represents the baseline.

Emission factors were selected for each control level and applied to the throughput. The 80, 35, and 10 mg/l emission factors did not change from nonwinter to winter. The calculated emission factors for submerged fill are 667 mg/l for the nonwinter and 860 mg/l for the winter. Those for splash fill are 1,611 mg/l for the nonwinter and 2,079 mg/l for the winter. Using these emission factors, the VOC emissions for each attainment class were calculated and the HAP emissions estimated using the appropriate emission factors.

Tank truck leakage emissions are also attributed to the loading rack since they occur in the rack area while the truck is loading. As noted previously, it was assumed that all throughput controlled for loading racks was subject to leak-tight tank truck requirements. The three basic control levels are annual leak tightness inspections, enhanced

TABLE D-19. BASELINE EMISSIONS FROM BULK TERMINALS

Baseline Emissions	Loading Rack Emissions (Mg/yr)		Tank Truck Leakage Emissions (Mg/yr)		Fugitive Emissions (Mg/yr)		Storage Tank Emissions (Mg/yr)	
	HAP	VOC	HAP	VOC	HAP	VOC	HAP	VOC
Existing	2,690	43,680	2,890	41,840	3,130	40,740	4,910	80,310
New	270	4,350	840	12,120	1,210	15,710	600	9,900
TOTAL	2,960	48,030	3,730	53,960	4,340	56,450	5,510	90,210

TABLE D-20. BULK TERMINAL BASELINE LOADING RACK ANNUAL THROUGHPUT BY AREA AND CONTROL LEVEL

Area/Control Level	Throughput (10^6 liters)[a]
NONWINTER	
Moderate and above ozone NA areas	
80 mg/l	48,600
35 mg/l	22,300
10 mg/l	55,400
5 mg/l	5,400
uncontrolled	0
All other areas	
80 mg/l	30,600
35 mg/l	14,000
10 mg/l	34,900
5 mg/l	3,500
uncontrolled	88,900
WINTER	
Moderate and above ozone nonattainment areas not also CO nonattainment	
80 mg/l	8,300
35 mg/l	3,800
10 mg/l	9,400
5 mg/l	940
uncontrolled	0

TABLE D-20. (Concluded)

Area/Control Level	Throughput (10^6 liters)[a]
Moderate and above ozone nonattainment areas that are also CO nonattainment	
80 mg/l	14,600
35 mg/l	6,650
10 mg/l	16,650
5 mg/l	1,700
uncontrolled	0
CO nonattainment areas that are not moderate or above ozone nonattainment areas	
80 mg/l	1,100
35 mg/l	500
10 mg/l	1,300
5 mg/l	130
uncontrolled	4,100
Attainment areas	
80 mg/l	13,200
35 mg/l	6,100
10 mg/l	15,100
5 mg/l	1,500
uncontrolled	37,800

[a] The throughputs shown in this table reflect estimated actual emitting levels of loading racks at bulk terminals, which are often better than the 80, 35, or 10 mg/l regulatory limits in effect at the terminals (see Section D.1.1).

leak tightness inspections, and uncontrolled.

For the uncontrolled case, the emissions would all be attributed to the loading rack. For the annual leak tightness inspections, the emission factors were calculated to be 111 mg/l for the nonwinter season and 143 mg/l for the winter. The enhanced leak tightness testing emission factors are 27.8 mg/l for nonwinter and 35.8 mg/l for winter.

D.3.2.2 Storage Tank Emissions. The baseline bulk terminal storage tank populations and throughputs shown in Table D-6 were divided according to attainment area designation in the same fashion as discussed above for terminal loading racks. This breakdown of bulk terminal storage tank parameters is shown in Table D-21. The VOC emissions were then calculated using the emission factors shown in Table D-22 for each attainment designation and the proper HAP to VOC ratios applied to estimate HAP emissions.

D.3.2.3 Fugitive Emissions. Since it was considered that fugitive emissions from leaking pumps and valves were uncontrolled at the baseline, it was not necessary to break down the number of components by control level by attainment area. Rather, the total nationwide number of components was calculated (115,750 valves and 10,240 pumps) and the same emission factors discussed above under pipeline pumping stations were applied to obtain baseline nationwide VOC emissions. These VOC emissions were assigned to the various attainment areas using the same proportions as the bulk terminal loading rack throughput and multiplied by the proper HAP to VOC ratio to estimate baseline HAP emissions.

D.3.3 Bulk Plants

The baseline bulk plant throughputs and populations shown in Table D-10 were divided according to attainment area designation in the same fashion as discussed above for terminal loading racks. This breakdown of bulk plant parameters is shown in Table D-23. The VOC emissions were

TABLE D-21. BULK TERMINAL BASELINE STORAGE TANK THROUGHPUT AND POPULATION BY AREA AND CONTROL LEVEL

Area/Control Level	Population (# of Tanks)	Throughput (10^6 bbl/yr)
NONWINTER		
<u>Moderate and above ozone NA areas</u>		
External floater/primary seals only	657	307
External floater/primary and secondary seals	694	325
Fixed-roof with internal floater	899	196
Fixed-roof uncontrolled	0	0
<u>All other areas</u>		
External floater/primary seals only	992	464
External floater/primary and secondary seals	531	249
Fixed-roof with internal floater	959	209
Fixed-roof uncontrolled	729	159
WINTER		
<u>Moderate and above ozone nonattainment areas not also CO nonattainment</u>		
External floater/primary seals only	115	54
External floater/primary and secondary seals	115	54
Fixed-roof with internal floater	153	33
Fixed-roof uncontrolled	0	0

TABLE D-21. (Concluded)

Area/Control Level	Population (# of Tanks)	Throughput (10^6 bbl/yr)
<u>Moderate and above ozone nonattainment areas that are also CO nonattainment</u>		
External floater/primary seals only	194	91
External floater/primary and secondary seals	212	99
Fixed-roof with internal floater	270	59
Fixed-roof uncontrolled	0	0
<u>CO nonattainment that are not moderate or above ozone nonattainment areas</u>		
External floater/primary seals only	28	13
External floater/primary and secondary seals	44	21
Fixed-roof with internal floater	49	11
Fixed-roof uncontrolled	3	1
<u>Attainment areas</u>		
External floater/primary seals only	439	205
External floater/primary and secondary seals	206	96
Fixed-roof with internal floater	403	88
Fixed-roof uncontrolled	340	74

TABLE D-22. EMISSION FACTORS FOR BULK TERMINAL STORAGE TANKS[a,b]

Type of Emission	VOC Emission Factor Nonwinter	VOC Emission Factor Winter	Units
Fixed-Roof Uncontrolled			
Breathing losses	8.9	12.5	Mg VOC/yr/tank
Working losses	34.8	45.1	Mg VOC/yr/tank
Internal Floating Roof[c]			
Rim Seal losses	0.5	0.6	Mg VOC/yr/tank
Fitting losses	1.1	1.4	Mg VOC/yr/tank
Deck Seam losses	0.6	0.7	Mg VOC/yr/tank
Working losses	7.33×10^{-8}		Mg VOC/bbl throughput
External Floating Roof			
Standing Storage losses			
Primary seal[d]	12.7	18.5	Mg VOC/yr/tank
Secondary seal[e]	6.1	8.9	Mg VOC/yr/tank
Working losses	4.61×10^{-8}		Mg VOC/bbl throughput

[a] Emission factors calculated with equations from Section 4.3 of AP-42 using a nonwinter RVP of 10.2 psi, a winter RVP of 14.0 psi, and a temperature of 60°F, as discussed in Section 3.2.1.2.

[b] Assumes storage tanks at bulk terminals have a capacity of 2,680 m^3 (16,750 bbl), a diameter of 15.2 meters (50 feet), and a height of 14.6 meters (48 feet).

[c] Assumes that internal floating roof is equipped with a liquid-mounted resilient seal (primary only).

[d] Assumes that external floating roof is equipped with a primary metallic shoe seal.

[e] Assumes that external floating roof tank is equipped with a shoe-mounted secondary seal.

TABLE D-23. BULK PLANT BASELINE ANNUAL THROUGHPUT BY AREA AND CONTROL LEVEL

Area/Control Level	Throughput (10^6 liters)
NONWINTER	
<u>Moderate and above ozone NA areas</u>	
vapor balance incoming/vapor balance outgoing with no exemptions	12,584
vapor balance incoming/vapor balance outgoing with 4,000 gallon/day exemption	7,450
vapor balance incoming with submerged fill outgoing	571
uncontrolled	0
<u>All other areas</u>	
vapor balance incoming/vapor balance outgoing with no exemptions	8,354
vapor balance incoming/vapor balance outgoing with 4,000 gallon/day exemption	6,802
vapor balance incoming with submerged fill outgoing	0
uncontrolled	23,600
WINTER	
<u>Moderate or above ozone nonattainment areas not also CO nonattainment</u>	
vapor balance incoming/vapor balance outgoing with no exemptions	3,786
vapor balance incoming/vapor balance outgoing with 4,000 gallon/day exemption	1,927
vapor balance incoming with submerged fill outgoing	268
uncontrolled	0

TABLE D-23. (Concluded)

Area/Control Level	Throughput (10^6 liters)
<u>Moderate and above ozone nonattainment areas that are also CO nonattainment</u>	
vapor balance incoming/vapor balance outgoing with no exemptions	2,136
vapor balance incoming/vapor balance outgoing with 4,000 gallon/day exemptions	1,579
vapor balance incoming with submerged fill outgoing	0
uncontrolled	0
<u>CO nonattainment areas that are not moderate or above ozone nonattainment areas</u>	
vapor balance incoming/vapor balance outgoing with no exemptions	63
vapor balance incoming/vapor balance outgoing with 4,000 gallon/day exemptions	423
vapor balance incoming with submerged fill outgoing	0
uncontrolled	1,768
<u>Attainment areas</u>	
vapor balance incoming/vapor balance outgoing with no exemptions	3,868
vapor balance incoming/vapor balance outgoing with 4,000 gallon/day exemptions	2,778
vapor balance incoming with submerged fill outgoing	0
uncontrolled	9,338

then calculated for each attainment designation using the emission factors shown in Table D-24 and the proper HAP to VOC ratios applied to estimate HAP emissions. Baseline bulk plant emissions are shown in Table D-25.

D.3.4 Service Stations

Service station baseline emissions were calculated in a manner very similar to bulk plants. The baseline service station throughputs shown in Table D-13 were divided according to attainment area designation in the same fashion as discussed above for terminal loading racks. This breakdown of service station throughput is shown in Table D-26. The VOC emissions were then calculated for each attainment designation using the emission factors calculated and the proper HAP to VOC ratios were applied to estimate HAP emissions. The VOC emission factors are 970 mg/l and 1,254 mg/l for nonwinter and winter submerged fill, respectively. The splash fill factors are 1,526 mg/l and 1,972 mg/l for nonwinter and winter, respectively. Baseline service station emissions from storage tank filling are shown in Table D-27.

TABLE D-24. BULK PLANT EMISSION FACTORS

Type of Emission	VOC Emission Factor (mg/liter) Nonwinter	Winter
Tank Truck Unloading (Incoming Loads)		
Storage tank filling		
uncontrolled vapor	977	1,260
balance	49	63
Tank Truck Loading (Outgoing Loads)		
Storage tank draining		
uncontrolled vapor	391	504
balance	20	25
Tank truck filling		
splash filing	1,611	2,079
submerged filling	667	860
vapor balance	56	72
Storage Tank Breathing	179	259

TABLE D-25. BASELINE EMISSIONS FROM BULK PLANTS

Baseline Emissions	Storage Tank Emissions (Mg/yr)		Loading Rack Emissions (Mg/yr)		Tank Truck Leakage Emissions (Mg/yr)		Fugitive Emissions (Mg/yr)	
	HAP	VOC	HAP	VOC	HAP	VOC	HAP	VOC
Existing	1,680	30,550	2,050	35,350	760	11,340	7,890	112,190
New	280	5,060	340	5,850	130	1,880	1,310	18,570
TOTAL	1,960	35,600	2,390	41,200	890	13,210	9,190	130,760

TABLE D-26. SERVICE STATION BASELINE THROUGHPUT BY AREA AND CONTROL LEVEL

Area/Control Level	Throughput (10^6 liters)
NONWINTER	
<u>Moderate and Above Ozone NA Areas</u>	
vapor balance with no exemptions	73,501
vapor balance with 10,000 gallon/month exemption	55,681
submerged fill	0
uncontrolled	0
<u>All Other Areas</u>	
vapor balance with no exemptions	32,850
vapor balance with 10,000 gallon/month exemption	42,546
submerged fill	3,747
uncontrolled	95,151
WINTER	
<u>Moderate or above ozone nonattainment areas not also CO nonattainment</u>	
vapor balance with no exemptions	23,414
vapor balance with 10,000 gallon/month exemption	14,988
submerged fill	0
uncontrolled	0

TABLE D-26. (Concluded)

Area/Control Level	Throughput (10^6 liters)
Moderate and above ozone nonattainment areas that are also CO nonattainment	
vapor balance with no exemptions	11,174
vapor balance with 10,000 gallon/month exemption	11,215
submerged fill	0
uncontrolled	0
CO nonattainment areas that are not moderate or above ozone nonattainment areas	
vapor balance with no exemptions	273
vapor balance with 10,000 gallon/month exemption	2,350
submerged fill	0
uncontrolled	6,657
Attainment Areas	
vapor balance with no exemptions	15,186
vapor balance with 10,000 gallon/month exemption	17,671
submerged fill	1,763
uncontrolled	38,120

TABLE D-27. BASELINE EMISSIONS FROM SERVICE STATIONS

Baseline Emissions	Underground Tank Filling Emissions (Mg/yr)	
	HAP	VOC
Existing	10,970	197,460
New	920	16,510
TOTAL	11,880	213,970

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

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15. SUPPLEMENTARY NOTES

16. ABSTRACT

National emission standards for hazardous air pollutants (NESHAP) are being proposed for the gasoline distribution industry under authority of Section 112(d) of the Clean Air Act as amended in 1990. This background information document provides technical information and analyses used in the development of the proposed NESHAP. The alternatives analyzed are to limit emissions of hazardous air pollutants (HAPs) from existing and new Stage I gasoline distribution facilities. Gasoline vapor emissions contain about ten of the listed HAPs. Stage I sources include bulk gasoline terminals and plants, pipeline facilities, and underground storage tanks at service stations. Emissions of HAP's from these facilities occur during gasoline tank truck and railcar loading, gasoline storage, and from vapor leaks from tank trucks, pumps, valves, flanges and other equipment in gasoline service.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Air Pollution Volatile Organic Compounds Hazardous Air Pollutants - Gasoline Bulk Terminals Bulk Plants Pipelines Service Stations	Air Pollution Control	13 b

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