REGULATORY SUPPORT DOCUMENT FOR THE FINAL EVAPORATIVE EMISSION REGULATION AND TEST PROCEDURE FOR 1984 AND LATER MODEL YEAR GASOLINE-FUELED HEAVY-DUTY VEHICLES

PREPARED BY

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Approved By

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DATE: ______________________________

Notice

This Regulatory Analysis was completed under the assumption that the Final Rule would be implemented with the start of the 1984 model year. However, the implementation date has been delayed one year to the start of the 1985 model year. This change in implementation date affects both the environmental and economic analyses of Chapters 4 and 5. For example, the constantly changing vehicle mix will be slightly different in 1985 as compared to 1984. Thus, the percentage of total NMHC emissions controlled as a result of controlling HDG evaporative emissions would be expected to be slightly different. Because the differences between 1984 and 1985 are small and because the impact of this regulation is small, the differences in the final air quality analyses as contained in Chapter 4 would be negligible. Likewise, the 1-year delay in implementation date is not expected to have any noticeable effect on the economic analysis of Chapter 5. Therefore, we have decided that reanalysis of the environmental and economic impact is not necessary.

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CHAPTER 1

SUMMARY

I. Background and Description of Action

The Final Rule establishes a 3.0 g/test evaporative emission standard for gasoline-fueled heavy-duty vehicles (HDGVs) with Gross Vehicle Weight Ratings (GVWRs) between 8,500 and 14,000 lbs. inclusive. For HDGVs with GVWRs greater than 14,000 lbs., this Final Rule establishes a standard of 4.0 gpt.

The implementation date of this Final Rule is the start of the 1985 model year. The test procedure is essentially the same as in light-duty except for changes necessary to accommodate HDGVs. The vehicle is placed in a Sealed Housing for Evaporative Determination (SHED) for the diurnal and hot-soak portions of the test. After these two results have been added, the deterioration factor (df) is applied and the final number must then be at or below the appropriate standard.

EPA projects that many Air Quality Control Regions (AQCRs) will continue to exceed the ambient air quality standards for ozone even with the implementation of all present and planned control strategies for reducing nonmethane hydrocarbon (NMHC) emissions from mobile and stationary sources. Furthermore, AQCRs which are not expected to meet the ozone standard by 1995 tend to be the areas of high population density. Therefore, it is desirable that all reasonable methods of NMHC control be analyzed and those which are most cost effective be implemented.

There is currently no Federal control of evaporative emissions from heavy-duty vehicles; however, the hardware which has been developed for the control of light-duty vehicle evaporative emissions can be used on HDGVs. EPA estimates that application of this technology will enable HDGVs to comply with the 3.0/4.0 gpt standard and will result in a 92 percent reduction in in-use HDGV evaporative emissions.

II. Environmental Impact

This Final Rule will cause a typical HDGV in low-altitude areas to emit 341 kg (752 lbs.) less evaporative NMHC over its lifetime than if uncontrolled. For a HDGV operating in high-altitude areas, the projected decrease in lifetime evaporative NMHC emissions is 445 kg (981 lbs.). These decreases are about 92 percent reductions from the uncontrolled levels.

The air quality analysis investigates the impact this rulemaking will have on 24 AQCRs which are experiencing high ozone concentrations. Twenty-two of these are low-altitude while the other two are high-altitude. The analysis projects that for the case which does not include Inspection/Maintenance programs, this Final Rule will bring into compliance with the ozone standard one additional low- and one additional high-altitude AQCR in 1988. However, with I/M, the benefits are less apparent as no additional AQCRs are brought into compliance.

The air quality analysis also projects the total number of exceedances of the ozone standard by these AQCRs. With I/M, this Final Rule causes one less high-altitude exceedance in 1988 and one less low-altitude exceedance in 1995. Without I/M, one less low-altitude exceedance in 1995 and two less in 2000 are projected.

The implementation of this Final Rule is not expected to have any noticeable effect on water or solid waste pollution. With proper use of existing control technology there should be no increase in exhaust NMHC from HDGVs as a result of this HDGV evaporative emission Final Rule.

III. Economic Impact

A. Character of the Industry

The major impact of this rulemaking will be on the "primary" HDGV manufacturers. These are General Motors Corporation, Ford Motor Company, Chrysler Corporation and International Harvester. These manufacturers sell complete and incomplete vehicles. The incomplete vehicles are sold to "secondary" manufacturers who then complete the vehicles by adding cargo-carrying devices, extra fuel tanks, operator's enclosures, etc. Although there are hundreds of secondary manufacturers, the impact on them will be minor. They need only to stay within the limits set by the primary manufacturers on a few vehicle parameters. If they wish to exceed the limits, then they will have to submit an engineering evaluation to EPA showing that their modifications have not caused the vehicle(s) to exceed the standard.

U.S. domestic retail sales of HDGVs in 1977 were 380,000 vehicles. This number is expected to stay about the same through 1984 because of slow growth and dieselization. In 1984 retail sales are expected to be 388,000 which then climbs to 415,000 by 1988.

B. Impact on Consumers

We estimate that this Final Rule will result in a "sticker price" increase for HDGVs of $42. Since HDGVs typically cost from $11,000 to $50,000, this "sticker price" increase is about a 0.38 to 0.08 percent increase which should have virtually no affect on sales of HDGVs.

We do not expect any increased maintenance costs as a result of this Final Rule nor do we expect any change in fuel economy.

C. Impact on Industry

The costs of this Final Rule to the primary manufacturers have been divided into two main categories. The first category, investment costs, includes expenditures for testing equipment, testing space, development testing and R&D for control hardware. These costs are estimated to be $5.79M for the industry (discounted to 1984 at 10 percent). When these costs are amortized over five production years (1984-88 model year) the per vehicle cost increase is $3.50. The second category of costs is the control system hardware. These costs have been estimated to be $38.50/vehicle bringing the total per vehicle price increase to $42. Profits at the various manufacturing levels have been included in the above estimates.

Another impact on the industry would be the lost sales of HDGVs due to the price increse. However, as discussed above, because the "sticker price" increase is such a small percentage of the retail price we project the decrease in sales of HDGVs due to this Final Rule will be virtually nil.

D. Government Costs

This Final Rule will cost the Federal government some small amount in the form of an employee's time to review and file the primary manufacturers' descriptions of their evaporative emission family-control system combinations, their statements of compliance, and any other data EPA might request. Then, EPA will need to issue the certificates of compliance. We estimate that 0.1 person-year of effort will be more than enough to perform these tasks.

If, at some later date, EPA has reason to believe that there exists a major in-use problem where certified HDGVs are not meeting the evaporative emission standards, then costs to the agency will be incurred to purchase and install equipment and to organize and carry out a confirmatory and/or an in-use testing program. However, with a good-faith effort from the manufacturers, EPA does not anticipate that such a problem will arise.

E. Cost Effectiveness

The cost effectiveness of this Final Rule is estimated to be $112/ ton of NMHC controlled. This is quite inexpensive as can be seen by comparison to some other recently promulgated mobile source HC control strategies. The regulation controlling LDV exhaust from 1.5 to .41 grams HC/mi was estimated to cost $470/ton HC controlled. Controlling motorcycles from uncontrolled levels to 8 grams HC/mi was estimated to cost $365/ton HC. Since many urban areas will not meet the ozone standard by 1990, more and more costly HC control strategies will need to be implemented so as to bring these areas as close to the standard as is economically feasible. This Final Rule is exceptional in that it is cheaper than most other previously promulgated mobile source control strategies.

CHAPTER 2

INTRODUCTION

I. Need for Control, Background and Description of this Action

In many geographic regions a large portion of nonmethane hydrocarbons (NMHC), carbon monoxide (CO), and nitrogen oxides (NOx) present in the air are attributable to motor vehicle emissions. Congress, in recognition of the air pollution problem, passed the Clean Air Act which provides in part for a national air pollution program to monitor and control emissions from new motor vehicles and engines. Section 202(a) of the Clean Air Act (42 U.S.C. 7521) provides that the Administrator shall prescribe standards for motor vehicle emissions if such emissions may reasonably be anticipated to endanger public health or welfare. Under Section 206, the Administrator must test or require testing of new motor vehicles to determine compliance with applicable standards under Section 202. The general power to promulgate regulations is granted in Section 301.

The need for further control of NMHC emissions is based on the determination that the present and planned regulations for control of mobile and stationary source NMHC emissions are insufficient to bring many Air Quality Control Regions (AQCRs) into compliance with the ambient air quality standards for ozone. For example, of the 24 AQCRs included in our air quality analysis[1] of this Final Rule, 15 are projected to still be in noncompliance for ozone in 1995.

The health effects of ozone have been considered and described in previous publications.[2] Ozone is created during photochemical reactions involving reactive hydrocarbons and is thus controlled indirectly by controlling NMHC. Ambient air quality standards have been set, based on those considerations, at levels which assure adequate public protection from the regulated pollutants. The air quality standard for ozone is 0.12 parts per million (maximum 1-hour concentration not to be exceeded more than once per year). Since this ambient air quality standard will be exceeded in many air quality control regions, a reduction in NMHC emissions beyond present and planned regulations is necessary.

Fuel evaporative hydrocarbon emissions have been studied and measured since 1958. Federal control of evaporative emissions was first implemented for light-duty vehicles of the 1971 model year. During following years, EPA and the Society of Automotive Engineers (SAE) determined that the test procedure being used at that time only measured a small part of the total evaporative emissions. An improved test method Sealed Housing for Evaporative Determination, (SHED) procedure was developed by SAE and EPA, and Federal regulations adopting this improved procedure were implemented for light-duty vehicles (LDVs) and light-duty trucks (LDTs) beginning with the 1978 model year. The emission standard implemented at that time was 6.0 grams/test, and EPA has since promulgated a standard of 2.0 g/test for 1981 and later model years.

This Final Rule will, for the first time on a nationwide basis, control evaporative emissions from gasoline-fueled heavy-duty vehicles (HDGs). HDGs produced for sale in California have been equipped with evaporative emission control systems since 1972; however, the California regulation does not require vehicle testing.

This Final Rule establishes a split standard for the control of evaporative emissions from HDGs. The standard for HDGs with Gross Vehicle Weight Ratings (GVWRs) of 8,500 to 14,000 lbs. is 3.0 grams per test (gpt). The standard for HDGs with GVWRs greater than 14,000 lbs. is 4.0 gpt. The test procedure is a full-SHED procedure similar to that used for LDVs and LDTs. However, this rulemaking is based upon a "self-certification" procedure in which a manufacturer will not normally need to submit any test data (unless specifically requested by EPA). Rather, it will generally only need to submit a statement that its HDGs meet (or, in some cases, a statement that the HDG is designed to meet) the appropriate standards. Furthermore, EPA does not intend to do any confirmatory testing, although the Agency does reserve the authority to do such testing if it believes a problem is developing. Thus, whereas this Final Rule establishes standards based on the full-SHED test procedure, manufacturers can use alternative test procedures where they find them equivalent.

Diesel-powered heavy-duty vehicles are not included in this regulation because development testing has confirmed that the low volatility of diesel fuel does not result in a significant quantity of fuel evaporative emissions.

II. Alternative Actions Considered

In the broadest sense, the options available to EPA as alternative actions to promulgating this HDG evaporative emission regulation include: 1) more stringent control of other mobile sources, 2) control of stationary sources, and 3) take no action. Each of these strategies has its advantages and disadvantages. The "no action" alternative, although it has the advantage of eliminating all burdens for manufacturers, is not a real option since air quality analyses clearly show that the ozone ambient air quality standard will not be met in many areas of the country in the foreseeable future. Concerning the choice between HDG control and more control of stationary sources or other mobile sources, the principal measure for our choice of HDG control has been one of relative cost effectiveness. As our economic analysis later in this document will show, HDG evaporative control, as structured in this Final Rule, provides a much greater degree of control per dollar spent than the other alternatives. This rulemaking represents a relatively low cost, efficient approach to control. It also has the advantages of simplicity and timeliness over stationary source control strategies (many of which will also be needed to meet the ozone standard). The Agency therefore concludes that this Final Rule is a desirable NMHC control strategy.

Once a source of emissions has been selected for control, consideration of alternatives consists of different ways to structure the regulation controlling that source. Many alternatives were considered in finalizing this HDG evaporative emission regulation. These alternatives were developed from manufacturer's comments, additional data collection and changing economic factors brought to EPA's attention during the comment period. The "Summary and Analysis of Comments," which can be found in the Public Docket (OMSAPC-79-1), is basically a detailed presentation and analysis of the alternatives considered in developing this Final Rule. The following discussion will briefly summarize the most important alternatives considered and the resultant final positions.

One alternative that received much consideration was the appropriate level of the standard. In the Notice of Proposed Rulemaking (NPRM) we identified a standard of 3.0 gpt as the level which was technically feasible for all HDGs. However, in their comments on our proposal, the manufacturers claimed that while a 3.0 gpt standard could be easily met for the lower weight classes of HDGs, the higher weight classes would require substantial R&D and the resultant control hardware would be significantly more expensive than if the standard was relaxed to 4.0 gpt. We determined that relaxing the standard to 4.0 gpt for the "heavy" HDGs (greater than 14,000 lbs. GVWR) would affect air quality in only a minor way while it would allow a substantial cost savings to the industry. Thus, this Final Rule includes a split standard of 3.0 gpt for HDGs with GVWRs of 8,500 to 14,000 lbs. and 4.0 gpt for HDGs with GVWRs greater than 14,000 lbs. GVWR. The manufacturers generally agreed that these were appropriate levels for control.

Another area where a number of alternatives were considered is the final certification procedure. We had proposed a certification scheme similar to that used for light-duty vehicles. The manufacturer would have submitted test data to EPA showing that its vehicles met the standard. EPA would then either have confirmatory tested the vehicles or issued a certificate of conformity. During final rulemaking a substantial effort was directed at developing a less burdensome certification procedure. The industry's economic situation as well as an Agency trend to simplify the certification process were major forces behind the alternative that was finally chosen. Under this Final Rule, manufacturers will generally only be required to submit a statement that their HDGs meet (or, is some cases, that they have been designed to meet) the appropriate standard. They will not be required to routinely submit test data or, for that matter, even do any testing beyond what they themselves need in developing hardware to meet the standards. In their comments, manufacturers claimed that such cost-saving methods as component bench testing could be used to predict SHED test results. Under this approach, we expect these methods to be used to realize additional cost reductions. EPA does not intend to do any routine confirmatory testing but rather will issue the certificate of conformity based upon receipt of the manufacturer's statement of compliance. The Agency does, however, retain the authority to do in-use and/or confirmatory testing if a problem exists.

This certification alternative should result in an in-use control level close to that which would have been obtained with the proposed certification procedure if the manufacturers put forth a good faith effort. At the same time, it will be less burdensome because the industry will have greater flexibility in developing their control systems, they will save money by eliminating unnecessary testing and EPA will save resources because of its minimal role.

Other areas in which many alternatives were considered in the development of the final position include: 1) the test procedure (which remains basically the same as that proposed), 2) the handling of incomplete vehicles (which has been greatly simplified), and 3) available leadtime (which has been increased by delaying implementation until the start of the 1985 MY). The reader is referred to the "Summary and Analysis of Comments" for the detailed discussions of these and other areas, all of which include alternatives assessment before recommending the final position.

III. Structure of this Report

This report is an assessment of the environmental and economic impact of setting an evaporative emission standard of 3.0 gpt for HDGs with GVWRs of 8,500 lbs. to 14,000 lbs. and 4.0 gpt for HDGs with GVWRs greater than 14,000 lbs. This Final Rule will be implemented with the start of 1985 MY.

The remainder of this document is divided into five major sections. Chapter 3 presents a general description of gasoline-fueled heavy-duty vehicles, a brief description of the manufacturers of these vehicles, and a description of the market in which they compete. It also will discuss the use to which these HDGs are put, and describe the primary-user groups.

Chapter 4 assesses the primary and secondary environmental impacts associated with this HDG evaporative emission regulation. The degree of control reflected by the standard is described and projections of air pollutant emissions for the urban areas considered (with and without the standards) are presented. Secondary effects on other media are also discussed.

Chapter 5 presents an examination of the costs of complying with this Final Rule. Costs to manufacturers are analyzed in terms of both fixed and variable costs. These are looked at on both a per-vehicle and an aggregate basis. Costs to consumers and to the government are also discussed.

Chapter 6 discusses the cost effectiveness of the Final Rule. The cost effectiveness of this regulation ($122 per ton NMHC) is compared to the cost effectiveness of other recently promulgated mobile source control strategies. Cost effectiveness is expressed in terms of the number of dollars required to control one ton of NMHC.

References

1. "Analysis of the Evaporative Emission Regulations for 1984 and Later Model Year Gasoline-Fueled Heavy-Duty Vehicles," U.S. EPA, OANR, OMS, ECTD, SDSB, J. Wallace and M. Wolcott, TEB-EF-82-1, November 1981.

2. Air Quality Criteria Documents, Nos. AP-62, AP-63, AP-64, and AP-84.

CHAPTER 3

DESCRIPTION OF THE PRODUCT AND THE INDUSTRY

I. Heavy-Duty Gasoline Vehicles

A heavy-duty vehicle (HDV) as defined by EPA is a vehicle whose gross vehicle weight rating (GVWR) exceeds 8500 pounds. This differs from that in the Amended Clean Air Act which specified 6000 pounds GVWR as the lower limit of HDVs. The reason for this difference is that, although EPA is required to regulate all vehicles heavier than 6000 pounds GVWR to at least the levels dictated by the Act,[1] light-duty trucks (LDTs) in the 6000-8500 pounds GVWR range are dealt with under separate regulations. The regulations proposed here are aimed at the greater than 8500 pound GVWR population only.

The industry uses GVWR as a basis for reporting truck (and bus) production and sales data. Their traditional categories are as follows:

Class	Weight (pounds-GVWR)
I	0 - 6,000
II	6,001 - 10,000
III	10,001 - 14,000
IV	14,001 - 16,000
V	16,001 - 19,500
VI	19,501 - 26,000
VII	26,001 - 33,000
VIII	33,001 and over

EPA's definition of LDTs sets the division between the LDT class and the HDV class at 8500 pounds GVWR. Thus, some of the class II trucks will be included with all of those in classes III through VIII in the HDV class. In 1973 EPA had estimated that only about 5 percent of those vehicles in weight classes I and II have gross vehicle weights in excess of 8500 pounds.[2] This percentage has been recalculated for the 1979 calendar year, and found to be approximately 6 percent.[3] Using values of 5.0 percent in 1973 and 6 percent in 1979, a linear relation was used to estimate this percentage for 1974, 1975 and 1976. Prior to 1973, a value of 5 percent is assumed correct. Table 3-A gives the U.S. domestic detail sales of all gasoline-fueled trucks and buses for these years.

To look for a moment at the sales trends for gasoline-fueled heavy-duty vehicles (HDGs) the lighter weight (8,501 - 10,000 pounds GVWR) truck has shown a substantial increase in numbers. In the mid-ranges of the heavy-duty class, there is no evidence of either an increasing or decreasing trend. However, in categories heavier than 16,000 pounds, the trend has been toward decreasing numbers of retail sales. In the two heaviest vehicle categories

Table 3-A

Gasoline Engine Usage in Heavy-Duty Vehicles*

Year	8,501 10,000	10,001-14,000	14,001-16,000	16,001-19,500	19,501-26,000	26,001-33,000	33,000 and over	Yearly Totals
1979	148,829	17,366	2,361	3,146	123,625	19,043	7,645	322,015
1978	187,336	34,014	5,959	3,982	144,923	15,597	7,160	398,971
1977	173,017	30,064	3,231	4,989	149,254	13,526	6,005	380,080
1976	147,002	43,411	67	8,920	143,007	11,597	5,561	359,635
1975	104,201	19,497	6,508	13,757	147,267	13,509	8,748	313,487
1974	121,535	8,916	8,120	24,325	211,861	19,382	19,138	413,277
1973	137,949	52,558	8,448	37,037	195,741	22,587	17,473	471,793
1972	112,321	57,803	10,138	37,487	174,019	27,482	13,855	433,105

* Source: FS-3, FS-5, MVMA data.

(26,00-133,000 and 33,000 and over) the substantial decrease in gasoline vehicles is mainly due to a trend toward a greater use of diesel vehicles in these weight classes. It should be noted here that heavy-duty vehicles can be subclassed by two different engine types; gasoline engines or diesel engines. Diesel engines do not contribute significantly to evaporative emissions, and therefore will not be subject to the evaporative regulations in this package. However, since diesel vehicles are an integral part of the heavy-duty vehicle industry, a brief mention of their magnitude in the industry is in order.

All the manufacturers that produce gasoline-fueled vehicles also produce diesel vehicles. In 1979, 96 percent of all trucks heavier than 33,000 pounds GVWR were diesel, as shown in Table 3-B. Likewise, 55 percent of all trucks between 26,000 pounds and 33,000 pounds were diesel, and 11 percent of all trucks from 19,500 to 26,000 pounds were diesel. Also, in general, the yearly trend has been toward an increasing percentage of diesels in these GVWR weight classes. There were no diesels in the weight categories less than 19,500 pounds GVWR, with exception of a few thousand in the 0-8500 pound category. Primarily all buses over 26,000 pounds are equipped with diesel engines and primarily all buses below 26,000 pounds are equipped with gasoline engines.

Heavy-duty vehicles in a single weight category do not represent a homogeneous class of vehicles, either in terms of use, or of functional characteristics. While LDTs are used by-and-large for personal transportation, heavy-duty trucks are almost exclusively used for commercial purposes. The 1972 Census of Transportation conducted by the Department of Commerce indicates that trucks are used in agriculture, construction, mining, wholesale and retail trade, manufacturing, and lumbering and forestry, as well as by utility, service, and "for hire" industries. Most functional applications of HDVs are not readily transferable to other transportation modes such as air, rail, water or pipeline.

As Table 3-C shows, the uses of HDVs vary with gross vehicle weight. For the lighter trucks, those in the 8500-20,000 pound GVWR range, we find that the primary applications are in the agriculture, construction, services, and wholesale and retail trade markets, where the trucks are generally used for pickup and delivery. Personal use of trucks in this category, while limited, consists primarily of operation of motor homes built on truck chassis. Some people also use "heavy" pickup trucks for personal transportation.

HDVs in the 20,001 - 26,000 pound GVWR range find uses in the agriculture, construction, and wholesale and retail trade markets. Forestry, lumbering, and manufacturing account for most of the other applications.

Table 3-B

Diesel Factory Sales as a Percentage of
All Heavy-Duty Vehicle Factory Sales*

Year	8,500-10,000	10,000-14,000	14,000-16,000	16,000-19,500	19,500-26,000	26,000-33,000	33,000 and over	All HD Vehicles
1979	--	--	--	--	11%	60%	96%	39%
1978	--	--	--	--	8%	62%	96%	32%
1977	--	--	--	--	7%	58%	96%	31%
1976	--	--	--	--	4%	49%	94%	24%
1975	--	--	--	1%	3%	45%	88%	21%
1974	--	--	--	--	2%	40%	88%	28%
1973	--	--	3%	--	2%	45%	89%	26%
1972	--	--	2%	--	2%	32%	89%	24%

* Source: Data from 1980 MVMA, Motor Vehicles Facts and Figures.

Table 3-C

Trucks: Percent Distribution of Size
Classes by Vehicle and Operational Characteristic: 1972*

Characteristic	Number (Thousands)	Percent	10,000 Or Less Lbs. GVW	10,000-20,000 Lbs. GVW	20,000-26,000 Lbs. GVW	26,001 Or More Lbs. GVW
MAJOR USE						
Agriculture	4,258	21.6%	20.1%	32.1%	33.2%	10.3%
Forestry and Lumbering	187	1.0	0.5	1.4	2.8	3.6
Mining	77	0.4	0.2	0.6	0.7	1.9
Construction	1,693	8.6	6.9	10.2	14.0	19.1
Manufacturing	443	2.3	1.3	3.3	4.4	8.5
Wholesale and Retail Trade	1,875	9.5	6.1	18.9	23.0	18.3
For Hire	770	3.9	0.6	6.0	7.2	30.6
Personal Transportation	8,122	41.2	53.4	11.0	2.1	1.0
Utilities	505	2.6	2.5	3.1	3.8	1.9
Services	1,409	7.6	7.7	10.5	6.0	2.5
All Other	327	1.7	1.2	3.5	3.4	2.8
BODY TYPE						
Pickup, Panel, Multi-stop, Walk-in	14,464	73.3%	92.6%	31.3%	4.4%	2.1%
Platform	1,645	8.4	2.2	27.4	28.9	21.0
Platform w/Added Device	336	1.8	0.4	5.6	7.0	4.4
Cattlerack	479	2.5	1.4	6.7	6.7	2.4
Insulated Nonrefrigerated Van	96	0.5	0.1	1.2	1.2	3.1
Insulated Refrigerated Van	178	1.0	0.1	2.4	2.3	5.3
Furniture Van	192	1.0	0.2	3.7	2.8	3.2
Open Top Van	58	0.3	0.1	0.6	0.4	1.9
All Other Vans	610	3.1	0.7	6.3	7.2	18.6
Beverage Truck	87	0.5	0.1	1.4	3.0	1.6
Utility Truck	370	1.9	1.7	3.4	2.0	0.9
BODY TYPE						
Garbage and Refuse Collector	69	0.4	0.1	1.3	1.4	1.2
Winch or Crane	83	0.5	0.1	0.8	3.5	1.8
Wrecker	115	0.6	0.3	2.3	0.6	0.2
Pole and Logging	53	0.3	0.1	0.3	1.4	2.4
Auto Transport	30	0.2	0.1	0.2	0.1	1.4
Dump Truck	468	2.4	0.3	3.1	17.3	14.0
Tank Truck for Liquids	287	1.5	0.1	2.3	9.7	9.1
Tank Truck for Dry Bulk	29	0.2	--	0.1	0.6	1.5
Concrete Mixer	66	0.4	0.1	0.2	0.1	4.1
All Other	33	0.2	0.1	0.6	0.5	0.6

* Source: 1972 Census of Transportation, U.S. Department of Commerce.

Table 3-C (Cont'd)

Trucks: Percent Distribution of Size
Classes by Vehicle and Operational Characteristic: 1972*

Characteristic	Number (Thousands)	Percent	10,000 Or Less Lbs. GVW	10,000-20,000 Lbs. GVW	20,000-26,000 Lbs. GVW	26,001 Or More Lbs. GVW
MAJOR USE						
ANNUAL MILES						
5,000	4,621	23.5%	22.0%	33.2%	35.8%	12.7%
5 - 9,999	5,540	28.1	30.2	25.6	25.2	13.8
10-19,999	6,598	33.5	36.2	27.8	24.0	22.4
20-29,999	1,647	8.4	8.1	8.1	8.3	11.5
30-49,999	772	4.0	2.9	4.1	4.9	13.4
50-74,999	270	1.4	0.5	0.9	1.5	11.5
75,000	300	1.5	0.4	0.6	0.5	15.1
Total Percent		100.0%	100.0%	100.0%	100.0%	100.0%
Total Trucks	19,745		14,598	2,822	828	1,500

* Source: 1972 Census of Transportation, U.S. Department of Commerce.

The heavier trucks (26,001 pounds GVWR and over) are primarily found in the construction, wholesale and retail trade, and "for hire" markets. While the number of trucks used for mining and manufacturing is not large, these markets use the heavy-duty trucks extensively. Trucks in this category are used only to a limited extent in the other market sectors.

Since the ultimate goal of the various commercial enterprises that use heavy trucks is to make a profit, trucks operated by these businesses are designed specifically to meet particular functional needs in an economical manner. Thus, the HDVs produced for the U.S. market are often "custom" built to satisfy requirements of the operational environment faced by the ultimate use. This operational environment might be defined in terms of economic variables (i.e., operating costs of alternative means of transport, value of products to be transported, operating costs of alternative types of trucks) or operational variables (i.e., distances to be traveled, qualities of the load to be transported, types of shipping procedures to be utilized, state and Federal regulations on truck use, safety, operation).

Buses equipped with heavy-duty engines are usually in the 19,501 - 26,000 GVWR (Class VI) category. Uses of buses include school transporation as well as intercity and transit passenger service. Most school-type buses are gasoline fueled, the remainder are diesels.

By defining their operating environment, users of HDVs can tell vehicle manufacturers what characteristics their truck should have when it is completed. Examples of the design parameters which may be specified include engine type (diesel or gasoline), horsepower, number of cylinders, displacement, natural aspiration vs. turbocharging, transmission, body type (single unit, or combination), gross vehicle weight, maximum load weight, vehicle length, number of axles, axle arrangement, distance between tandem axles, and tire size.

II. Manufacturers

Although for many heavy-duty vehicles the engine manufacturer and the vehicle chassis manufacturer may differ, this is only true in the case of diesels. For HDGs, as with the automobile industry, the engine manufacturer and the vehicle chassis manufacturer are one and the same. However, in many cases a "secondary" manufacturer purchases the incomplete vehicle (engine chassis combination) from the "primary" manufacturer and builds it into a completed vehicle. Table 3-D shows the 1979 gasoline HDV domestic factory sales (both complete and incomplete) for each primary manufacturer. The four companies that produce gasoline HDVs (8500 pounds GVWR and over), in order of decreasing sales volume are General Motors (GM), Ford, Chrysler, and International Harvester (IHC). Note that IHC is mainly concentrated toward the heavier weight classes. While each of the these four

Table 3-D

1979 Calendar Year U.S, Domestic Factory Sales for Gasoline Trucks and Buses by GVWR Class*

Manufacturer	0-8500	8,501-10,000	10,001-14,000	14,001-16,000	16,001-19,500	19,501-26,000	26,001-33,000	33,000 and over	Yearly Totals
Chevrolet	838,011	53,490	--	--	2,098	35,326	6	2,843	931,774
GMC	211,625	13,507	20	--	982	21,686	50	929	248,799
Dodge	195,480	12,477	16,303	2,358	--	--	--	--	226,618
Ford	816,552	52,120	952	--	--	46,500	8,716	6,912	931,752
IHC	22,985	--	--	--	6	20,542	8,214	858	52,605
Jeep	98,764	--	--	--	--	--	--	--	98,764
TOTAL	2,183,417	131,594	17,275	2,358	3,086	124,054	16,986	11,542	2,490,312

Manufacturer	Total Vehicles Subject to HDG Regulation (8500 GVWR and over)
GM	130,937
Ford	115,200
Dodge	31,138
IHC	29,620

* Source: FS-3, FS-5, MVMA data, 1980 MVMA Facts and Figures.

manufacturers also produce gasoline trucks less than 8500 pounds GVWR, so do they also produce diesel vehicles over 8500 pounds GVWR. One other U.S. manufacturer of gasoline trucks is AMC (Jeep). However they do not produce any vehicles over 8500 pounds. The factory sales data are domestic sales data only, and does not include imports.

Table 3-E shows the 1979 factory sales data for buses. Recall that only those buses under 26,000 pounds are gasoline, and only those over 26,000 pounds are diesel. Note that 100 percent of the total 1979 gasoline-fueled buses were in the 19,501 to 26,000 pound GVW weight class. Also the major bus manufacturer was IHC.

Table 3-F is a list of the gasoline engines produced by the major truck manufacturers for both motor vehicles and other uses.

III. Users of Heavy-Duty Vehicles

As Section A of this chapter notes, most HDVs are used for commercial purposes. The types of trucks used to meet the transportation needs of various enterprises are as diverse as the needs themselves. Basically, however, these trucks move some commodity from one point to another.

Table 3-G lists some of the types of products moved by trucks and other means of transport and the percentage (by weight), of all freight that each means of transport carries. Though the data was collected a few years ago (1972 survey), it is interesting to see the fractional distribution of freight and how it was transported. In 1972 nearly half of the commodities listed were shipped by truck, and trucks accounted for 23 percent of all intercity freight. In 1977, trucks carried almost 25 percent of all intercity freight.[4]

Trucking can be divided into two types of carriers, local and intercity. The rule of thumb is that local carriers are those who conduct 50 percent or more of their business in a metropolitan area. The intercity (line haul or over-the-road) carriers conduct local pickup and delivery between metropolitan areas. Local carriers accounted for $67.5 billion in freight transporation expenses and intercity carriers $67.3 billion in 1978.[5] Most local carriers are gasoline-fueled, whereas, the majority of intercity carriers are diesel trucks.

Another way of examining the trucking industry is to distinguish between private ownership and "for hire" trucking. The trucks in "private" fleets are under the control of each particular company for the shipment of their own goods, trucking not being their principle business. Examples of "private" truck owners are the various utility companies (e.g., Bell Telephone System) or retail stores that own their own delivery trucks; and manufacturers of consumer products who make deliveries to retail concerns are private truck owners.

Table 3-E

1979 U.S. Domestic Bus Sales (Including School Bus Chassis)*

	8,500-10,000	10,000-14,000	14,000-16,000	16,000-19,500	19,500-26,000	26,000-33,000	33,000 and over	Total
Chevrolet	--	--	--	--	4,582	--	--	4,582
GMC	--	--	--	--	2,736	189	1,579	4,504
Ford	--	--	--	--	5,046	--	--	5,046
IHC	--	--	--	--	13,304	968	--	14,272
AM/General	--	--	--	--	--	--	382	382
Others	--	--	--	--	--	1,001	2	1,003

* Source: FS-3, 1979 MVMA data.

Table 3-F

Manufacturers of Gasoline-Fueled Engines for Use in Heavy-Duty Vehicles*

Manufacturer	Engine Families	Displacements Available (CID)
Chrysler	3	318, 360
Ford	5	300, 351, 370, 400, 429, 460, 477, 534
GM	4	292, 350, 366, 427, 440, 454
IHC	4	345, 391, 400, 446, 537
Bluebird	1	427
Revcon	1	454

* Source: Federal Register Vol. 44, NO. 140, Part III, July 19, 1979; EPA Certification data.

Table 3-G

Commodities Shipped by Mode of Transport

Group	Tons: Motor Carrier	Tons: Private Truck	Tons: Total Truck	Tons: Rail	Tons: Other	Tons/Miles: Motor Carrier	Tons/Miles: Private Truck	Tons/Miles: Total Truck	Tons/Miles: Rail	Tons/Miles: Other
Meat & Dairy Products	41.7%	39.1%	80.8%	18.8%	.4%	54.3%	17.2%	71.5%	27.8%	.6%
Canned, Frozen & Other Food Products	20.3	23.0	43.3	50.7	6.0	18.3	9.5	27.8	66.8	5.4
Candy, Cookies, Beverages Tobacco Products	25.7	58.4	84.1	15.4	.4	28.8	25.8	54.6	43.1	2.2
Basic Textiles & Leather Products	61.4	27.7	89.1	9.7	1.2	61.0	21.0	82.0	16.1	1.8
Apparel & Related Products	69.4	15.6	85.0	8.5	6.5	67.0	9.5	76.5	13.4	10.1
Paper & Allied Products	28.0	17.9	45.9	51.7	2.3	18.9	5.6	24.5	73.8	1.5
Basic Chemicals, Plastics, Synthetic Rubber & Fibers	30.1	12.1	42.2	48.6	9.2	21.6	4.7	26.3	63.1	10.5
Drugs, Paints & Other Chemical Products	38.6	15.7	54.3	37.8	7.9	32.0	8.4	40.4	44.3	15.2
Petroleum & Coal Products	16.0	8.4	24.4	9.7	65.8	3.4	1.6	5.0	7.9	87.1
Rubber & Plastic Products	59.1	15.2	74.3	24.4	1.2	56.8	9.3	66.1	32.1	1.8
Lumber & Wood Products, Except Furniture	16.2	36.3	52.5	45.8	1.6	7.6	10.7	18.3	76.8	4.9
Furniture & Fixtures	41.4	34.7	76.1	22.0	1.9	39.9	20.5	60.4	37.1	2.5
Stone, Clay & Glass Products	47.2	23.7	70.9	21.9	7.2	36.6	11.3	47.9	45.3	6.7
Primary Iron & Steel Products	44.4	6.7	51.1	43.7	5.2	35.9	4.8	40.7	51.6	7.7
Primary Nonferrous Metal Products	31.4	15.1	46.5	51.6	1.9	23.4	7.7	31.1	67.2	1.6
Fabricated Metal Products	55.3	25.1	80.4	17.3	2.3	60.1	13.0	73.1	23.3	3.6
Metal Cans & Misc. Metal Products	44.1	17.8	61.9	36.8	1.3	40.3	7.1	47.4	50.5	2.1
Industrial Machinery, Except Electrical	59.4	18.9	78.3	19.6	2.0	75.7	8.9	84.6	12.3	3.0
Machinery, Except Elec-trical and Industrial	53.4	17.7	71.1	26.5	2.3	49.7	8.9	58.6	37.7	3.6
Communication Products & Parts	64.5	12.4	76.9	13.0	10.0	59.9	5.6	65.5	18.0	16.5

* Source: Motor Vehicle Facts and Figures, 1976 Data from 1972 Commodity Transportation Survey - U.S. Bureau of Census.

Table 3-G (Cont'd)

Commodities Shipped by Mode of Transport*

	Tons					Tons/Miles				
Group	Motor Carrier	Private Truck	Total Truck	Rail	Other	Motor Carrier	Private Truck	Total Truck	Rail	Other
Electrical Products & Supplies	49.3	14.1	63.4	35.0	1.3	46.0	8.4	54.4	43.2	2.6
Motor Vehicles & Equipment	37.3	3.0	40.3	59.3	.4	17.4	1.0	18.4	80.9	.8
Transportation Equipment Except Vehicles	23.9	54.8	78.7	19.5	1.8	30.3	43.1	73.4	24.0	2.7
Instruments, Photo Equipment Watches & Clocks	63.8	10.9	74.7	20.9	4.4	53.9	5.7	59.6	34.4	6.0
TOTAL ALL SHIPPER GROUPS	31.1%	18.3%	49.4%	31.7%	18.8%	20.9%	6.8%	27.7%	42.0%	30.3%
Total all Shipper Groups Except Petroleum and Coal	35.7%	21.3%	57.0%	38.4%	4.5%	28.6%	9.1%	37.7%	56.9%	5.4%

* Source: Motor Vehicle Facts and Figures, 1976 Data from 1972 Commodity Transportation Survey - U.S. Bureau of Census.

In contrast, "for hire" trucks are used by companies or individual owner/operators whose business it is to transport someone else's freight.[6] Examples of firms in this latter category are United Parcel Service, Roadway Express, Consolidated Freightways, and the various movers of household goods (United Van Lines, North American Van Lines, Allied Van Lines). Some companies, like Hertz and Ryder, are in the business of renting trucks for use by others.

"For hire" trucks accounted for about 4 percent of all trucks in use in 1975. Over 50 percent of these trucks were combinations (tractor-trailer) most with five or more axles (see Table 3-H).[5]

Finally, looking at just those manufacturers of heavy-duty gasoline vehicles and engines, Table 3-I shows their total sales(including light-duty vehicles, etc.), their net income (dollars), and the total people they employed in 1979. The total number of people employed in the entire trucking industry is over 9 million people (1973 ATA estimate).

IV. Future Sales of Gasoline-Fueled Heavy-Duty Vehicles

The future sales projections of HDGs are shown in Table 3-J. These projection were obtained by first using the heavy-duty vehicle sales estimates (both gasoline and diesel) from Data Resources.[7] The total heavy-duty vehicle sales were calculated by assuming that 13 percent of Data Resources' estimates for "light trucks" fall into EPA's heavy-duty vehicle category. This percentage was obtained from previous work on sales estimates derived from Data Resources.[8] This number was then added to the "heavy and medium truck" estimates by Data Resources which is also assumed to belong into EPA's heavy-duty vehicle category. Next, the total heavy-duty vehicle estimates were broken down into vehicle class, according to the percentages estimated in the regulatory analysis for control of gaseous emissions for heavy-duty vehicles.[9] Once broken down into vehicle class, the fraction of gasoline vehicles in each class (again, as estimated in reference [9]) were multiplied by the total sales within each class to obtain the future sales estimates for gasoline-fueled heavy-duty vehicles.

The evaporative emission standards are different only for heavy-duty vehicles weighing more than 14,000 pounds or vehicles weighing less than or equal to 14,000 pounds. According to the analysis above, approximately 53 percent of HDGs weigh 14,000 pounds or less and are thus affected by the 3 g/test standard, and 43 percent of the vehicles weigh more than 14,000 pounds and are thus affected by the 4 g/test standard. This distinction will be important for estimating the emission reductions in Chapter 4, Environmental Impact.

Table 3-H

"For Hire" Trucks In Use (1974)*

Single Unit Trucks	Number	Percent
2 Axles	378,845	39.4
3 Axles	43,276	4.6
Subtotal	422,121	44.0
Combination Trucks		
3 Axles	70,181	7.3
4 Axles	145,899	15.2
5 or more	321,499	33.5
Subtotal	537,579	56.0
Total Trucks for Hire	959,700	100.0
Total Trucks In Use	23,648,008	
% Trucks Used for Hire	4.067%	

* Source: Transportation Energy Conservation Data Book, Edition 3, February 1979, Oak Ridge National Laboratory, Table 1.26

Table 3-I

1979 U.S. Vehicle and Engine Manufacturer Information*

Company	Total Sales ($)	Net Income ($)	No. of Employees
Chrysler	12,001,900,000	-1,097,300,000	133,811
Ford	43,513,700,000	1,169,300,000	494,579
General Motors	66,311,200,000	2,892,700,000	853,000
International Harvester	8,392,042,000	369,562,000	97,660

* Source: Fortune, May 5, 1980; Moody's News Reports; Company annual reports.

Table 3-J

Future Sales of Gasoline-Fueled Heavy-Duty Vehicles

Year	Vehicle Class IIB	III	IV	V	VI	VII	VIII	Total
1984	173,800	32,600	5,500	13,500	155,000	7,400	0	388,000
1985	180,000	35,000	5,900	17,000	168,000	5,200	0	411,000
1986	185,000	36,000	6,200	17,000	170,000	3,700	0	418,000
1987	190,000	37,000	6,300	17,000	167,000	1,900	0	419,000
1988	190,000	37,000	6,300	17,000	165,000	0	0	415,000

V. Conclusion

Overall the heavy-duty vehicle industry consists of a complex array of vehicles and engines, of various types, sizes, and of end uses. Sizes range from 8,500 pounds to as high as 65,000 pounds GVWR. For the concerns of evaporative emissions the number of engine types is reduced considerably, since only gasoline engines are considered. Also, the number of manufacturer's that produce HDGs is reduced to four primary manufacturers; GM, Ford, Chrysler (Dodge), and International Harvester (IHC). The picture is even more simplified by the fact that these manufacturers produce their own engines. This portion of the HDV industry accounts for approximately 400,000 HDGs produced annually, which is about 3 percent of 14 million total motor vehicles produced each year.[10] EPA has estimated [11] that the typical HDG has a useful life of 8 years and approximately 114,000 miles. Since the sales, the and the products themselves are everchanging entities, it should be no surprise to see the picture change as the industry responds to the pressure of consumer need, corporate finances, and government regulation.

References

1. Clean Air Act as amended, August 1977, Section 202(b) (3)(c).

2. Based on 1973 GM and Ford production data.

3. Based on 1977 GM, Ford, and Chrysler production data.

4. "Motor Vehicle Facts and Figures," 1978 MVMA data.

5. Transportation Energy Conservation Data Book, Edition 3, February 1979, Oak Ridge National Laboratory, Table 1.26.

6. "American Truck Trends: 1975, ATA."

7. "The Data Resources U.S. Long-Term Review," Data Resources, Winter 1980-81.

8. "Draft Regulatory Analysis, Environmental Impact Statement and NOx Pollutant Specific Study for Proposed Gaseous Emission Regulations for 1985 and Later Model Year Light-Duty Trucks and 1986 and Later Model Year Heavy-Duty Engines," EPA, OMSAPC, 1981.

9. "Regulatory Analysis and Environmental Impact of Final Emission Regulations for 1984 and Later Model Year Heavy-duty Engines," EPA, OMSAPC, December, 1979.

10. 1978 MVMA Facts and Figures.

11. "Average Lifetime Periods for LDTs and HDVs," G. Passavant, EPA, OMSAPC, November, 1979.

CHAPTER 4

ENVIRONMENTAL IMPACT

I. Background

The Clean Air Act as amended in 1970 contained many provisions aimed at removing harmful pollutants from the air that we breathe. Among other things, the Act called for the creation of National Ambient Air Quality Standards, expressed as the maximum allowable concentrations a particular pollutant could reach without endangering public health and welfare.[1] To date, ambient air quality standards have been set for seven pollutants: particulate matter, lead, sulfur dioxide (SO_2), carbon monoxide (CO), nitrogen oxides (NOx), hydrocarbons (HC), and ozone (of which nonmethane hydrocarbons (NMHCs) are the main precursors). Of these seven pollutants, mobile sources are major contributors for three: NMHC, CO, and NOx.

Although significant improvements have been made in air quality since 1970, a review of air quality monitoring data makes it clear that additional reductions in NMHC, CO, and NOx emissions will be necessary if ambient air quality goals set by Congress in the Clean Air Act are to be achieved throughout the nation.[2]

II. Primary Impact

As discussed previously, this rulemaking consists of a split standard to control evaporative hydrocarbon emissions from gasoline-fueled heavy-duty vehicles (HDGs): 3 grams/test (gpt) for HDGs with GVWR less than or equal to 14,000 pounds and 4 gpt for those HDGs exceeding 14,000 pounds GVWR. The primary impact analysis focuses on 24 cities, 22 of which are in low-altitude areas and 2 in high-altitude areas (refer to Table 4-A). These cities were chosen because they experience high ozone concentrations. In this section, the effect of controlling evaporative HC emissions according to the above described standards (and the case of continued noncontrol) will be examined in terms of their relative impacts on air quality (pollutant concentration) and total emissions.

Projected NMHC emissions in low- and high-altitude areas are derived from NMHC emission factors for given model years, vehicle population data, and mileage accumulations rates.[3] The historical emission factors listed in Table 4-B are calculated using operational data from in-use heavy-duty vehicle (HDV) surveys in New York, Los Angeles, and St. Louis.[4] Those for 1984 and beyond were derived based on information in EPA's latest version of the Mobile Source Emission Factors Document modified according to the level of control being promulgated.[3][5] Emission factors are intended to reflect actual emissions from in-use vehicles and, as such,

Table 4-A

Low- and High-Altitude Areas Studied in this Analysis

Urban Area
New York, NY-NJ
Philadelphia
Washington, D.C.
Louisville, KY
Cincinnati
Baltimore
Worcester, MA
Boston
Denver*
Salt Lake City*
Providence
Allentown, PA
Cleveland
Pittsburgh
Nashville
Houston
St. Louis
Detroit
Portland, OR
Richmond, VA
Seattle
Milwaukee

* High-altitude cities.

Table 4-B

Evaporative HC Emission Factors for
Gasoline Heavy-Duty Vehicles by Model Year*

Model Years	Low Altitude	High Altitude
Pre-1968	8.95 g/mi	11.58 g/mi
1968-1983	3.25	4.23
1984+**	0.26	0.33

* These factors were derived according to in-use tests for pre-1984 models and tests extrapolated from light-duty vehicles for the 1984 and beyond models. The following equation was then used based on these test results:

$$E_f = \frac{(H.S.)(T.P.D.) + D.}{M.P.D.} + C.C.$$

Where:

E_f = emission factor in grams per mile

H.S. = hot soak (1.09 gpt for low-altitude 1984+, 12.70 gpt for low-altitude 1968-1983 and pre-1968, 1.42 gpt for high-altitude 1984+, and 16.51 gpt for high-altitude 1968-1983 and pre-1968)**

T.P.D. = trips per day = 6.88

D. = diurnal (1.86 gpt for low-altitude 1984+, 31.90 gpt for low-altitude 1968-1983 and pre-1968, 2.42 gpt for high-altitude 1984+, and 41.47 gpt for high-altitude 1968-1983 and pre-1968)**

M.P.D. = miles per day = 36.7

C.C. = crankcase emissions (0.0 g/mi for 1968 and beyond at all altitudes, 5.70 g/mi for low-altitude pre-1968, 7.35 g/mi for high-altitude pre-1968).

** As discussed earlier, this rulemaking is a two step approach with a 3.0 gpt standard for HDG's weighing up to 14,000 pounds GVWR and a 4.0 gpt standard for those above this limit. In determining the hot soak and diurnal emission values for the 1984+ cases, a sales weighting of 53.3 percent for HDG's weighing 14,000 pounds and under and 46.7 percent for those above was used, as determined earlier. The low-altitude hot soak and diurnal test values for the lower weight category are 0.94 and 1.61 gpt, respectively. For the heavier weight category at low-altitude, the hot soak and diurnal test values are 1.26 and 2.14 gpt respectively. The high-altitude hot soak and diurnal test values are 1.3 times the low-altitude values, as determined in the Federal Register, January 24, 1980.

are not the same as the vehicle emissions standards. Since the performance of emission control systems will deteriorate over time, new vehicles generally have emission levels below applicable standards to enable them to meet standards over their entire useful life.

As vehicles age, a certain percentage will be maladjusted or experience emission control system failures. This means that although a properly adjusted vehicle will meet the standards, the average emission rate for the whole fleet may exceed that level. Through this process of vehicle deterioration then, some of the benefit of any standard is lost. The amount of loss depends upon the amount of maintenance required for the emission control system (the more maintenance required, the more chance of neglect), plus the emission rate associated with maladjustment or failure of emission controls. Implementation of an Inspection/Maintenance (I/M) program will reduce the number of vehicles with excess emissions and thereby improve the effectiveness of applicable standards. The air quality analysis in this section was determined both with and without I/M.

Using the emission rates in Table 4-B and assuming a life-time of 114,000 miles over 8 years,[6] the emission reduction potential of this rulemaking can be determined on a per vehicle basis. This has been done and the results depicted in Table 4-C. As can be seen, a typical HDG in low-altitude areas will emit approximately 341 kilograms less evaporative NMHC over its lifetime as a result of this rulemaking. Similarly, a typical high-altitude HDG will emit nearly 445 kilograms less NMHC via evaporation.

Using these same emission rates an analysis was done of the air quality impact of HDG evaporative emission control in each of the selected regions. The Empirical Kinetic Modeling Approach (EKMA) was used to project future ozone air quality improvements for each region. The EKMA procedure has been developed by EPA in an attempt to provide an improved analysis of the relationship between ozone and precursor emissions while avoiding the complexity of photochemical dispersion models.[7]

In preparing the air quality projections, baseline emission rates for various source categories were taken from the National Emissions Data System (NEDS). It should be noted that the relative changes from strategy to strategy are more reliable than predictions of absolute levels of air quality. Therefore, the results will be expressed as percentage gains over baseline between various strategies, estimated regions above the standard and total number of exceedances. Tables 4-D and 4-E show the results of this analysis.

According to this investigation, quantifiable air quality benefits of this rulemaking first appear in 1988, four years

Table 4-C

Per Vehicle Lifetime Emissions
of Evaporative Hydrocarbons (Kilograms)

High Altitude	
Without Control	482.2
With Control	37.6
Net Reduction	444.6
Low Altitude	
Without Control	370.5
With Control	29.6
Net Reduction	340.9

Table 4-D

Ozone Air Quality Analysis
for 22 Low-Altitude Areas

Average Percent Change in
Ozone Concentration from Base Year (1979)

Description	1985	1987	1988	1990	1995	2000
No Control, With I/M	-22	-23	-23	-23	-22	-19
Control, With I/M	-22	-23	-24	-24	-22	-19
No Control, Without I/M	-18	-20	-20	-21	-20	-17
Control, Without I/M	-18	-20	-20	-21	-20	-18

Estimated Number of
Regions Above Standard of 0.12 ppm

Description	1985	1987	1988	1990	1995	2000
No Control, With I/M	15	13	13	13	14	14
Control, With I/M	15	13	13	13	14	14
No Control, Without I/M	16	16	16	15	14	15
Control, Without I/M	16	16	15	15	14	15

Total Number of Exceedances
of Standard in the 22 Regions

Description	1985	1987	1988	1990	1995	2000
No Control, With I/M	71	61	60	61	71	84
Control, With I/M	71	61	60	61	70	84
No Control, Without I/M	84	76	75	72	77	89
Control, Without I/M	84	76	73	72	76	87

Table 4-E

Ozone Air Quality Analysis
for 2 High-Altitude Areas

Average Percent Change in
Ozone Concentration from Base Year (1979)

Description	1985	1987	1988	1990	1995	2000
No Control, With I/M	-21	-24	-25	-26	-25	-22
Control, With I/M	-21	-24	-26	-27	-26	-23
No Control, Without I/M	-17	-20	-21	-22	-22	-20
Control, Without I/M	-17	-20	-22	-23	-24	-21

Estimated Number of
Regions Above Standard of 0.12 ppm

Description	1985	1987	1988	1990	1995	2000
No Control, With I/M	2	1	1	1	1	1
Control, With I/M	2	1	1	1	1	1
No Control, Without I/M	2	2	2	1	1	1
Control, Without I/M	2	2	1	1	1	1

Total Number of Exceedances
of Standard in the 2 Areas

Description	1985	1987	1988	1990	1995	2000
No Control, With I/M	4	3	3	2	3	4
Control, With I/M	4	3	2	2	3	4
No Control, Without I/M	6	5	5	3	3	4
Control, Without I/M	6	5	3	3	3	4

after its implementation, in both low- and high-altitude cities as compared to the no control case. For the non-I/M case, this action brings one low- and one high-altitude region into compliance in 1988; 1 less low-altitude exceedance in 1995 and 2 less in 2000 are also realized. With I/M, the benefits are less apparent as no additional regions are brought into compliance. However, HDG evaporative control in the I/M case does result in 1 less high-altitude exceedance in 1988 and 1 less low-altitude exceedance in 1995.

From these tables it can be seen that adding control of HDG evaporative emissions is not enough, in itself, to bring all areas under compliance with regard to ozone, even with the benefits of I/M programs. However, one should not infer from this observation that reducing HDG evaporative emissions is not a prudent step towards the goal of bringing all regions into compliance. When trying to provide healthful air for the nation's populace, control strategies should be implemented which achieve the greatest benefit per dollar. Thus, the cost of control, along with its benefits, should also be a key determinant when deciding the merits of a given strategy. Since data alluded to earlier clearly indicate that much of the nation has still not attained the ozone National Ambient Air Quality Standard of 0.12 parts per million, further reductions of its precursors, principally NMHC, are necessary. This strategy will aid in achieving such reductions. Chapter 6 will address the issue of cost-effectiveness and show that HDG evaporative control is indeed a wise course of action.

III. Secondary Environmental Impact

A. Energy Consumption

For HDGs which are equipped with conventional fuel systems, no change in energy consumption is anticipated due to implementation of these regulations.

B. Exhaust Hydrocarbon Emission Interaction

Depending on the design of the evaporative control system used to meet the 3.0/4.0 gpt standard, an interaction could occur due to the purging of additional evaporative emissions into the engine which would enrich the fuel/air mixture and cause additional exhaust HC and carbon monoxide to be generated from the combustion process. Whether or not this occurs is dependent on the rate and the total amount of HC purged into the engine and the operating condition of the vehicle when purging takes place.

C. Water, Noise and Solid Waste Pollution

Complying with this evaporative emission regulation for heavy-duty gasoline vehicles is expected to have negligible impact on water pollution, on the ability of the HDV manufacturers to meet present and future noise emission regulations, or on generation of solid wastes by the HDV industry.

References

1. Information on the health effects of the HC, CO, and NOx pollutants which are of concern in this report will not be discussed in this report since they are well documented elsewhere. For a summary of this data, as well as citations to other reports on health effects of HC, CO, and NOx, see Chapter 3 of "Air Quality, Noise and Health," Report of a Panel of the Interagency Task Force on Motor Vehicle Goals Beyond 1980, March 1976.

2. Code of Federal Regulations, Title 40, Part 81, Subpart C July 1, 1980.

3. "Compilation of Air Pollutant Emission Factors: Highway Mobile Sources," Draft Document, EPA, March 1981, EPA 460/3-81-005.

4. EPA Report - "Truck Driving Patterns and Use Survey, Phase II," Final Report, Part II Los Angeles, L. Higdon, May 1978. EPA Report - Truck Driving Pattern and Use Survey Phase II - Final Report, Part I, Wilbur Smith and Associates, June 1977.

5. "Analysis of the Evaporative Emission Regulations for 1984 and Later Model Year Gasoline-Fueled Heavy-Duty Vehicles," J. Wallace and M. Wolcott, EPA Technical Report TEB-EF-82-1, November 1981.

6. "Average Lifetime Periods for Light-Duty Trucks and Heavy-Duty Vehicles," Glenn W. Passavant, U.S. EPA, SDSB 79-24, November 1979.

7. "Methodology to Conduct Air Quality Assessments of National Mobile Source Emission Control Strategies", EPA-450/4-80-026, October 1980.

CHAPTER 5

ECONOMIC IMPACT

This chapter will examine the cost of meeting the evaporative emission standards of 3.0 g/test for heavy-duty gasoline-fueled vehicles (HDGs) weighing 14,000 lbs or less, and 4.0 g/test for HDGs weighing more than 14,000 lbs. The major cost incurred in meeting either of the standards will be the production of the necessary evaporative emission control system components. Also manufacturers must purchase and install the necessary evaporative emissions testing equipment since these regulations require equipment not previously needed for measuring HDG evaporative emissions. Other costs that are discussed below include facility space cost, research and development (R&D) costs and development testing costs.

This chapter has been divided into two major sections: the cost to manufacturers and the cost to consumers. Manufacturers' primary cost will involve the adding of evaporative emission control hardware to their vehicles. Lesser costs will result from investments in equipment and test facilities and for the development of control hardware for meeting evaporative emission standards. The consumer will pay for costs incurred by the manufacturer and in addition pay for a profit that the manufacturer seeks to make on his investment.

Following these two major sections, the aggregate cost to the nation for the first five years the HDG evaporative emission standards are in effect will be determined.

I. Cost to Vehicle Manufacturers

On April 30, 1980, the Notice of Proposed Rulemaking for control of evaporative emissions of HDGs was published. Since then, the four major manufacturers of HDGs (Chrysler, Ford, GM, and International Harvester (IH)) provided cost estimates in their comments submitted subsequent to the NPRM.[1] The manufacturers' cost estimates were based on the proposed standard of 3 g/test; not on the split standard (3.0 g/test for vehicles 14,000 lbs. or less, 4.0 g/test for vehicles greater than 14,000 lbs.) of this Final Rule. The manufacturers provided both hardware and investment costs. However, on the basis of EPA's analysis of the manufacturers' cost estimates, there is insufficient cost data supporting most of these estimates and thus an independent analysis of the costs to the manufacturers will be performed here.

The costs to the manufacturers of meeting these HDG evaporative emission standards can be conveniently separated into two types: variable and fixed. The variable costs, which are essentially the cost of emission control hardware, will be analyzed first. This cost will be determined on a per vehicle basis in terms of the retail price equivalant. The fixed costs will be determined next for the whole vehicle fleet and then converted to a per vehicle basis. The fixed costs represent the capital investments each manufacturer must make prior to actual implementation of the standards. These fixed costs will include test facility equipment or modifications, additional building space, development of HDGs for meeting the evaporative emission standard, and R&D costs for development of control hardware.

A. Control System Components Costs (Hardware)

Manufacturers have submitted control hardware cost estimates of their own in their comments to the NPRM.[1] The estimates ranged from about $65 to $350, with very little breakdown or analysis of how these costs were obtained. A more thorough analysis will be performed here, as the manufacturers comments were not sufficient to support their cost estimates.

In this section, the retail price equivalent (RPE) of the emission control required by this regulation will be determined. First, the factors that contribute to the RPE will be discussed. Second, the cost of each emission control system component will be estimated. Finally, the total hardware cost resulting from this regulation will be summarized.

1. Cost Methodology

In general the retail price equivalent (RPE) for a component of emission control hardware includes the direct material, direct labor, fixed and variable overhead and profit at the vendor level, tooling expense, and overhead and profit at the corporate and dealer level. In this analysis, R&D will not be included in the emission control hardware costs as it is not considered to be a variable cost. R&D costs will be estimated separately under "Fixed Costs." Other than this exception, the RPE calculations and estimates used in this chapter will follow RPE formulas used in recent regulatory analyses,[2][3] and will not be discussed in detail here. Corporate overhead and profit and dealer overhead and profit in this analysis are included in the RPE (at 100 percent of the vendor level costs instead of the 29 percent used in past analyses, as will be explained later) as they are considered costs to the manufacturer who will seek a return on its investment. For the most part, estimates of vendor costs will be taken from an Exxon report.[4]

All costs are based on the appropriate production volumes, according to sales figures estimated later in this report. It is also assumed that all control hardware items are manufactured by outside suppliers.

All costs in this analysis will be estimated in 1981 dollars. As in past regulatory analyses, an 8 percent per annum inflation rate will be used to convert costs from previous year dollars to 1981 dollars. This inflation rate can be supported by the fact that the new car consumer price index (NCPI) for the years 1977, 1978, 1979, and 1980 was 7.2, 6.2, 7.4, and 8.0 percent, respectively. While the NCPI is lower than the composite Consumer Price Index for the past 3-4 years, it is a much better indicator of the specific inflation rate for vehicle manufacturing. The NCPI may reflect some lowering of profits to sell cars and trucks in the last few years. However, the 8 percent inflation rate provides some degree of compensation for the effect of such practices.

2. Estimated Cost for Each Component

The estimated control system component costs (Table 5-A) were obtained from an Exxon report concerning light-duty vehicle evaporative emissions control, from discussions with the author of that Exxon report, from discussions with carburetor and charcoal canister manufacturers and by inflating numbers from the previous year by the proper inflation rate (8 percent per year).[4] The estimated prices shown are retail prices which EPA obtained by multiplying the estimated component costs to the vehicle manufacturer by a factor of two (as was done in the Exxon report).

This 100 percent markup is very conservative. In fact, recent analysis by EPA has shown that the average actual markup is about 29 percent.[2][3] However, it is not clear in the Exxon report at what stage of production the 100 percent markup factor was applied. Simply using the 29 percent factor in place of the 100 percent factor might not be appropriate. Instead, a complete reanalysis of component costs would be necessary. Since, as we shall see, even the higher costs represented by the 100 percent markup would be acceptable, there is no need to attempt to recalculate the figures.

The components listed in Table 5-A include two charcoal canisters and charcoal in the air cleaner. This quantity of charcoal should be adequate for all vehicles. Also, included as part of the control hardware components are the liquid-vapor separator, the roll-over valve, hoses, tubing, and switchover to impermeable tubing. Both the liquid-vapor separator and the roll-over valve prevent liquid from entering the vapor lines. Hoses and tubing include those from fuel tank to carbon canister, from canister to engine, and from the carburetor to the canister. Impermeable fuel line tubing is necessary to prevent evaporative loss from fuel line tubing of normal composition.

As shown in Table 5-A the total retail price for the evaporative control system components is expected to be about $38.50 per vehicle.

Table 5-A

Control System Components and Estimated Costs for Control of Evaporative Emissions from Gasoline-Fueled Heavy-Duty Vehicles to a 3.0/4.0 g/t Level

New Component or Change	Estimated Cost to the Consumer
Carburetor	
Bowl Vent (2-Way Switch Valve)	$ 5.50
Shaft Seals	1.25
Charcoal Canisters*	
Two Canisters	17.00
Purge Air Intake from Air Cleaner	0.75
Air Cleaner	
Increase Volume	
Charcoal Bed	5.50
Shut-Off for Intake Snorkel	Not Required**
Fuel Tank	
Threaded Fuel Cap	0.75
Liquid-Vapor Separator and Roll-Over Valve	1.25
Hoses and Tubing	1.25
Impermeable Fuel Lines	$ 5.00
Total	$38.25***

* The same size system should be adequate for all classes of HDGs, especially in light of the fact that vehicles heavier than 14,000 lbs. are allowed to emit 1 more gram/test than HDGs 14,000 lbs. and lighter.

** If charcoal is utilized in the air cleaner, the snorkel does not require sealing.

*** 1981 dollars.

B. Fixed Costs

The fixed (or capital) costs of evaporative emission control for HDGs will be examined in this section. These fixed costs include test equipment costs (chassis dynamometer, SHEDS, and facility space), industry R&D costs for control hardware, development testing costs, and certification costs.

Table 5-B summarizes the estimated industry investment costs which are discussed below.

1. Testing Equipment Costs

The abbreviated certification procedure to be implemented for this regulation will probably necessitate the use of development testing equipment such as HDV chassis dynamometers, SHED(s), HC analyzers (FIDs), chart recorders, temperature achievers, heating blankets and equipment for durability testing. Industry's actual investment costs for this regulation could be less than those estimated here because the abbreviated certification provides for the use of any test method and/or engineering evaluation the manufacturer deems acceptable to assure themselves that emissions are below the standard. For example, increased utilization of component testing could decrease industry investment in SHEDs and facilities costs.

In the following conservative analysis of industry equipment costs it will be assumed that all necessary testing for compliance of this regulation will be a part of the manufacturers' development work which will be accomplished using the full-SHED test procedure and possibly through some bench test programs. There are no certification costs considered because the certification "procedure" will generally include only a statement of compliance by the manufacturer. The data to support the statement of compliance can be extracted from normal development work. It should be remembered that actual development costs could be lower than EPA's estimates due to the provision for "engineering evaluations" for HDGs exceeding 26,000 lbs. GVW.

In addition to equipment costs, the facilities space necessary to install the equipment has value and this analysis includes a fair rate of return for the use of that space.

a. Chassis Dynamometers

This Final Rule will require no new heavy-duty chassis dynamometers to be purchased due to the abbreviated certification procedure. The abbreviated certification procedure allows for light-duty dynamometers to be converted to heavy-duty dynamometers by adding inertia and trim weights. According to a dynamometer manufacturer, a light-duty

Table 5-B

Industry Investment Costs

Item	1981	1982	1983	1984	Cost 1985	1986	1987	1988	Number	Total Discounted Cost*
Retrofit Dyna-mometer**	$ 25,000	-	-	-	-	-	-	-	4	$0.13M
SHEDs***	$141,000	-	-	-	-	-	-	-	4	$0.75M
Develop-ment Testing****		$680	-	$31	$31	$31	$31	-	1200	$0.93M
Facility Space*****	$15/ ft²	$15/ ft²	$15/ ft²	$15/ ft²	$15/ ft²	$15/ ft²	$15/ ft²	$15/ ft²	15,000 sq.ft.	1.32M
R&D for Control Hardware	$2.00M	-	-	-	-	-	-	-		$2.66M

* Total costs are discounted to 1984 (@ 10 percent) and are 1981 dollars.

** These dynamometers are converted from light-duty dynamometers and apply to Class VI and lower HDGs.

*** This cost also includes auxilary equipment.

**** Includes cost for use of vehicle, installation of control system, cost for emission testing, and cost for personnel involved with durability testing.

***** Includes necessary environmental control and employee parking.

dynamometer can be upgraded to handle 13,500 pounds inertia weight for about $25,000.[5] Upgrading to this inertia weight would handle only Class VI and below HDGs. Thus, Class VII and Class VIII vehicles are not required to prove compliance on a chassis dynamometer. (Sales of Class VII and VIII HDGs will account for less than 2 percent of the total HDG market after 1983.)

The number of dynamometers each manufacturer needs depends upon the number of development vehicles each manufacturer must test. The maximum number of development vehicles expected to be tested by a manufacturer in any year is 8 (by GM). This maximum number is expected to occur in the first year of implementation and then should drop in subsequent years; this will be discussed in more detail below.

The dynamometer usage time required for a development test can be split into 3 categories; control system preconditioning, vehicle preconditioning before the diurnal phase of the test procedure and vehicle warm-up for the hot-soak phase of the test. Each of these categories has a specific amount of dynamometer usage time associated with it. They will be briefly discussed below and then summed to obtain the total dynamometer usage time required for one development test.

The test procedure requires that a new carbon canister be stabilized before an evaporative emission test takes place. This stabilization consists of 30 load/purge cycles of any vapor storage device which absorbs non-methane hydrocarbons (NMHC) vapors and subsequently releases them to the engine induction system. The first 20 such cycles can be done with a bench-type procedure whereby gasoline vapors are passed through the vapor storage device and then the device is purged with air. The last 10 cycles, however, must be done with the control system installed on the development vehicle. This "build-up" vehicle must be run over the chassis dynamometer driving cycle once for each of the 10 remaining load/purge cycles. Since each driving cycle takes twenty (20) minutes, the total dynamometer usage time is 200 minutes for control system stabilization.

The second area of dynamometer usage time during a test is the time required for vehicle preconditioning prior to the diurnal SHED test. This will usually consist of one 20-minute driving cycle but may consist of up to a total of four. Since EPA's technical staff expects that the 30 load/purge cycles will be sufficient to stabilize the control system, only 2 driving cycles should ever be required for vehicle preconditioning. Therefore, the dynamometers usage time for vehicle preconditioning is estimated to be (2 driving cycles per diurnal test) X (20 minutes per driving cycle) for a total of 40 minutes.

The final category of dynamometer usage time is the vehicle warm-up prior to the hot soak SHED test. This consists of one driving cycle per hot-soak test, or 20 minutes.

Summation of the above 3 dynamometer usage time categories results in a total of 260 minutes of dynamometer time per vehicle. Some other minor aspects of dynamometer usage time include vehicle tie down time, dynamometer calibration time and practice runs. If 100 minutes is allowed for these minor aspects then the total dynamometer time per vehicle tested is 360 minutes or 6 hours. As pointed out previously in this section the maximum number of development vehicles expected to be tested by any manufacturer is 8. Assuming a normal 8 hour work day, a manufacturer could conceivably finish testing his 8 final, development vehicles in as little as 2 weeks (5 day work week) of dynamometer time. By allowing an extra week for dynamometer downtime and scheduling inefficiencies GM, for example, should be able to complete final, development testing on all of its vehicles in 3 weeks worth of dynamometer time thereby leaving approximately 11 months of dynamometer time to do any R&D for which it might need the chassis dynamometer.

The above analysis shows that even if the maximum number of development vehicles are tested, each manufacturer would need only one retrofit chassis dynamometer. However, as discussed under development costs later, it is likely that the maximum number of vehicles will be tested only in the first year of implementation.

The total cost of retrofit dynamometers would then be $100,000 (undiscounted) for the four HDG manufacturers. Assuming manufacturers invest in these dynamometers in 1981, the discounted cost in 1984 would be $133,000, based on a 10 percent discount rate.

b. <u>Sealed Housings for Evaporative Determination (SHEDs)</u>

In addition to a dynamometer, it is assumed that each manufacturer will need at least one SHED. The amount of time a SHED must be used for development purposes is less complex than dynamometer usage time. The normal test procedure requires a one hour diurnal soak in the SHED and a one hour hot soak in the SHED for each complete test. Allowing 2 hours per development vehicle for SHED purging and set-up time gives a total of 4 hours of SHED usage time per test. All manufacturers will need only one SHED under the abbreviated certification procedure. The above SHED usage time analysis indicates that even GM and Ford would need only one SHED. Thus, the estimated total number of SHEDs required by the industry is 4.

Manufacturers have estimated the cost of a SHED to be anywhere from $50,000 to $250,000.[1] Because of this wide range of costs, EPA performed a further analysis based on estimates of the EPA SHED facility. The technical staff of EPA has estimated that a SHED 12' x 14' x 40' will cost $100,000, and the necessary support equipment (i.e., FID, chart recorders (2), heat blankets, temperature achievers (2), mixing fans, air conditioning, thermocouples, fuel chiller, tubing and bottles) will cost approximately $41,000 (1981 dollars). The total estimated industry cost for SHEDs is, therefore, 4 x $141,000 or $564,000 (1981 dollars and undiscounted). Assuming the SHEDs were bought in 1981, the discounted cost to 1984 would be $750,000 (at a 10 percent discount rate).

c. Facility Space

Another area of consideration under the general category of investment costs is the space required for equipment installation and for the parking of development vehicles. The rental cost of similar facility space is used as the estimate of the value of the manufacturers' space. EPA has determined that the long-term facility space rental rate, including the necessary environmental control and employee parking, is about $15/ft^2 per year (1981 dollars). This estimate was made by averaging the current EPA Motor Vehicle Emissions Laboratory (MVEL) space rental cost and the square footage cost of a 20,000 ft^2 building amortized over 25 years. The EPA MVEL in Ann Arbor, Michigan currently rents for about $13.50 ft^2. This facility is about 10 years old and the cost includes employee parking space. This facility is more complex (i.e., expensive) than would be needed for just HDG evaporative emissions testing since it includes laboratories and considerable office space.

A building at a cost of $150/ft^2 and amortized over 25 years would give a yearly payment of $16.50/ft^2. Discussions with builders in the Detroit area have determined that an allowance of $150/ft^2 for building cost would be conservative and would include heating/cooling, parking, wiring, plumbing and all other environmental control. The average of $13.50/ft and $16.50/ft^2 is $15/ft^2. This analysis will allow $15/ft^2 for the manufacturer's space that must be used to install the necessary development equipment and to park HDGs during development work. Also, this analysis will treat the facility space costs as an annual expense and all discounting will be from the beginning of any given year.

The amount of space required for each manufacturer has been estimated in the following way. By assuming one dynamometer, one SHED, parking space for HDGs (four parking spaces for GM and Ford, two parking spaces for Chrysler and IH), a durability-bench test room, and area to maneuver the vehicles; IH and Chrysler will need about 3,000 ft^2 each and GM and Ford will each need 4,000 ft^2. Summation of each manufacturer's expected square footage requirements and multiplication by $\$15/ft\text{-}yr^2$ gives a total industry facility space cost of $225,000 per year (1981 dollars).

The total facility space cost is estimated over eight years. EPA assumes that the manufacturers have already allocated space for heavy-duty evaporative emissions testing. Therefore, the allowance for facility space cost begins in 1981 and continues through 1988 (i.e., five years after implementation). Thus, the 8-year period, 1981 though 1988 is appropriate. Each of the 8 years' $255,000 facility space cost is discounted (at 10 percent) to 1984. The total cost in 1981 dollars is $1.32 million.

2. Industry R&D Costs for Control Hardware

The R&D costs associated with this regulation will be minimal because the sources of evaporative emissions and the technology to control evaporative emissions are well understood from experience in the light-duty evaporative emission control program. There are no major differences between LDVs and HDGs which affect the required control technology. Uncontrolled HDGs do emit more evaporative hydrocarbons than uncontrolled LDVs because of greater fuel tank and carburetor bowl volumes and higher engine compartment temperatures. Increased canister working capacities and air cleaner volumes will be needed to control the higher emission rates, but the control technology will remain basically the same.

Although control technology for HDGs should be similar to that for LDVs, there still may be a small R&D cost associated with evaporative emission control hardware for HDGs. If a $1 R&D cost (undiscounted) is assumed to occur for each HDG sold between 1984-1988 this would amount to an undiscounted cost of about $2 million industry wide (based on sales projection to be discussed later), or about $100,000 per evaporative emission family (based on the number of family-systems to be discussed in the next section). From past experience on analyzing R&D costs for vehicle families, a $100,000 R&D cost per HDG family should be reasonable for a control technology very similar to that used for LDVs. Assuming that the $2 million total R&D cost is spent in 1981, the discounted cost in 1984 (at a 10 percent discount rate) is $2.66 million.

3. Development Testing Costs

Development costs depend on the number of vehicles manufacturers will test, the number of tests per vehicle, and the cost per test. The following table summarizes these costs and the following paragraphs discuss each in detail.

Item		$/Test
Use of Vehicle		$ 80
Personnel Cost to Install Control System Personnel		$ 20
Cost for Testing		$500
Personnel Cost for Durability Testing		$ 20
	Total	$620

The regulations will differentiate product lines into evaporative family-control system combinations. An evaporative family will be those vehicles which have the same carburetor fuel bowl volumes. These families may be subdivided into control system combinations. Control system combinations will be determined on the basis of the method of vapor storage, vapor storage material, vapor storage working capacity, method of carburetor bowl venting and vapor purge technique.

EPA has estimated the number of evaporative families for each manufacturer based on the manufacturer's product offerings in 1980.[5] EPA reviewed the different carburetors and emission control systems offered on each HDG model. These combinations were then placed into evaporative family-control systems. It is estimated that at most Ford will have 6 familysystem combinations, GM will have 8, IHC will have 4 and Chrysler will have 2 family-system combinations.

Estimating the number of development tests required for each family-system unit is difficult. In reality the number is likely to be different for each family-system because calibration within each family-system will require different degrees of development effort.

For each family-system only the worst case vehicle configuration will require emission control development. This vehicle would be below a Class VII rating, because Class VII and Class VIII vehicles can not be used with the facilities described previously in this chapter (since these two classes cannot be tested on retrofit dynamometers). The number of development tests should be less than that estimated for most emission regulations which, in general, require more difficult technologies. The evaporative emission control technology is expected to be extrapolated from light-duty hardware and experience. Thus, the magnitude of the task is not as great as in some other emission control programs. Development testing is likely to consist of a combination of various bench tests for characterization and full test procedures with correlated results for assurance of meeting the standard. It is difficult here to estimate exactly how many bench tests may be used and how many full test procedures may be performed. For this analysis, it is assumed that at most the equivalent of 50 full test procedures will be required for development of each engine family, based on the expected ease of development of HDG evaporative emission control.

Development carryover will also reduce the number of vehicle builds required in subsequent years. If the exhaust, evaporative and crankcase emission control systems on an evaporative family-system combination don't change from one year to the next, then most likely the development work from the previous year can be "carried over" to the next year. Thus, development costs are eliminated for those evaporative familysystem combinations where carryover is exercised. There is every reason to believe that HDG evaporative emission testing will also be substantially reduced by carryover.

According to certification data[6] the carry over for LDVs evaporative emission families is about 95 percent per year. It is assumed here that this carryover rate would apply to HDGs, since it is also expected that evaporative family-systems will not change frequently from year to year. Based on the total of about 20 evaporative emission families for the first year, approximately 95 percent of this, or 19 families, should obtain carryover for following years. Thus, only 1 evaporative family-system per year industry-wide should require further development after the first year of this regulation.

The number of development tests for the first year are shown below, again based on the number of evaporative families per manufacturer and the number of tests per evaporative family:

Manufacturer	1984
Ford	300
GM	400
IHC	200
Chrysler	100
Total	1000

For each subsequent year to 1984, the number of development tests is 50/year. Thus, the total number of development tests between 1984 and 1988 is 1200.

The cost per development test is determined by considering the cost of using the vehicle, the cost of personnel time to install the evaporative emission control system, the cost of personnel time to test for evaporative emissions and the cost of personnel time for durability testing.

A full evaporative emission test will require the manufacturer to select and "build-up" a representative HDG.

This selected vehicle will need no permanent modifications and will accumulate a total of less than 1000 miles during testing. EPA has assumed that the manufacturer will purchase the vehicle at wholesale and will sell it after testing at a 20 percent discount. The retail price of a typical HDG is in the range of $16,000 to $22,000; therefore, the expected cost for using the vehicle for development testing should be approximately $4,000 per vehicle. On a per test basis, this cost is equivalent to $80/test.

There will be personnel costs for installation of the complete evaporative control system on the test vehicle. During the first year after implementation of these regulations manufacturers will have to custom fit the evaporative control system to their vehicles. Thereafter, such control components as carburetor vents, air cleaner volume expansion, carbon canister positioning, canister purge lines, etc. will be an integral part of all HDG vehicles. Thus, in each subsequent year personnel time to custom fit evaporative control system components to the development vehicle will be limited to only those components which a manufacturer chooses to redesign or to add to the system. EPA's staff estimates that $1,000 per development vehicle build should be sufficient to cover the above personnel costs. This amounts to $20 per test. This average figure is conservative considering the minor installation costs after the first year.

Another cost of the development tests is the personnel time associated with testing the vehicle, including analyzer repair and data analysis. The personnel time for a development test is estimated to be about 10 hours. If $50 per hour is estimated as a rate which includes all overhead such as fuel, analyzer maintenance and data handling costs, then this personnel cost for testing of a development vehicle is $500.

The final development cost associated with the regulations is the personnel cost for durability testing of the components of the evaporative emission control system. Personnel time for durability testing will be needed for such duties as placing the components in ozone chambers, in vibration machines and in fuel vapor flow devices. Also, general observation of the durability testing will be required because of the dangerous nature of the fuel vapors. Durability testing time will decrease from the first year of implementation because of the previously discussed carryover practice. The technical staff of EPA estimates that $1,000 per development vehicle or $20 per test will be adequate for durability testing.

Summation of the above costs equals $620 per vehicle test. Since all HDG evaporative emission families must be certified for the first year of this regulation, certification for the 1984 model-year should begin in mid 1983, and development testing should occur in early 1983. It is assumed here that development testing will actually begin in 1982 for meeting the certification requirements for the 1984 model year. For each year subsequent to 1984, it is assumed that development testing will occcur only one year prior to the model year because only 5 percent of the first year development testing is necessary. The development costs should be discounted to 1984, and this multiplied by the expected number of development vehicle builds gives the development costs in the following table:

Expected Development Cost (Thousand $)

Manufacturer	1982 (for 1984 MY)	1984 (for 1985 MY)	1985 (for 1986 MY)	1986 (for 1987 MY)	1987 (for 1988 MY)
Ford	225				
GM	300				
IHC	150				
Chrysler	150				
Total*	825	31	28	26	23

Thus the total industry development cost of this regulation is expected to be $0.93M. When this total is amortized over the expected industry production for the 1984 MY through the 1988 MY, the per vehicle cost increase attributable to development is expected to be $0.54 (1981 dollars).

4. Certification Costs

An abbreviated certification procedure is to be implemented for control of HDG vehicle evaporative emissions. Under this procedure, a manufacturer will not need to submit any test data or engineering evaluation to show compliance of their evaporative emission control systems. Instead, manufacturers will be required to submit a simple statement that their HDGs will meet the standards if tested (or, in some cases, that their HDGs are designed to meet such standards). Such a statement would constitute the entire certification process. EPA would not normally test vehicles for compliance with the standard at certification time.

Because the certification process is basically the submittal of a statement to EPA, it is assumed here that no pure certification costs would be incurred by the manufacturer. The cost of development test work leading up to the manufacturer's statement was already analyzed in the "Developmental Testing Cost" section of this chapter. Since

* Discounted @ 10% to 1984. For years 1985-1988, it is assumed that only one engine family industry-wide will require development work.

EPA expects manufacturers to couple their development and certification program together any cost relating to a manufacturer's statement of compliance for certification has already been considered under development costs, and certification costs will be taken as zero.

5. Summary of Capital Costs

The total industry investment cost is obtained by first discounting dynamometer costs, SHED costs, and development costs to 1984 and then summing them. This sum comes to $1.81M. To this sum is added the facility space cost for 8 years. Eight years is consistent with the 5-year period for aggregate cost and the 5-year period of amortization of total costs that is used to calculate the per vehicle price increase. EPA assumes that the manufacturers have already allocated space to heavy-duty evaporative emissions testing. Therefore, the allowance for facility space cost begins in 1981 and continues through 1988 (i.e., 5 years after implementation). Thus, the 8-year period, 1981 through 1988 is appropriate. Each of the 8 years' $225,000 facility space costs is discounted (@ 10%) to 1984. The total cost in 1981 dollars is $1.32M. Thus, the total industry investment cost thus far is $3.13M in 1981 dollars discounted to 1984. The R&D costs, in 1981 dollars and discounted to 1984, is $2.66 million. The total industry investment cost is then $5.79 million (discounted to 1984). When the total industry investment costs are amortized over five production years (1984 MY - 1988 MY) the per vehicle cost increase in 1981 dollars and discounted to 1984 is about $3.50.

C. Summary

In summary, the total investment cost discounted to 1984 for dynamometers, SHEDs, development testing, facility space, and R&D for control hardware is $5.79 million. These investment costs, when amortized over 5 years production, are equal to $3.50 per vehicle (1981 dollars).

The hardware costs must be added to these fixed costs so that the initial price increase per vehicle can be calculated. The hardware cost is estimated to be about $38.50 per vehicle. When the amortized fixed costs and the hardware costs are added, the retail price increase per vehicle is about $42 (1981 dollars). By far the largest portion of the above retail price increase is the cost of control system hardware which represents 95 percent of the per vehicle cost increase.

II. Cost to Users of Gasoline-Fueled Heavy-Duty Vehicles

Purchasers of HDGs initially will have to pay for the costs of any emissions control equipment used to meet the standards and the costs to certify these vehicles. The vehicle manufacturers pass this cost on to the purchaser by increasing the initial cost or "sticker price" of the vehicle. As discussed in the previous section, the average cost increase is estimated to be $42 per vehicle, assuming a 3.0 g/test control for vehicles weighing less than or equal to 14,000 pounds and a 4.0 g/test control for vehicles weighing over 14,000.

Vehicle users will also have to pay for any increase in vehicle operating costs which might occur as a result of the standards to be imposed by EPA. These costs fall into two categories: maintenance and fuel. Based on experience gained with evaporative emissions control on light-duty vehicles and lightduty trucks, EPA concludes that these regulations will not cause vehicles to require additional maintenance. This conclusion can be supported by the California regulation for evaporative emissions of HDGs, where maintenance of evaporative control systems is not required. It is also expected that no fuel penalty or savings will occur due to these standards. It was originally stated in the proposal that fuel savings would occur if an evaporative control system were installed in conjunction with closed-loop feedback control. However, it is now expected that HDG vehicles will not require closed loop control for the NOx standards to be promulgated in 1986; thus, no fuel savings can be expected.

III. <u>5-Year Aggregate Cost (1984-1988)</u>

The 5-year aggregate cost to the nation of complying with these 1985, Federal HDG evaporative emission regulations consists of the sum of increased emission control costs and capital costs. These costs will be calculated for a five-year period (1984-88) of compliance. The five-year costs of compliance are dependent on the number of vehicles sold during that period. The five year costs are based on the best sales forecast to date, and are subject to errors inherent in any such forecast.

A factor which will affect the vehicle growth rate is the trend toward greater use of diesel engines. Market sources project that this trend will continue due to the diesel's lower lifetime operating costs.[7] The fraction of diesel HDV sales is expected to grow from 42 percent in 1984 to 50 percent in 1989.[2] Annual sales will be based on recent HDV sales projections by Data Resources and dieselization projections used in previous EPA analyses. These sales projections are given in Table 5-C.

To calculate total costs for emission control equipment and capital expenses associated with this regulation, an average cost per vehicle, as discussed in section A, is applied to the total number of vehicles to be sold in 1984-1988 (i.e., 2,060,000 vehicles). Since the cost of compliance for a 3.0 and 4.0 g/t standard is estimated at $42 per vehicle, the five-year purchase cost for this is $86 million. Discounting this cost to 1984, using a 10 percent discount rate, results in a value of $71.7 million. The results of these calculations are shown in Table 5-D.

Table 5-C

Estimated Retail Sales of
Gasoline-Fueled Heavy-Duty Vehicles Over 8,500 lbs. GVWR

Calendar Year	8501-14,000 lb**	14,001 lbs. and greater**	Sales
1984	206,000	184,000	390,000
1985	215,000	195,000	410,000
1986	221,000	199,000	420,000
1987	227,000	193,000	420,000
1988	227,000	193,000	420,000
		Total for 1984-1988	2,060,000

* Projections obtained by assuming that the total estimates of HDGs are the sum of 13 percent of LDTs, and medium and heavy-duty vehicles, as projected by Data Resources,[7] multiplied by the fraction of HDGs estimated in the regulatory analysis for heavy-duty gaseous emissions.[2] See Chapter 3, Description of Industry, for a detailed analysis.

** Using sales data by weight class presented in Chapter 3, Description of Industry, and EPA dieselization projections, the expected split above and below 14,000 lbs. GVWR is on the average 47 percent and 53 percent, respectively.

Table 5-D

Calculation of the 5-Year (1984-88) Aggregate Cost

Year	No. of Vehicles	Retail Price Increase $/Vehicle	Undiscounted Cost ($M)	Discounted* Cost ($M)
1984	390,000	$42	16.4	16.4
1985	410,000	$42	17.2	15.6
1986	420,000	$42	17.6	14.5
1987	420,000	$42	17.6	13.2
1988	420,000	$42	17.6	12.0
Totals	2,060,000		86.4	71.7

* Discounted at 10 percent to 1984 (1981 dollars). Cost are discounted from the beginning of each model year.

IV. Impact on Vehicle Sales

Raising the price of gasoline-fueled heavy-duty vehicles may affect their sales. This impact can be determined if the demand price elasticity figure for these vehicles is known. Such a number has been calculated using an equilibrium price/quantity impact model developed for EPA's Office of Noise Abatement Control.[9] The analysis resulting from this model indicated that the price elasticity of demand for new trucks is in the range of -0.9 to -0.5. For the purposes of this study a -0.7 price elasticity will be assumed. This means that a 1 percent increase in the price of HDGs should result in a 0.7 percent decrease in the demand for those vehicles.

Prices of HDGs vary considerably. The smaller trucks may cost between $11,000 and $16,000. Tractor units can cost anywhere between $32,000 and $54,000. Using $11,000 to $54,000 as the vehicle cost range, the $42 per vehicle retail cost estimate of meeting the regulation represents a 0.08 to 0.38 percent increase in the vehicle price. Thus, assuming demand will change in accordance with the relationship determined through the price/quantity impact model, there will be a 0.06 to 0.27 percent decrease in the number of vehicles sold (approximately 250 to 1100 units per year) as a result of this emission regulation. This predicted decrease is quite small, especially when the year-to-year fluctuations in sales and dieselization are considered.

References

1. "Summary and Analysis to Comments on Proposed Regulations of Heavy-Duty Evaporative Emission Control," SDSB, EPA.

2. "Regulatory Analysis and Environmental Impact of Final Emission Regulations for 1984 and Later Model Year Heavy-Duty Engines", Docket No. OMSAPC-78-4, Room 2903B, 401 M Street, S.W., Washington, D.C., 20460.

3. "Regulatory Analysis: Light-Duty Diesel Particulate Regulations", Docket No. OMSAPC-78-3, Room 2903B, 401 M Street, S.W., Washington, D.C., 20460.

4. "Investigation and Assessment of Light-Duty Vehicle Evaporative Emission Sources and Control", P. J. Clarke, Exxon Research and Engineering Company, EPA Report No. EPA-460/3-76-014, June 1976.

5. Conversation with Clayton Manufacturer.

6. "Control of Air Pollution From New Motor Vehicles and New Motor Vehicle Engines; Federal Certification Test Results for 1980 Model Year," Federal Register, Vol. 45, No. 168, August 27, 1980.

7. American Trucking Association.

8. Background Document for Medium and Heavy Truck Noise Emission Regulations, Appendix C, EPA-55D/9-76-008, March, 1976.

9. "The Data Resources U.S. Long-Term Review; The Economic Outlook 1980 to 1990," Data Resources Inc., Winter 1980-1981.

CHAPTER 6

COST EFFECTIVENESS

The goal of mobile source air pollution control activity is to obtain clean air at minimum cost to society. For effectiveness in implementing this goal, a mechanism is needed by which the relative cost and effectiveness of the various mobile source emission control strategies can be assessed. Cost effectiveness (CE) is such a mechanism by which to assess the cost per unit of desired result. In this case, cost effectiveness is expressed in terms of dollars spent to prevent one ton of pollutant from entering the atmosphere. Once cost effectiveness is calculated for a series of control strategies, the strategies can be compared. The most efficient strategy is the one with the lowest cost necessary to control a ton of pollutant. In addition to the cost effectiveness of given strategies, the amount of control available by the strategies and the amount of control required to meet the air quality goal must also be known. A given strategy may be very cost effective but not provide much pollution control. Alternately, a strategy might provide a large amount of pollution control but not be cost effective.

The equation for cost effectiveness is expressed as follows:

$$CE(\$/Ton) = \frac{\text{Initial Cost + Operating Cost over Useful Life}(\$)}{\text{Reduction in Emissions over Useful Life (Tons)}}$$

Control costs include several factors. Usually the largest factor is the cost for developing, producing, and installing pollution control equipment on vehicles or engines so that they comply with applicable emission regulations. The expected "Initial Cost" is the change in purchase price of a vehicle to the consumer; however, it includes more than just the cost of the control hardware. It also includes some allocated portions of the cost of development testing costs. In addition, the incremental change in "Initial Cost" will also include the amortized cost of modifications and/or additions made to the vehicle manufacturer's test facilities.

The second type of cost sometimes attendant to new regulations is a change in vehicle "Operating Cost" which can be directly attributed to the imposition of these regulations. An example is maintenance cost (or savings) associated with repair or replacement of parts which would not have been present on these vehicles prior to implementation of the new regulations. Based on previous experience with LDV evaporative control, EPA expects the incremental maintenance costs for this rulemaking to be zero.

Another cost which would be included in incremental "Operating Cost" is any change in fuel consumption resulting by the regulation. Under this regulation, no fuel savings or penalty should occur.

As discussed in Chapter 4, the reduction in NMHC evaporative emissions from HDGs due to this standard is estimated to be 2.99 g/mile and lifetime miles for these vehicles is 114,000 miles. Lifetime emission reduction would then be 341 kilograms.

Table 6-A shows the cost effectiveness of this strategy compared to that of previous studies. It should be pointed out that the cost effectiveness comparisons between strategies is not strictly valid because each represents average cost effectiveness over varying sized increments of emission reduction. As the total emissions decrease, the cost of removing an additional increment of pollutant usually increases. The most desirable comparison among control strategies would compare the cost effectiveness of removing the last increment of emissions in each of the different control strategies. If this incremental cost data were available, the cost effectiveness of the different control strategies could be easily compared. Such data is, however, not available. With this limitation in mind, it appears that the action is quite cost-effective when compared to other strategies.

Table 6-A

Cost Per Vehicle and Cost Effectiveness*
of Alternative Actions

	Cost per Vehicle, $	Cost Effectiveness, $/Ton NMHC
HDG Evap. Regulation	42	112
1978 Evap. Regulations [1]	7.3	50
1981 Evap. Regulations [2]	1-5	20-100
LDV Exhaust HC Emissions from 1.5 to 0.41 g/mi [3]	62-164	470
LDT Exhaust HC Emissions (2.0 to 1.7 g/mile & expand class to 8,500 lbs. GVWR) [4]	220	200
LDT Exhaust HC (1.7 to 0.73 g/mile) [5]	95	164
HDV Exhaust HC [6]		
Gasoline-Fueled	477	238
Diesel	195	253
Motorcycle Exhaust HC [7] (uncontrolled to 8 g/mi)		365

See attached page for explanation of footnotes.

* 10 percent discount rate.

References

1. "Environmental and Inflationary Impact Statement - Revised Evaporative Emission Regulations for the 1978 Model Year", August 1978 (Implementation of 6 g/t by SHED for LDV and LDT).

2. "Environmental and Economic Impact Statement - Revised Evaporative Emission Regulations for 1981 and Later Model Year Gasoline-Fueled LDV and LDT," August 1978 (2 g/t by SHED).

3. "Analysis of Some Effects of Several Specified Alternative Automotive Emission Control Schedules," prepared jointed by EPA, DOT and FEA, April 8, 1976, p. 15. Assumes cost to achieve statutory levels for CO and HC are equally split, (i.e., 50% for CO, 50% for HC).

4. "Environmental Impact Statement - Emission Standards for New Light-Duty Trucks," November 29, 1976. Cost of $220 is to bring 6,000 to 8,500 lb. trucks into compliance. $8 for all others.

5. "Regulatory Analysis and Environmental Impact of Final Emission Regulations for 1984 and Later Model Year Light-Duty Trucks," EPA, OMSAPC, May 20, 1980.

6. "Regulatory Analysis and Environmental Impact of Final Emission Regulations for 1984 and Later Model Year Heavy-Duty Engines," EPA, OMSAPC, December, 1979.

7. "Environmental and Economic Impact Statement - Exhaust and Crankcase Regulations for the 1978 and Later Model Year Motorcycles."