Final Regulatory Impact Analysis: Refueling Emission Regulations for Light Duty Vehicles and Trucks and Heavy Duty Vehicles

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Preface Note

This Regulatory Impact Analysis was developed under the assumption that the requirement for onboard refueling vapor recovery (ORVR) systems would apply equally to all highway motor vehicles, i.e., passenger cars as well as all classes of trucks. For reasons discussed in the preamble, however, the final rule departs from this presumption in the following two ways.

First, the proposed ORVR requirements have not been finalized at this time for heavy-duty vehicles (HDVs), i.e., trucks over 8,500 pounds Gross Vehicle Weight Rating (GVWR). The proposed requirements for ORVR systems in HDVs are still being evaluated, and pertinent discussions and conclusions in this document will be important considerations within that ongoing review process.

Second, the phase-in schedule for implementation of ORVR systems on light-duty trucks (LDTs) has been postponed. For light duty vehicles (LDVs), 40 percent of model year 1998, 80 percent of model year 1999, and 100 percent of model year 2000 and later vehicles are required to be equipped with ORVR systems. The phase-in period for light LDTs (up to 6,000 lbs GVWR) begins at the completion of the LDV phase-in. Thus, 40 percent of model year 2001, 80 percent of model year 2002, and 100 percent of model year 2003 and later light LDTs must be equipped with ORVR systems. The phase-in period for heavy LDTs (6,001-8,500 lbs GVWR) follows, such that 40 percent of model year 2004, 80 percent of model year 2005, and 100 percent of later model year heavy LDTs must be ORVR-equipped.

EPA has determined that these two changes do not have a large impact on the analysis and conclusions in this document. When fully phased in, the ORVR requirement will still apply to about 91 percent of all gasoline-fueled truck sales and to 97 percent of gasoline-fueled vehicle sales overall. This will account for about 94 percent of total gasoline refueling emissions. In regard to the postponement of ORVR implementation in LDTs, the effect is to delay, but not reverse or alter, the benefits and costs of the onboard control program. In sum, the overall impact of both changes on the cost effectiveness of ORVR systems is small. Thus, the quantitative and qualitative analyses contained in this document have not been specifically revised to reflect these changes.

Chapter 1: Introduction

Culminating a rulemaking process which has spanned more than a decade, the Environmental Protection Agency (EPA) is now promulgating final regulations requiring all highway light-duty vehicles, light-duty trucks, and heavy-duty vehicles to meet onboard refueling vapor recovery (ORVR or onboard control) standards. Accordingly, the purpose of this analysis is to evaluate the costs, benefits, and overall cost effectiveness of onboard control for the reduction of refueling emissions from highway motor vehicles.

1.1 Background

The current regulatory analysis is built upon a strong foundation provided by a number of previous economic studies, *Federal Register* notices, public comments, and technical support documents published throughout the course of this rulemaking. Key among these earlier documents was the *Evaluation of Air Pollution Regulatory Strategies for Gasoline Marketing Industry* (EPA-450/3-84-012a, July 1984). This study assessed the need for control of refueling emissions and compared two competing strategies for achieving this objective: 1) "onboard" systems, which would be incorporated into the design of the vehicle, and 2) "Stage II" systems, which would be built into the design of the fuel dispensing pump. On August 19, 1987, based on this study and related public comment (*see Response to Public Comments*, EPA-450/3-84-012c, July 1987), EPA published a Notice of Proposed Rulemaking (NPRM) to require onboard control of refueling vapors (52 FR 31162). The NPRM was accompanied by a two-volume *Draft Regulatory Impact Analysis* (EPA-450/3-87-001a and -001b, July 1987), which examined in detail the estimated costs to be incurred by vehicle manufacturers and consumers as well as the projected air quality benefits associated with the proposed onboard control regulation. Ongoing vehicle testing and additional analysis led EPA to the conclusion that, independent of refueling emission controls, improved control of evaporative emissions was also needed. As a result, revised cost estimates were developed, focusing on the costs of onboard control of refueling vapors as incremental to the costs of enhanced evaporative emission controls.[1]

To a large extent, the current regulatory analysis adopts the analytic methodologies which were used in these earlier studies. For example, many of the specific cost estimates developed in the older studies remain valid today and, after suitable adjustment for inflation, are incorporated in the current analysis. On the other hand, the regulatory environment into which ORVR will be implemented has continued to evolve during the past few years, and some reorientation of the analysis is required. Fuel volatilityp controls are in place and programs to improve the in-use effectiveness of onboard systems

[1]Memorandum from Jean Schwendeman to The Record, "Onboard and Evaporative Control System Cost Estimates for the Supplemental Notice of Proposed Rulemaking", December 22, 1988. (docket A-87-11, item IV-B-19).

have been implemented. However, two other changed circumstances, discussed below, are particularly important in regard to the analysis of ORVR systems.

First, on March 24, 1993, EPA published regulations for enhanced evaporative emission standards and test procedures (58 FR 16002). These requirements will phase in beginning with model year 1996 and will become fully effective by model year 1999. In contrast, under section 202(a)(6) of the Clean Air Act (as amended), ORVR control systems will be required to be installed on 40 percent of each vehicle manufacturer's production beginning with model year 1998, rising to 80 percent in 1999 and 100 percent in the year 2000 and thereafter. Thus, enhanced evaporative emission control hardware will already be in place in sufficient numbers of vehicles by the time ORVR control will be required in the same vehicles. Since refueling emissions and evaporative emissions have a common source and can be controlled largely with the same technology, many of the hardware and other costs which would otherwise be incurred for ORVR implementation will already have been incurred for compliance with the enhanced evaporative emission control requirements. The current analysis therefore assumes an integrated control strategy, and attributes to onboard control only those cost items which are incremental to evaporative emission control. This incremental cost approach was suggested by many public commenters and is also consistent with the basic concepts underlying EPA's 1988 cost memorandum cited above. Cost estimates specific to evaporative emission controls have recently been updated for inclusion in the Regulatory Impact Analysis which accompanied the final rule on evaporative emission standards and testing (item V-B-1 in Docket A-89-18).

The second important change impacting the regulatory analysis is the current expectation that, by the time onboard controls begin to take effect in 1998, Stage II controls will have been implemented in 43 ozone nonattainment areas, covering about 44 percent of the nation's fuel consumption. Under section 182(b)(3), Stage II is required in serious, severe, and extreme nonattainment areas and, as a result of the delay in the onboard control requirement, a number of moderate areas plan to implement Stage II, as well. To the extent that Stage II implementation is expected to achieve refueling vapor emission reductions, then the associated air quality and fuel recovery benefits cannot be credited to onboard. Obviously, this will have an impact on the computed costs and cost effectiveness of onboard controls.

More fundamentally, the implementation of Stage II brings into sharp focus the issue of applicability of onboard controls to the various vehicle classes. For light-duty vehicles (LDVs), the use of onboard systems was mandated by section 202(a)(6) of the Clean Air Act Amendments of 1990 and reaffirmed by decision of the U.S. Court of Appeals in 1993. However, the final ORVR regulations also include onboard control requirements for light-duty trucks (LDTs) and heavy-duty vehicles (HDVs), based on EPA's general authority under Clean Air Act section 202(a)(1). Given the anticipated implementation of Stage II controls in all of the serious, severe, and extreme ozone nonattainment areas and in most of the moderate nonattainment areas as well, it is reasonable to ask whether application of ORVR requirements to LDTs and HDVs is appropriate or whether Stage II should be retained.

This issue involves the interrelationship of a number of complex factors. For example, under section 202(a)(6), the EPA Administrator is authorized to revise or waive

Stage II requirements in serious, severe, or extreme nonattainment areas at such time that vehicles equipped with onboard control systems come into widespread use. Likewise, there would be no need under these circumstances for states to continue Stage II requirements in moderate nonattainment areas. However, LDTs and HDVs comprise about 40 percent of the annual highway gasoline consumption. Therefore, in the absence of onboard controls in these vehicles as well as in LDVs, the need for Stage II control of refueling vapors would likely be permanent.

Resolution of the question as to the appropriateness of ORVR requirements in LDTs and HDVs therefore depends on the relative cost effectiveness of two alternatives: 1) restriction of ORVR requirements to light duty vehicles, with retention of Stage II in nonattainment areas solely for the purpose of controlling LDT and HDV refueling emissions, versus 2) implementation of ORVR in all vehicle classes, with possible phase-out of Stage II. These two alternatives are discussed in further detail and their relative costs and benefits are quantified in the body of this document.

1.2 Organization of the Analysis

To provide a framework for the technical and quantitative analyses which follow, more detailed background information is presented in Chapters 2 and 3. Chapter 2 describes the key components and operating principles of ORVR technology, while Chapter 3 defines other parameters basic to the analysis (e.g., vehicle classes, Stage II areas, and gasoline market segments). In Chapter 4, the expected emission reduction benefits of onboard control systems is estimated. Manufacturer, consumer, and aggregate costs of onboard control are projected in Chapter 5. Chapter 6 discusses and quantifies the cost effectiveness of retaining Stage II control for LDT/HDV refueling emissions. Finally, by integrating all of these elements of the regulatory analysis, Chapter 7 computes the cost effectiveness of ORVR systems as a strategy for reduction of volatile hydrocarbon emissions, assesses the sensitivity of the cost-effectiveness values to changes in key parameters, and discusses related benefits expected to result from the onboard control program.

Chapter 2: Technology

2.1 Introduction

The fundamental purpose of an onboard refueling vapor recovery (ORVR) system is to prevent refueling vapors from being released to the atmosphere. This is achieved by storing vapors displaced from the fuel tank during a refueling event and subsequently routing these hydrocarbon vapors to the engine to be burned during vehicle operation.

The ORVR test procedure is performance-based, and manufacturers have substantial flexibility in deciding how to control refueling emissions with an onboard system. EPA has not prescribed any particular technology. However, most past ORVR designs have been canister-based. In such a system, displaced hydrocarbon vapors from the refueling event are routed to a canister and stored by being adsorbed onto a bed of activated carbon contained within the canister. During vehicle operation, manifold vacuum is used to pull ambient air over the carbon bed, stripping the hydrocarbons from the canister. This hydrocarbon-rich purge gas is then routed to the engine and burned.

Onboard systems, regardless of their specific design, must meet certain basic engineering requirements to be effective in controlling refueling emissions. Primarily, they must provide for the routing of vapors from the fuel tank to the engine, rather than allowing the vapors to escape uncontrolled to the outside ambient air. This will likely be accomplished through the use of 1) a fillneck seal which will prevent the vapors from continuing to escape out the fillneck, 2) a fuel tank vent mechanism, to allow for the controlled routing of the vapors from the fuel tank, 3) vapor lines for transporting the vapors, 4) a canister containing activated carbon to temporarily store the vapors, and 5) a purge system to regenerate the canister and route the vapors to the engine. While this provides a general description of an effective onboard system, specific designs can vary greatly in terms of components utilized, complexity, effectiveness, and cost. The details of the technology are further described in this chapter.

This chapter, and the regulatory analysis as a whole, focus on the technology necessary to meet the refueling emission standard on gasoline-fueled vehicles. It is expected that vehicles that operate on most alternative fuels will be inherently low in refueling emissions and will therefore not require modifications or incur additional benefits. Some alternative fuels such as M85 and E85 contain a substantial amount of gasoline and will thus have fairly high uncontrolled refueling emissions. The technology required for these alcohol/gasoline vehicles would be very similar to that discussed in this chapter.

2.2 Onboard Refueling and Evaporative Vapor Recovery Systems

Traditionally, ORVR control system designs have been similar to evaporative emission control systems now in use on automobiles. The resemblance will become even stronger as enhanced evaporative control systems are phased in beginning with model year 1996 vehicles. This is because the new evaporative emission standards and test procedures will likely cause canister working capacity to be increased to a level similar to that required by refueling vapor loads and the purge system will need to be upgraded to meet the new test procedure requirements.

The primary physical difference between an evaporative control system and an ORVR system lies in the need to prevent vapors from escaping via the fillneck during a refueling event. This need forces the introduction of some type of fillneck seal. Another differences between the evaporative and ORVR systems is the frequency and rate of canister loadings. Evaporative emissions are generated during vehicle operation and in response to daily temperature cycles. These emissions occur over long periods of time, during driving or diurnal heat builds, but have very low vapor flow rates (about one gram per minute). Refueling emissions, on the other hand, are produced less frequently but at much greater rates (30 to 40 grams per minute). This generates the need for a larger diameter vapor vent line for the canister as compared to the enhanced evaporative program.

Although refueling emissions present a much larger quantity of emissions at one time than do evaporative emissions, the 1996 evaporative emission regulations require a three-day test which will generate similar amounts of hydrocarbon vapors as a refueling event. The similarities in the magnitude of these vapor loads encourage the development of integrated refueling/evaporative control systems. In the past, many commentors asserted that EPA's test procedure would drive them to utilize separate refueling and evaporative vapor control systems. At the 22 July 1993 hearing, EPA announced a possible change to the dispensed temperature in the previously proposed refueling test procedure. With this change, manufacturers expressed confidence that they would be able to utilize integrated refueling and enhanced evaporative vapor recovery systems with no additional canister capacity and the same purge strategy.

2.3 Description of ORVR System

This section describes the likely canister-based ORVR hardware for an integrated refueling/evaporative control system. Other systems are not precluded, but past analyses and information from vehicle manufacturers strongly suggest that ORVR systems will use the technology discussed below. Vehicle changes incremental to those required by the enhanced evaporative control systems are also discussed.

2.3.1 Fillneck Seal

In an ORVR system, a seal is needed to prevent the escape of vapors through the vehicle fillneck during a refueling event. There are two ways in which such a seal may be created: mechanically or via a dynamic liquid seal. A mechanical seal would likely consist of an annular elastomeric material through which the nozzle must pass during refueling that prevents vapors from escaping the system alongside the nozzle. A liquid seal is formed when liquid gasoline accumulates in a manner that completely fills the entire diameter of the filltube, preventing vapor from flowing out. Each technology has advantages and disadvantages.

The mechanical seal's prime advantage is its high theoretical efficiency. This is because it completely seals the fillneck, eliminating all vapor releases to the atmosphere. However, there are concerns about durability and tampering effects on the seal's integrity and efficiency. Damage to fuel dispensing nozzles in the form of burrs, nicks and dents can reduce the effectiveness of a mechanical seal or cause it to be torn. In addition, a mechanical seal would require more care on the part of the consumer, because the nozzle would have to be inserted into the fillneck with a certain degree of precision and effort. This additional inconvenience, although slight, may instigate tampering or removal of the seal altogether. Mechanical seals also would be subject to wear over the life of the vehicle. They would need to be able to sustain approximately 300-500 nozzle insertions without failure. Additionally, a pressure relief valve would be required in conjunction with a mechanical seal, to prevent damage to the fuel tank and other components if the automatic nozzle shutoff failed or if the vapor line between the fuel tank and the canister became blocked.

As mentioned, mechanical seals are designed to fit snugly around the nozzle with an annular elastomer material. A mechanical seal also serves an anti-spitback function, allowing for the removal of any existing anti-spitback seal. Air entrainment is relatively low in such a design, but it is prone to possible malfunction. It is possible that onboard control systems in very large trucks may use mechanical seals because of the prevalence in these vehicles of short fillneck configurations, where the fillneck is integrated into the tank itself. As described below, submerged-fill liquid seals may be possible in these trucks as well.

Liquid seals are created by shaping the fillneck in such a way that the liquid being dispensed prevents vapors from escaping. In the original proposal, it was assumed that these seals would consist of a "J-tube" design, in which the fillneck is curved at the bottom soon after entering the tank. Liquid seals can be created through other configurations as well, such as a submerged fill (fuel enters below liquid level) or an elongated fill (fuel backs up in a relatively long, narrow fillneck during refueling). With proper fillneck geometry the liquid inflow itself will actually block vapor escape from the fillneck. Such systems are preferred by manufacturers because they do not require additional hardware and are not susceptible to malfunction, tampering or malmaintenance. In fact, many light-duty vehicles (LDVs), light-duty trucks (LDTs) and light heavy-duty gasoline vehicles (LHDGVs) presently have narrow fillnecks which provide relatively effective liquid seals[1]. In addition, such designs are generally less expensive then their mechanical counterparts. Although issues such as air entrainment must be considered with liquid seals, it is expected that, with the modified test procedure discussed at the July 22, 1993 hearing, most manufacturers will use some type of liquid seal system.

A liquid seal eliminates the problems of durability and tampering that affect the mechanical seal. A liquid seal has no mechanical parts to wear or be damaged. Such a system would be transparent to the consumer and would thus not be subject to tampering.

[1]"A Study of Uncontrolled Automotive Refueling Emissions." Prepared for the Laboratory Research Council, Inc. by Automotive Testing Laboratories, Inc. 5 January 1998, (docket A-87-11, item IV-D-565).

Liquid seal systems also do not require pressure relief valves. Tank over-pressure would result in fuel rising in the fillneck and subsequent nozzle shutoff. Similarly, failure of the nozzle automatic shutoff mechanism would have no additional safety implications with the liquid seal system, because failure would result in fuel spit-back and subsequent manual shutoff as now occurs.

Unlike mechanical seals, a liquid seal has a liquid/air interface in the fillneck. The liquid/air interface combined with the relatively high liquid flow rates may entrain additional air into the tank. This entrained air will result in greater emission generation rates and could result in the need for a larger storage device than necessary for a mechanical seal. However, manufacturers have stated in response to the changed test procedure that they will be able to utilize liquid seals in integrated refueling/evaporative vapor control systems.

EPA expects that manufacturers will use the least expensive solution possible to provide an adequate seal. Both EPA and the manufacturers believe that liquid seals will be adequate to meet the refueling emission standard and, therefore, LDVs, LDTs and LHDGVs will likely utilize liquid seals. On the other hand, the fuel tanks of heavy heavy-duty gasoline vehicles (HHDGVs) often have short, wide fillnecks which may not be conducive to formation of a liquid seal. While a submerged fill may be possible, EPA will conservatively assume in this analysis that HHDGVs using side-saddle tanks will use a mechanical seal.

2.3.2 Anti-Spitback Valve

Some studies of refueling emissions have included consideration of fuel spillage as a result of the refueling event. In the previously mentioned rule regarding enhanced evaporative emission controls, EPA promulgated a fuel dispensing spitback standard to control fuel spillage. Manufacturers are expected to incorporate an anti-spitback valve in the fillneck to control these emissions. An in-use limit on dispensing rate was also enacted to ensure compatibility between the fillneck/anti-spitback valve designs and refueling in the field.

2.3.3 Fuel Tank

As the fuel enters the fuel tank via the fillneck, the rising liquid displaces the vapors in the tank. Currently, these vapors are vented to the atmosphere. On most vehicles, this venting occurs through a vent line external to the fillneck. Many larger trucks (HHDGVs) use wider fillnecks which allow the vapors to return via the same tube through which the fuel enters. In order to meet the refueling emission standards, the displaced fuel tank vapors must be contained. As previously described, the most likely scenario is for the vapors to be routed out of the top of the fuel tank to the carbon canister.

Any modifications to the tank needed as a result of the ORVR requirements will be minor. The vent valve hole may need to be increased in diameter to accept a larger vapor vent/rollover valve and the port for the external vapor vent line will be removed. These changes will be primarily tooling changes. Removal of the external vapor vent line (involving steel and/or rubber tubing and clamps) will be a hardware cost credit) for the ORVR system.

2.3.4 Vent/Rollover Valve

The vent/rollover valve provides the method of controlled escape for gasoline vapors during the refueling event in an ORVR system. The vent has a mechanism which closes the vent in the event of vehicle rollover to prevent spillage of vapors or liquid fuel. The vapor vent/rollover valve also acts as a fill limiter. As the gasoline level rises to the top of the tank, the float valve seats itself in a housing at the vent orifice. As the float blocks the vent orifice, the pressure rises in the tank and a column of gasoline rises in the fillneck. When the column of gasoline reaches the tip of the gasoline nozzle, automatic shutoff is triggered and the refueling event is completed. The fill limiting action would be designed to provide a soft but effective close, so that the pressure in the tank does not rise too suddenly and cause spillage at the end of the refueling event.

Essentially all vehicles currently have evaporative vent/rollover valves, but these will need to be upgraded to handle the greater vapor flow rates that will occur in a refueling event. It is expected that the fuel vent valves, located at the top of fuel tanks as part of current evaporative systems, will be replaced by a multi-purpose valve of similar design. Such a valve would have an enlarged orifice to accommodate the larger refueling vapor loading rates and a secondary evaporative orifice to be used when the fill limiter closed the vent, as well as the fill limiters and rollover protection discussed above. In some cases, this valve may also incorporate a liquid/vapor separator function.

However, the size of the orifice likely to be necessitated by the refueling emissions standard could result in substantial fuel loss in the event of a rollover accident. In order to provide rollover protection in accordance with Federal Motor Vehicle Safety Standard (FMVSS) 301, the float valve could be spring loaded, such that it would close if the vehicle were turned on its side or upside down. Current evaporative vapor vent valves operate in a similar fashion.

2.3.5 Vent/Purge Vapor Lines

Two vapor lines are necessary in an ORVR system for proper operation: 1) the vapor vent line which routes vapors from the fuel tank to the vapor storage device, 2) the vapor purge line which directs vapors from the canister to the engine for canister purging. The size of these lines (both length and diameter) is dependent on the canister location, the vapor flow rate, and the allowable tank pressure increase. An improved evaporative control system would have vent/purge vapor lines serving the same functions.

Due to the widespread use of fuel injection in vehicles, and resultant decrease in hot soak vapors coming from the fuel system components in the engine compartment, EPA expects most canisters to be located at the rear of the vehicle near the fuel tank as opposed to under the vehicle hood as is the case in most current evaporative emission control designs. Locating the canister in the rear of the vehicle, near the fuel tank, has several advantages. It will allow a decrease in the length of the vapor vent line, which will reduce the resistance to flow and may allow for a smaller increase in the vent line's diameter and thus enhance the use of a liquid seal. Due to expected vapor flow rates, however, the vapor vent line will still need to be larger in diameter than the evaporative vapor vent line to prevent high backpressure during refueling. While moving the canister to the rear of the vehicle will reduce the length of the *vent* vapor line, it will increase the length of the *purge* vapor line. However, EPA expects the increase in the length of the purge line to be essentially the same as the decrease in the length of the vapor vent line. Therefore, the only incremental change is the difference in the vapor vent line diameters from that required for improved evaporative control.

2.3.6 Canister

The only currently available technology that can be utilized to temporarily store vapors is activated carbon, which is contained in the canister shell. The vapors which are displaced from the fuel tank by the incoming fuel are routed via the vapor vent line to the canister and are adsorbed by the carbon. The canister shell consists of a durable material, generally steel or plastic, that can be formed into a volumetric canister to hold the activated carbon. EPA expects that essentially all manufacturers will use activated carbon contained in a canister shell as the technology to capture and temporarily store the refueling vapor.

In the past, both EPA and the industry assumed that canister capacity would have to increase to handle the increased vapor loads from refueling. However, the promulgation of the March 1993 enhanced evaporative emission rule has already increased the canister capacity requirements. With the test procedure discussed at the 22 July 1993 hearing, the industry stated that integrated refueling/evaporative vapor recovery systems are possible with no increase in canister capacity beyond that of the enhanced evaporative emissions requirement. Thus, the current analysis does not include any incremental canister costs in the total costs of onboard control systems.

Recently, improved activated carbon products have been developed which provide greater working capacity with less volume of carbon. These new developments may directionally help manufacturers reduce the size of carbon canisters and maintain working capacity.

It is also worth noting, as discussed above, that canisters are likely to be located in the rear of the vehicle. This is expected to have safety benefits in addition to the system design advantages discussed earlier.

2.3.7 Purge Valve

Ultimately, the refueling vapors are burned in the vehicle's engine. The purge valve is used to open the purge vent line between the canister and the engine to allow manifold vacuum to pull air through the canister and purge it of the hydrocarbon load. The electronic control unit (ECU), an onboard computer, sends signals to open and close the valve at appropriate times. Each vehicle model has a slightly different purge strategy, but usually purging occurs under acceleration or heavy loads. Purge strategies are necessary to avoid large amounts of purge vapor from creating an overly rich air-fuel ratio in the engine which could affect exhaust emission performance and driveability, but yet to purge the carbon in sufficient time to accept the new vapor loading. Because the refueling test procedure allows for the same purge driving and requires approximately the same vapor load as for the improved evaporative procedure, no changes are anticipated in the purge valve for integrated ORVR/evaporative systems. In some cases, changes may be desirable to optimize the purge strategy for exhaust emissions and driveability and to allow the additional refueling vapor loads to be purged off. However, given the sequencing of the elements of the improved evaporative/refueling test procedure and the values of the test parameters, in most cases the purge strategies used for the improved evaporative requirement will be effective for an integrated refueling/evaporative system as well.

2.3.8 Onboard Diagnostics

In a rule published in the Federal Register on 19 February 1993 (58 FR 9468), onboard diagnostics (OBD) will be required on highway motor vehicles. For evaporative systems, these OBD systems will require operational checks on the purge valve and pressure checks in the fuel tank, vapor and purge lines. The same OBD hardware used in the evaporative control system will also be required on an integrated evaporative/refueling vapor control system. It is expected to perform to the same function and have the same positive effects on in-use performance, catching leaks of more than 3 grams per refueling event[2]. OBD only applies to LDVs and LDTs.

2.4 Summary Table

Table 2.1 contains a summary of the hardware changes expected for improved evaporative systems and ORVR systems. In the table, *X*s indicate which regulation required the modification or addition of the indicated hardware component.

[2] Memorandum from Bryan J. Manning to Docket No. A-87-11, titled "Determination of Flow Rate for Vapor Vent Line Lead in Onboard Vapor Recovery System" (docket A-87-11, section IV-B).

Table 2.1—Summary of Refueling/Evaporative Vapor Control System Hardware Changes

Hardware Component	Improved Evaporative Control	ORVR Control
Fillneck Seal (liquid)		X
Anti-Spitback Valve	X	
Remove External Vent Line		X
Fuel Tank Modifications	X	X
Vent/Rollover Valve	X	upgrade
Enlarge Vapor Vent Line		X
Lengthen Vapor Purge Line		X
Shorten Vapor Vent Line		X
Enlarge Canister	X	
Rear Located Canister		X
Modify Purge Valve	X	
Modify Purge Strategy	X	
Onboard Diagnostics	X	

Chapter 3: Background Information

This chapter, in combination with the technology discussions in the previous chapter, is intended to provide background data for the analytic discussions and derivations which follow. Information is included on the following topics: vehicle classification, projected fleet sales, fuel economy, and fuel consumption; Stage II areas, waivers, and in-use efficiency; and segmentation of the gasoline market.

3.1 Vehicle Information

3.1.1 Vehicle classification

The costs and benefits of ORVR depend on the distribution of vehicles covered by the ORVR standard among the various vehicle weight classes. Light-duty vehicles (LDVs) (also known as passenger cars), as defined by 40 CFR 86.82-2, are covered by the mandate for this rule in section 202(a)(6) of the CAA. LDVs are not further subdivided in this analysis.

Trucks are subdivided into several groups for this analysis, reflecting their divergent sizes and operating characteristics. However, the categorization of trucks is complicated by the fact that EPA and the vehicle manufacturing industry do not apply the same weight criteria in classifying trucks. The two different classification systems are summarized and compared in Table 3.1, below.

As the table indicates, the truck fleet is traditionally broken down by the industry into eight weight classes (I-VIII). Classes I and II, which include trucks up to 10,000 lbs gross vehicle weight rating (GVWR), are considered by the industry to be light-duty trucks (LDTs), while classes III through VIII are included in the heavy-duty vehicle (HDV) category. Under EPA's definition, LDTs include Class I and part of Class II (up to 8,500 lbs GVWR), while HDVs are considered to be those greater than 8,500 pounds. Thus, EPA subdivides Class II into two subclasses, IIa and IIb. Class IIa trucks (6,001-8,500 lbs GVWR) are considered heavy light-duty trucks and Class IIb trucks (8,501-10,000 lbs GVWR) are included in the light heavy-duty vehicle group. Class II trucks are allocated among IIa and IIb subcategories with at 90/10 split.

Table 3.1—Classification Systems for Light Duty Trucks (LDTs) and Heavy Duty Vehicles (HDVs)

<table>
<tr><th colspan="2">Industry Classification</th><th>Weight Range (Pounds GVWR)</th><th colspan="3">EPA Classification</th></tr>
<tr><td>I</td><td rowspan="3">Light Duty Trucks</td><td>Up to 6,000</td><td colspan="2">LLDT (LDT1+LDT2)</td><td rowspan="2">Light Duty Trucks</td></tr>
<tr><td>(IIa)
II</td><td>6,001-8,500</td><td colspan="2">HLDT (LDT3+LDT4)</td></tr>
<tr><td>(IIb)</td><td>8,501-10,000</td><td rowspan="2">Otto
LHDV</td><td rowspan="4">Diesel
LHDV</td><td rowspan="7">Heavy Duty Vehicles</td></tr>
<tr><td>III</td><td rowspan="6">Heavy Duty Vehicles</td><td>10,001-14,000</td></tr>
<tr><td>IV</td><td>14,001-16,000</td><td rowspan="5">HHDV</td></tr>
<tr><td>V</td><td>16,001-19,500</td></tr>
<tr><td>VI</td><td>19,501-26,000</td><td rowspan="2">MHDV</td></tr>
<tr><td>VII</td><td>26,001-33,000</td></tr>
<tr><td>VIII</td><td>> 33,000</td><td>HHDV</td></tr>
</table>

Abbreviations: GVWR = Gross Vehicle Weight Rating, LLDT = Light light-duty trucks, HLDT = Heavy light-duty trucks, LHDV = Light heavy-duty vehicles, MHDV = Medium heavy-duty vehicles, HHDV = Heavy heavy-duty vehicles.

Approximately 87 percent of all heavy-duty gasoline vehicles (HDGVs) fall into Class IIb, and almost all of the remaining 13 percent fall into either Class VI (19,501-26,000 lbs GVWR) or Class VII (26,001-33,000 lbs GVWR). It should be noted that, except for capacity, the fuel systems of many LHDGVs do not differ appreciably from those of LDTs and can benefit directly from the transfer of LDT technology.

3.1.2 Projected Fleet Sales

Table 3.2 displays EPA vehicle sales projections for gasoline-powered LDVs, light LDTs (classes I and IIa), LHDGVs (classes IIb-V) and HHDGVs (trucks and buses classes VI-VIII) for the years 1998 to 2020. These sales projections were derived from the Mobile 4.1 fuel consumption model to assure consistency between the vehicle sales used to determine costs and the fuel consumption used to determine fuel recovery credits and emission reduction benefits.[1]

The sales projections were derived by determining a base sales figure for each year and vehicle class, and then increasing those base sales by the amount indicated by

[1] The MOBILE model is frequently used by EPA to determine the effects of regulatory programs on the emissions of automobiles and trucks. The latest version of the model at the time of this analysis was MOBILE5a; however, the fuel consumption portion of the model has not been updated since MOBILE4.1. The fuel consumption model projects fleet fuel consumption, fuel consumption through ORVR-equipped vehicles, alternative fuel penetration, fleet vehicle miles traveled, road fuel economy, vehicle registrations and total emissions. For more information see: Memorandum from James G. Bryson to EPA Air Docket A-87-11, titled " MOBILE4.1 Fuel Consumption Model Run Data".

the MOBILE4.1 model for each year. The Mobile4.1 model assumes a 25 year fleet life. That is, after 25 years all the vehicles sold initially will have been scrapped at some time in the intervening 25 year period. However, for a given model year, new vehicle sales are actually equal to replacements for *all* the preceding model year vehicles scrapped in that year, plus the growth (or contraction) in the total in-use fleet. A sophisticated analysis would apply vehicle class-specific scrappage rates to vehicle class specific new vehicle sales for each preceding model year to determine replacement vehicle sales. A simplified yet reasonably accurate approach would be to select a base sales rate which is representative of average new vehicle sales values over a given number of years and use that base as the total replacement fleet. This approach misses the cyclical swings which occur in vehicle sales, but this is not significant for an analysis such as this which relies more on total sales over many years and whose results are insensitive to cyclic changes.

EPA selected 1990 as the base year. Based on inspection of sales results over the last ten years, 1990 was considered reasonably representative of the average and was consistent with the year selected as the base for other fuel-related parameters in the analysis. Specific values for the sales in each of the vehicle subclasses were derived from 1990 AAMA sales data[2,3]. All figures used to develop the base sales figures were derived from the AAMA data. The diesel fraction of vehicles in each class was taken from the MOBILE4.1 Fuel Consumption model (0.0 percent of LDVs, 1.1 percent of LDTs, 23 percent of LHDVs and 67 percent of HHDVs).[4] The base sales figures for gasoline-powered vehicles were: LDVs 9,300,000; LDTs 4,080,000; LHDGVs 356,000; HHDGVs 77,000.

The growth rate for any given year was the subclass-specific change in registrations provided by the MOBILE4.1 model output. The combination of the base sales figure plus the change in total subclass-specific registrations gives the projected vehicle sales for a given year. The results are presented in Table 3.2, below.

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[2]*AAMA Motor Vehicle Facts and Figures '93*. (American Automobile Manufacturer's Association).

[3]*MVMA Factory Sales of Trucks and Buses*. 12 Months 1990 Sales, (Motor Vehicle Manufacturer's Association), 11 February 1991.

[4] The ORVR requirement applies to diesel fueled vehicles, but they are expected to comply without a control system since emissions are inherently low.

Table 3.2—Projected Gasoline Vehicle Sales

Year	LDV	LDT	LHDGV	HHDGV
1998	10,600,000	5,280,000	448,000	78,300
1999	10,800,000	5,430,000	461,000	78,600
2000	11,000,000	5,590,000	474,000	78,600
2001	11,100,000	5,740,000	487,000	79,000
2002	11,300,000	5,890,000	500,000	79,900
2003	11,500,000	6,040,000	513,000	81,100
2004	11,700,000	6,200,000	519,000	82,400
2005	11,800,000	6,350,000	533,000	83,800
2006	12,000,000	6,500,000	548,000	85,100
2007	12,200,000	6,650,000	563,000	86,500
2008	12,400,000	6,800,000	577,000	88,200
2009	12,600,000	6,950,000	592,000	89,700
2010	12,800,000	7,110,000	605,000	91,900
2011	13,000,000	7,250,000	620,000	93,700
2012	13,200,000	7,400,000	636,000	95,800
2013	13,400,000	7,550,000	652,000	97,900
2014	13,600,000	7,700,000	667,000	100,000
2015	13,800,000	7,850,000	683,000	102,200
2016	14,000,000	7,990,000	697,000	104,200
2017	14,100,000	8,130,000	711,000	106,100
2018	14,300,000	8,270,000	725,000	108,100
2019	14,500,000	8,420,000	739,000	110,100
2020	14,700,000	8,560,000	752,000	112,200

3.1.3 Projected Road Fuel Economy

Refueling emissions are directly proportional to fuel consumption and, therefore, fuel economy data are needed to develop per-vehicle emission reductions. Table 3.3 presents projected fuel economy statistics (in miles per gallon) for new gasoline-powered LDVs, LDTs, LHDVs, and HHDVs purchased during the time period covered by this analysis. These projections were taken from the MOBILE4.1 Fuel Consumption Model.

Table 3.3—Projected Road Fuel Economy (Miles per Gallon) by Vehicle Class

Year	LDV	LDT	LHDGV	HHDGV
1996	22.94	17.42	10.81	5.80
1997	22.91	17.40	10.84	5.79
1998	22.88	17.37	10.87	5.79
1999	22.85	17.36	10.90	5.78
2000	22.82	17.32	10.92	5.78
2001	22.79	17.31	10.94	5.77
2002	22.77	17.28	10.97	5.77
2003	22.74	17.26	10.99	5.77
2004	22.71	17.24	11.01	5.77
2005	22.69	17.23	11.03	5.77
2006	22.66	17.20	11.05	5.77
2007	22.63	17.19	11.07	5.77
2008	22.61	17.16	11.08	5.77
2009	22.58	17.15	11.10	5.77
2010	22.55	17.12	11.11	5.77
2011	22.59	17.14	11.11	5.76
2012	22.57	17.12	11.13	5.76
2013	22.54	17.10	11.14	5.76
2014	22.52	17.08	11.15	5.76
2015	22.49	17.06	11.16	5.76
2016	22.48	17.05	11.17	5.76
2017	22.45	17.04	11.19	5.76
2018	22.43	17.02	11.20	5.76
2019	22.40	17.01	11.21	5.76
2020	22.38	17.00	11.22	5.76

3.1.4 Projected Fleet Fuel Consumption

The MOBILE4.1 Fuel Consumption Model projects total fleet fuel consumption and, with some minor modifications, ORVR-controlled fuel consumption. The ORVR-controlled consumption is based on the increase of vehicles in the fleet purchased in years after ORVR implementation. The model takes into account the three year phase-in of the standard (40, 80, 100 percent) beginning in 1998 and assumed vehicle use factors and scrappage rates. Table 3.4 contains the results. As can be seen in the final column, a number of years must pass before ORVR covers a significant portion of the nationwide fuel consumption. However, by 2010, ORVR systems are expected to cover nearly 87 percent of the fuel consumption and, by 2020, this figure will reach 99 percent control. In the MOBILE4.1 model, full fleet turnover requires 25 years.

Table 3.4—Projected Fuel Consumption Figures (gallons)

Year	LDVs	LDTs	LHDGVs	HHDGVs	All ORVR	All Gasoline	% Control
1998	2.305E+09	1.358E+09	1.613E+08	5.377E+07	3.877E+09	1.234E+11	3.14%
1999	8.263E+09	5.184E+09	6.031E+08	2.010E+08	1.425E+10	1.257E+11	11.33%
2000	1.634E+10	1.078E+10	1.253E+09	4.176E+08	2.879E+10	1.283E+11	22.44%
2001	2.451E+10	1.667E+10	1.937E+09	6.455E+08	4.376E+10	1.309E+11	33.42%
2002	3.231E+10	2.239E+10	2.597E+09	8.658E+08	5.817E+10	1.336E+11	43.54%
2003	3.991E+10	2.764E+10	3.265E+09	1.088E+09	7.190E+10	1.364E+11	52.72%
2004	4.716E+10	3.230E+10	3.953E+09	1.318E+09	8.473E+10	1.391E+11	60.91%
2005	5.348E+10	3.599E+10	4.592E+09	1.531E+09	9.559E+10	1.419E+11	67.35%
2006	5.881E+10	3.894E+10	5.153E+09	1.718E+09	1.046E+11	1.449E+11	72.23%
2007	6.357E+10	4.147E+10	5.636E+09	1.879E+09	1.126E+11	1.478E+11	76.16%
2008	6.818E+10	4.386E+10	6.068E+09	2.023E+09	1.201E+11	1.508E+11	79.68%
2009	7.283E+10	4.657E+10	6.562E+09	2.187E+09	1.282E+11	1.538E+11	83.34%
2010	7.733E+10	4.956E+10	7.113E+09	2.371E+09	1.364E+11	1.568E+11	86.98%
2011	8.118E+10	5.239E+10	7.675E+09	2.558E+09	1.438E+11	1.595E+11	90.17%
2012	8.457E+10	5.500E+10	8.161E+09	2.720E+09	1.505E+11	1.626E+11	92.55%
2013	8.740E+10	5.723E+10	8.592E+09	2.864E+09	1.561E+11	1.657E+11	94.21%
2014	8.983E+10	5.924E+10	8.980E+09	2.993E+09	1.610E+11	1.688E+11	95.41%
2015	9.212E+10	6.123E+10	9.357E+09	3.119E+09	1.658E+11	1.720E+11	96.44%
2016	9.406E+10	6.306E+10	9.685E+09	3.228E+09	1.700E+11	1.747E+11	97.31%
2017	9.590E+10	6.478E+10	9.980E+09	3.327E+09	1.740E+11	1.776E+11	97.99%
2018	9.760E+10	6.638E+10	1.025E+10	3.416E+09	1.776E+11	1.804E+11	98.46%
2019	9.921E+10	6.792E+10	1.050E+10	3.501E+09	1.811E+11	1.833E+11	98.81%
2020	1.008E+11	6.943E+10	1.074E+10	3.581E+09	1.845E+11	1.862E+11	99.09%

3.2 Stage II Information

3.2.1 Stage II Areas

The areas included as Stage II areas in this analysis are listed in Table 3.5. Included are all non-attainment areas categorized as serious, severe, or extreme, as well as a majority of the moderate areas and a few marginal areas (i.e., the Portland, Oregon area, a large portion of western Washington state, and Sussex County, Delaware). Moderate and marginal areas are included as Stage II areas if they have already implemented Stage II or if they are in states that have promulgated Stage II legislation and with great certainty will implement the program by 1998.[5] Stage II has been implemented in the entire state of California; thus, attainment areas in California (accounting for about 3.3 percent of the state's gasoline throughput) are included on the list. One additional attainment area (Las Vegas, Nevada) has implemented Stage II, and is also shown on the list below and is included in the analysis. Appendix A contains the full list of Stage II areas used in this analysis.

[5]EPA memorandum from Paul M. Argyropoulos, FOSD to Stage II Contacts, dated June 15, 1993, titled "Stage II Program Status Summary" (docket A-87-11, item IV-D-834).

Table 3.5—Stage II Areas

Greater Connecticut	CT	Miami-Ft. Lauderdale-W.Palm	FL
Washington	VA, DC, MD	Atlanta	GA
Philadelphia-Wilmington-Trenton	PA, NJ, DE	Baton Rouge	LA
Sussex Co	DE	Nashville	TN
Chicago-Gary-Lake County	IL, IN	Phoenix	AZ
St. Louis	IL, MO	Beaumont-Port Arthur	TX
Louisville	IN, KY	Dallas-Ft. Worth	TX
Cincinnati-Hamilton	OH, KY	El Paso	TX
Greater Massachusetts	MA	Houston-Galveston-Brazoria	TX
Baltimore	MD	Portland-Vancouver AQMA	WA, OR
Portsmouth-Dover-Rochester	NH	Seattle-Tacoma	WA
Atlantic City	NJ	San Diego	CA
Allentown-Bethlehem-Easton	NJ	LA-South Coast Air Basin	CA
NY-NJ-Long Island	NY, NY	San Joaquin	CA
Cleveland-Akron-Lorain	OH	San Francisco Bay Area	CA
Dayton-Springfield	OH	Monterey Bay	CA
Toledo	OH	Sacramento Metro	CA
Reading	PA	Ventura county	CA
Pittsburgh-Beaver Valley	PA	S. Barbara-S. Maria-Lompoc	CA
Richmond-Petersburg	VA	Remainder of California*	CA
Kewaunee Co.	WI	Las Vegas*	NV
Milwaukee-Racine	WI	Salt Lake City	UT
Manitowoc Co	WI		

*Designates Attainment Areas

3.2.2 Stage II Control Efficiency

Stage II efficiency data was taken from the 1991 Stage II technical guidance document.[6] The sections below will address Stage II equipment efficiency and reductions in efficiency due to exemption of small gasoline dispensing facilities.

3.2.2.1 Stage II Equipment Efficiency

Although Stage II systems can achieve capture efficiencies of 95 percent or better when first installed, reductions in the certified efficiency can occur through wear and tear, malfunctions, or system problems. The in-use efficiency of a Stage II program is directly proportional to proper installation, operation and maintenance of the control equipment. These factors can be monitored and enforced by state air quality agencies. The Stage II technical guidance document determined in-use efficiencies of 92 percent with semi-annual inspections, 86 percent with annual inspections and 62 percent with minimal or less frequent inspections. The current analysis assumes annual inspections nationwide, noting that some areas, such as California, may perform inspections more

[6] *Technical Guidance—Stage II Vapor Recovery Systems for Control of Vehicle Refueling Emissions at Gasoline Dispensing Facilities.* U.S. EPA Technical Report No. EPA-450/3-91-022a,b, November, 1991, pp. 4-46 to 55 (docket A-87-11, item IV-A-08).

frequently, but others do so at greater intervals. Therefore, in this analysis, the vapor capture efficiency of Stage II equipment is estimated to be 86 percent.

3.2.2.2 Stage II Waivers

To reduce the economic burden on small entities, CAA section 182(b)(3) permits waivers of Stage II requirements for small gasoline marketers, i.e., facilities which sell less than 10,000 gallons of gasoline per month (50,000 gallons per month in the case of independent marketers of gasoline). Furthermore, CAA section 324[7], which specifically addresses vapor recovery for small marketers, allows a state or local agency to establish an exemption from the Stage II requirement for independent small marketers at a level less than 50,000 gallons per month. Depending on the state, Stage II programs may thus provide waivers for stations with gasoline throughput ranging from zero (i.e., no waivers) to a single exemption level of 10,000 gallons per month for both stations owned by major oil companies and independent stations (a 10/10 program) to 10,000 gallons per month for major brands and 50,000 gallons per month for independent small businesses (a 10/50 program).

Appendix A shows which areas have adopted the single waiver level of 10,000 gallons and which use the 10,000/50,000 gallon exemption level. Areas in California are assumed to have no Stage II exemptions for small businesses. Based on these exemption levels, EPA estimates that a weighted average of 5.7 percent of the consumption in Stage II areas will flow through exempted gasoline fueling facilities and will therefore not be subject to Stage II control. Combining this waiver rate with the equipment efficiency discussed above would yield an overall Stage II capture efficiency of 80.3 percent. However, the calculations in this analysis apply the Stage II equipment efficiency and the waiver rate independently.

3.3 Segmentation of Gasoline Market

The gasoline distribution market can be divided in many ways. Several of these are helpful for this analysis: ozone attainment status, presence of Stage II controls, and metropolitan versus nationwide service station distribution.

The distribution of primary importance is that of attainment status. EPA estimates that 54.9 percent of the nationwide fuel consumption is through areas designated as marginal or worse for ozone nonattainment. (Areas designated to be in moderate or worse nonattainment status account for 46.8 percent of nationwide fuel consumption, while areas considered to be serious, severe, or extreme account for 29.8 percent.) Because VOC control is most needed in high-ozone areas, many regulatory approaches, such as volatility control, Stage II vapor recovery, and Inspection/Maintenance programs, are applied only in these nonattainment areas. However, ORVR control cannot be limited just to areas with significant pollution problems. Vehicles may be sold in one area, but operate over a relatively broad range, or may be resold to a new area throughout their

[7] Formerly Clean Air Act section 325, redesignated by PL96-300.

life. Thus, ORVR control is a nationwide commitment. Nevertheless, this analysis focuses to a large extent on the effects of ORVR specifically in nonattainment areas.

As discussed above, the presence of Stage II control is another important factor in the segmentation of the gasoline distribution market. While mandated Stage II control is largely a function of ozone attainment status, some areas have exceeded EPA requirements. EPA estimates (see Appendix A) that 45.0 percent of the gasoline consumed in the U.S. is through areas with Stage II control. Almost all (44.2 percent) of this is within nonattainment areas. Thus, approximately 98 percent of Stage II fuel consumption is within nonattainment areas, with about 81 percent of the nonattainment area fuel is covered by Stage II controls. Less than two percent of attainment area fuel is covered by Stage II.

To analyze Stage II costs, it is important to know the typical distributions of refueling facilities by size (as measured by gasoline throughput) in Stage II areas. The 1991 Stage II technical guidance document distinguished two size distribution patterns: metropolitan and nationwide service station distributions.[8] Because ozone nonattainment is primarily a problem of cities, the current analysis assumes that service stations in nonattainment areas follow the metropolitan distribution unless the whole state is a nonattainment area. This topic is discussed further in Chapter 6.

3.4 Additional Background Data

For general reference, Appendix D contains the original spreadsheets which provide the data for many of the tables presented in this and succeeding chapters. Included are a variety of spreadsheets and parameter summaries containing data on vehicle sales and fuel economy, control efficiencies and emission factors, and ORVR costs, benefits, cost effectiveness.

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[8] *Technical Guidance—Stage II Vapor Recovery Systems for Control of Vehicle Refueling Emissions at Gasoline Dispensing Facilities.* U.S. EPA Technical Report No. EPA-450/3-91-022a,b, November, 1991, pp. 2-26 (docket A-87-11, item IV-A-08).

Chapter 4: Emission Reduction Benefits

4.1 Introduction

This chapter assesses the reduction in volatile organic compound (VOC) emissions as a result of onboard refueling vapor recovery (ORVR) systems. The potential impacts of refueling emission reductions on energy, health, and the environment are discussed in Chapter 7.

4.2 Methodology

Emission reductions resulting from ORVR are estimated by applying projections of the in-use efficiency of ORVR systems to estimates of baseline (uncontrolled) refueling emissions. Previous analyses have shown that refueling emissions can be modeled using an empirical equation based upon a few parameters.[1,2] These include Reid Vapor Pressure (RVP) of the dispensed gasoline, dispensed temperature (Td) of the gasoline, and delta temperature (ΔT), defined as the difference between the temperature of the gasoline in the vehicle tank (Tt) and the dispensed temperature of the gasoline used to refill the tank (i.e. Tt -Td).

In this analysis, baseline refueling emission factors (grams/gallon) were developed for five regions covering the contiguous United States. This regional approach was used in order to make use of available Td and ΔT data. As discussed further below, state-level RVP information was aggregated at the regional level based on each state's fuel consumption, and a weighted RVP for each region was calculated. Regional refueling emission factors were calculated using the regional temperature and RVP values and then were weighted by the amount of fuel consumed in each region to produce a nationwide average refueling emission factor. Total nationwide refueling emissions (in metric tons) were calculated by multiplying the nationwide refueling emission factor by the number of gallons of fuel consumed in the nation.

In-use efficiency of ORVR systems is modeled by comparing uncontrolled refueling emission loads per refueling event to the canister capacity required to meet the refueling test procedure. Refueling emissions load varies with the RVP, Td, ΔT, and amount of fuel dispensed. Consistent with the baseline emissions analysis, a regional

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[1] "Refueling Emissions from Uncontrolled Vehicles," EPA Technical Report No. EPA-AA-SDSB-85-6 (Docket A-87-11, item II-A-6).

[2] "A Study of Uncontrolled Automotive Refueling Emissions," prepared by Automotive Testing Laboratories, Inc. for the Coordinating Research Council, Inc., January 5, 1988 (Docket A-87-11, item IV-D-565).

approach was used in this analysis to determine in-use efficiency. Regional in-use efficiencies were applied to regional baseline emissions to produce estimates of emissions reductions resulting from ORVR systems.

Emission reduction benefits of ORVR systems were calculated for the years 1998 - 2020 to account for the effect of fleet turnover and to address the potential discontinuation of Stage II controls, as described in section 202(a)(6) of the Clean Air Act.

4.2.1 Regional Designations

The regions used in this analysis are based on regional designations used in a 1975 gasoline temperature survey conducted for the American Petroleum Institute (API) by the Radian Corporation.[3] The study surveyed 56 U.S. gasoline stations located in 22 cities; these were grouped into six geographic regions. Dispensed fuel temperatures were monitored using analog strip chart recorders, which allowed Radian to determine daily average dispensed temperatures. However, ΔT was monitored only on specific days representative of the four seasons, due to the greater effort required to obtain vehicle tank temperatures.

Not all of the stations reported data for all months of the year, resulting in a few gaps in the data. The most serious of these gaps occurred in the Pacific Northwest (region 6 in the Radian report) where ΔT data were reported only for the month of May. Because the climate in the Pacific Northwest is adequately similar to that of the Northern Central U.S. (region 4 in the Radian report), it was concluded that the Northern Central temperature data could be used for both regions. Thus, the Pacific Northwest was handled as an extension of the Northern Central region in this analysis. The resulting five regions, shown in Figure 4.1, do not include Alaska and Hawaii because gasoline temperature data is unavailable from these states.

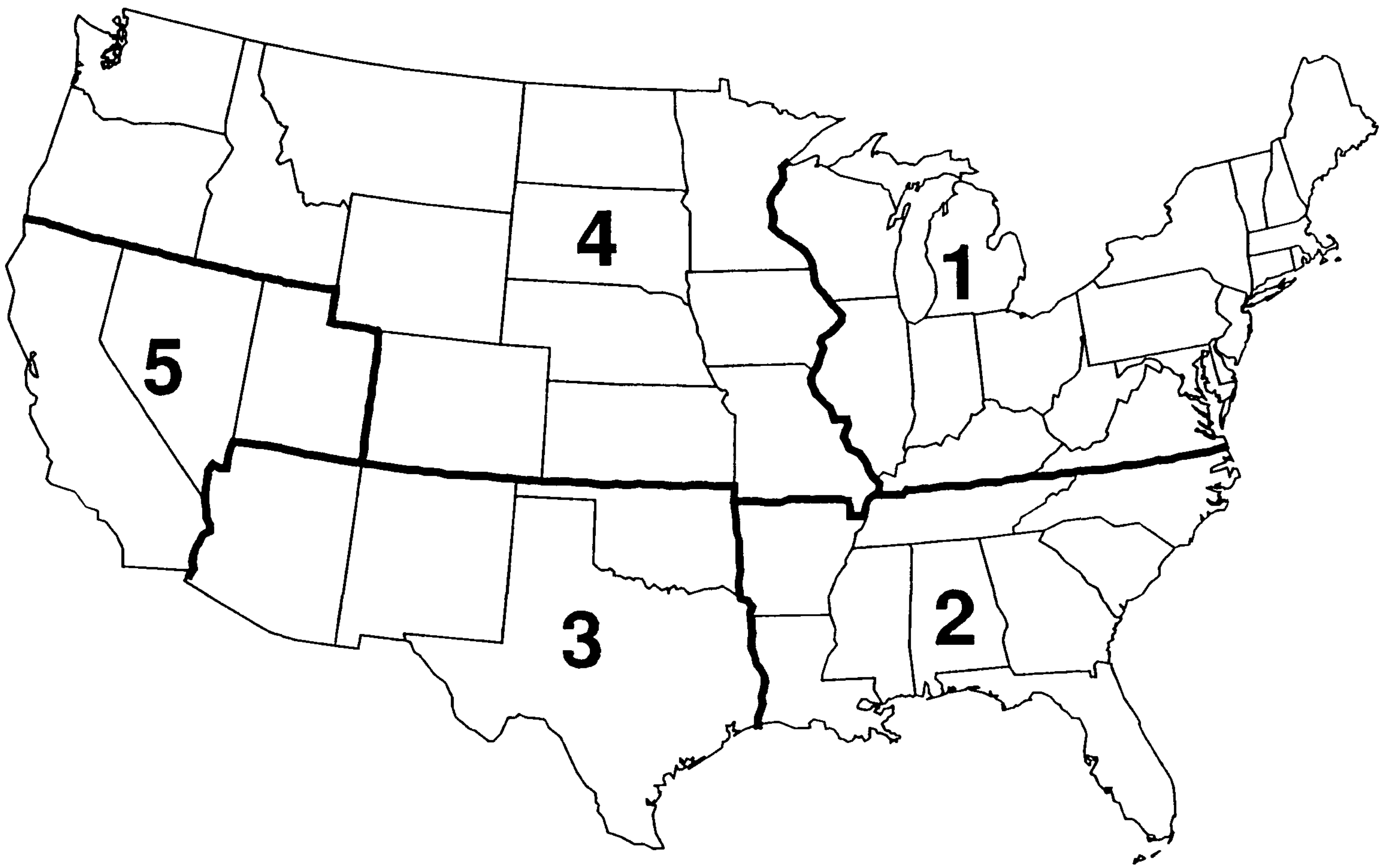
4.2.2 Areas Covered in Regional Analysis

Regional emission factors and control efficiency were determined for ozone nonattainment areas, Stage II areas, and all areas (both attainment and nonattainment areas nationwide). The nonattainment area analysis is important because the primary purpose for controlling refueling emissions is to help bring ozone nonattainment areas into attainment and to keep them in attainment in the future. Also, reformulated gasoline and fuel volatility programs, which significantly affect refueling emissions, are targeted primarily at nonattainment areas.

The Stage II area analysis examines the impact of Stage II on the benefits of ORVR systems. As discussed in Chapter 3, Stage II controls are required in serious, severe, and extreme nonattainment areas and are expected to be installed in most

[3] "Summary and Analysis of Data From Gasoline Temperature Survey Conducted at Service Stations by American Petroleum Institute," API Publication No. 4278, prepared for API by Radian Corp., November 11, 1976 (Docket A-84-07, item I-F-105).

Figure 4.1
Regions for Emission Reduction Benefits Analysis



moderate nonattainment areas. Also considered in this analysis are states which have opted to install Stage II systems in marginal areas as part of their state implementation plans.

Benefits for attainment and nonattainment areas combined were calculated to allow the evaluation of overall nationwide cost-effectiveness of ORVR systems. Unlike the various fuels programs and the Stage II program, ORVR systems will be implemented in all areas of the country. Thus, although nonattainment areas are the primary focus of the ORVR program, all areas must be considered when determining cost-effectiveness.

4.2.3 Months Considered in Regional Analysis

Regional baseline emission factors and in-use efficiency values were determined based on the characteristics of fuel during the ozone season, i.e., the five summer months, May through September. Annual benefits were then calculated by applying these summertime emission factors and in-use efficiency to annual fuel consumption data. This approach is consistent with the methodology used in previous EPA regulatory analyses of onboard and Stage II refueling emission control strategies.[4]

4.3 Regional Fuel RVP and Consumption

Before an estimate of regional baseline refueling emissions can be made, the RVP of the gasoline available for sale in each region and the amount of gasoline in each RVP class must be known. With this information, weighted average RVP can be calculated for each region and used to determine baseline refueling emission rates. This section describes the expected effects of various regulatory programs on summertime RVP levels and explains the method used to determine the relative amount of each fuel consumed.

4.3.1 RVP Control Programs

Three recent federal and state actions have been proposed or finalized which affect the RVP of fuel sold during the 5-month ozone season in nonattainment areas. These actions are federally mandated reformulated gasoline, Phase II volatility control, and California Phase 2 reformulated gasoline. These programs either directly limit RVP or will likely force the use of lower RVP fuel. The areas in which various fuels are sold depend upon the program.

Based on the cost-effectiveness of various strategies which could be used to meet reformulated gasoline performance requirements, EPA currently expects that the RVP of reformulated gasoline will be approximately 6.7 pounds per square inch (psi)[5]. The draft regulatory impact analysis (RIA) for the reformulated gasoline notice of proposed

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[4]"Draft Regulatory Impact Analysis: Proposed Refueling Emission Regulation for Gasoline-Fueled Motor Vehicles, Volumes I and II, July 1987 (Docket A-87-11, items II-A-18 and II-A-19).

[5]*Final Regulatory Impact Analysis For Reformulated Gasoline*, 13 December 1993, p. 276. (docket A-92-12, item V-B-1).

rulemaking (NPRM) identifies areas expected to be covered by the reformulated gasoline rulemaking.[6] Covered areas include the nine cities specified in the Clean Air Act and several areas which have opted in to the reformulated gasoline program.[7]

The Phase II volatility program establishes limits for fuel RVP in all areas of the U.S (56 FR 64704, December 12, 1991). The RVP limit depends on the state, month, and ozone classification. From May through September, gasoline sold in northern states (both attainment and nonattainment areas) is limited to 9.0 psi under the rule. In the warmer southern states, RVP is limited to 7.8 psi in nonattainment areas and 9.0 psi in attainment areas.

California Phase 2 reformulated gasoline regulations will require that all gasoline sold or made available as a motor vehicle fuel in California meet an RVP standard of 7.0 psi.[8] This standard would apply during the RVP season, defined by California Resources Board (CARB) as the months April through October.

Table B-2 in Appendix B, discussed further below, indicates the RVP of fuel sold in each nonattainment area in the nation.

4.3.2 Consumption Weighting

EPA estimated the amount of consumption of a given RVP fuel by apportioning available state fuel consumption data based upon population in the areas covered under the relevant summer fuel programs. For example, the amount of reformulated fuel sold in a state was determined by multiplying the state's gasoline consumption by the ratio: [population in reformulated gasoline areas] / [total state population].

State gasoline consumption data reported by the National Petroleum News (NPN) for the year 1990 was used for this analysis.[9] The NPN estimate is based on Federal Highway Administration data and includes both highway and non-highway fuel usage. Because ORVR applies only to highway vehicles, the NPN estimate was multiplied by 94.6 percent, based on highway fuel use estimates by the Federal Highway Administration.[10]

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[6]"Draft Regulatory Impact Analysis For The Notice of Proposed Rulemaking of the Complex Model, Phase II Performance Standards and Provisions for Renewable Oxygenates," February 5, 1993, Table A-V-1a (Docket A-92-12, item II-B-1).

[7]EPA also included some areas which have opted in to the reformulated gasoline program since the NPRM was published. These areas are identified with a *Federal Register* citation in Tables B-1 and B-2 of Appendix B under the "Area" column.

[8]"Executive Order G-770," final regulation order for Phase 2 reformulated gasoline, State of California Air Resources Board, September 18, 1992.

[9]"National Petroleum News, 1992 Fact Book," Mid-June 1992.

[10]"Highway Statistics 1990," U.S. Department of Transportation, Federal Highway Administration, Table MF-26.

Population data for the year 1990 was obtained from the Bureau of the Census in Washington, D.C.[11] EPA obtained population data for every county in the nation for this analysis. Ozone attainment status as described in the Federal Register on November 6, 1991 was used in compiling the list of nonattainment areas (56 FR 56694). Table B-1 in Appendix B contains populations by ozone attainment status for all areas in the contiguous U.S.

Descriptions of covered areas under the summer fuel programs were used to designate each nonattainment county as either a 6.7, 7.0, 7.8 or 9.0 RVP area. Consumption of each RVP class of gasoline was then determined by simply apportioning a state's total fuel consumption based on each county's RVP designation and population. Table B-2 in Appendix B contains the summer fuel consumption (as a percent of nationwide fuel consumption) for each area in the contiguous U.S. Stage II designations are also included in Table B-2.

It should be noted that Table B-2 contains fuel consumption percentages applicable to the months June through September rather than May through September. Because the Phase II volatility limit changes between May and June (from 9.0 psi to 7.8 psi) in the southern states, fuel consumption in the month of May had to be factored in separately. For this purpose, in each region, the fuel consumption percentage applicable to 9.0 RVP fuel in May was assumed to be equal to the sum of the 7.8 RVP and 9.0 RVP fuel consumptions applicable to June and the succeeding summer months. The fuel consumption percentages applicable to the entire five-month summertime period were then calculated as weighted averages of the percentages for May and for the period June through September.

Tables 4.1, 4.2, and 4.3 below summarize regional summertime fuel consumption as a percent of the nation's total throughput for nonattainment areas, all areas, and Stage II areas, respectively.[12] Table 4.3 includes fuel consumption from ozone attainment areas in Nevada and California. These two areas, which account for 0.72 percent of the nation's fuel consumption (or 1.6 percent of the fuel sold in Stage II areas), are not included in the nonattainment area emission reduction benefits analysis, but are included in the all-areas benefit analysis.

[11] "1990 Census of Population And Housing Summary Tape File 1C," Statistical Information Office, Population Division, Bureau of the Census.

[12] Totals shown in these tables, and in other tables presented later in this chapter, may not compute exactly due to rounding.

Table 4.1—RVP Distribution of Gasoline Consumed In Nonattainment Areas May - September

Region	6.7 RVP	7.0 RVP	7.8 RVP	9.0 RVP	Total	Avg RVP
1	21.98%	0.00%	0.00%	6.77%	28.76%	7.2
2	0.00%	0.00%	5.75%	1.44%	7.19%	8.0
3	3.34%	0.00%	1.04%	0.26%	4.63%	7.1
4	0.00%	0.00%	1.10%	1.44%	2.54%	8.5
5	6.85%	4.43%	0.37%	0.09%	11.74%	6.9
Totals	32.17%	4.43%	8.25%	10.00%	54.86%	7.3

Table 4.2—RVP Distribution of Gasoline Consumed In All Areas (Attainment and Nonattainment Areas Combined) May - September

Region	6.7 RVP	7.0 RVP	7.8 RVP	9.0 RVP	Total	Avg RVP
1	22.04%	0.00%	0.00%	19.00%	41.05%	7.8
2	0.00%	0.00%	5.75%	15.29%	21.03%	8.7
3	3.34%	0.00%	1.04%	7.10%	11.47%	8.2
4	0.00%	0.00%	1.10%	12.48%	13.57%	8.9
5	6.85%	4.82%	0.37%	0.84%	12.88%	7.0
Totals	32.23%	4.82%	8.25%	54.71%	100.00%	8.1

Table 4.3—RVP Distribution of Gasoline Consumed In Stage II Areas May - September

Region	6.7 RVP	7.0 RVP	7.8 RVP	9.0 RVP	Total	Avg RVP
1	19.10%	0.00%	0.00%	2.73%	21.83%	7.0
2	0.00%	0.00%	2.88%	0.72%	3.60%	8.0
3	3.34%	0.00%	1.04%	0.26%	4.63%	7.1
4	0.00%	0.00%	1.10%	1.44%	2.54%	8.5
5	6.85%	4.82%	0.27%	0.42%	12.36%	6.9
Totals	29.29%	4.82%	5.29%	5.57%	44.96%	7.1

4.4 Baseline Emission Factors

Baseline emissions in grams per gallon (g/gal) were estimated using an equation developed by Automotive Testing Laboratories, Inc (ATL).[13] Earlier EPA analysis of refueling emissions utilized an equation developed by EPA.[14] However, the EPA equation was based on testing conducted on only 8 vehicles, compared with 22 vehicles for the ATL equation. Because the ATL equation is based on a broader mix of domestic and import vehicles and contains a larger number of trucks, EPA concluded that the ATL equation is a better predictor of emission factors for these purposes.

[13]"A Study of Uncontrolled Automotive Refueling Emissions," prepared by Automotive Testing Laboratories, Inc. for the Coordinating Research Council, Inc., January 5,1988 (Docket A-87-11, item IV-D-565).

[14]"Refueling Emissions from Uncontrolled Vehicles," EPA Technical Report No. EPA-AA-SDSB-85-6, Appendix B (Docket A-87-11, item II-A-6).

Inputs to the ATL equation include RVP of the dispensed gasoline, Td, and ΔT. The ATL equation is as follows:

Equation 4-1:

$$EF\ (g/gal) = \exp[-1.2798 - 0.0049(\Delta T) + 0.0203(Td) + 0.1315(RVP)]$$

Regional Td and ΔT data for the 5-month ozone season were taken from Appendix B, Table B-3 and Table B-4, respectively. This data, based on the Radian report, was obtained from an earlier EPA report which analyzed the Radian data.[15] In the EPA report, minor temperature data gaps were filled by points interpolated from the Radian data. Average RVP values for each region were taken from Tables 4.1, 4.2, and 4.3 presented above.

Tables 4.4, 4.5, and 4.6 summarize the ATL equation inputs and the resulting baseline refueling emission factors for nonattainment areas, all areas, and Stage II areas, respectively. Average values for Td, ΔT, and RVP over the 5-month ozone season were used as input into the ATL equation to estimate uncontrolled emission factors. Average values can be used in estimating baseline emissions due to the linearity of the ATL equation.

The tables indicate that baseline refueling emissions are lower in nonattainment areas due to use of lower RVP fuel. The region with the highest refueling emission factor is the southeast (region 2). This is because the Radian data inexplicably indicated significantly higher Td's in this region of the country than in any other.

It should be noted that this analysis required the use of RVP inputs outside of the range for which the ATL equation was developed. The variable ranges under which the ATL equation was developed are 70°F < Td < 88°F, -10°F < ΔT < +10°F, and 8.8 < RVP < 11.6. ATL states in its report that "extrapolating the correlation equation outside the range of the variable tested can cause significant errors."

To determine if the ATL equation could be extrapolated without resulting in significant error, EPA examined other refueling emission factor equations which apply for fuel RVP levels down to 7.0 psi. EPA compared the effect of RVP on refueling emission factors predicted in the ATL equation with the RVP effect predicted in equations developed by Scott Environmental Technology and by Exxon Research and Engineering Co.[16] The percentage reduction in the refueling emission factor (at test procedure temperature conditions) resulting from a reduction in RVP from 9.0 to 7.0 psi was nearly identical (around 30 percent) for all three equations. Thus, EPA believes that the ATL equation is reasonably accurate for the RVP levels encountered in this analysis.

[15]Ibid

[16]See page 11 of the document referenced in footnote 10.

Table 4.4—Baseline Refueling Emission Factors for Nonattainment Areas

Region	Fuel Consumption	RVP (psi)	Td (°F)	ΔT (°F)	EFu (g/gal)
1	28.76%	7.2	74	11.4	3.1
2	7.19%	8.0	88	7.5	4.6
3	4.63%	7.1	81	7.0	3.5
4	2.54%	8.5	79	12.0	4.0
5	11.74%	6.9	79	5.2	3.3
Totals	54.86%	7.3	78	9.2	3.4

Table 4.5—Baseline Refueling Emission Factors for All Areas (Attainment and Nonattainment Areas Combined)

Region	Fuel Consumption	RVP (psi)	Td (°F)	ΔT (°F)	EFu (g/gal)
1	41.05%	7.8	74	11.4	3.3
2	21.03%	8.7	88	7.5	5.0
3	11.47%	8.2	81	7.0	4.1
4	13.57%	8.9	79	12	4.2
5	12.88%	7.0	79	5.2	3.4
Totals	100%	8.1	79	9.4	3.9

Table 4.6—Baseline Refueling Emission Factors for Stage II Areas

Region	Fuel Consumption	RVP (psi)	Td (°F)	ΔT (°F)	EFu (g/gal)
1	21.83%	7.0	74	11.4	3.0
2	3.60%	8.0	88	7.5	4.6
3	4.63%	7.1	81	7.0	3.5
4	2.54%	8.5	79	12.0	4.0
5	12.36%	6.9	79	5.2	3.3
Totals	44.96%	7.1	78	9.0	3.3

4.5 In-Use Efficiency of ORVR Systems

In-use efficiency of ORVR systems was determined by comparing in-use canister capacity to the vapor load resulting from in-use refueling events. In-use refueling vapor load is the product of the in-use refueling emission factor (in grams per gallon) and the volume of gasoline dispensed (in gallons).

4.5.1 In-Use Canister Capacity

For the purposes of this discussion, canister capacity includes both breakthrough capacity and post-breakthrough capacity. Breakthrough capacity is defined as the amount of vapor that can be captured before a significant amount of hydrocarbon is emitted from the canister. Post-breakthrough capacity refers to the ability of the canister to capture vapors at a reduced efficiency after breakthrough occurs.

In estimating in-use canister breakthrough capacity, EPA assumed that the canister size and design will be engineered based on the demands of the ORVR test procedure. Thus, canister breakthrough capacity was estimated by multiplying the ATL emission factor predicted under test procedure conditions by the number of gallons dispensed during the refueling test. Using test procedure conditions (Td = 67°F, ΔT = 13°F, and RVP = 9.0 psi), the ATL equation predicts a refueling emission factor of 3.3 g/gal. Limited data from manufacturers suggest that use of liquid seals may add an additional 25 percent of vapor due to the effects of air entrainment during refueling, raising the refueling emission factor to 4.1 g/gal.[17]

The volume of fuel added during the refueling test is equal to 90 percent of tank volume. Using a nominal fuel tank size of 20 gallons (average tank sizes are smaller), the amount of gasoline dispensed during the refueling test would be 18 gallons. Multiplying the gallons dispensed by the test procedure emission factor results in an estimated in-use canister breakthrough capacity of approximately 75 grams. This compares well with GM's estimate of canister breakthrough capacity required by the refueling test procedure.[18]

For vehicles utilizing integrated refueling and evaporative systems, evaporative vapors could load the canister prior to refueling, resulting in a lower in-use canister breakthrough capacity than estimated above. Loss in breakthrough capacity could occur, for example, if a vehicle is parked for several days and then is driven only a short distance before refueling, allowing little opportunity for the purge system to restore canister capacity.

However, the effect of integrated systems on in-use canister capacity should be small. First, the new evaporative test procedure is expected to result in higher purge rates (58 FR 16002, March 24, 1993). The improved procedure will require vehicles to be capable of purging a loaded canister during the exhaust emissions test in preparation for a multiple-day diurnal heat build. Rapid purge helps to restore capacity, even during short drives typical of in-use driving patterns.

Second, in most cases, the evaporative load would use up only a portion of the available canister capacity before a refueling event. Under the new evaporative test procedure, manufacturers must ensure adequate canister capacity to handle three high temperature diurnals. EPA data suggests that eighty five percent of diurnal events are of one day duration or less.[19] Thus, even if no purge opportunity exists before refueling, the evaporative load would likely not reduce canister breakthrough capacity greatly.

Third, manufacturers are expected to include a design safety factor of 10 to 20 percent when sizing the canister to ensure that vehicles pass the refueling certification test. This design safety margin will provide additional in-use canister capacity which will help mitigate any loss in canister capacity resulting from evaporative emissions.

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[17]Letter from Samuel A. Leonard, GM, to Richard D. Wilson, EPA, August 20, 1993 (Docket A-87-11, item IV-D-854).

[18]Ibid.

[19]"Reductions in Evaporative Emissions and Running Losses from Enhanced Vehicle-Based Control," EPA memo from A. Stout to C. Gray, December 19, 1989 (Docket A-89-18, item II-B-5).

Furthermore, due to economies of scale, manufacturers will likely use only a few canister sizes to cover all models and fuel tank sizes. For example, the canister used on vehicles with a 20 gallon fuel tank could also be used on vehicles with 16 or 18 gallon fuel tanks. Thus, in many cases, ORVR systems will have more canister capacity than necessary to pass the refueling test. Finally, due to weathering of fuel in the underground storage tank, the RVP of the fuel will be less than that used in the above analysis. This will decrease the uncontrolled emission factors in use.

4.5.2 Canister Control Efficiency

Refueling canisters operate at essentially 100 percent collection efficiency until the canister's breakthrough capacity is reached. When the vapor load to the canister exceeds breakthrough capacity, vapors are emitted from the canister. Once vapor begins escaping, the efficiency gradually decreases until the canister reaches saturation (zero percent collection efficiency). Thus, a canister continues to store some vapor even after its breakthrough capacity is exceeded.

Post-breakthrough canister efficiency was modeled in this analysis by assuming a linear decrease in control efficiency with increasing vapor load to the canister. Because of the rapid loading inherent in refueling events, it was conservatively assumed that the collection efficiency drops off fairly quickly, reaching zero after a post-breakthrough vapor load to the canister equal to one-fourth of the pre-breakthrough load (Figure 4.2).

While this capture after breakthrough increases in-use efficiency, the vehicle is still required to meet the 0.20 g/gal refueling emission standard in certification. Meeting this standard, accounting for fillneck and deterioration losses, is likely to result in designs with little or no breakthrough during the test. Thus, post-breakthrough capture of refueling emissions is an added in-use benefit and a byproduct of the nature of the control technology, and adds further to the assurance of high in-use efficiency.

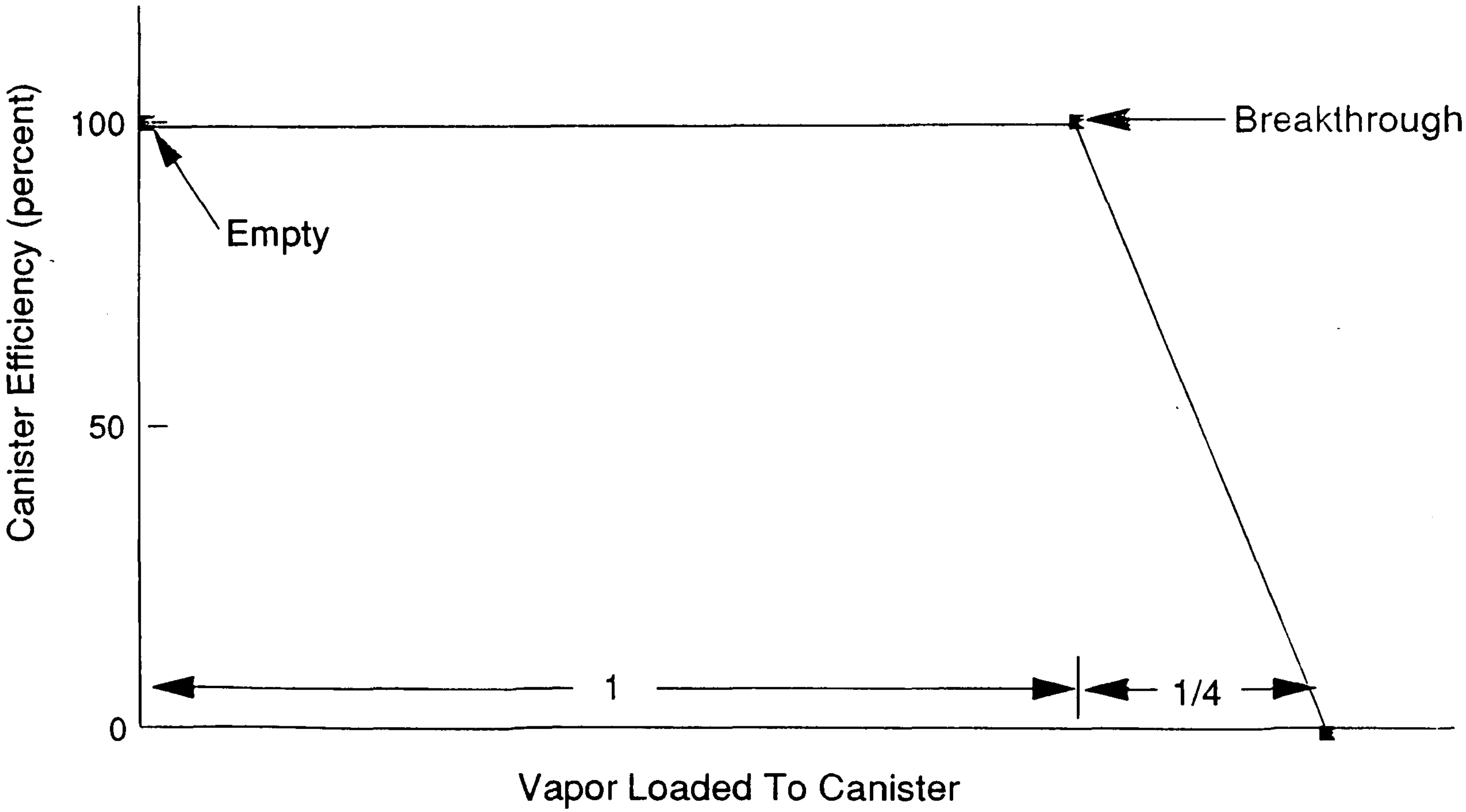
4.5.3 In-Use Refueling Emission Factors

Consistent with the baseline emission factor analysis and the estimate of canister breakthrough capacity, the ATL equation was used to estimate in-use refueling emission factors. However, distributions rather than averages were used for the dispensed temperature and RVP inputs to the ATL equation to ensure that all possible breakthrough events were considered. As described above, the ORVR system operates at essentially 100 percent collection efficiency until canister breakthrough capacity is exceeded. Use of averages rather than distributions of in-use conditions could ignore some refueling events which cause canister breakthrough, thus overestimating control efficiency.[20]

Although distributions were used for Td and RVP inputs, average values were used for ΔT. This simplification was considered appropriate because the ATL equation

[20]A similar situation would occur if one were to analyze the ability of a one-liter container to hold two volumes of liquid equal to 0.5 l and 1.5 l. Although the container could hold the average of the two volumes of liquid, it would not be capable of holding the larger volume if considered separately.

Figure 4.2
Canister Efficiency Curve



is fairly insensitive to changes in ΔT and because the ΔT data was more limited. A sensitivity analysis performed for regions one and two showed that use of a regional average value for ΔT rather than a distribution affected the estimate of in-use efficiency by less than one percent. Table B-4 in Appendix B, which was also used in determining baseline emissions, contains the regional ΔT data used in this analysis.

Table B-5 contains the regional distributions of dispensed temperature data used in this analysis. The data, taken directly from the Radian report, represents Td's for the period May through September. EPA calculated ATL emission factors for each Td in the regional distributions and weighted them according to frequency of occurrence. Separate calculations were performed for 6.7, 7.0, 7.8 and 9.0 RVP fuel areas.

4.5.4 In-Use Refueling Load

In-use refueling load was calculated by multiplying the in-use emission factors by the number of gallons dispensed. A distribution of refueling events was used to estimate the amount of fuel dispensed during refueling. EPA used a distribution of refueling events based on a survey conducted by General Motors.[21,22] The survey contained information on fuel tank levels before and after refueling events. The GM survey, which included 1,184 events, relied on the vehicle owner's estimate of fuel gauge reading before and after refueling to determine the percent of tank volume dispensed during refueling.

Because the survey method appears to have resulted in some discontinuities in the distribution, EPA smoothed the distribution while maintaining the cumulative frequencies within each third of the distribution (i.e. 0-30%, 40-60%, and 70-100%). The EPA adjustment is conservative in that the distribution was shifted toward larger refueling amounts, resulting in larger vapor loads to the canister. Figure 4.3 contains the GM survey results and the EPA-modified distribution of refueling amount.

4.5.5 In-Use Control Efficiency

Tables 4.7, 4.8, and 4.9 summarize the regional uncontrolled emission factors (EFu), the controlled emission factor (EFc), and the corresponding ORVR system efficiencies for the various summer fuels. The totals represent weighted values based on the relative fuel consumption within each region. A sample calculation is provided in Appendix C to more clearly explain the method used to determine the control efficiencies in each region.

As shown in Tables 4.7, 4.8, and 4.9, the theoretical in-use efficiency of ORVR systems is 97.4 percent in nonattainment areas, 93.5 percent in all areas, and 98.0 percent in Stage II areas. The somewhat lower efficiency in all areas is due to the use of higher volatility fuels in attainment areas and the higher than expected dispensed temperatures in the Southeast (region 2).

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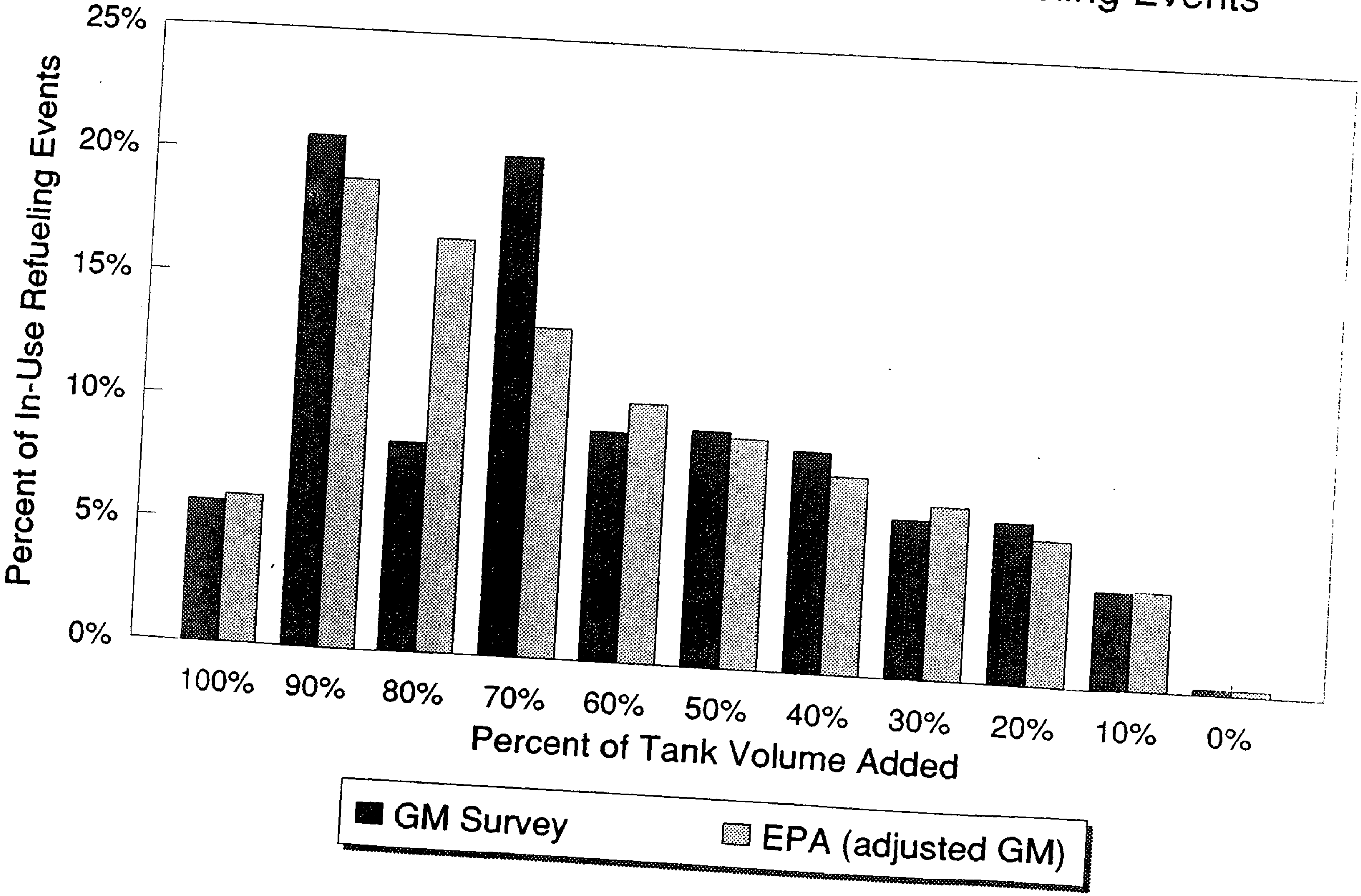
[21]"Survey of Vehicle Refueling," Michael S. Lombardo and Gesa Behrens, SAE 871085.

[22]"Draft Regulatory Impact Analysis, Control of Gasoline Volatility and Evaporative Hydrocarbon Emissions from New Motor Vehicles," EPA, July 1987, pg 2-79 (Docket A-85-21, item II-A-45).

Figure 4.3
Distribution of Fill Amounts for In-use Refueling Events



The theoretical in-use efficiency of ORVR control was reduced somewhat to account for systems that fail to operate properly in use. System failure may occur due to component failure, consumer malmaintenance, or tampering. Failure rates of ORVR systems used in this analysis are based on evaporative system failure rates contained in EPA's MOBILE emission factor model, version 5a (MOBILE5a).[23]

MOBILE5a contains two categories for evaporative system failure: pressure failure and purge failure. Pressure failure is defined as a loss of fuel system integrity resulting in evaporative vapors escaping to the atmosphere instead of being routed to the canister. This failure mode is not expected to apply to ORVR controls for two reasons. First, liquid seals (which will likely be used on most vehicles) are not expected to deteriorate in use. Second, due to the higher vapor generation rates during refueling, and the very short time of refueling events relative to evaporative emissions, small leaks in an ORVR system are not expected to significantly affect refueling control.

Purge failure results in loading the canister beyond capacity and subsequent breakthrough of the vapors. Over a vehicle's useful life (50,000 miles for the current model year), MOBILE5a estimates that roughly 3.5 percent of vehicles have purge system failure.[24] EPA expects that this failure rate will be maintained over 100,000 miles as a result of the full useful life requirement of section 202(d)(1) of the CAA. This is a reasonable judgment because the full useful life requirement will force manufacturer to upgrade system reliability. Thus, ORVR failure rates are projected to be 3.5 percent over the full useful life of the vehicle in this analysis.

The number of in-use failures of vapor control systems are expected to be limited by Inspection and Maintenance (I/M) programs [57 FR 52950, November 5, 1992] and by onboard diagnostic (OBD) systems [58 FR 9468, February 19, 1993]. Both programs monitor the functionality of the purge system.[25] The I/M program and OBD program are expected to reduce purge system failures by 80 percent in areas covered by either basic or enhanced I/M.[26] For this analysis, EPA assumes that the I/M program is required in all ozone nonattainment areas. Thus, the purge failure rate of ORVR systems is expected to be 0.7 percent (20 percent of the 3.5 percent nominal failure rate) in nonattainment areas.

In attainment areas, the actual purge failure rate of ORVR systems is expected to be somewhat higher due to the absence of I/M programs. Without I/M, EPA estimates that only 60 percent of the purge failures caught by the OBD system will be repaired.[27]

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[23] *Federal Register*, Volume 58, pg 29409, 20 May 1993.

[24] "Draft MOBILE5 Hot Soak and Diurnal Emissions," handout from EPA workshop, July 8, 1992 (Docket A-89-18, item IV-B-8).

[25] Basic I/M programs will check the OBD system for a purge system failure code, while enhanced I/M programs will test the purge system independent of the OBD system. Both methods are assumed to be equally effective at identifying purge system failures.

[26] Memorandum from Dan Barba to EPA Air Docket A-87-11, titled "Estimate of Reduction of Evaporative System Purge Failures Resulting from Recent EPA Actions" (docket A-87-11, section IV-B).

[27] "Survey of Vehicle Owners in the On-board Diagnostics Program," prepared for EPA by Westat, Inc., 18 July 1990 (docket A-90-35, item II-A-6)

Assuming that OBD catches 80 percent of the purge failures, the purge failure rate of ORVR systems is estimated to be 1.8 percent ([1-0.8*0.6]*3.5) in attainment areas. Weighting the attainment area and nonattainment area failure rates by fuel consumption results in an ORVR failure rate in all areas of 1.2 percent. (This could be slightly higher for the relatively few heavy duty vehicles in this analysis, because OBD does not apply to this class of vehicles.)

As shown in Tables 4.7 through 4.9, the reduction in vapor capture efficiency caused by control system failures results in the following efficiencies for ORVR in use: 96.7 percent for nonattainment areas, 92.3 percent for all areas and 97.3 percent for Stage II areas.

As discussed in section 4.5.1, liquid seals may increase vapor generation by as much as 25 percent due to air entrainment. This does not affect the emissions of an ORVR-equipped vehicle when it is operating properly, but it will increase emissions in vehicles with failed recovery systems. This increase in the emission rate from failed vehicles was taken into account by adjusting the in-use ORVR efficiencies in Equation 4-2 in the next section.

Table 4.7—In-Use ORVR Control Efficiency in Nonattainment Areas

Region	RVP (psi)	Fuel Use (% of U.S.)	EFu (g/gal)	EFc (g/gal)	Control Efficiency
1	6.7	21.98%	2.84	0.001	100.0%
	7.8	0.00%	3.28	0.020	99.4%
	9.0	6.77%	3.84	0.153	96.3%
2	6.7	0.00%	3.82	0.125	96.9%
	7.8	5.75%	4.41	0.429	90.6%
	9.0	1.44%	5.16	1.018	80.7%
3	6.7	3.34%	3.35	0.019	99.5%
	7.8	1.04%	4.87	0.140	96.5%
	9.0	0.26%	4.53	0.507	89.1%
4	6.7	0.00%	3.17	0.035	99.1%
	7.8	1.10%	3.66	0.169	96.0%
	9.0	1.44%	4.29	0.489	90.0%
5	6.7	6.85%	3.25	0.016	99.6%
	7.0	4.43%	3.38	0.030	99.2%
	7.8	0.37%	3.75	0.114	97.2%
	9.0	0.09%	4.40	0.431	90.6%
Totals		55%	3.40	0.12	97.4%

In-use failure rate = 0.7%

In-use control efficiency = 96.7%

Table 4.8—In-Use ORVR Control Efficiency In All Areas (Attainment and Nonattainment Areas Combined)

Region	RVP (psi)	Fuel Use (% of U.S.)	EFu (g/gal)	EFc (g/gal)	Control Efficiency
1	6.7	22.04%	2.84	0.001	100.0%
	7.8	0.00%	3.28	0.020	99.4%
	9.0	19.00%	3.84	0.153	96.3%
2	6.7	0.00%	3.82	0.125	96.9%
	7.8	5.75%	4.41	0.429	90.6%
	9.0	15.29%	5.16	1.018	80.7%
3	6.7	3.34%	3.35	0.019	99.5%
	7.8	1.04%	4.87	0.140	96.5%
	9.0	7.10%	4.53	0.507	89.1%
4	6.7	0.00%	3.17	0.035	99.1%
	7.8	1.10%	3.66	0.169	96.0%
	9.0	12.48%	4.29	0.489	90.0%
5	6.7	6.85%	3.25	0.016	99.6%
	7.0	4.43%	3.38	0.030	99.2%
	7.8	0.37%	3.75	0.114	97.2%
	9.0	0.84%	4.40	0.431	90.6%
Totals		100%	3.88	0.32	93.5%

In-use failure rate = 1.2%
In-use control efficiency = 92.3%

Table 4.9—In-Use ORVR Control Efficiency In Stage II Areas

Region	RVP (psi)	Fuel Use (% of U.S.)	EFu (g/gal)	EFc (g/gal)	Control Efficiency
1	6.7	19.10%	2.84	0.001	100.0%
	7.8	0.00%	3.28	0.020	99.4%
	9.0	2.73%	3.84	0.153	96.3%
2	6.7	0.00%	3.82	0.125	96.9%
	7.8	2.88%	4.41	0.429	90.6%
	9.0	0.72%	5.16	1.018	80.7%
3	6.7	3.34%	3.35	0.019	99.5%
	7.8	1.04%	4.87	0.140	96.5%
	9.0	0.26%	4.53	0.507	89.1%
4	6.7	0.00%	3.17	0.035	99.1%
	7.8	1.10%	3.66	0.169	96.0%
	9.0	1.44%	4.29	0.489	90.0%
5	6.7	6.85%	3.25	0.016	99.6%
	7.0	4.82%	3.38	0.030	99.2%
	7.8	0.27%	3.75	0.114	97.2%
	9.0	0.42%	4.40	0.431	90.6%
Totals		45%	3.31	0.09	98.0%

In-use failure rate = 0.7%
In-use control efficiency = 97.3%

4.6 Benefits

To calculate the emission benefits of installing ORVR on vehicles, the in-use efficiency and uncontrolled emission factors developed earlier in this chapter are used to derive emission benefit rates (grams per gallon) according to equation 4-2 below.

Equation 4-2:

$$\text{Benefit Rate} = [(EF_u)(\eta_{ORVR} - ae) - (S2\%)(EF_u^{S2})(\eta_{ORVR}^{S2} - ae^{S2})]$$

$$+ [(S2\%)(EF_u^{S2})[(\eta_{S2})(1 - Waivers_{S2})](\eta_{ORVR}^{S2} - ae^{S2})]$$

Where:

EF_u = uncontrolled refueling emission factor for all areas (3.9 g/gal) or for NAA (3.4 g/gal)

EF_u^{S2} = uncontrolled refueling emission factor for Stage II areas (3.3 g/gal)

η_{S2} = Stage II control efficiency (0.86)

S2% = fraction of areas with Stage II control (0.450 for all areas and 0.805 for NAA)

$Waivers_{S2}$ = average fraction of fuel consumption exempted from Stage II (0.0570)

η_{ORVR} = ORVR in-use control efficiency for all areas (0.923) or for NAA (0.967)

η_{ORVR}^{S2} = ORVR in-use control efficiency in Stage II areas (0.973)

ae = air entrainment factor (0.003 for all areas and 0.002 for NAA)

ae^{S2} = air entrainment factor for Stage II areas (0.002)

By inserting the appropriate uncontrolled refueling emission factor (EF_u) and ORVR control efficiency (η_{ORVR}), the equation can be used to calculate either the all-areas benefit rate or the nonattainment-area benefit rate. The equation first computes the nominal ORVR vapor recovery rate $[(EF_u)(\eta_{ORVR}\text{-}ae)]$. It then subtracts out the portion of the recovery rate which applies to Stage II areas $[(S2\%)(EF_u^{S2})(\eta_{ORVR}^{S2}\text{-}ae^{S2})]$, leaving the portion which applies to non-Stage II areas. Finally, the equation recomputes and adds back the Stage II portion, using the applicable baseline emission rates and efficiencies. The later part of the equation also accounts for the fact that, in Stage II areas, the vapors available to be recovered by ORVR are reduced, thus diminishing the benefit of ORVR controls. Hence, the emission benefit is decreased by the portion of the vapors that Stage II would capture. This amount is determined by the Stage II capture efficiency, with a factor to account for exempted fuel. In Stage II areas, Stage II reduces the ORVR benefit by approximately 81 percent. This reduction in emission benefit due to Stage II is about 36 percent in the all-areas analysis, and 80 percent in nonattainment areas.

The emission benefit rates calculated for all areas and nonattainment areas are tabulated in Table 4.10. With the projected Stage II implementation discussed in Chapter 3, these emission benefit rates are 2.42 g/gal in all areas and 1.19 in nonattainment areas.

If Stage II control were discontinued at some point in the future, these emission benefit rates would rise to 3.59 g/gal for all areas and 3.28 g/gal for nonattainment areas.

Table 4.10—ORVR Emission Benefit Rates (g/gal)

	With Stage II	Without Stage II
All Areas	2.42	3.59
Nonattainment Areas	1.19	3.28

To determine total emission benefits, these emission benefit rates are multiplied by projected ORVR gasoline consumption (from Chapter 3). In Tables 4.11.1-4, the fuel consumption projections presented in Table 3.4 and the emission benefit rates from Table 4.10 are used to determine annual emission benefits in each vehicle weight class for both all-areas and nonattainment areas. To determine total nationwide benefits for a given scenario and year, the benefits from each vehicle class must be summed. Chapter 7 develops the scenarios for costs and benefits and computes these total benefit figures.

Table 4.11.1—LDV Emission Benefits

Year	Projected ORVR Fuel Consumption	Benefits: All Areas (Mg) with S2	Benefits: All Areas (Mg) no S2	Benefits: NAA (Mg) with S2	Benefits: NAA (Mg) no S2
1998	2.30E+09	5,577	8,274	1,506	4,150
1999	8.26E+09	19,997	29,665	5,398	14,880
2000	1.63E+10	39,541	58,658	10,675	29,423
2001	2.45E+10	59,304	87,976	16,010	44,128
2002	3.23E+10	78,192	115,996	21,109	58,183
2003	3.99E+10	96,572	143,261	26,071	71,859
2004	4.72E+10	114,135	169,315	30,812	84,928
2005	5.35E+10	129,427	192,001	34,940	96,306
2006	5.88E+10	142,332	211,145	38,424	105,909
2007	6.36E+10	153,850	228,233	41,534	114,480
2008	6.82E+10	164,996	244,767	44,543	122,774
2009	7.28E+10	176,260	261,477	47,584	131,155
2010	7.73E+10	187,131	277,604	50,518	139,244
2011	8.12E+10	196,467	291,453	53,039	146,191
2012	8.46E+10	204,668	303,618	55,253	152,293
2013	8.74E+10	211,499	313,752	57,097	157,376
2014	8.98E+10	217,396	322,500	58,689	161,764
2015	9.21E+10	222,929	330,708	60,182	165,881
2016	9.41E+10	227,628	337,679	61,451	169,378
2017	9.59E+10	232,072	344,273	62,651	172,685
2018	9.76E+10	236,183	350,371	63,761	175,744
2019	9.92E+10	240,098	356,179	64,818	178,657
2020	1.01E+11	243,898	361,816	65,843	181,485

Table 4.11.2—LDT Emission Benefits

Year	Projected ORVR Fuel Consumption	Benefits All Areas (Mg) with S2	Benefits All Areas (Mg) no S2	Benefits NAA (Mg) with S2	Benefits NAA (Mg) no S2
1998	1.36E+09	3,285	4,874	887	2,445
1999	5.18E+09	12,545	18,610	3,387	9,334
2000	1.08E+10	26,095	38,711	7,045	19,417
2001	1.67E+10	40,340	59,843	10,890	30,017
2002	2.24E+10	54,194	80,396	14,630	40,326
2003	2.76E+10	66,881	99,216	18,055	49,766
2004	3.23E+10	78,154	115,939	21,099	58,154
2005	3.60E+10	87,085	129,188	23,510	64,800
2006	3.89E+10	94,235	139,796	25,440	70,120
2007	4.15E+10	100,351	148,868	27,091	74,671
2008	4.39E+10	106,132	157,444	28,652	78,973
2009	4.66E+10	112,703	167,192	30,426	83,862
2010	4.96E+10	119,946	177,936	32,381	89,251
2011	5.24E+10	126,795	188,096	34,230	94,348
2012	5.50E+10	133,102	197,454	35,933	99,041
2013	5.72E+10	138,485	205,438	37,386	103,046
2014	5.92E+10	143,367	212,681	38,704	106,679
2015	6.12E+10	148,170	219,805	40,000	110,253
2016	6.31E+10	152,597	226,373	41,195	113,547
2017	6.48E+10	156,772	232,567	42,323	116,654
2018	6.64E+10	160,646	238,314	43,368	119,537
2019	6.79E+10	164,363	243,828	44,372	122,303
2020	6.94E+10	168,024	249,259	45,360	125,027

Table 4.11.3—LHDGV Emission Benefits

Year	Projected ORVR Fuel Consumption	Benefits			
		All Areas (Mg)		NAA (Mg)	
		with S2	no S2	with S2	no S2
1998	1.61E+08	390	579	105	290
1999	6.03E+08	1,459	2,165	394	1,086
2000	1.25E+09	3,032	4,498	819	2,256
2001	1.94E+09	4,686	6,952	1,265	3,487
2002	2.60E+09	6,286	9,325	1,697	4,677
2003	3.27E+09	7,902	11,723	2,133	5,880
2004	3.95E+09	9,566	14,191	2,582	7,118
2005	4.59E+09	11,112	16,484	3,000	8,268
2006	5.15E+09	12,469	18,498	3,366	9,278
2007	5.64E+09	13,640	20,235	3,682	10,150
2008	6.07E+09	14,685	21,785	3,964	10,927
2009	6.56E+09	15,880	23,558	4,287	11,817
2010	7.11E+09	17,213	25,536	4,647	12,808
2011	7.67E+09	18,573	27,552	5,014	13,820
2012	8.16E+09	19,751	29,300	5,332	14,696
2013	8.59E+09	20,793	30,846	5,613	15,472
2014	8.98E+09	21,731	32,238	5,867	16,170
2015	9.36E+09	22,643	33,590	6,113	16,849
2016	9.68E+09	23,437	34,768	6,327	17,439
2017	9.98E+09	24,151	35,827	6,520	17,971
2018	1.02E+10	24,801	36,791	6,695	18,454
2019	1.05E+10	25,415	37,703	6,861	18,911
2020	1.07E+10	26,001	38,571	7,019	19,347

Table 4.11.4—HHDGV Emission Benefits

Year	Projected ORVR Fuel Consumption	Benefits			
		All Areas (Mg)		NAA (Mg)	
		with S2	no S2	with S2	no S2
1998	5.38E+07	130	193	35	97
1999	2.01E+08	486	722	131	362
2000	4.18E+08	1,011	1,499	273	752
2001	6.46E+08	1,562	2,317	422	1,162
2002	8.66E+08	2,095	3,108	566	1,559
2003	1.09E+09	2,634	3,908	711	1,960
2004	1.32E+09	3,189	4,730	861	2,373
2005	1.53E+09	3,704	5,495	1,000	2,756
2006	1.72E+09	4,156	6,166	1,122	3,093
2007	1.88E+09	4,547	6,745	1,227	3,383
2008	2.02E+09	4,895	7,262	1,321	3,642
2009	2.19E+09	5,293	7,853	1,429	3,939
2010	2.37E+09	5,738	8,512	1,549	4,269
2011	2.56E+09	6,191	9,184	1,671	4,607
2012	2.72E+09	6,584	9,767	1,777	4,899
2013	2.86E+09	6,931	10,282	1,871	5,157
2014	2.99E+09	7,244	10,746	1,956	5,390
2015	3.12E+09	7,548	11,197	2,038	5,616
2016	3.23E+09	7,812	11,589	2,109	5,813
2017	3.33E+09	8,050	11,942	2,173	5,990
2018	3.42E+09	8,267	12,264	2,232	6,151
2019	3.50E+09	8,472	12,568	2,287	6,304
2020	3.58E+09	8,667	12,857	2,340	6,449

Chapter 5: Economic Impact

5.1 Introduction

This chapter presents a detailed analysis of the costs expected to be incurred as a result of the ORVR requirements. For manufacturers, the economic impact of the ORVR regulation will include incremental costs for various vehicle hardware components, as well as start-up costs for research and testing and for new or expanded facilities. Impacts on consumers are expected to include vehicle price increases covering manufacturers' ORVR costs plus operating cost savings associated with fuel economy changes.

This analysis is largely an update of the previous EPA cost estimates discussed in Chapter 1, with particular emphasis on the analysis which accompanied the 1987 proposed rule[1] and the follow-up 1988 EPA cost memorandum[2]. Although both the 1991 and 1993 notices requested comments on EPA's earlier cost analyses, little input was received in the subsequent comment periods. Industry's cost estimates have been insufficiently supported to cause EPA to change its analysis significantly. Commentors have identified no hardware that EPA's analysis had not accounted for, and have provided no direct challenge to the assumptions that have gone into EPA's past cost estimates.

As a result, some of the estimated costs which appeared in the earlier analyses have simply been adjusted to account for inflation and then used in the current analysis. In such instances, the adjustment for inflation is based on the ratio of Consumer Price Index for new cars with added safety and emissions equipment, as reported in *AAMA Motor Vehicle Facts and Figures '93*. Using the most recently available 1992 index of 136.7 and the 1984 index of 103.6, the new car inflation rate between 1984 and 1993 is 32 percent (136.7 divided by 103.6). Similarly, the inflation rate between 1988 and 1992 is fifteen percent. The 1992 value is adequate for the analysis at hand. Mid-1993 costs might perhaps be one to two percent higher, but this adjustment would be beyond the precision of this analysis.

The cost analysis assumes that ORVR systems will be integrated with the enhanced evaporative emission controls expected as a result of the recent regulations establishing new evaporative emission standards and test procedures (58 FR 16002, March 24, 1993). It further assumes that the enhanced evaporative emission controls will be in place on vehicles prior to the phase-in of ORVR control systems. Therefore, only those costs of onboard control which are incremental to enhanced evaporative emission control

[1] *Draft Regulatory Impact Analysis* (EPA-450/3-87-001a and -001b, July 1987).

[2] "Onboard and Evaporative Control System Cost Estimates for the Supplemental Notice of Proposed Rulemaking," EPA memorandum from Jean Schwendeman to the Public Docket, December 22, 1988 (docket A-87-11, item IV-B-19).

are included in this analysis. The costs of enhanced evaporative emission control were estimated in the Regulatory Impact Analysis (RIA) which accompanied that rulemaking[3].

5.2 Vehicle Manufacturing Costs

This section discusses the estimated costs of onboard control systems to vehicle manufacturers, including both hardware and developmental costs. The estimates are based on the onboard control system configurations which EPA considers most likely to be implemented in compliance with ORVR requirements as discussed in Chapter 2. However, the future cost of onboard control is not known with certainty. New technological developments could change even the general appearance of such systems. Economies of scale will play a significant role in the manufacturing of onboard systems for different vehicle types, potentially causing costs to be higher for some models and lower for others. Future changes in other parameters (e.g. RVP control) could also influence the onboard costs realized by vehicle manufacturers. However, it is generally presumed that, overall, the trend would be for onboard control system costs to decrease, not increase.

5.2.1 Hardware Costs

As discussed in Chapter 2, the ORVR system hardware components affected by the ORVR system include: the fillneck seal, anti-spitback valve, external vent line, vent/purge vapor lines, canister, and purge valve. Estimated costs for each of these components are discussed below. All cost estimate quotes assume high volume manufacturing.

On a per-vehicle basis, ORVR hardware costs depend on whether a vehicle has single or dual fuel tanks. Hardware costs for dual-tank vehicles are nearly twice those of single-tank vehicles because each system will require the necessary control hardware. The 1988 cost memorandum estimated that zero percent of LDVs, twenty percent of LDTs and LHDGVs, and fifteen percent of HHDGVs have dual tanks, with single-tank vehicles comprising the balance. No challenges were made to these estimates in the public comments received, so they are retained in the current analysis. These ratios of single- to dual-tank designs are used in weighting the per-tank costs for each hardware component to derive a weighted average total cost for each vehicle class.

5.2.1.1 Fillneck Seal Assembly

As discussed in Chapter 2, this analysis presumes that all vehicle types other than HHDGVs will use liquid vapor seals to minimize costs. LDVs, LDTs and LHDGVs presently have small diameter fillnecks of adequate length to provide a liquid seal during

[3]"Final Regulatory Impact Analysis and Summary and Analysis of Comments—Control of Vehicle Evaporative Emissions," U.S. EPA, February 1993. (docket A-89-18, item V-B-1).

refueling. Therefore, no cost has been allocated for seal hardware for these classes of vehicles, other than with the fuel tank modifications discussed below.

HHDGVs have several different fuel tank arrangements, which may prevent the formation of a liquid seal. Some HHDGV fuel tanks have no fillneck, some have short fillnecks and some have large diameter fillnecks. The sealing mechanism for these tanks may vary depending on design and location constraints. However, EPA believes that manufacturers will use the least expensive method possible to provide an adequate seal. In some cases a submerged fill liquid seal approach may be possible, but to be conservative, EPA assumes that all HHDGVs will elect a mechanical seal. The 1988 cost memorandum used the 1987 analysis as the basis for the seal costs for HHDGVs, and estimated $3.30 manufacturer cost in 1988 dollars. For this analysis, mechanical seal costs for HHDGVs are estimated at $8.00 per tank, based on cost quotes provided by a potential mechanical seal manufacturer[4] for a mechanical seal design with pressure relief valves. Weighting this per-tank cost by the 0.15 to 0.85 ratio of single- to dual-tank designs yield an average cost of $9.20 per HHDGV.

5.2.1.2 Anti-Spitback Valve

To meet the enhanced evaporative emissions control requirements, most vehicles will utilize an anti-spitback check valve to prevent fuel from "spitting" back out of the fillneck at the time of automatic nozzle shut-off during vehicle refueling. This test was originally proposed in the ORVR proposal, but was implemented in the evaporative emissions rule. Therefore, the cost of the anti-spitback apparatus is not attributed to the ORVR system. Furthermore, a mechanical seal should provide adequate protection from spitback, and thus will not likely require an anti-spitback valve. Based on the manufacturer cost which was estimated for this device in the February 1993 evaporative emissions impact analysis, HHDGVs are thus credited with $0.35 per tank for the removal of the anti-spitback valve from future vehicles. Taking into account the proportion of single- and dual-tank vehicles, this amounts to a weighted average credit of $0.40 per HHDGV.

5.2.1.3 External Vent Line

The external vent line is presently used on most vehicles to allow vapors to escape from the fuel tank to the atmosphere during a refueling event. The use of an external vent line allows a fillpipe to be narrower in diameter because it only needs to handle the incoming fuel flow and not the returning vapor. With the adoption of ORVR standards, refueling vapors will be routed out of the top of the fuel tank to the ORVR canister. Thus, the external vent line will no longer be needed and can be removed from future vehicles with a corresponding cost savings. In the 1988 cost memorandum, removal of the external vent line was calculated as a net cost savings at the manufacturer cost level of $1.26 for LDVs and $1.48 for LDTs and LHDGVs. These values have been inflated

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[4]Meeting with John Hopsteader and Lawrence Engle, Walboro Corporation, on 13 July 1993 (docket A-87-11, item IV-E-103).

to $1.44 and $1.70, respectively, in 1992 dollars. HHDGVs have large diameter fillnecks with short fill heights and therefore do not usually have external vent lines; therefore, no cost savings is credited to vehicles in that weight class. Weighting the per-tank savings by the ratio of single- and dual-tank vehicles and rounding to the nearest $0.05 results in a weighted average credit of $1.45 for LDVs and $2.05 for LDTs and LHDGVs.

5.2.1.4 Vapor Vent/Rollover Valve

Vapor vent/rollover valve modifications are necessary for ORVR systems to operate properly. The ORVR system vapor vent/rollover valve will have a larger diameter venting orifice to allow for the greater vapor flow rates associated with refueling. However, with this larger venting orifice, tank backpressure will likely not be sufficient to induce automatic nozzle shutoff. The valve will need a fill-limiting float to close off the venting orifice when the tank is full and thus create enough backpressure to cause nozzle shut-off. A small secondary orifice will also be needed to allow venting of diurnal and other evaporative emissions when the tank is full. This secondary orifice only needs to be approximately the size of current evaporative orifices (0.05 inches diameter). Some designs may also incorporate a liquid/vapor separator function.

The 1988 cost memorandum assumed that the larger diameter orifice and the buoyant float would be needed to achieve improved control of evaporative emissions, and thus assigned a $3.50 estimate for these components to evaporative emissions control. Only an incremental cost of $0.50, for the secondary valve orifice, was allocated to ORVR. However, the enhanced evaporative emission regulations promulgated in 1993 did not necessitate any changes to the vapor vent/rollover valve, and thus the entire cost of $4.00 (in 1988 dollars) should be allocated to the ORVR incremental estimate.

To obtain a more up-to-date range of estimates for the vapor vent/rollover valve, the Ford System design[5] was used to represent a suitable valve system with a larger orifice to allow venting of refueling vapors. Current retail cost quotes were obtained from the parts department of a Ford dealer for the valve used in the Ford ambulance and for a more conventional vent/rollover valve from a Ford Taurus[6]. These quotes were then adjusted to estimate the manufacturer cost of the part. This was done by dividing the dealer price quote by a factor of 4 in accordance with the Lindgren[7] report, resulting in an incremental manufacturer cost of $4.72 per fuel tank for the vapor vent/rollover valve. Weighting this cost by the appropriate ratio of single- and dual-tank vehicles and rounding to the nearest nickel yields an average per-vehicle cost of $4.70 for LDVs, $5.65 for LDTs and LHDGVs and $5.45 for HHDGVs.

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[5]*Application of Onboard Refueling Emission Control System to a 1988 Ford Taurus Vehicle* EPA Technical Report No. EPA-AA-SDSB-91-06. (docket A-87-11, item IV-A-06).

[6]Part numbers are E8UZ-9B593-A and E9DZ-9B593-A for the ambulance and the Taurus valve, respectively.

[7]"Cost Estimations for Emission Control-Related Components/Systems and Cost Methodology Description," Leroy H. Lindgren, Rath and Strong for U.S. EPA, EPA-460/3-78-002, March 1978.

5.2.1.5 Vent/Purge Vapor Lines

As in the 1988 cost memorandum, vapor lines are assumed to be comprised of welded steel tubing with rubber connecting pieces. The length of the lines estimated in the evaporative emissions RIA will not be changed as a result of ORVR, but their use will be reallocated as a result of moving the canister to the rear of the vehicle. As discussed in Chapter 2, the *purge* line will get longer and the *vent* line correspondingly shorter. On the other hand, the diameter of the *vent* vapor line will need to be increased to handle the higher vapor flow rates occurring in a refueling event, while the diameter of the *purge* vapor line will not be changed, because purge rates are not expected to increase due to the ORVR requirements.

EPA assumes that LDV and LDT manufacturers will maximize the use of impermeable steel in fuel and vapor lines, leaving several short sections that require a somewhat flexible material. Steel lines are advantageous from both a cost and emissions perspective. For heavier trucks, the need for design flexibility, low production runs, and long vent line will lead to the use of elastomer hoses throughout the system. EPA understands that concerns for chemical resistance and electrostatic dissipation are prompting some changes in materials selection. Some manufacturers may choose to use teflon coated or fluoroelastomer rubber in their flexible lines to reduce permeation. However, EPA has not considered the possible positive or negative effects of such changes in estimating the cost of meeting ORVR requirements, because such changes are likely to occur because of enhanced evaporative control requirements.

No additional costs for clamps were included because very similar clamps to those used in enhanced evaporative systems will be used. The size of the clamps may be increased slightly along with the increase in the vapor vent line hose, but the number of clamps is not expected to change. This slight modification to the size of several of the clamps is not expected to increase costs.

For vent line costs, EPA used the 1988 cost memorandum manufacturer costs, appreciated to 1992 dollars. Table 5.1 shows the calculation of incremental costs associated with the increased diameter of the vapor vent lines.

Table 5.1—Calculation of Incremental Vapor Vent Line Costs

	LDV	LDT	LHDGV	HHDGV
ORVR Diameter (in)	0.500	0.500	0.625	0.625
Evap. Diameter (in)	0.375	0.375	0.500	0.500
Steel Tubing				
ORVR Cost ($/ft)	$0.16	$0.16	NA	NA
Evap. Cost ($/ft)	$0.13	$0.13	NA	NA
Incremental Cost ($/ft)	$0.03	$0.03	NA	NA
Length (ft)	2.0	2.0	0.0	0.0
Steel Tubing Cost	$0.06	$0.06	$0.00	$0.00
Flexible Tubing				
ORVR Cost ($/ft)	$0.53	$0.53	$0.67	$0.67
Evap. Cost ($/ft)	$0.43	$0.43	$0.53	$0.53
Incremental Cost ($/ft)	$0.10	$0.10	$0.14	$0.14
Length (ft)	1.0	1.0	8.0	15
Flexible Tubing Cost	$0.10	$0.10	$1.12	$2.10
Total Incremental Cost/Tank	$0.16	$0.16	$1.16	$2.10
Single/Dual Tank Weighting	1.0	1.2	1.2	1.15
Weighted Avg. Cost/Vehicle*	$0.15	$0.20	$1.35	$2.40

* Rounded to the nearest $0.05.

As Table 5.1 shows, EPA estimates that average costs due to the increased diameter of the vapor vent line, rounded to the nearest nickel, will be $0.15 for LDVs, $0.20 for LDTs, $1.35 for LHDGVs and $2.40 for HHDGVs.

5.2.1.6 Canister

No incremental changes to the canister or its carbon contents are foreseen as a result of the ORVR requirements. Manufacturers and EPA agree that, with the slightly modified test procedure discussed at the 22 July 1993 hearing, integrated evaporative/refueling systems will require the same canister working capacity as the enhanced evaporative emission requirements. Chrysler stated in its comments, "The ORVR system can be integrated with the evaporative system, using approximately the same size canister."[8] Ford stated, "Under the test procedure described above [discussed at 22 July 1993 hearing], Ford believes that in most passenger car applications, it will be able to design an integrated ORVR/EVAP system using the same canister capacity as originally required for enhanced evaporative emissions. Although these changes seem directionally correct for trucks, it is unknown at this time whether an integrated system could be designed for these applications."[9] While manufacturers state that it is unclear if canister working capacity will change for trucks, they do not state that it is untrue for the LDTs and HDGVs. As has been discussed in previous notices and is further discussed in the final rule, EPA believes that the technology required for trucks is fundamentally the same as that required for LDVs. Thus, EPA does not expect any

[8] Comments from Chrysler Corporation, dated 20 August 1993, p. 9 (docket A-87-11, item IV-D-860).

[9] Comments from Ford Motor Company, dated 20 August 1993, pp. 3-4 (item IV-D-836 in docket A-87-11).

changes to canister volume or working capacity as a result of the ORVR requirement, and no additional cost for the canister is included in this cost analysis.

5.2.1.7 Purge Valve

The purge valve controls the vapor flow from the canister to the engine, and is a necessary component of an ORVR system. However, EPA does not expect the purge valve to require any modifications due to the ORVR requirements. Although purge valves are expected to be upgraded from that discussed in the 1988 cost memorandum, these upgrades are expected and accounted for in the enhanced evaporative emissions control cost analysis. Some costs may be entailed for reprogramming the electronics that control the purge valve as a result of the ORVR requirements. However, these costs are considered to be part of systems engineering costs and are estimated in section 5.2.2.6. Thus, no incremental hardware cost is attributed to the purge valve.

5.2.1.8 Total Incremental Hardware Cost

Table 5.2 summarizes and totals the manufacturer costs for the ORVR hardware components discussed above. As shown in the table, ORVR hardware costs are expected to be less than five dollars for all vehicle classes except the heaviest trucks, which are less than twenty dollars.

Table 5.2—Per-Vehicle Incremental ORVR Hardware Cost

Component	LDV	LDT	LHDGV	HHDGV
Fillneck Seal(s)	$0.00	$0.00	$0.00	$9.20
Anti-Spitback Valve	$0.00	$0.00	$0.00	-$0.40
External Vent Line	-$1.45	-$2.05	-$2.05	$0.00
Vent/Rollover Valve(s)	$4.70	$5.65	$5.65	$5.45
Vapor Lines	$0.15	$0.20	$1.35	$2.40
Canister	$0.00	$0.00	$0.00	$0.00
Purge Valve	$0.00	$0.00	$0.00	$0.00
Total Cost	$3.40	$3.80	$4.95	$16.65

5.2.2 Onboard Development/Capital Costs

Manufacturers' developmental costs will be incurred in five key areas: fuel tank modifications, facility modifications, systems engineering, safety compliance, and emission certification compliance. The development costs used in this analysis are all assumed to be recovered by the manufacturer within the first five years of production. Vehicle packaging and assembly costs are also discussed below.

Because manufacturers will incur many capital outlays for equipping all new domestic vehicles with enhanced evaporative controls, capital outlays are generally not expected to be substantially greater for onboard controls than those for enhanced evaporative systems.

Some of the costs used in this analysis are taken directly from previous analyses, with appropriate adjustments for inflation. In these previous analyses, a Retail Price Equivalent (RPE) adjustment of 26 percent for manufacturer overhead and profit was included directly in the individual cost figures. In the current analysis, overhead and profit are added at a later point and thus the RPE markups of 26% are subtracted out of the previous estimates. (See section 5.3.1 for a more detailed discussion of RPE).

5.2.2.1 Fuel Tank/Fillneck Modification Costs

While the 1988 cost memorandum did not include any costs for modifying the fuel tank, the current analysis takes a more conservative approach and does include tooling costs for modifications to the fuel tank and fillneck and removal of the external vent line. The 1987 analysis estimated RPE costs for fuel tank modification of $0.50, equivalent to a $0.40 manufacturer cost. For this analysis, these costs are estimated at $0.50 per tank at the manufacturer level. This is not a hardware cost item because the cost per tank is not affected by the tooling change. After weighting for the proportion of dual tanks in each class and rounding to the nearest $0.05, these costs amount to $0.50 for LDVs, and $0.60 for LDTs, LHDGVs and HHDGVs.

5.2.2.2 Vehicle Packaging Costs

Packaging costs arise when hardware or vehicle modifications must be made in order to accommodate new or enlarged components. Given the high likelihood of integrated evaporative and refueling vapor recovery systems, no change is foreseen in vehicle packaging due to the ORVR requirement. Thus, no packaging cost was allocated.

5.2.2.3 Certification Compliance Costs

The costs of certification (or recertification) compliance were estimated to be zero in the 1988 analysis because these costs were attributed to the evaporative emissions requirement to be phased in at the same time. The February 1993 evaporative emissions rule estimated certification costs to be $0.15 RPE per vehicle ($0.12 manufacturer cost). This value was tripled from the 1988 value of $0.05 due to increased testing burden. With an ORVR requirement, more testing will be added to the certification process. Although the refueling test procedure can be performed independently of an evaporative emissions test, modifications to the evaporative system in developing an integrated vapor recovery system may force recertification. Thus the entire evaporative testing burden is included in ORVR certification costs. An additional $0.05 is added for the additional testing requirements, for a total ORVR manufacturer certification cost (rounded to the nearest $.05) of $0.15 per vehicle.

5.2.2.4 FMVSS 301 Testing Costs

To address the responsibilities regarding the safety of vapor recovery systems and the questions brought up by the inclusion of ORVR on LDTs and HDVs, it is expected that manufacturers will perform additional crash testing to verify fuel system crash durability. This testing will be performed in accordance with Federal Motor Vehicle Safety Standard (FMVSS) 301. A 1987 EPA technical report[10] estimated that, for LDVs, LDTs and LHDGVs, the amortized additional crash testing costs would be $0.12 per vehicle in 1986 dollars and that, for HHDGVs, the cost would be $0.70 per vehicle in 1987 dollars. Inflated to 1992 dollars and rounded to the nearest $0.05, these values are $0.15 per vehicle for LDVs, LDTs and LHDGVs and $0.80 for HHDGVs.

5.2.2.5 Facility Modification Costs

The 1988 cost memorandum contained an estimated RPE cost of $0.45 for facility modifications ($0.36 manufacturer cost). When adjusted for inflation and rounded to the nearest nickel, this yields an allocated manufacturer cost of $0.40 per vehicle in the current analysis. This estimate is conservative, since enhanced evaporative systems, which are very similar in general design concept, will already be in place when onboard controls are phased-in. Any facility modifications made for enhanced evaporative controls are likely to be useful for development of ORVR systems.

5.2.2.6 Systems Engineering Costs

Systems engineering costs are those incurred in developing an ORVR system that is integrated with other related vehicle/engine systems. In some cases, this is a straightforward engineering design problem, in others it involves not only design, but also follow-up testing and evaluation.

Costs for systems engineering, similar to costs for facility modifications, were assumed to be the same as those used in the 1988 cost memorandum, accounting for inflation. These values were converted to manufacturer cost levels. Accounting for the weighting of single- and dual-tank vehicles and rounding to the nearest $0.05, this results in a per-vehicle average cost of $0.45 for LDVs, $0.80 for LDTs, $0.75 for LHDGVs and $1.60 for HHDGVs.

5.2.2.7 Assembly Costs

No incremental cost was estimated for vehicle assembly. The 1988 analysis assembly cost included the additional cost to install the ORVR and evaporative canister in separate systems, due to the need for a canister in the engine compartment for carbureted vehicles. With the change in the test procedure discussed at the 22 July 1993 hearing, most manufacturers intend to use integrated vapor control systems. EPA expects

[10] *Safety Implications of Onboard Refueling Vapor Recovery Systems.* EPA Technical Report EPA-AA-SDSB-87-05, July 1987, p. 66, 91.

that the time and amount of labor needed to install an integrated ORVR/evaporative system onto a vehicle is no more than that needed for an enhanced evaporative system due to their similar canister size and location. Therefore, no increase in vehicle assembly cost was allocated, incremental to that for enhanced evaporative systems.

5.2.2.8 Total Development/Capital Costs

Table 5.3 summarizes the average per-vehicle developmental cost components for each vehicle class. As the table shows, the incremental development costs are relatively modest, ranging from $1.70 for LDVs to $3.60 for HHDGVs

Table 5.3—Development and Production ORVR Costs, Per Vehicle

Item	LDV	LDT	LHDGV	HHDGV
Tank/Fillneck Mods	$0.50	$0.60	$0.60	$0.60
Certification	$0.15	$0.15	$0.15	$0.15
FMVSS 301 Testing	$0.15	$0.15	$0.15	$0.80
Facility Modification	$0.40	$0.40	$0.40	$0.40
Systems Engineering	$0.45	$0.80	$0.75	$1.60
Total Cost	$1.65	$2.10	$2.05	$3.60

5.3 Costs to Consumers

Implementation of the new ORVR standard is expected to impact the consumer in two ways. First, the purchase price of a new vehicle is expected to rise. Second, the net costs to operate an ORVR-equipped vehicle are expected to be different from the operating costs of vehicles without onboard control systems. These two consumer cost components are discussed below.

5.3.1 Vehicle Price Increase

It is anticipated that vehicle manufacturers will pass along their incremental costs for ORVR, including a markup for overhead and profit, to vehicle purchasers. Thus, consumers will experience purchase price increases based on the manufacturing costs discussed above in section 5.2. It is assumed that the basis for price increases include development costs during the first five years of ORVR vehicle sales and that, after five years, development costs no longer affect the purchase price.

To account for manufacturer overhead and profit markup, the total incremental manufacturer costs for each vehicle class are multiplied by the appropriate Retail Price Equivalent factor (RPE). This calculation yields an estimate of the impact on consumer costs. The RPE markups used in this analysis are the same as those used in all previous EPA analyses of ORVR costs (1.26 for LDVs and LDTs, 1.27 for HDGVs). These factors were developed by EPA as a supplement to a contractor report[11] on hardware costs and was supported in a later contractor study[12].

Table 5.4—Increase In Vehicle Cost

Item	LDV	LDT	LHDGV	HHDGV
Manufacturer Hardware Cost	$3.40	$3.80	$4.95	$16.65
Manufacturer Development Cost	$1.65	$2.10	$2.05	$3.60
Total Cost (before overhead)	$5.05	$5.90	$7.00	$20.25
RPE Markup	26%	26%	27%	27%
Hardware Cost RPE	$4.28	$4.79	$6.29	$21.15
Development Cost RPE	$2.08	$2.65	$2.60	$4.57
Total RPE	$6.36	$7.44	$8.89	$25.72

5.3.2 Operating Cost Changes

Onboard control systems will result in changes in consumer costs for vehicle operation. For integrated systems using liquid seals, no increases in operating costs related to ORVR systems maintenance or in-use inspections is expected. However, changes in fuel consumption are anticipated. This operating cost change has two components: a weight penalty and a recovery credit. The weight penalty accounts for reduced vehicle fuel economy due to the slight increase in vehicle weight caused by hardware additions. The fuel recovery credit accounts for the fact that fuel vapors, rather than being lost to the atmosphere, are captured by the vapor recovery system and later burned productively in the engine. As a result of these two effects, a net weight penalty/fuel recovery credit is incurred. These are described below.

5.3.2.1 Onboard Weight Penalty

In previous analyses, a perceived need for enlarged canister working capacity dominated the estimated vehicle weight increases. With the changes in the ORVR test procedure, no changes to the enhanced evaporative canister are foreseen. Therefore the weight penalty for ORVR systems is very small.

To calculate the weight penalty, each ORVR system component was weighed. Then, the weight of the associated evaporative system component it replaced was subtracted to obtain a net incremental weight change. No incremental weight increase was calculated for the canister shell, carbon, purge valve, OBD hardware and anti-spitback apparatus because no incremental changes are expected to this hardware. For each vehicle class, the incremental weights were summed, and the total was multiplied

[11]"Cost Estimations for Emission Control-Related Components/Systems and Cost Methodology Description," Leroy H. Lindgren, Rath and Strong for U.S. EPA, EPA-460/3-78-002, March 1978.

[12]"Update of EPA's Motor Vehicle Emission Control Equipment Retail Price Equivalent (RPE) Calculation Formula," Jack Faucett Associates for U.S. EPA, 4 September 1985.

by a weight multiplication factor of 1.1 as done in the 1988 EPA cost analysis[13]. The result was then calculated as a percent of the total vehicle weight.[14] This percentage was multiplied by a sensitivity factor (the ratio between percent change in fuel economy for each percent change in vehicle weight) to obtain the projected decrease in fuel economy due to the incremental weight of ORVR hardware. Finally, the change in fuel economy was multiplied by a presumed cost per gallon of gasoline of $0.82 (excluding taxes), yielding the ORVR weight penalty in dollars per gallon. The weight penalty calculation and results are presented in Table 5.5. As can be seen in the table, these values are quite small, even when considering the large number of miles typically driven by a vehicle (see Tables 5.7.1 and 5.7.2).

Table 5.5—Calculation of Weight Penalty

Item	LDV	LDT	LHDGV	HHDGV
Incremental Vent Line Weight (g)	57	69	669	1201
Incremental Rollover/Vent Valve Weight (g)	29	34	34	33
Incremental Fillneck Seal Weight (g)	0	0	0	46
Removal of External Vent Line (g)	-60	-72	-72	0
Incremental Weight (g/tank)	26	31	631	1281
Incremental Weight (g)	26	37	757	1473
X weight multiplication factor of 1.1 (kg)	28.6	41.2	833	1620
Avg. Vehicle Weight (kg)	1,463	1,866	4,186	10,181
Change in Weight	0.002%	0.002%	0.020%	0.016%
Sensitivity Factor	-0.329	-0.402	-0.402	-0.402
Percent Change in FE	-0.000 643%	-0.000 887%	-0.008 003%	-0.006 398%
Fuel Price (no taxes) ($/gal)	$0.82	$0.82	$0.82	$0.82
Weight Penalty ($/gal)	-$0.000 005	-$0.000 007	-$0.000 066	-$0.000 052

5.3.2.2 Fuel Recovery Credit

A cost savings is credited to ORVR to account for the retention and combustion of fuel vapors that otherwise would be lost to the atmosphere. Consistent with the methods used in previous ORVR regulatory analysis documents, the fuel recovery credit was calculated using the uncontrolled emission rate, ORVR in-use capture efficiency, specific heat content of the fuel, and Stage II control effectiveness as shown in equation 5-1, below, and tabulated in Table 5.6. The table presents data for four scenarios: 1) all-areas, reflecting the average rate nationwide, including both Stage II and non-Stage II areas, 2) nonattainment areas, 3) all areas, with no Stage II control (after Stage II discontinuation), and 4) nonattainment areas after Stage II discontinuation.

[13] This factor accounts for modifications to the vehicle to enable it to carry the increased emission control equipment i.e., brackets, modifications to the frame or suspension.

[14] *Weights for LDVs and LDTs from "Light-Duty Automotive Technology and Fuel Economy Trends Through 1993* EPA Technical Report No. EPA/AA/TDG/93-01, May 1993.

Equation 5-1:

$$\text{Recovery Credit} = (EF_u)(1 - (Areas_{s2})(\eta_{s2})[1 - (Waivers_{s2})]\}(\eta_{ORVR})(E_v/E_g)(Cost_{gas})/\rho$$

Table 5.6—Calculation of Fuel Recovery Credit

Item	Variable	All Areas	NAA Areas	All Areas (S2 disc.)	NAA (S2 disc.)
5-month ozone season emission rate (g/gal)	EF_u	3.90	3.30	3.90	3.30
Percent of areas with Stage II	$Areas_{s2}$	45.00%	80.51%	0.00%	0.00%
Stage II Efficiency	η_{s2}	86.00%	86.00%	NA	NA
Average Stage II Waivers	$Waivers_{s2}$	5.70%	5.70%	NA	NA
5 month ozone season efficiency*	η_{ORVR}	92.0%	97.1%	92.0%	97.1%
Equivalency Factor (Relative Energy Value)	E_v/E_g	0.90	0.90	0.90	0.90
Gas cost—no taxes ($/gal)	$Cost_{gas}$	$0.82	$0.82	$0.82	$0.82
Fuel density (kg/gal)	ρ	2.79	2.79	2.79	2.79
Gasoline Recovery Credits ($/gal)		$0.000 603	$0.000 294	$0.000 949	$0.000 844

* Adjusted for air entrainment losses

Vapor recovery is calculated as the emission rate of the vapors multiplied by ORVR's efficiency. Since the amount of vapors available to be recovered by ORVR is reduced by the presence of Stage II, the emission rate is reduced in the equation by the fraction of areas which have Stage II, multiplied by the Stage II efficiency. An additional factor accounts for waivers from Stage II requirements.

After adjustment for Stage II effects, the emission rate is multiplied by the ORVR efficiency to determine actual vapors captured and then consumed in the engine. However, the hydrocarbon vapors emitted from the tank have a bias toward lighter components, which have lower energy values than whole gasoline. This reduced energy content means that the amount of vapors captured must be reduced in order to estimate an equivalent amount of gasoline. An equivalency factor of 0.9 was used in the 1987 regulatory analysis[15]. Although fuel volatility has decreased in recent years, which would tend to increase the energy content of the vapors, the previous value is retained in the current analysis as a conservative estimate. Finally, the gasoline-equivalent grams of vapor are converted to gallons and then to dollars, using the fuel density (ρ=2.79 kg/gallon) and fuel cost ($0.82 per gallon without taxes).

As the table shows, ORVR fuel recovery credits are lower in the presence of Stage II vapor recovery. Furthermore, because reduced-volatility gasoline is used in nonattainment areas, these areas also have lower uncontrolled emission rates.

As noted in the table, five-month summertime uncontrolled emission rates and efficiencies are utilized to calculate the fuel recovery credit. As explained in Chapter 4, summer emission rates are greater, and efficiencies are lower than wintertime values. Thus, when these factors are multiplied together, very similar recovery rates are obtained

[15]Evaluation of Air Pollution Regulatory Strategies for Gasoline Marketing Industry—Response to Public Comments. EPA-450/3-84-012c, July 1987, p. 2-129.

for winter and summer. In fact, the seven-month non-summer emission rates and efficiencies would yield slightly higher recovery rates, and thus the summertime values are conservative.

5.3.2.3 Total Operating Cost Changes

Tables 5.7.1-2 contain total incremental operating costs for ORVR, on both a fuel consumption and average vehicle life basis. The operating total cost per gallon of fuel consumed is merely the sum of the fuel recovery credit and the weight penalty. To determine an average lifetime incremental operating cost, this value was multiplied by the projected lifetime fuel consumption. Lifetime fuel consumption, in turn, was calculated using fuel economy numbers from the MOBILE4.1 Fuel Consumption model and values from mileage accumulation rates from MOBILE5a and vehicle survival rates from Oak Ridge National Laboratory's Transportation Energy Data. Because the savings will occur over the lifetime of the vehicle, they were discounted at a 7 percent rate to the first year of vehicle use based on the fuel fraction consumed in a given year[16].

In areas where Stage II will be implemented, much of the fuel recovery benefits must be credited to Stage II rather than to ORVR. Table 5.7.1 contains the operating costs incurred in all areas nationwide by vehicles equipped with ORVR systems, given that 45 percent of fuel nationwide is dispensed in Stage II areas. Table 5.7.2 contains the all-areas operating costs if Stage II controls were discontinued.

Table 5.7.1—All Areas Average Incremental Operating Costs Nationwide

Item	LDV	LDT	LHDGV	HHDGV
Weight Penalty ($/gal)	$0.000 005	$0.000 007	$0.000 066	$0.000 052
Fuel Recovery Credit ($/gal)	$0.000 603	$0.000 603	$0.000 603	$0.000 603
Operating Cost ($/gal)	-$0.000 597	-$0.000 595	-$0.000 537	-$0.000 550
Projected 2010 Fuel Economy (mpg)	22.55	17.12	11.11	5.77
Projected Avg. Life (miles)	122,390	158,399	174,665	169,121
Lifetime Fuel Consumption (gal)	5,427	9,252	15,721	29,310
Lifetime Operating Cost ($)	-$3.24	-$5.51	-$8.44	-$16.13
Lifetime Per-Vehicle Operating Cost (NPV)	-$2.35	-$3.70	-$5.50	-$11.00

[16]Memorandum from James G. Bryson to EPA Air Docket A-98-11, titled " Average Vehicle Life and Fuel Consumption." (docket A-87-11, section IV-B).

Table 5.7.2—All Areas Average Incremental Operating Costs Nationwide (Stage II discontinued)

Item	LDV	LDT	LHDGV	HHDGV
Weight Penalty ($/gal)	$0.000 005	$0.000 007	$0.000 066	$0.000 052
Fuel Recovery Credit ($/gal)	$0.000 949	$0.000 949	$0.000 949	$0.000 949
Operating Cost ($/gal)	-$0.000 944	-$0.000 942	-$0.000 883	-$0.000 897
Projected 2010 Fuel Economy (mpg)	22.55	17.12	11.11	5.77
Projected Avg. Life (miles)	122,390	158,399	174,665	169,121
Lifetime Fuel Consumption (gal)	5,427	9,252	15,721	29,310
Lifetime Operating Cost ($)	-$5.12	-$8.71	-$13.89	-$26.28
Lifetime Per-Vehicle Operating Cost (NPV)	-$3.75	-$5.85	-$9.00	-$17.90

5.4 Aggregate Costs, by Vehicle Type

5.4.1 Per Vehicle Costs

Table 5.8.1 and 5.8.2 summarize the total costs of ORVR systems. The vehicle cost increase reflects the additional sticker price for a typical vehicle with ORVR control. This figure includes the manufacturer hardware costs and development costs and profits and overhead. Table 5.8.1 includes the full development cost amortized over the first five years of production. Table 5.8.2, a long-term cost projection, does not include the development costs. The operating cost is the combination of the weight penalty and the fuel recovery credit experienced over the life of the vehicle, discounted to the year of vehicle purchase, as developed in section 5.3.2.3. The operating cost shown is the national average. Operating cost will be higher in areas without Stage II and lower in areas with Stage II. The weighted net cost reflects the fraction of total sales which each vehicle class accounts for in the United States, based on projections for the year 2010. Note that for LDVs, LDTs and LHDGVs, total costs are approximately $5 per vehicle. These costs would be below $3 per vehicle once development costs are amortized out over the first five years of vehicle production. For HHDGVs, costs are somewhat higher, but are still below $20 per vehicle.

Table 5.8.1—Average Total Per-Vehicle Costs for ORVR (Stage II in Place)

Item	LDV	HLDT	LHDGV	HHDGV
Increase in Vehicle Price (RPE)[17]	$6.36	$7.44	$8.89	$25.72
Avg. Lifetime Operating Cost (NPV)	-$2.35	-$3.70	-$5.50	-$11.00
Total Cost	$4.01	$3.74	$3.39	$14.72
Sales-Weighted Net Cost (RPE)[18]				$3.94

[17] Development costs included in this figure are only attributed to the first five years of ORVR vehicle production. Vehicle price increase would later be reduced.

[18] Sales weightings: LDVs 62.1%; LDTs 34.5%; LHDGVs 2.9%; and HHDGVs 0.4%.

Table 5.8.2—Long-term Average Total Per-Vehicle Costs for ORVR (Stage II discontinued)

Item	LDV	HLDT	LHDGV	HHDGV
Increase in Vehicle Price (RPE)[19]	$4.28	$4.79	$6.29	$21.15
Avg. Lifetime Operating Cost (NPV)	-$3.75	-$5.85	-$9.00	-$17.90
Total Cost	$0.53	-$1.06	-$2.71	$3.25
Sales-Weighted Net Cost (RPE)[20]				-$0.10

5.4.2 Total Nationwide Costs

Tables 5.9.1-4 display nationwide costs due to implementation of ORVR systems in LDVs, LDTs, LHDGVs, and HHDGVs, respectively. These costs are presented year by year on a cash-flow basis. Thus, hardware and development costs are incurred in the year of vehicle purchase, while operating costs occur over the life of the vehicle.[21] Hardware and development costs are based on numbers of new vehicle sales, and operating costs are based on ORVR fuel consumption. Note that ORVR vehicle purchases are lower in the first two years due to the incremental phase-in (40/80/100) of the ORVR requirement.

[19] Does not include development costs, which are considered short-term.

[20] Sales weightings: LDVs 62.1%; LDTs 34.5%; LHDGVs 2.9%; and HHDGVs 0.4%.

[21] The MOBILE4.1 Fuel Consumption Model, on which this analysis is based, projects fuel consumption for 25 years of vehicle life. This analysis only includes 23 years, thus the full benefits and operating cost credits of even the first ORVR-equipped vehicles are not included in this analysis. Allowing all operating costs and benefits to be accrued to the vehicles would make this program even more cost effective.

Table 5.9.1—Nationwide Cost Figures for LDVs

Year	Projected ORVR Fuel Consumption	New ORVR Gasoline Vehicles	Nationwide Costs			
			Hardware (RPE)	Development (RPE)	Operating	
					S2 In Place	S2 Disc.
1998	2.30E+09	4,240,000	$18,147,200	$8,819,200	-$1,375,901	-$2,175,629
1999	8.26E+09	8,640,000	$36,979,200	$17,971,200	-$4,933,109	-$7,800,427
2000	1.63E+10	11,000,000	$47,080,000	$22,880,000	-$9,754,599	-$15,424,358
2001	2.45E+10	11,100,000	$47,508,000	$23,088,000	-$14,630,075	-$23,133,653
2002	3.23E+10	11,300,000	$48,364,000	$23,504,000	-$19,289,608	-$30,501,491
2003	3.99E+10	11,500,000	$49,220,000	$0	-$23,823,662	-$37,670,917
2004	4.72E+10	11,700,000	$50,076,000	$0	-$28,156,365	-$44,521,957
2005	5.35E+10	11,800,000	$50,504,000	$0	-$31,928,785	-$50,487,057
2006	5.88E+10	12,000,000	$51,360,000	$0	-$35,112,471	-$55,521,228
2007	6.36E+10	12,200,000	$52,216,000	$0	-$37,954,006	-$60,014,375
2008	6.82E+10	12,400,000	$53,072,000	$0	-$40,703,620	-$64,362,173
2009	7.28E+10	12,600,000	$53,928,000	$0	-$43,482,415	-$68,756,114
2010	7.73E+10	12,800,000	$54,784,000	$0	-$46,164,182	-$72,996,629
2011	8.12E+10	13,000,000	$55,640,000	$0	-$48,467,321	-$76,638,444
2012	8.46E+10	13,200,000	$56,496,000	$0	-$50,490,319	-$79,837,288
2013	8.74E+10	13,400,000	$57,352,000	$0	-$52,175,542	-$82,502,030
2014	8.98E+10	13,600,000	$58,208,000	$0	-$53,630,233	-$84,802,244
2015	9.21E+10	13,800,000	$59,064,000	$0	-$54,995,191	-$86,960,570
2016	9.41E+10	14,000,000	$59,920,000	$0	-$56,154,421	-$88,793,590
2017	9.59E+10	14,100,000	$60,348,000	$0	-$57,250,910	-$90,527,402
2018	9.76E+10	14,300,000	$61,204,000	$0	-$58,264,962	-$92,130,862
2019	9.92E+10	14,500,000	$62,060,000	$0	-$59,230,865	-$93,658,186
2020	1.01E+11	14,700,000	$62,916,000	$0	-$60,168,317	-$95,140,521

Table 5.9.2—Nationwide Cost Figures for LDTs

Year	Projected ORVR Fuel Consumption	New ORVR Gasoline Vehicles	Nationwide Costs: Hardware (RPE)	Development (RPE)	Operating: S2 In Place	S2 Disc.
1998	1.36E+09	2,112,000	$10,116,480	$5,596,800	-$807,797	-$1,278,899
1999	5.18E+09	4,344,000	$20,807,760	$11,511,600	-$3,084,316	-$4,883,068
2000	1.08E+10	5,590,000	$26,776,100	$14,813,500	-$6,415,842	-$10,157,518
2001	1.67E+10	5,740,000	$27,494,600	$15,211,000	-$9,918,235	-$15,702,482
2002	2.24E+10	5,890,000	$28,213,100	$15,608,500	-$13,324,651	-$21,095,498
2003	2.76E+10	6,040,000	$28,931,600	$0	-$16,443,867	-$26,033,820
2004	3.23E+10	6,200,000	$29,698,000	$0	-$19,215,535	-$30,421,905
2005	3.60E+10	6,350,000	$30,416,500	$0	-$21,411,346	-$33,898,300
2006	3.89E+10	6,500,000	$31,135,000	$0	-$23,169,450	-$36,681,717
2007	4.15E+10	6,650,000	$31,853,500	$0	-$24,673,072	-$39,062,242
2008	4.39E+10	6,800,000	$32,572,000	$0	-$26,094,533	-$41,312,689
2009	4.66E+10	6,950,000	$33,290,500	$0	-$27,710,127	-$43,870,487
2010	4.96E+10	7,110,000	$34,056,900	$0	-$29,490,770	-$46,689,589
2011	5.24E+10	7,250,000	$34,727,500	$0	-$31,174,711	-$49,355,593
2012	5.50E+10	7,400,000	$35,446,000	$0	-$32,725,594	-$51,810,940
2013	5.72E+10	7,550,000	$36,164,500	$0	-$34,048,898	-$53,905,986
2014	5.92E+10	7,700,000	$36,883,000	$0	-$35,249,323	-$55,806,492
2015	6.12E+10	7,850,000	$37,601,500	$0	-$36,430,117	-$57,675,917
2016	6.31E+10	7,990,000	$38,272,100	$0	-$37,518,571	-$59,399,150
2017	6.48E+10	8,130,000	$38,942,700	$0	-$38,545,222	-$61,024,537
2018	6.64E+10	8,270,000	$39,613,300	$0	-$39,497,710	-$62,532,509
2019	6.79E+10	8,420,000	$40,331,800	$0	-$40,411,662	-$63,979,472
2020	6.94E+10	8,560,000	$41,002,400	$0	-$41,311,800	-$65,404,563

Table 5.9.3—Nationwide Cost Figures for LHDGVs

Year	Projected ORVR Fuel Consumption	New ORVR Gasoline Vehicles	Nationwide Costs			
			Hardware (RPE)	Development (RPE)	Operating	
					S2 In Place	S2 Disc.
1998	1.61E+08	179,200	$1,127,168	$465,920	-$86,620	-$142,431
1999	6.03E+08	368,800	$2,319,752	$958,880	-$323,842	-$532,499
2000	1.25E+09	474,000	$2,981,460	$1,232,400	-$672,783	-$1,106,271
2001	1.94E+09	487,000	$3,063,230	$1,266,200	-$1,039,935	-$1,709,986
2002	2.60E+09	500,000	$3,145,000	$1,300,000	-$1,394,783	-$2,293,470
2003	3.27E+09	513,000	$3,226,770	$0	-$1,753,568	-$2,883,427
2004	3.95E+09	519,000	$3,264,510	$0	-$2,122,688	-$3,490,379
2005	4.59E+09	533,000	$3,352,570	$0	-$2,465,724	-$4,054,440
2006	5.15E+09	548,000	$3,446,920	$0	-$2,766,926	-$4,549,713
2007	5.64E+09	563,000	$3,541,270	$0	-$3,026,787	-$4,977,007
2008	6.07E+09	577,000	$3,629,330	$0	-$3,258,595	-$5,358,173
2009	6.56E+09	592,000	$3,723,680	$0	-$3,523,869	-$5,794,370
2010	7.11E+09	605,000	$3,805,450	$0	-$3,819,658	-$6,280,741
2011	7.67E+09	620,000	$3,899,800	$0	-$4,121,352	-$6,776,823
2012	8.16E+09	636,000	$4,000,440	$0	-$4,382,689	-$7,206,545
2013	8.59E+09	652,000	$4,101,080	$0	-$4,614,005	-$7,586,902
2014	8.98E+09	667,000	$4,195,430	$0	-$4,822,189	-$7,929,223
2015	9.36E+09	683,000	$4,296,070	$0	-$5,024,467	-$8,261,832
2016	9.68E+09	697,000	$4,384,130	$0	-$5,200,660	-$8,551,551
2017	9.98E+09	711,000	$4,472,190	$0	-$5,359,136	-$8,812,136
2018	1.02E+10	725,000	$4,560,250	$0	-$5,503,339	-$9,049,252
2019	1.05E+10	739,000	$4,648,310	$0	-$5,639,667	-$9,273,419
2020	1.07E+10	752,000	$4,730,080	$0	-$5,769,598	-$9,487,066

Table 5.9.4—Nationwide Cost Figures for HHDGVs

Year	Projected ORVR Fuel Consumption	New ORVR Gasoline Vehicles	Nationwide Costs			
			Hardware (RPE)	Development (RPE)	Operating	
					S2 In Place	S2 Disc.
1998	5.38E+07	31,320	$662,418	$143,132	-$29,572	-$48,230
1999	2.01E+08	62,880	$1,329,912	$287,362	-$110,560	-$180,314
2000	4.18E+08	78,600	$1,662,390	$359,202	-$229,690	-$374,604
2001	6.46E+08	79,000	$1,670,850	$361,030	-$355,037	-$579,033
2002	8.66E+08	79,900	$1,689,885	$365,143	-$476,183	-$776,611
2003	1.09E+09	81,100	$1,715,265	$0	-$598,673	-$976,381
2004	1.32E+09	82,400	$1,742,760	$0	-$724,692	-$1,181,906
2005	1.53E+09	83,800	$1,772,370	$0	-$841,805	-$1,372,908
2006	1.72E+09	85,100	$1,799,865	$0	-$944,637	-$1,540,616
2007	1.88E+09	86,500	$1,829,475	$0	-$1,033,354	-$1,685,306
2008	2.02E+09	88,200	$1,865,430	$0	-$1,112,494	-$1,814,376
2009	2.19E+09	89,700	$1,897,155	$0	-$1,203,059	-$1,962,080
2010	2.37E+09	91,900	$1,943,685	$0	-$1,304,042	-$2,126,774
2011	2.56E+09	93,700	$1,981,755	$0	-$1,407,041	-$2,294,757
2012	2.72E+09	95,800	$2,026,170	$0	-$1,496,263	-$2,440,268
2013	2.86E+09	97,900	$2,070,585	$0	-$1,575,234	-$2,569,064
2014	2.99E+09	100,000	$2,115,000	$0	-$1,646,309	-$2,684,980
2015	3.12E+09	102,200	$2,161,530	$0	-$1,715,367	-$2,797,608
2016	3.23E+09	104,200	$2,203,830	$0	-$1,775,520	-$2,895,712
2017	3.33E+09	106,100	$2,244,015	$0	-$1,829,624	-$2,983,951
2018	3.42E+09	108,100	$2,286,315	$0	-$1,878,856	-$3,064,243
2019	3.50E+09	110,100	$2,328,615	$0	-$1,925,398	-$3,140,150
2020	3.58E+09	112,200	$2,373,030	$0	-$1,969,757	-$3,212,495

In order to determine the total cost in any given year, the hardware, development and operating costs for each vehicle type must be added. As discussed in section 5.3.2, operating costs vary due to the presence of Stage II controls. Accordingly, operating costs are listed for Stage II areas or non-Stage II areas. These operating costs are listed as if the entire nation were either one type or the other. To determine actual operating costs nationwide, these two categories must be weighted (45.0 percent Stage II/ 55.0 percent non-Stage II). In order to determine the total costs of implementing ORVR across all vehicle types, hardware, development and operating costs must be added from each vehicle category. This is done in Table 5.10, which contains total nationwide costs. The first two cost columns contain costs for implementing ORVR just on trucks, while the other cost columns contain ORVR costs for all vehicle classes.

Finally, it should be noted that the costs in Tables 5.9.1-4 and 5.10 are conservative. Vehicle hardware and development costs are incurred for all new vehicles in the analysis (1998-2020), but recovery credits are only included for fuel consumed in those years. If all recovery credits were claimed, costs would be less.

Table 5.10—Total Nationwide Costs

Year	LDTs, LHDGVs & HHDGVs		All Vehicle Classes	
	No Stage II	With Stage II	No Stage II	With Stage II
1998	$16,642,358	$17,187,929	$41,433,129	$42,778,428
1999	$31,619,384	$33,696,548	$78,769,357	$83,713,839
2000	$36,186,659	$40,506,736	$90,722,301	$100,712,137
2001	$31,075,408	$37,753,703	$78,537,756	$93,719,629
2002	$26,156,049	$35,126,011	$67,522,557	$87,704,402
2003	$3,980,006	$15,077,527	$15,529,089	$40,473,864
2004	-$388,921	$12,642,355	$5,165,122	$34,561,991
2005	-$3,784,208	$10,822,564	-$3,767,265	$29,397,779
2006	-$6,390,262	$9,500,772	-$10,551,490	$25,748,301
2007	-$8,500,310	$8,491,032	-$16,298,685	$22,753,026
2008	-$10,418,478	$7,601,139	-$21,708,651	$19,969,519
2009	-$12,715,601	$6,474,280	-$27,543,715	$16,919,865
2010	-$15,291,069	$5,191,565	-$33,503,698	$13,811,383
2011	-$17,818,117	$3,905,951	-$38,816,561	$11,078,630
2012	-$19,985,143	$2,868,064	-$43,326,431	$8,873,746
2013	-$21,725,786	$2,098,028	-$46,875,816	$7,274,486
2014	-$23,227,264	$1,475,609	-$49,821,509	$6,053,376
2015	-$24,676,257	$889,149	-$52,572,827	$4,957,958
2016	-$25,986,352	$365,309	-$54,859,942	$4,130,888
2017	-$27,161,718	-$75,077	-$57,341,120	$3,022,013
2018	-$28,186,138	-$420,039	-$59,113,000	$2,518,998
2019	-$29,084,316	-$668,003	-$60,682,502	$2,161,132
2020	-$29,998,615	-$945,644	-$62,223,135	$1,802,039

Chapter 6: Stage II Retention Analysis

6.1 Introduction

As discussed in Chapter 3, Stage II vapor recovery systems have been implemented in all serious, severe, and extreme ozone non-attainment areas, and are expected to be in place in nearly all of the moderate non-attainment areas by 1998. Stage II has also been installed in a few areas classified as marginal for ozone non-attainment. A list of current and expected Stage II areas used in this analysis is provided in Chapter 3 and Appendix A.

As previously mentioned, Clean Air Act section 202(a)(6) authorizes the EPA Administrator to waive Stage II requirements once onboard control systems "are in widespread use throughout the motor vehicle fleet." Since trucks comprise over 40 percent of the gasoline fuel consumption, implementation of ORVR systems in LDTs and HDVs is probably a necessary condition for meeting the "widespread use" criterion. Thus, if ORVR regulations were limited to LDVs, permanent retention of Stage II control systems would be likely.

This chapter evaluates the course which is *not* being followed in the final ORVR rule. That is, it examines the costs and benefits which would apply if Stage II had to be retained for the sole purpose of controlling the refueling emissions from LDTs and HDVs. The analysis is based on a hypothetical scenario which assumes that 1) ORVR requirements pertain only to LDVs, 2) ORVR systems have been installed on essentially all LDVs, and 3) Stage II controls have been retained in order to control the refueling emissions from LDTs and HDVs, which do not have onboard controls. Under this scenario, the control of refueling emissions in LDVs is logically credited to ORVR; thus, the benefits and fuel recovery credits ascribed to Stage II are limited only to its effectiveness in controlling the refueling emissions of LDTs and HDVs. (In contrast, Chapter 7 presents the opposite analysis. That is, Chapter 7 examines the cost effectiveness of ORVR under a scenario which credits to ORVR only those benefits and fuel recovery credits that are incremental to the benefits of Stage II.)

The analysis in this chapter makes use of emission factors and in-use efficiency factors developed previously in Chapter 4. Another key source of data is the Stage II technical guidance document.[1]

The discussions in this chapter are not meant to imply that EPA has decided to remove the federal Stage II requirements at such time that vehicles with ORVR systems are in widespread use. This decision will be made in the future when actual in-use data will be available for the necessary supporting analysis.

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[1]*Technical Guidance—Stage II Vapor Recovery Systems for Control of Vehicle Refueling Emissions at Gasoline Dispensing Facilities.* (EPA-450/3-91-022a), November 1991.

6.2 Stage II Installations

6.2.1 Model Plant Definitions

The costs and benefits of Stage II controls depend in large part on the number of facilities in which they are installed and the amount of fuel which is dispensed through these facilities. The data used for this section is in Appendices A and D.

Refueling stations are divided into five categories (Model Plants 1-5), based on their annual fuel throughput. The characteristics of facilities in each of these categories is shown below in Table 6.1.

Table 6.1—Characteristics of Service Station Model Plants[a]

	Model Plant 1	Model Plant 2	Model Plant 3	Model Plant 4	Model Plant 5
Fuel Throughput Range (gal/month)	Under 10,000	10,000-24,999	25,000-49,999	50,000-99,999	100,000 +
Average Throughput (gal/year)	47,000	240,000	420,000	780,000	2,220,000
Nationwide:[b]					
% Consumption	8.8	17.8	27.5	27.2	18.8
% Retail Distribution	26.0	30.0	26.5	14.0	3.5
Metropolitan Areas:					
% Consumption	2.8	5.0	12.4	29.1	50.6
% Retail Distribution	8.6	15.0	23.5	32.3	20.6

[a] Source: 1991 EPA Stage II Technical Guidance, Tables 2-6 and 2-9 thru 2-12.
[b] Includes both metropolitan and non-metropolitan areas

6.2.2 Number and Distribution of Stage II Facilities

The number of service stations in Stage II areas and their distribution by model plant size were estimated as follows (see Appendix A for table showing details). First, within each state, the total Stage II gasoline throughput was estimated by multiplying the total fuel consumption for the state by the percentage of the state's population residing in counties projected to be covered by Stage II requirements (see methodology described in Chapter 4). These calculations led to the conclusion that about 45 percent of the annual fuel consumption was covered by Stage II, excluding off-road gasoline consumption, which was estimated at 5.4 percent.[2]

Next, the throughput in each Stage II area was allocated to Model Plant categories 1 through 5 according to either the Nationwide or Metropolitan Area distribution shown above in Table 6.1. The decision rule used in this allocation process was the following: For Stage II areas covering an entire state, the allocation was based on the Nationwide distribution. Otherwise, it was based on the Metropolitan Area distribution. In total, this decision rule resulted in the allocation of about 59 percent of all Stage II throughput by

[2] "Highway Statistics 1990," U.S. Department of Transportation, Federal Highway Administration, Table MF-26.

the metropolitan distribution, and 41 percent by the nationwide distribution. See Appendix A for actual distribution of model plants

Finally, the throughput for each Stage II area and model plant category was divided by the respective average model plant throughput (as presented in Table 6-1) to calculate the estimated number of refueling stations of each model plant size in each Stage II area. Summing the Stage II throughputs and refueling station estimates across each model plant category yields the results shown below in Table 6-2.

Table 6.2—Estimated Total Throughput and Number of Stations in Stage II Areas by Model Plant Size

	Model Plant 1	Model Plant 2	Model Plant 3	Model Plant 4	Model Plant 5	Total
Annual Throughput (in 10^9 gallons)	2.50	4.87	8.84	13.5	18.0	47.7
Number of Stations	53,189	20,288	21,055	17,312	8,157	120,001

6.2.3 Stage II Exemptions

Service stations exempt from Stage II requirements must be excluded from this analysis. As described in Chapter 3, the size of station (as measured by throughput) waived from Stage II varies from state to state. A throughput-weighted analysis of the expected exemptions in each Stage II area yields an estimate of about 5.7 percent of consumption waived from Stage II control in Stage II areas. However, to simplify the evaluation, EPA has used a single exemption level of 10,000 gallons per month (i.e., the 10/10 exemption program) for purposes of the Stage II retention analysis. As explained previously, many states are in fact electing this approach and, for those which are either more or less stringent than 10/10, it is still a reasonable balance point. Under this simplifying assumption, the costs and benefits of Model Plan 1 can simply be omitted from the Stage II retention analysis presented in the next section.

To estimate the percentage of fuel waived under the 10/10 program assumption, the Model Plant 1 consumption percentages under the Nationwide and Metropolitan distributions shown in Table 6.1 (8.8 percent and 2.8 percent, respectively) were weighted by the 41/59 ratio of Nationwide to Metropolitan Stage II areas developed above, to yield about a 5.3 percent Stage II waiver rate. This is sufficiently close to the weighted average rate of 5.7 percent, mentioned above, to assure that the simplified 10/10 approach does not introduce significant error. Furthermore, the 10/10 simplifying assumption is a conservative approach with respect to comparison with ORVR, because it will reduce the projected number of smaller model plant stations and increase the number of larger model plant stations, thus increasing costs. This assumption is conservative, because the actual real-world situation retains some Model Plant 1 facilities and reduces the number of Model Plant 2 facilities. Due to their higher throughputs, larger model plants can achieve some economies of scale. The simplifying assumption made in this analysis will overestimate the number of Model Plant 2 facilities and underestimate the number of Model Plant 1 facilities, thus decreasing costs and making Stage II cost effectiveness more attractive.

6.3 Costs and Benefits of Stage II Retention

6.3.1 Annual Costs and Fuel Recovery Credits

Maintenance and other indirect facility costs of Stage II were extracted from the 1991 Stage II technical guidance document[3] for multi-product dispensers and adjusted to 1993 dollars at an average annual inflation rate of 3 percent. Enforcement costs of $84 per model plant were calculated from data on total annual enforcement costs and total plants available in the 1987 Draft Regulatory Impact Analysis document[4], and similarly adjusted for inflation. Capital costs are assumed to be "sunk costs," and were not included in this analysis. In the case of Model Plant 1, the costs were set at zero, under the assumption that all service stations of this size are waived from Stage II requirements.

Offsetting some of the costs are credits due to the recovery of refueling vapors from LDTs and HDVs by Stage II installations. The methodology used to compute the fuel recovery credits was similar to that explained in Chapter 5. Briefly, this method is as follows. First, the mass of emissions recovered by Stage II was calculated by multiplying the average throughput in each model plant (except Model Plant 1) by the summertime uncontrolled refueling emission factor in Stage II areas (3.3 g/gal) and by the Stage II in-use efficiency rate (86 percent--see Chapter 3). To be conservative, emptying losses (also called breathing losses), estimated at 0.30 g/gal[5], were also included in the analysis. The uncontrolled emission factor as a function of Model Plant size and the impacts of Stage II control are not well documented. (Further discussion of this issue is available in the Summary and Analysis of Comments accompanying this final rule.) The mass of emissions was converted to gallons by dividing by the density of gasoline (2.79 kg/gal). The projected 2010 nationwide percentage of gasoline consumed by LDTs and HDVs (43 percent) was then used to estimate the applicable portion of the total fuel recovery. The result was multiplied by $0.82, the average cost of a gallon of gasoline (excluding taxes), to obtain the Stage II fuel recovery credit in LDTs and HDVs.

6.3.2 Annual Benefits

Emission reductions were determined by multiplying the throughput of each model plant (except Model Plant 1) by the Stage II area summertime refueling emission factor (3.3 g/gal), and adjusting the result by the Stage II efficiency rate of 86 percent. Since the benefits in this analysis are limited to LDT and HDV emissions reductions, the total emissions were multiplied by 43 percent (MOBILE 4.1 Fuel Consumption Model 2010

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[3]*Technical Guidance—Stage II Vapor Recovery Systems for Control of Vehicle Refueling Emissions at Gasoline Dispensing Facilities.* (EPA-450/3-91-022a), November 1991, Table 5-11, page 5-30

[4]*Technical Guidance—Stage II Vapor Recovery Systems for Control of Vehicle Refueling Emissions at Gasoline Dispensing Facilities.* (EPA-450/3-91-022a), November 1991, Table 2-30 (page 2-69) and Table 2-9 (page 2-20)

[5]The Stage II technical support document (pp 3-25 to 3-29) estimated breathing losses to be 120 mg/L (0.45 g/gal). However, volatility controls have reduced the baseline uncontrolled emission rate from 1340 mg/L (5.07 g/gal) in the Stage II analysis (page 3-30) to 3.3 g/gal in the current analysis. The breathing loss emissions were decreased by the same percentage, resulting in an emission rate of 0.30 g/gal. See the summary and analysis of comments document for additional information.

projected LDT/HDV fraction of gasoline fuel consumption) to derive the emission reductions applicable to these vehicles in each model plant.

6.3.3 Cost Effectiveness

For each of Model Plants 2-5, the benefits in section 6.3.2 were divided by the net costs in section 6.3.1 to obtain the cost effectiveness of Stage II retention in dollars per metric ton. The model plant results were then weighted on the basis of the relative number of stations in each category, to derive a nationwide average cost effectiveness of Stage II retention of approximately $3,100 per metric ton of emission reductions.

The costs, benefits, and cost effectiveness of Stage II retention are summarized below in Table 6-3.

Table 6.3—Stage II Retention Costs and Benefits*

	Model Plant 1	Model Plant 2	Model Plant 3	Model Plant 4	Model Plant 5	Totals
Number of Plants	53,189	20,288	21,055	17,312	8,157	120,001
Costs						
Capital Recovery cost	$0	$0	$0	$0	$0	
Maintenance cost	$0	$655	$1,305	$1,965	$3,278	
Other Indirect cost	$0	$515	$742	$1,024	$1,557	
Enforcement cost	$0	$84	$84	$84	$84	
Recovery credit/gal	$0	$0.0004	$0.0004	$0.0004	$0.0004	
Recovery per plant	$0	$94	$164	$305	$861	
Annual Cost/plant	$0	$1,159	$1,966	$2,768	$4,059	
Total Cost (all plants)	$0 (waved)	$23,522,816	$41,403,336	$47,912,326	$33,111,235	$145,949,713
Benefits						
Vapor Recovery(kg/gal)	0.0013	0.0013	0.0013	0.0013	0.0013	
Avg. throughput/yr	47,000	240,000	420,000	780,000	2,220,000	
Per plant benefits (kg/yr)	0.0	319.5	559.1	1038.4	2928.8	
Total (Mg) (all plants)	0 (waved)	6,482	11,773	17,976	23,892	60,123
Cost Effectiveness ($/Mg)	$0 (waved)	$3,629	$3,517	$2,665	$1,386	Weighted Avg. $3,070

* Benefits and recovery credits included only for LDTs and HDVs

As indicated in Table 6.3, total costs for Stage II retention increase with the size of the model plant, due primarily to higher maintenance and indirect costs for the larger facilities. Stage II retention benefits (i.e., reduction of refueling emissions from LDTs and HDVs) vary directly with annual throughput. Due to economies of scale, the cost effectiveness of Stage II retention improves with increasing size of the model plant. In sum, the weighted average cost per megagram of VOC emission reduction due to Stage II retention is estimated to be $3,070. This outcome should be evaluated in relation to the ORVR cost effectiveness calculations which are presented in the next chapter.

6.3.4 Moderate Nonattainment Areas Without Stage II

As was discussed previously, a few states containing moderate nonattainment areas have not yet acted to require Stage II controls. However, if ORVR systems were not required in LDTs and HDVs, and if Stage II thus had to be retained elsewhere to control LDT/HDV refueling emissions, it is possible that the remaining non-Stage II moderate areas would also need to implement Stage II in order to control the refueling emissions from these vehicles. An argument can be made that the cost effectiveness of Stage II retention should include the costs of installing and maintaining Stage II in these moderate nonattainment areas which have so far been categorized as non-Stage II areas.

The cost effectiveness of *installing* Stage II solely for controlling LDT/HDV refueling emissions is substantially worse than the cost of *retaining* it for the same purpose, because capital costs must be taken into account. The moderate nonattainment areas without Stage II represent about 3.3 percent of nonattainment area fuel consumption and about 1.8 percent of nationwide fuel consumption. Assuming a 10/10 exemption level and the metropolitan service station distribution for these areas, EPA estimates that the moderate areas that have not implemented Stage II would account for about 2.7 percent of all Stage II stations nationwide. Thus, in determining the overall cost of retaining Stage II for control of LDT/HDV refueling emissions, the costs of Stage II installation would need to be considered for 2.7 percent of stations, while only the retention costs discussed earlier in this chapter would be included for the other 97.3 percent. Using the Stage II capital costs in the Technical Guidance document[6] (adjusted for inflation) for the new installations and the costs in Table 6.3 for the other cost categories, EPA estimates that the cost per megagram of VOC control for Stage II retention would increase to $3,225.

However, the areas in question have not yet implemented Stage II and, given their nonattainment status, it is unclear whether all will do so. To be conservative, EPA will assume no further Stage II implementation in moderate areas, but the analysis and discussion above indicate that it would adversely impact the overall Stage II retention cost effectiveness.

[6] *Technical Guidance—Stage II Vapor Recovery Systems for Control of Vehicle Refueling Emissions at Gasoline Dispensing Facilities.* (EPA-450/3-91-022a), November 1991, Table 5-1, p. 5-30.

Chapter 7: Cost Effectiveness

7.1 Introduction

This chapter assesses the cost effectiveness of ORVR systems for the control of refueling emissions by examining the ratio between the program's costs and the reduction of volatile organic compound (VOC) emissions. The cost effectiveness of different scenarios is calculated and a sensitivity analysis is conducted to evaluate the impacts of potential variations in costs and benefits assumptions. In addition, this chapter discusses other benefits that can be attributed to onboard controls in terms of energy savings, health effects, and welfare effects.

The analysis included in this chapter utilizes cost and benefit data obtained from Chapters 4, 5, and 6 to estimate the cost effectiveness of ORVR systems in terms of dollars ($) per megagram (Mg or metric ton) of VOCs reduced under various scenarios. Cost effectiveness is evaluated based on the net present value (NPV) of annual costs and benefits projected for the 23-year period 1998-2020, discounted at a rate of seven percent to the year 1998.

The cost effectiveness evaluation focuses on two main issues: 1) the impact of including ORVR systems in all vehicle classes (i.e., LDVs, LDTs, and HDVs) and 2) the relationship between LDT/HDV onboard controls and Stage II controls. The analysis compares the cost effectiveness of onboard controls in nonattainment areas (NAAs) and nationwide (All-Areas, i.e., nonattainment and attainment areas combined) under several scenarios. In addition, the evaluation compares the cost effectiveness of onboard controls in trucks (i.e., LDTs and HDVs) and in all vehicles under different Stage II implementation assumptions.

As described in Chapter 1, the use of ORVR systems in LDVs was mandated by section 202(a)(6) of the Clean Air Act (CAA) Amendments of 1990. However, the final ORVR regulations expand the application of onboard controls to include LDTs and HDVs. This decision is supported by the cost effectiveness analysis presented in this chapter.

7.2 Methodology

This chapter assesses the cost effectiveness of ORVR systems under different scenarios which depend on: 1) the classes of vehicles examined, 2) the areas (Nonattainment Areas or All-Areas) included, and 3) various Stage II assumptions. The assessment includes four primary analyses: Nonattainment Areas Truck analysis, All-Areas Truck analysis, Nonattainment Areas All-Vehicles analysis, and All-Areas All-Vehicles analysis. Each of these analyses, whether Nonattainment Areas or All-Areas, includes costs for implementing ORVR systems nationwide because the onboard requirement is expected to apply to vehicles in all 50 states (i.e., nonattainment and attainment areas). On the other hand, benefits are defined according to the conditions of the particular analysis under consideration (i.e., Nonattainment Areas or All-Areas).

Thus, the Nonattainment Areas Truck analysis evaluates the cost effectiveness of ORVR systems in the nonattainment areas using all-area cost and nonattainment area benefit data for trucks (i.e., LDTs and HDVs) only. Similarly, the All-Areas Truck analysis evaluates the cost effectiveness in trucks considering nationwide benefits. The Nonattainment Areas All-Vehicles analysis and the All-Areas All-Vehicles analysis assume the implementation of ORVR systems in all vehicles classes, considering either nonattainment area benefits or all-area benefits, respectively.

Three different scenarios were evaluated within each Nonattainment Areas or All-Areas analysis (for a total of twelve scenarios). The first scenario is a baseline case that assumes no Stage II controls. This baseline scenario is included to compare the relative cost effectiveness of ORVR systems in relation to the presence or absence of Stage II controls during the evaluation period (i.e., 1998-2020). In the baseline case, benefits (refueling vapor emission reductions) and fuel recovery credits are attributed to ORVR. The second scenario assumes the presence of Stage II controls throughout the evaluation period. In this case, ORVR benefits and fuel recovery credits are those additional benefits that are incremental to the benefits of Stage II controls. This approach acknowledges the fact that Stage II controls are already in place prior to the implementation of the onboard program. The third scenario assumes that Stage II is discontinued in 2010 due to the presence of ORVR systems. The year 2010 is used to represent the point in time when ORVR systems penetrate the in-use vehicle population to the extent that Stage II requirements could become essentially redundant (i.e., same percent of fuel coverage). In this scenario, the ORVR benefits between 1998-2009 are only those incremental to Stage II controls. Beginning in 2010, all benefits are attributed to the onboard program due to the assumed discontinuation of Stage II.

A summary of the factors included in the different cost effectiveness scenarios is shown in Table 7.1.

Table 7.1—Summary of ORVR Cost Effectiveness Scenarios

Analyses/Scenarios	Cost Basis	Benefit Basis*	Vehicles Included
Nonattainment Areas Truck Analysis			
1. Baseline (Stage II Absent)	All	NAA	LDTs and HDVs
2. Stage II Present	All	NAA	LDTs and HDVs
3. Stage II Discontinued in 2010	All	NAA	LDTs and HDVs
All-Areas Truck Analysis			
4. Baseline (Stage II Absent)	All	All	LDTs and HDVs
5. Stage II Present	All	All	LDTs and HDVs
6. Stage II Discontinued in 2010	All	All	LDTs and HDVs
Nonattainment Areas All-Vehicles Analysis			
7. Baseline (Stage II Absent)	All	NAA	LDVs, LDTs, and HDVs
8. Stage II Present	All	NAA	LDVs, LDTs, and HDVs
9. Stage II Discontinued in 2010	All	NAA	LDVs, LDTs, and HDVs
All-Areas All-Vehicles Analysis			
10. Baseline (Stage II Absent)	All	All	LDVs, LDTs, and HDVs
11. Stage II Present	All	All	LDVs, LDTs, and HDVs
12. Stage II Discontinued in 2010	All	All	LDVs, LDTs, and HDVs

NAA = Nonattainment area
All = All-Areas (i.e., attainment and nonattainment areas combined)
* When Stage II is present, ORVR benefits are incremental to Stage II benefits.

7.3 Costs, Benefits, and Cost Effectiveness Results

7.3.1 Cost and Benefit Data

Expected costs and VOC reductions for each of the years 1998-2020 and for each scenario are shown in the tables below. Tables 7.2 and 7.4 focus on the costs and benefits of ORVR in trucks, while Tables 7.3 and 7.5 tabulate the costs and benefits for all vehicles combined. Cost data include hardware, development, and operating costs. Fuel recovery credits are part of the operating costs.

As was mentioned previously, this analytical approach overestimates the costs and underestimates the emission reduction benefits of ORVR systems. This is because the consumer costs are incurred in the year the vehicle is acquired, but fuel recovery credits and emission reductions occur over the life of the vehicle as it uses fuel. The MOBILE4.1 fuel consumption model assumes that any model year vehicle takes 25 years to be completely eliminated from the fleet. However, because this analysis stops in the year 2020, fuel recovery and emission reduction benefits of none of the vehicles are ever fully considered. If these benefits were included, the cost effectiveness of various ORVR scenarios would be improved. However, because discounted costs and benefits are used to calculate NPV values as of 1998, the effect on the cost effectiveness would be minor.

Table 7.2—Annual (1998-2020) ORVR Cost Data ($)—Truck Analysis

Scenario	Nonattainment Areas Truck Analysis			All-Areas Truck Analysis		
Year	Baseline (No Stage II)	Stage II Present	Stage II Discontinued In 2010	Baseline (No Stage II)	Stage II Present	Stage II Discontinued In 2010
1998	$16,642,358	$17,187,929	$17,187,929	$16,642,358	$17,187,929	$17,187,929
1999	$31,619,384	$33,696,548	$33,696,548	$31,619,384	$33,696,548	$33,696,548
2000	$36,186,659	$40,506,736	$40,506,736	$36,186,659	$40,506,736	$40,506,736
2001	$31,075,408	$37,753,703	$37,753,703	$31,075,408	$37,753,703	$37,753,703
2002	$26,156,049	$35,126,011	$35,126,011	$26,156,049	$35,126,011	$35,126,011
2003	$3,980,006	$15,077,527	$15,077,527	$3,980,006	$15,077,527	$15,077,527
2004	-$388,921	$12,642,355	$12,642,355	-$388,921	$12,642,355	$12,642,355
2005	-$3,784,208	$10,822,564	$10,822,564	-$3,784,208	$10,822,564	$10,822,564
2006	-$6,390,262	$9,500,772	$9,500,772	-$6,390,262	$9,500,772	$9,500,772
2007	-$8,500,310	$8,491,032	$8,491,032	-$8,500,310	$8,491,032	$8,491,032
2008	-$10,418,478	$7,601,139	$7,601,139	-$10,418,478	$7,601,139	$7,601,139
2009	-$12,715,601	$6,474,280	$6,474,280	-$12,715,601	$6,474,280	$6,474,280
2010	-$15,291,069	$5,191,565	-$15,291,069	-$15,291,069	$5,191,565	-$15,291,069
2011	-$17,818,117	$3,905,951	-$17,818,117	-$17,818,117	$3,905,951	-$17,818,117
2012	-$19,985,143	$2,868,064	-$19,985,143	-$19,985,143	$2,868,064	-$19,985,143
2013	-$21,725,786	$2,098,028	-$21,725,786	-$21,725,786	$2,098,028	-$21,725,786
2014	-$23,227,264	$1,475,609	-$23,227,264	-$23,227,264	$1,475,609	-$23,227,264
2015	-$24,676,257	$889,149	-$24,676,257	-$24,676,257	$889,149	-$24,676,257
2016	-$25,986,352	$365,309	-$25,986,352	-$25,986,352	$365,309	-$25,986,352
2017	-$27,161,718	-$75,077	-$27,161,718	-$27,161,718	-$75,077	-$27,161,718
2018	-$28,186,138	-$420,039	-$28,186,138	-$28,186,138	-$420,039	-$28,186,138
2019	-$29,084,316	-$668,003	-$29,084,316	-$29,084,316	-$668,003	-$29,084,316
2020	-$29,998,615	-$945,644	-$29,998,615	-$29,998,615	-$945,644	-$29,998,615

Table 7.3—Annual (1998-2020) ORVR Cost Data ($)—All-Vehicles Analysis

Scenario	Nonattainment Areas All-Vehicles Analysis			All-Areas All-Vehicles Analysis		
Year	Baseline (No Stage II)	Stage II Present	Stage II Discontinued in 2010	Baseline (No Stage II)	Stage II Present	Stage II Discontinued in 2010
1998	$41,433,129	$42,778,428	$42,778,428	$41,433,129	$42,778,428	$42,778,428
1999	$78,769,357	$83,713,839	$83,713,839	$78,769,357	$83,713,839	$83,713,839
2000	$90,722,301	$100,712,137	$100,712,137	$90,722,301	$100,712,137	$100,712,137
2001	$78,537,756	$93,719,629	$93,719,629	$78,537,756	$93,719,629	$93,719,629
2002	$67,522,557	$87,704,402	$87,704,402	$67,522,557	$87,704,402	$87,704,402
2003	$15,529,089	$40,473,864	$40,473,864	$15,529,089	$40,473,864	$40,473,864
2004	$5,165,122	$34,561,991	$34,561,991	$5,165,122	$34,561,991	$34,561,991
2005	-$3,767,265	$29,397,779	$29,397,779	-$3,767,265	$29,397,779	$29,397,779
2006	-$10,551,490	$25,748,301	$25,748,301	-$10,551,490	$25,748,301	$25,748,301
2007	-$16,298,685	$22,753,026	$22,753,026	-$16,298,685	$22,753,026	$22,753,026
2008	-$21,708,651	$19,969,519	$19,969,519	-$21,708,651	$19,969,519	$19,969,519
2009	-$27,543,715	$16,919,865	$16,919,865	-$27,543,715	$16,919,865	$16,919,865
2010	-$33,503,698	$13,811,383	-$33,503,698	-$33,503,698	$13,811,383	-$33,503,698
2011	-$38,816,561	$11,078,630	-$38,816,561	-$38,816,561	$11,078,630	-$38,816,561
2012	-$43,326,431	$8,873,746	-$43,326,431	-$43,326,431	$8,873,746	-$43,326,431
2013	-$46,875,816	$7,274,486	-$46,875,816	-$46,875,816	$7,274,486	-$46,875,816
2014	-$49,821,509	$6,053,376	-$49,821,509	-$49,821,509	$6,053,376	-$49,821,509
2015	-$52,572,827	$4,957,958	-$52,572,827	-$52,572,827	$4,957,958	-$52,572,827
2016	-$54,859,942	$4,130,888	-$54,859,942	-$54,859,942	$4,130,888	-$54,859,942
2017	-$57,341,120	$3,022,013	-$57,341,120	-$57,341,120	$3,022,013	-$57,341,120
2018	-$59,113,000	$2,518,998	-$59,113,000	-$59,113,000	$2,518,998	-$59,113,000
2019	-$60,682,502	$2,161,132	-$60,682,502	-$60,682,502	$2,161,132	-$60,682,502
2020	-$62,223,135	$1,802,039	-$62,223,135	-$62,223,135	$1,802,039	-$62,223,135

Table 7.4—Annual (1998-2020) ORVR Benefit Data (Mg)—Truck Analysis

Scenario	Nonattainment Areas Truck Analysis			All-Areas Truck Analysis		
Year	Baseline (No Stage II)	Stage II Present	Stage II Discontinued In 2010	Baseline (No Stage II)	Stage II Present	Stage II Discontinued In 2010
1998	2,832	1,027	1,027	5,646	3,806	3,806
1999	10,782	3,912	3,912	21,496	14,490	14,490
2000	22,425	8,136	8,136	44,708	30,137	30,137
2001	34,666	12,577	12,577	69,112	46,588	46,588
2002	46,562	16,893	16,893	92,828	62,575	62,575
2003	57,606	20,900	20,900	114,847	77,418	77,418
2004	67,645	24,542	24,542	134,860	90,909	90,909
2005	75,824	27,509	27,509	151,167	101,901	101,901
2006	82,492	29,928	29,928	164,459	110,861	110,861
2007	88,204	32,001	32,001	175,848	118,538	118,538
2008	93,542	33,938	33,938	186,491	125,712	125,712
2009	99,618	36,142	36,142	198,603	133,877	133,877
2010	106,329	38,577	106,329	211,983	142,897	211,983
2011	112,775	40,915	112,775	224,833	151,559	224,833
2012	118,637	43,042	118,637	236,520	159,437	236,520
2013	123,676	44,870	123,676	246,566	166,209	246,566
2014	128,240	46,526	128,240	255,664	172,342	255,664
2015	132,718	48,151	132,718	264,592	178,360	264,592
2016	136,799	49,632	136,799	272,730	183,846	272,730
2017	140,615	51,016	140,615	280,337	188,974	280,337
2018	144,142	52,296	144,142	287,369	193,714	287,369
2019	147,518	53,520	147,518	294,099	198,250	294,099
2020	150,823	54,719	150,823	300,688	202,692	300,688

Table 7.5—Annual (1998-2020) ORVR Benefit Data (Mg)—All-Vehicles Analysis

Scenario	Nonattainment Areas All-Vehicles Analysis			All-Areas All-Vehicles Analysis		
Year	Baseline (No Stage II)	Stage II Present	Stage II Discontinued in 2010	Baseline (No Stage II)	Stage II Present	Stage II Discontinued in 2010
1998	6,982	2,533	2,533	13,920	9,383	9,383
1999	25,662	9,310	9,310	51,161	34,487	34,487
2000	51,848	18,811	18,811	103,366	69,678	69,678
2001	78,795	28,587	28,587	$157,089	105,893	105,893
2002	104,745	38,002	38,002	$208,825	140,768	140,768
2003	129,465	46,971	46,971	$258,108	173,989	173,989
2004	152,572	55,354	55,354	$304,176	205,043	205,043
2005	172,130	62,450	62,450	$343,167	231,327	231,327
2006	188,401	68,353	68,353	$375,604	253,193	253,193
2007	202,684	73,535	73,535	$404,080	272,388	272,388
2008	216,316	78,480	78,480	$431,258	290,709	290,709
2009	230,773	83,726	83,726	$460,080	310,138	310,138
2010	245,574	89,095	245,574	$489,587	330,028	489,587
2011	258,966	93,954	258,966	$516,286	348,026	516,286
2012	270,930	98,295	270,930	$540,138	364,104	540,138
2013	281,052	101,967	281,052	$560,318	377,708	560,318
2014	290,003	105,215	290,003	$578,164	389,738	578,164
2015	298,599	108,333	298,599	$595,300	401,289	595,300
2016	306,177	111,082	306,177	$610,409	411,473	610,409
2017	313,300	113,667	313,300	$624,609	421,046	624,609
2018	319,886	116,056	319,886	$637,740	429,897	637,740
2019	326,175	118,338	326,175	$650,278	438,349	650,278
2020	332,308	120,563	332,308	$662,504	446,591	662,504

7.3.2 Average and NPV Costs and Benefits

The above data were used to calculate the average annual costs and benefits and the 1998 NPV for each scenario, as shown in Table 7.6. Total annual costs and benefits are discounted at a rate of seven percent to derive the NPV as of 1998.

Table 7.6—Annual Average (1998-2020) and 1998 NPV ORVR Costs and Benefits

Analyses/Scenarios	Costs ($)		Benefits (Mg)[a]	
	Average	1998 NPV	Average	1998 NPV
Nonattainment Areas Truck Analysis				
1. Baseline (Stage II Absent)	-6,942,552	20,464,348	92,368	819,742
2. Stage II Present	10,850,674	178,375,566	33,512	297,406
3. Stage II Discontinued in 2010	-1,228,703	96,179,248	73,469	569,300
All-Areas Truck Analysis				
4. Baseline (Stage II Absent)	-6,942,552	20,464,348	184,150	1,634,276
5. Stage II Present	10,850,674	178,375,566	124,134	1,101,657
6. Stage II Discontinued in 2010	-1,228,703	96,179,248	164,878	1,378,903
Nonattainment Areas All-Vehicles Analysis				
7. Baseline (Stage II Absent)	-11,362,045	101,489,902	208,841	1,860,757
8. Stage II Present	28,875,540	460,005,463	75,769	675,092
9. Stage II Discontinued in 2010	1,709,402	274,563,086	165,612	1,288,384
All-Areas All-Vehicles Analysis				
10. Baseline (Stage II Absent)	-11,362,045	101,489,902	416,355	3,709,692
11. Stage II Present	28,875,540	460,005,463	280,663	2,500,684
12. Stage II Discontinued in 2010	1,709,402	274,563,086	372,275	3,126,051

[a] When Stage II is present, ORVR benefits are incremental to Stage II benefits.

7.3.3 Cost Effectiveness Results

The cost effectiveness for each scenario is obtained by dividing the 1998 NPV cost shown in Table 7.6 by the respective 1998 NPV benefit. The results are shown in Table 7.7. Cost effectiveness is shown as 1998 NPV dollars per megagram of VOCs reduced and 1998 NPV dollars per US ton of VOCs reduced.

Table 7.7—ORVR Cost Effectiveness Results

Analyses/Scenarios	Cost Effectiveness ($/Mg)	Cost Effectiveness ($/US Ton)
Nonattainment Areas Truck Analysis		
1. Baseline (Stage II Absent)	25	27
2. Stage II Present	600	660
3. Stage II Discontinued in 2010	169	186
All-Areas Truck Analysis		
4. Baseline (Stage II Absent)	13	14
5. Stage II Present	162	178
6. Stage II Discontinued in 2010	70	77
Nonattainment Areas All-Vehicles Analysis		
7. Baseline (Stage II Absent)	55	60
8. Stage II Present	681	750
9. Stage II Discontinued in 2010	213	234
All-Areas All-Vehicles Analysis		
10. Baseline (Stage II Absent)	27	30
11. Stage II Present	184	202
12. Stage II Discontinued in 2010	88	97

Another way to examine the cost effectiveness of ORVR controls would be to disaggregate the vehicle classes to present the individual vehicle class cost effectiveness. This is shown in Table 7.8. The same cost and benefit values used in Table 7.7 were used to develop these figures, but costs and benefits were not aggregated into trucks or all-vehicles groups. The cost effectiveness values presented are for the scenario in which Stage II is discontinued in 2010. Costs per Mg would be lower in the baseline case and higher if Stage II were assumed to be present forever.

Table 7.8—Individual Vehicle Class Cost Effectiveness (Stage II Disconinued in 2010)

	All Areas ($/Mg)	Nonattainment Areas ($/Mg)
LDV	102	248
LDT	74	181
LHDGV	15	35
HHDGV	138	327

Note that cost effectiveness values are very attractive for each vehicle class. Light-duty trucks and LHDGV cost effectiveness values are more attractive than that of LDVs due to their higher fuel consumption (and higher recovery credits) but relatively similar costs. The costs per Mg for HHDGVs are modestly higher than those for LDVs.

7.3.4 Discussion of Results

7.3.4.1 Baseline Scenarios

As discussed earlier, a baseline case was evaluated for each of the four primary analyses to estimate the cost effectiveness of ORVR systems assuming no Stage II controls. The purpose of the baseline scenarios was to demonstrate the cost effectiveness of onboard controls and to compare the relative costs and benefits of ORVR systems in relation to the presence or absence of Stage II controls.

As shown in Table 7.7, the baseline data illustrate that the ORVR program is extremely cost effective (i.e., very low cost per Mg). However, EPA recognizes that the Stage II controls are already implemented in many nonattainment areas and that it would be unreasonable to attribute the control of refueling emissions to the ORVR program only. In view of this, EPA evaluated two other scenarios that consider either the presence of Stage II controls until 2020 or the discontinuation of Stage II in 2010. The following sections describe the cost effectiveness results for each analysis in terms of these two scenarios.

7.3.4.2 Nonattainment Areas Truck Analysis

The Nonattainment Areas Truck analysis results show the cost effectiveness of onboard control of LDT and HDV refueling emissions in the nonattainment areas. In the presence of Stage II, the cost effectiveness is $600 per Mg of emission reduction. If Stage II is discontinued in 2010, the cost per Mg is reduced to $169. These results compare very favorably with the Stage II retention scenario evaluated in Chapter 6, which showed that maintenance of Stage II for the sole purpose of controlling truck refueling emissions would cost about $3,100 per Mg of emission reduction.

7.3.4.3 All-Areas Truck Analysis

The All-Areas Truck analysis assesses the cost effectiveness of onboard controls in trucks when nationwide benefits are considered. The cost effectiveness of these scenarios is better than the cost effectiveness of the previous analysis (Nonattainment Areas Truck analysis) because environmental benefits increase when all areas (i.e., both attainment and nonattainment) are included. When Stage II is present throughout the evaluation period (1998-2020) the cost effectiveness is $162 per Mg. The cost per Mg decreases to $70 if Stage II is discontinued in 2010.

7.3.4.4 Nonattainment Areas All-Vehicles Analysis

This analysis examined the cost effectiveness of ORVR systems in the nonattainment areas, taking into account the NAA benefits and fuel recovery credits and the all-area costs for all vehicle classes (LDVs, LDTs, and HDVs). The cost effectiveness under these conditions is $681 per Mg with retained Stage II and $213 per Mg with Stage II discontinued in 2010. These results are slightly less favorable than those of the Nonattainment Areas Truck Analysis, which indicates that the cost effectiveness of ORVR systems in trucks is, on the average, somewhat better than in passenger cars.

7.3.4.5 All-Areas All-Vehicles Analysis

These scenarios consider nationwide costs and benefits for all vehicle classes. Under these conditions, environmental benefits increase as compared to the previous analyses, resulting in attractive ORVR cost effectiveness values. The cost effectiveness of onboard controls with Stage II present is $184 per Mg. Cost effectiveness improves to $88 per Mg if Stage II is discontinued in 2010.

7.3.4.6 Summary

The results indicate that the ORVR program is a cost effective strategy for the control of refueling emissions in all vehicle classes for both Nonattainment Areas and All-Areas scenarios, even with Stage II controls in place.

As described earlier, the most cost effective results (i.e., low cost effectiveness values in terms of $/Mg reduced) are obtained under baseline conditions when onboard controls are assumed present with no Stage II during the evaluation period. However, these baseline scenarios were included only for comparison purposes. In reality, the cost effectiveness assessment of the ORVR program needs to take into account the effects of the Stage II program. Furthermore, since the primary reason for the ORVR requirement is ozone control, the analysis needs to focus on ozone nonattainment areas.

When Stage II controls are considered, the cost effectiveness of ORVR systems is affected because the benefits are distributed between the two programs. When Stage II is assumed present throughout the evaluation period, a large portion of the VOC reduction benefit is credited to Stage II control[1] (because Stage II is already in place prior to the implementation of the ORVR regulation). In this case, the ORVR benefits are defined as those incremental to the benefits achieved by Stage II. These benefits arise from: 1) ORVR control in nonattainment areas without Stage II, 2) ORVR control at refueling stations with Stage II waivers, and 3) ORVR control of Stage II inefficiencies. When Stage II is assumed to discontinue in 2010, then the cost effectiveness of onboard controls increases. Since the only difference between the two above scenarios is the discontinuation of the Stage II program after 2009, then the improvement in ORVR cost effectiveness can be directly related to attributing the control previously gained by Stage II to ORVR systems.

To put the cost effectiveness of ORVR systems in perspective, EPA compared the results in Table 7.7 with other control strategies. In this regard, onboard controls compare very favorably with previous EPA analyses on other strategies for the control of

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[1] Approximately 80 percent in nonattainment areas and 36 percent in all areas.

hydrocarbons, such as the onboard diagnostics (OBD) program, the enhanced inspection/maintenance (I/M) program, evaporative controls, and the Clean Fuel Fleet Program. For example, the cost effectiveness of the OBD program for the control of hydrocarbons is estimated to be $1,974 per ton.[2] The cost per ton of VOC reduction for the enhanced I/M program, based on the biennial high-tech program, is $500.[3] If the high-tech I/M program was performed on an annual basis, the cost effectiveness would increase to $1,300 per ton. For evaporative controls, the overall cost effectiveness is estimated to be $170 per Mg when fuel consumption credits are considered.[4] The estimated cost per ton for the control of non-methane hydrocarbons in the Clean Fuel Fleet Program is over $8,000.[5]

7.4 Sensitivity Analysis

Cost effectiveness analyses often require the use of assumptions, judgements, and estimations in order to develop cost/benefit scenarios. In these situations, a sensitivity analysis is desirable to assess how changes in key assumptions might affect the results. To demonstrate such effects, EPA conducted a sensitivity analysis to examine the impact of several factors on the cost effectiveness of ORVR systems. The details of this sensitivity analysis are contained in the docket for this rulemaking.[6]

The following sections describe each of the sensitivity scenarios evaluated and their impact on cost effectiveness. The sensitivity analysis results are compared to the cost effectiveness results discussed in the previous sections. In addition, EPA examined the effects of various Stage II assumptions used in the Stage II retention analysis presented in Chapter 6.

7.4.1 ORVR Sensitivity Scenarios

7.4.1.1 Non-Integrated Systems

The cost analysis presented in Chapter 5 assumed that ORVR systems will be integrated with the enhanced evaporative emission controls required under recent regulations that establish new evaporative emission standards and test procedures (58 FR 16002, March 24, 1993). This assumption was based on the fact that integrated ORVR systems are far less expensive and, according to the commentors, presented fewer safety concerns than redundant systems for evaporative and refueling emission control. As a

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[2] 58 FR 9468, February 19, 1993.

[3] 57 FR 52950, November 5, 1992.

[4] 58 FR 16002, March 24, 1993.

[5] *"Draft Regulatory Impact Analysis - Clean Fuel Fleet Program,"* U. S. EPA, Office of Air and Radiation, Office of Mobile Sources, May 1993.

[6] Memo to the Docket from James G. Bryson entitled "Sensitivity Analysis for Onboard Refueling Vapor Recovery Regulatory Impact Analysis." (docket A-87-11, section IV-B).

result, the cost effectiveness evaluation considered only those ORVR costs that were incremental to evaporative emission control.

A sensitivity analysis was conducted to examine the impact on ORVR cost effectiveness if some non-integrated systems were installed by some vehicle manufacturers during the early years of the program. In the cost analysis, EPA estimated that the total hardware cost for integrated systems was $4.28 for LDVs, $4.79 for LDTs, $6.29 for LHDGV, and $21.15 for HHDGV (with a sales-weighted cost of $4.58). This sensitivity scenario assumed that ten percent of ORVR systems for LDVs, LDTs, and LHDGVs would be non-integrated for the first five years of the program (i.e., 1998-2002) at a cost of $20 (this was not done for HHDGVs because their cost was already above $20). The ten percent figure is conservative, given EPA's expectation and the comments received indicating that most vehicle manufacturers will use the less expensive integrated control strategy. The five-year period, also a conservative estimate, represents an interim period that would allow for the phase-in of integrated systems in all vehicles.

Table 7.9 compares the cost effectiveness results for the base case (i.e., integrated ORVR systems in all vehicles) and the sensitivity case (i.e., non-integrated systems in ten percent of vehicles during the first five years) for each scenario evaluated.

Table 7.9—ORVR Sensitivity Analysis—Non-Integrated Systems

Analyses/Scenarios	Cost Effectiveness ($/Mg)	
	Base Case: Integrated System In All-Vehicles	Non-Integrated System In 10% of Vehicles
Nonattainment Areas Truck Analysis		
1. Baseline (Stage II Absent)	25	63
2. Stage II Present	600	704
3. Stage II Discontinued In 2010	169	223
All-Areas Truck Analysis		
4. Baseline (Stage II Absent)	13	31
5. Stage II Present	162	190
6. Stage II Discontinued In 2010	70	92
Nonattainment Areas All-Vehicles Analysis		
7. Baseline (Stage II Absent)	55	102
8. Stage II Present	681	813
9. Stage II Discontinued In 2010	213	282
All-Areas All-Vehicles Analysis		
10. Baseline (Stage II Absent)	27	51
11. Stage II Present	184	220
12. Stage II Discontinued In 2010	88	116

Because of the increase in costs, the cost effectiveness of the ORVR program is reduced (i.e., cost per Mg increases) when non-integrated systems are used. In the baseline scenarios, the calculated cost effectiveness for the ORVR program with 10 percent non-integrated systems is $31-$102 per Mg, as compared to $13-$55 when integrated systems are assumed for all vehicles. When Stage II is present, the cost effectiveness is $190-$813 per Mg, as compared to $162-$681 per Mg in the base case. If Stage II is discontinued in 2010, the cost effectiveness is $92-$282 per Mg rather than $70-$213 per Mg as in the base case. Although the ORVR costs per Mg are slightly increased when non-integrated systems are considered, the sensitivity results demonstrate that onboard controls are still very attractive from a cost/benefit perspective.

7.4.1.2 Fuel Price

The cost effectiveness analysis assumed an average cost of a gallon of gasoline (excluding taxes) of $0.82. The fuel price was used to estimate the fuel recovery credits allocated to refueling emission controls. A sensitivity analysis was conducted to determine the impact of increasing the fuel price to $1.00. Table 7.10 summarizes the results for each scenario evaluated.

Table 7.10—ORVR Sensitivity Analysis—Fuel Price

Analyses/Scenarios	Cost Effectiveness ($/Mg)	
	Base Case: Fuel Price = $0.82	Fuel Price = $1.00
Nonattainment Areas Truck Analysis		
1. Baseline (Stage II Absent)	25	-89
2. Stage II Present	600	402
3. Stage II Discontinued in 2010	169	34
All-Areas Truck Analysis		
4. Baseline (Stage II Absent)	13	-45
5. Stage II Present	162	109
6. Stage II Discontinued in 2010	70	14
Nonattainment Areas All-Vehicles Analysis		
7. Baseline (Stage II Absent)	55	-60
8. Stage II Present	681	481
9. Stage II Discontinued in 2010	213	77
All-Areas All-Vehicles Analysis		
10. Baseline (Stage II Absent)	27	-30
11. Stage II Present	184	130
12. Stage II Discontinued in 2010	88	32

As shown in Table 7.10, the cost effectiveness of the onboard program is greatly improved when the fuel price is increased to $1.00. Increasing the fuel price causes an increase in the fuel recovery credits associated with the ORVR program. The increase in the fuel recovery credits causes a decrease in the program's costs and ultimately an improvement in the cost effectiveness of onboard controls. In the baseline case, the benefits exceed the costs, resulting in overall cost savings. Even when Stage II is assumed present over the entire evaluation period, the cost per Mg is reduced by about 30 percent.

7.4.1.3 In-Use Control Efficiency

In calculating the in-use efficiency of ORVR systems, EPA assumed that the number of in-use failures of ORVR systems was limited by the full life useful life requirement, I/M programs, and OBD systems. Thus, the analysis relied on these three programs to ensure the working efficiency of ORVR systems. If the I/M and OBD programs are less effective than anticipated for the detection and correction of ORVR failures, then the ORVR in-use efficiency will be reduced. This sensitivity analysis examines the impact of having a reduced ORVR in-use efficiency.

In the cost effectiveness analysis, EPA assumed an in-use ORVR efficiency (accounting for additional vapor generation due to air entrainment) of 92.0 percent in all areas (i.e nonattainment and attainment areas), 96.5 percent in nonattainment areas, and 97.1 percent in Stage II areas. This sensitivity scenario reduces each of the in-use ORVR control efficiencies for the different areas by five percent to account for possibly reduced I/M and OBD effectiveness. Table 7.11 shows the impact of in-use control efficiency on the ORVR cost effectiveness results.

Table 7.11—ORVR Sensitivity Analysis—In-Use Control Efficiency

Analyses/Scenarios	Cost Effectiveness ($/Mg)	
	Base Case	5% Reduction in In-Use Efficiency
Nonattainment Areas Truck Analysis		
1. Baseline (Stage II Absent)	25	57
2. Stage II Present	600	683
3. Stage II Discontinued in 2010	169	214
All-Areas Truck Analysis		
4. Baseline (Stage II Absent)	13	29
5. Stage II Present	162	186
6. Stage II Discontinued in 2010	70	89
Nonattainment Areas All-Vehicles Analysis		
7. Baseline (Stage II Absent)	55	88
8. Stage II Present	681	769
9. Stage II Discontinued in 2010	213	260
All-Areas All-Vehicles Analysis		
10. Baseline (Stage II Absent)	27	44
11. Stage II Present	184	209
12. Stage II Discontinued in 2010	88	108

A reduction in efficiency causes a reduction in benefits and a reduction in fuel recovery credits, resulting in a modest increase in the cost per Mg for all scenarios evaluated. Considering the fact that the 5 percent reduction in efficiency is a conservative assumption, it is evident that the onboard program remains an attractive strategy for the control of refueling emissions from a cost/benefit perspective.

7.4.1.4 Control of Breathing Loss Emissions

A minor component of refueling emissions is known as breathing loss (or emptying loss) emissions. These emissions are considered to be generated as part of the process in which ambient air is drawn into the gasoline underground storage tank to replace the lost volume of fuel having been dispensed. The air, as it becomes saturated with the gasoline vapors in the underground tank, expands slightly. This expansion is then assumed to give rise to emissions back out the underground tank's vent pipe. Breathing losses have not been measured extensively, but have been estimated based upon the theoretical considerations described above. EPA believes that breathing loss emissions are very small[7] and that onboard controls have no significant effect on breathing losses (see the Summary and Analysis of Comments of the ORVR regulation for further discussion).

While extensive supporting data are not available, some commentors have argued that Stage II systems have the potential to control breathing loss emissions. With the implementation of onboard controls in Stage II areas and possible eventual discontinuation of Stage II controls, the assumed control of breathing loss nonattainment area emissions by Stage II would then be reduced or eliminated. If this were the case, then breathing loss emissions could be controlled by the use of a pressure valve or limiting orifice in the underground storage tank vent pipe. Thus, a sensitivity analysis was conducted to examine how the ORVR cost effectiveness would be impacted if the cost of breathing loss controls on underground storage tanks was charged against the ORVR program. This scenario is very conservative, considering the fact that breathing losses are not expected to be a problem with the implementation of ORVR systems.

Based on conversations with potential vendors, the cost of breathing loss controls is $60 per system (i.e. per underground tank). To calculate the total costs of the breathing loss controls, the cost per tank is multiplied by the estimated number of underground storage tanks (344,000) nationwide. Using the service station distribution in Table 6.3, this analysis assumes two tanks for Model Plant 1, three tanks for Model Plants 2 and 3, four tanks for Model Plant 4, and five tanks for Model Plant 5. These are conservative, since Model Plant 1 stations would not have Stage II controls in most areas. The sensitivity scenario assumes that the estimated total cost for the breathing loss controls ($20.64 million) is allocated to all vehicles having onboard systems for the first five years of the program (i.e., 1998-2002). The end result is a cost per vehicle of $0.29, which is added to the first five years of hardware cost for the onboard program (this cost estimate neglects cost-reducing vapor recovery credits for many stations which would have to be considered in a more complete analysis). Because of the low cost per vehicle increase, the cost per Mg values are only slightly increased when breathing losses are considered. Table 7.12 summarizes the cost effectiveness results for ORVR systems, with and without breathing loss controls.

[7] Approximately 0.30 g/gal (see section 6.3.1).

Table 7.12—ORVR Sensitivity Analysis—Control of Breathing Loss Emissions

Analyses/Scenarios	Cost Effectiveness ($/Mg)	
	Base Case: Breathing Loss Controls Absent	Breathing Loss Controls Present
Nonattainment Areas Truck Analysis		
1. Baseline (Stage II Absent)	25	32
2. Stage II Present	600	620
3. Stage II Discontinued in 2010	169	180
All-Areas Truck Analysis		
4. Baseline (Stage II Absent)	13	16
5. Stage II Present	162	167
6. Stage II Discontinued in 2010	70	74
Nonattainment Areas All-Vehicles Analysis		
7. Baseline (Stage II Absent)	55	64
8. Stage II Present	681	706
9. Stage II Discontinued in 2010	213	226
All-Areas All-Vehicles Analysis		
10. Baseline (Stage II Absent)	27	32
11. Stage II Present	184	191
12. Stage II Discontinued in 2010	88	93

7.4.1.5 Number of Moderate Nonattainment Areas with Stage II

As described previously, the cost effectiveness analysis considered various scenarios under different Stage II implementation assumptions. When Stage II was assumed present, EPA included as Stage II areas all nonattainment areas categorized as serious, severe, or extreme, as well as most of the moderate areas and a few marginal areas expected to implement Stage II. This section evaluates the impact of a change in the number of moderate nonattainment areas assumed to have Stage II controls on the ORVR cost effectiveness. Two sensitivity scenarios are included. The first scenario assumes that all moderate nonattainment areas have Stage II (assuming metropolitan distribution and a 10/10 exemption level). The second scenario assumes that Stage II controls are not implemented in some moderate nonattainment areas presently planning to, as result of ORVR implementation. The moderate areas assumed to withdraw from Stage II are those which are currently delaying the implementation of the program, even though they have begun to consider Stage II controls.

Table 7.13 summarizes ORVR cost effectiveness results and shows the impact of the number of moderate nonattainment areas participating in the Stage II program. When all moderate nonattainment areas are considered, the cost effectiveness of the onboard program is slightly reduced (i.e, cost per Mg increases slightly) because a larger portion of the benefits for the additional Stage II nonattainment areas now are allocated to Stage II instead of onboard. The opposite happens when some moderate areas are withdrawn from the Stage II program. In fact, the cost effectiveness for the nonattainment areas scenarios is considerably improved with the assumed withdrawal of some moderate nonattainment areas from Stage II.

Table 7.13—ORVR Sensitivity Analysis—Number of Moderate Nonattainment Areas

Analyses/Scenarios	Cost Effectiveness ($/Mg)		
	Base Case: Majority of Moderate NAAs Considered to be Stage II	All Moderate NAAs Considered to be Stage II	Withdrawal of Some Moderate NAAs from Stage II
Nonattainment Areas Truck Analysis			
1. Baseline (Stage II Absent)	25	25	25
2. Stage II Present	600	663	399
3. Stage II Discontinued in 2010	169	177	142
All-Areas Truck Analysis			
4. Baseline (Stage II Absent)	13	13	13
5. Stage II Present	162	170	140
6. Stage II Discontinued in 2010	70	72	63
Nonattainment Areas All-Vehicles Analysis			
7. Baseline (Stage II Absent)	55	55	55
8. Stage II Present	681	750	459
9. Stage II Discontinued in 2010	213	222	182
All-Areas All-Vehicles Analysis			
10. Baseline (Stage II Absent)	27	27	27
11. Stage II Present	184	192	161
12. Stage II Discontinued in 2010	88	90	80

7.4.1.6 California Implementation

The cost effectiveness analysis assumed that the onboard requirement applies to vehicles in all 50 states. However, because California has its own motor vehicle emission control program, the possibility exists for California to apply for a CAA section 209 waiver from federal preemption for the control of evaporative emissions that could exclude onboard controls. This section examines the impact of not including California in the ORVR program. Stage II has been implemented in the entire state of California; thus, this scenario assumes that California maintains Stage II for the control of refueling emissions. When California is excluded from the cost effectiveness analysis, the overall nationwide costs of the onboard program are reduced due to a reduction in hardware costs (i.e., less vehicles considered). The benefits are also reduced by eliminating California from the analysis, due to reduced ORVR-controlled fuel consumption. However, given that ORVR benefits in California are relatively small because of the widespread implementation of Stage II in the state, the impact of the reduction in benefits is not as significant as the effect on costs. Thus, the overall cost effectiveness of the onboard program improves.

As shown by the results in Table 7.14, when California is excluded from the analysis, the ORVR cost effectiveness in the other states is improved. This does not suggest that ORVR controls are not appropriate for California. It only indicates that the cost per Mg of emission reduction for California alone is somewhat higher than for the other nonattainment areas due to higher fuel volatility control in California and the current widespread use of Stage II.

Table 7.14—ORVR Sensitivity Analysis—California Implementation

Analyses/Scenarios	Cost Effectiveness ($/Mg)	
	Base Case: ORVR in all 50 states	ORVR in all states, except California
Nonattainment Areas Truck Analysis		
1. Baseline (Stage II Absent)	25	23
2. Stage II Present	600	485
3. Stage II Discontinued in 2010	169	151
All-Areas Truck Analysis		
4. Baseline (Stage II Absent)	13	10
5. Stage II Present	162	121
6. Stage II Discontinued in 2010	70	55
Nonattainment Areas All-Vehicles Analysis		
7. Baseline (Stage II Absent)	55	54
8. Stage II Present	681	559
9. Stage II Discontinued in 2010	213	195
All-Areas All-Vehicles Analysis		
10. Baseline (Stage II Absent)	27	24
11. Stage II Present	184	139
12. Stage II Discontinued in 2010	88	71

7.4.2 Stage II Retention Sensitivity Analysis

The Stage II retention analysis presented in Chapter 6 examined the costs and benefits which would apply if Stage II controls had to be retained for the sole purpose of controlling the refueling emissions from LDTs and HDVs. This section evaluates three major factors affecting the calculation of Stage II retention cost effectiveness, as follows: fuel price, size distribution of Stage II facilities, and maintenance and other facility costs. The following sections provide a description of the three sensitivity scenarios. Table 7.15 shows the sensitivity analysis results for the different scenarios, as compared to Chapter 6 results (i.e., base case).

Table 7.15—Stage II Retention Sensitivity Analysis

Cost Effectiveness ($/Mg)			
Base Case (Chapter 6)	Fuel Price = $1.00	Metropolitan Distribution for all Stage II Areas	API Maintenance and Indirect Costs
3,070	3,006	2,808	4,207

7.4.2.1 Fuel Price

This sensitivity scenario evaluates the effect of increasing the fuel price from $0.82 to $1.00 in the Stage II retention analysis. The Stage II retention cost effectiveness results presented in Chapter 6 (which assumed a fuel price of $0.82) are compared with the sensitivity analysis results using a fuel price of $1.00, as shown in Table 7.15. As expected, the increase in fuel price results in a reduction in Stage II retention costs due to an increase in fuel recovery credits.

7.4.2.2 Distribution of Stage II Facilities

In the calculation of Stage II retention cost presented in Chapter 6, EPA assumed that refueling service stations (model plants) in nonattainment areas follow the metropolitan distribution pattern unless the whole state is a nonattainment area. This assumption resulted in the allocation of about 59 percent of all Stage II throughput by the metropolitan distribution and 41 percent by the nationwide distribution (see Chapter 6 for additional discussion).

In order to examine the impact of model plant distribution on the Stage II retention cost effectiveness, EPA evaluated a sensitivity scenario that assumes that all Stage II facilities follow a metropolitan distribution. Using a metropolitan distribution pattern results in reduced numbers of smaller model plants. Particularly, the metropolitan distribution causes a decrease in the number of Model Plant 1 refueling stations, which were assumed in this analysis to be exempt from Stage II requirements. Thus, the metropolitan distribution results in fewer waivers for Stage II stations. In addition, the use of a metropolitan distribution results in a relatively higher number of stations in the larger model plant categories, which are characterized by more efficient operations (i.e., higher throughput per unit of cost) than smaller stations. As a result, the cost effectiveness of Stage II retention is improved, as shown in Table 7.15.

7.4.2.3 Maintenance and Indirect Facility Costs

Maintenance and other indirect facility costs used in the Stage II retention analysis were presented in Chapter 6 (see Table 6.3). These costs were extracted from the 1991 Technical Guidance[8] document and adjusted to 1993 dollars at an average inflation rate

[8] *"Technical Guidance--Stage II Vapor Recovery Systems for Control of Vehicle Refueling Emissions at Gasoline Dispensing Facilities,"* U.S. EPA, EPA-450/3-91-022a, November 1991, Table 5-1, p. 5-30.

of 3 percent. For the different model plants the maintenance and indirect costs range between $150-$190 per facility.

EPA received comments from the American Petroleum Institute (API)[9] and General Motors (GM)[10] on the maintenance costs of Stage II. The API costs were higher (i.e., about $239 *per nozzle*[11], adjusted to 1993 dollars) than the EPA costs used in the Stage II retention cost effectiveness analysis. GM costs were somewhat between EPA and API costs. To be conservative, EPA selected the higher costs (i.e., API's costs) to conduct the sensitivity analysis. Also, EPA assumed that these costs included other indirect facility costs. The calculated cost effectiveness using API costs is shown in Table 7.15. As expected, the increase in maintenance and other indirect facility costs results in higher costs per Mg for the Stage II retention analysis.

7.4.3 Summary of Sensitivity Analyses

The above sections described the impact of various factors affecting the cost effectiveness of ORVR systems and Stage II retention. The sensitivity analysis results demonstrated that changes in major assumptions do not significantly affect the overall cost effectiveness of the ORVR program. Although modest changes in cost and benefits were observed, the ORVR cost effectiveness values still compare very favorably with other control strategies (as described in Section 7.3.4.6) and with Stage II retention. The cost per Mg for all ORVR sensitivity scenarios (Tables 7.9-7.14) remained much lower than the cost per Mg for Stage II retention scenarios (Table 7.15).

7.5 Other Benefits

7.5.1 Energy Impact

In addition to the projected economic benefits quantified in this analysis as "fuel recovery credits" (see Chapter 5), ORVR systems will also have a positive impact in terms of energy conservation. Fuel vapors that would otherwise have been lost to the atmosphere will now be saved and used instead to power the vehicle. This will result in fuel and energy savings that could ultimately translate into a reduction in gasoline and oil imports due to the net fuel consumption improvement. The estimated number of gallons of fuel recovered with the implementation of onboard controls is shown in Table 7.16. This analysis shows that there are positive energy conservation benefits due to onboard controls even in the presence of Stage II. The estimated nationwide fuel recovery for all vehicle classes averages about 84 million gallons per year and amounts to over 1.9 billion gallons during the period 1998-2020. This estimate assumes conservatively that 45 percent of fuel is dispensed through areas with Stage II control. If Stage II is

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[9] $200 per nozzle (in 1987 dollars), p. 64 of item IV-D-861 in docket A-87-11.

[10] $118-$129 (in 1987 dollars), p. 13 of item IV-D-854 in docket A-87-11.

[11] The Stage II technical guidance document (page 5-29) gives the following number of nozzles per multi-product model plant: Model Plant 1, 4; Model Plant 2, 6; Model Plant 3, 12; Model Plant 4, 18; Model Plant 5, 30.

discontinued in 2010, the benefits would increase to an average of about 117 million gallons per year or a total of about 2.7 billion gallons for the period 1998-2020.

Table 7.16—Projected Fuel Savings[a]

Year	LDV	LDT	HDV		All Classes
			LHDGV	HHDGV	
1998	1,677,928	985,118	105,634	36,064	2,804,745
1999	6,015,986	3,761,361	394,929	134,830	10,307,106
2000	11,895,853	7,824,198	820,468	280,110	20,820,628
2001	17,841,555	12,095,408	1,268,214	432,972	31,638,148
2002	23,523,913	16,249,575	1,700,955	580,711	42,055,153
2003	29,053,247	20,053,497	2,138,497	730,089	51,975,330
2004	34,337,030	23,433,579	2,588,644	883,771	61,243,024
2005	38,937,543	26,111,398	3,006,981	1,026,592	69,082,513
2006	42,820,087	28,255,427	3,374,300	1,151,996	75,601,810
2007	46,285,374	30,089,112	3,691,204	1,260,188	81,325,877
2008	49,638,561	31,822,601	3,973,896	1,356,699	86,791,758
2009	53,027,335	33,792,838	4,297,401	1,467,145	92,584,720
2010	56,297,783	35,964,354	4,658,119	1,590,295	98,510,551
2011	59,106,489	38,017,940	5,026,039	1,715,904	103,866,372
2012	61,573,559	39,909,261	5,344,743	1,824,711	108,652,274
2013	63,628,710	41,523,046	5,626,835	1,921,018	112,699,608
2014	65,402,723	42,986,980	5,880,718	2,007,694	116,278,114
2015	67,067,306	44,426,972	6,127,398	2,091,911	119,713,588
2016	68,481,001	45,754,355	6,342,268	2,165,269	122,742,893
2017	69,818,183	47,006,369	6,535,531	2,231,249	125,591,332
2018	71,054,832	48,167,939	6,711,389	2,291,287	128,225,447
2019	72,232,763	49,282,515	6,877,643	2,348,047	130,740,967
2020	73,375,996	50,380,243	7,036,095	2,402,143	133,194,477
average	47,091,033	31,212,786	4,066,430	1,388,291	83,758,541
sum	1,083,093,756	717,894,085	93,527,901	31,930,692	1,926,446,434

[a] Assumes 45 percent of fuel is dispensed through areas with Stage II.

7.5.2 Health Effects

Onboard controls will provide important air quality benefits by improving ambient ozone levels in all areas of the country. This includes those areas that are currently, or are projected to be, in violation of the National Ambient Air Quality Standard (NAAQS) for ozone, and those areas that are now in compliance with the ambient standard. Further, onboard controls will help protect the general public from the risks of cancer due to exposure to benzene, a component of gasoline vapor, and to evaporated gasoline as a whole. Reduced exposure to gasoline vapors is also expected to provide benefits in terms of the avoidance of non-cancer health effects.

7.5.2.1 Ozone reduction

The contribution of hydrocarbon emissions from gasoline refueling operations to ambient ozone levels has been recognized for some time. Refueling emissions consist almost entirely of non-methane hydrocarbons. In the presence of sunlight, these VOCs combine with other pollutants, in a series of chemical reactions, to produce ozone (and other photochemical oxidants). Ozone is a pulmonary irritant that adversely affects pulmonary membranes, lung tissues, and lung function. Animal studies also indicate that ozone may lead to an increased susceptibility to bacterial infection. These detrimental health effects may aggravate existing illness or lead to lung disease. By reducing VOC emissions, onboard controls will reduce the potential for ozone formation and ozone-related human health effects.

7.5.2.2 Benzene and Gasoline Vapors

Carcinogenic Effects

In addition to the concerns described above regarding ozone formation, there is evidence that direct exposure to gasoline vapor resulting from refueling emissions poses risks to public health. Gasoline and its vapors are a complex mixture of VOCs. One of the most important constituents, from a public health effects perspective, is benzene. Epidemiological studies indicate that benzene is a human carcinogen. Benzene carcinogenicity in animals has also been shown in laboratory studies. Based on this evidence, EPA classifies benzene as a Group A human carcinogen. In addition, EPA classifies gasoline vapor as a Group B2 (i.e., probable human carcinogen) based on sufficient evidence in animals that inhalation of wholly vaporized gasoline is carcinogenic.

EPA has estimated the annual incidences for different exposure scenarios involving refueling emissions.[12] These scenarios include occupational exposure, self-service exposure, and community exposure. Occupational exposure refers to the exposure of service station attendants to gasoline vapor. Self-service exposure refers to the exposure persons are subjected to in refueling their own vehicle. Community exposure refers to the exposure experienced by persons residing in the immediate vicinity of service stations. The estimated annual incidences for each scenario are summarized in Table 7.17. Although EPA has estimated annual incidences for both benzene and gasoline vapors, this analysis evaluates the impact of onboard controls on the cancer incidences for benzene exposure only. The reason for this is that, although EPA has recognized the potential cancer risk for gasoline vapor, the unit risk estimate for this mixture is highly uncertain.

[12] *"Motor Vehicle-Related Air Toxics Study,"* EPA 420-R-93-005, April 1993.

Table 7.17—Estimated Annual Average (1988-2020) Cancer Incidences Resulting from Uncontrolled Refueling Benzene Emissions[13]

Scenario	Annual Average Cancer Incidence
Occupational	1.7
Self-service	4.4
Community	0.5
Total	6.6

As shown in Table 7.17, self-service exposure results in the greatest annual cancer incidence because of the large number of people that pump their own gasoline. EPA recognizes that these estimated incidences have inherent uncertainties in terms of emission estimates, dose-response values, and exposure. In view of these uncertainties, the Agency interprets these values as plausible upper bounds of risk for possible effects. The upper bound of annual incidences for all scenarios is estimated to be 6.6.

Based on the above analysis, the Agency expects additional health effects benefits to occur in both attainment and nonattainment areas as a result of onboard control of benzene vapors in refueling emissions. Reducing human exposure to refueling vapors will directly reduce the potential cancer risk associated with benzene. EPA estimates that onboard controls will result in the reduction of 3 cancer incidences per year, if Stage II controls are present. This estimate assumes conservatively that ORVR systems are responsible for the control of 50 percent of all refueling emissions (due to the presence of Stage II controls) and an overall ORVR in-use efficiency of 92.0 percent. If Stage II is discontinued in the future then the number of cancer incidences avoided with onboard controls would increase to 6 incidences per year.

These additional benefits are certainly of value to society and are considered significant from a public health perspective. However, assigning exact monetary value to the number of cancer incidences avoided is problematic given the number of variables involved and the ways various segments of the society may value this type of benefit. In spite of this limitation, estimates for this value have been identified in the past in an attempt to evaluate the benefits of reduced cancer risks. For example, a range of $0.5 to $7.5 million per incidence avoided has sometimes been used by EPA and others in this type of analysis. While EPA is not endorsing these specific values for the purpose of this analysis, the estimates are useful in the evaluation of the overall cost effectiveness of ORVR systems. Clearly, if such monetary benefits were included, the costs of the ORVR program would be largely offset resulting in even more attractive cost effectiveness values.

Non-carcinogenic Effects

In addition to the above described benefits, the use of onboard controls will also prevent non-cancer effects. A description of non-cancer effects resulting from exposure

[13] *"Motor Vehicle-Related Air Toxics Study,"* EPA 420-R-93-005, April 1993.

to benzene and gasoline vapors is included in the EPA "Motor Vehicle-Related Air Toxics Study" referenced above. The major toxic effects of benzene in humans and other animals following inhalation exposure include central nervous system (CNS), hematological, and immunological effects. Exposure to gasoline vapors through inhalation may cause respiratory tract irritation, CNS depression, pulmonary edema, bronchial pneumonia, and heart damage.

Although the extent of non-cancer health benefits is not quantified in this analysis, EPA expects a reduction in non-carcinogenic effects due to the onboard control of refueling vapor emissions.

7.5.3 Welfare Effects

In addition to the human health effects described above, ozone may adversely affect vegetation, natural ecosystems, and various types of non-biological materials.[14]

Ozone effects on vegetation include damage to plant foliage, reduced plant growth, decreased yield, changes in crop quality, and alterations in susceptibility to stress. Nationwide economic losses due to ozone effects on crops have been estimated to be between two and three billion dollars. Ozone has also been identified as one of the agents responsible for the decline of forest ecosystems. It is important to realize that because a variety of energy and nutrient exchange linkages exist between different ecosystems, an adverse impact on a forest or agricultural ecosystem may in turn adversely affect adjacent aquatic systems. Thus, disruption induced by air pollution stress on terrestrial ecosystems will also often trigger dysfunctions in neighboring aquatic ecosystems, such as streams, lakes, and reservoirs.

Data are also available regarding the effects of photochemical oxidants, such as ozone, on both manmade and natural materials, such as elastomers, textile fibers and dyes, and certain types of paints. This damage to non-biological materials from ozone can be translated into costs (e.g., repair costs, replacement, impairment of life and/or aesthetics of materials, etc.). Although it is difficult to make a definite quantitative estimation of the damage costs related to ozone effects on non-biological materials, the magnitude of potential damage is expected to lie in the hundreds of millions of dollars.

7.6 Benefit-Cost Ratio

As was discussed above, EPA expects that the use of onboard controls will have a positive economic impact by reducing VOCs, thus preventing the formation of ozone and decreasing vegetation damage, agricultural losses, ecosystem effects, and damage to non-biological materials. Health benefits are expected, as well. If the benefits of VOC control are valued at $500 per Mg, as was done in the NPRM, the benefit-cost ratio can be estimated using the information in Table 7.6. Using the average annual costs and benefits, Table 7.18 shows that the benefit-cost ratio exceeds 1.0 for all cases.

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[14] *"Air Quality Criteria for Ozone and Other Photochemical Oxidants,"* EPA-600/8-84-020aF, August 1986.

Table 7.18—Benefit-Cost Ratios for each Scenario

Analyses/Scenarios	Average Annual Benefits ($millions)[a]	Average Annual Costs ($millions)	Benefit-Cost Ratio[b]
Nonattainment Areas Truck Analysis			
1. Baseline (Stage II Absent)	46.20	-7.00	-
2. Stage II Present	16.70	10.90	1.5
3. Stage II Discontinued in 2010	36.70	-1.30	-
All-Areas Truck Analysis			
4. Baseline (Stage II Absent)	92.10	-7.00	-
5. Stage II Present	62.00	10.90	5.7
6. Stage II Discontinued in 2010	82.40	-1.30	-
Nonattainment Areas All-Vehicles Analysis			
7. Baseline (Stage II Absent)	104.40	-11.40	-
8. Stage II Present	37.80	28.90	1.3
9. Stage II Discontinued in 2010	82.80	1.70	48
All-Areas All-Vehicles Analysis			
10. Baseline (Stage II Absent)	208.20	-11.40	-
11. Stage II Present	140.30	28.90	4.9
12. Stage II Discontinued in 2010	186.10	1.70	109

[a] Each Mg is valued at $500.
[b] Dashes (-) signify negative costs, yielding undefined benefit-cost -ratios.

These values are conservative, since they do not ascribe a monetary value to the health benefits. Furthermore, a benefit value of only $500 per Mg was used. In contrast, API suggested values ranging from $750 per ton in attainment areas to $7500 in extreme nonattainment areas. Using any value in this range would greatly increase the benefit-cost ratio.

7.7 Implications of Stage II Discontinuation on Benefit-Cost Ratios

Another way to examine the benefit-cost ratios would be to include the cost savings of discontinuing the redundant control of Stage II once ORVR is widely implemented. Discontinuation of Stage II in 2010 would result in a large cost savings from eliminated Stage II retention costs (including maintenance, indirect and enforcement—see Chapter 6). If these cost savings are included, nonattainment area all-vehicles average annual costs would be -$41 million, resulting in an actual cost savings in addition to other non-monetary benefits. (See Appendix E for data.) One might argue that not requiring ORVR for trucks would provide cost savings as well, however, these cost savings would be much less than provided by discontinuing Stage II controls.

7.8 Conclusions

The analyses included in this chapter demonstrate that the ORVR program is a very cost effective strategy for reducing refueling emissions. Furthermore, onboard controls will provide additional energy savings, health benefits, and welfare benefits throughout the country. Although the monetary value of these additional benefits has not been directly included in the cost effectiveness calculations, it is evident that these benefits would substantially improve the cost effectiveness of ORVR systems. In fact, if these benefits were included, the ORVR costs would be less than the ORVR benefits.

One key issue examined in this chapter was whether it was appropriate to extend the ORVR regulation to include LDTs and HDVs or whether Stage II should be retained for the control of refueling emissions from trucks. Different scenarios were evaluated to address this question. The cost effectiveness results support the application of nationwide ORVR systems to all vehicle classes, including LDTs and HDVs. The results also show that the ORVR program is more cost effective than Stage II retention for the control of truck refueling emissions.

Although EPA has not decided whether to allow discontinuation of Stage II once ORVR-equipped vehicles are in widespread use, this analysis does suggest that discontinuation of Stage II controls may be justifiable in the future. With implementation of ORVR systems in all vehicle classes, there may be no need to maintain Stage II controls. The results indicate that the ORVR program will be a cost effective option for Stage II in the long term due to its higher in-use control efficiency.

Appendix A: Supporting Data for Chapters 3 and 6

Region	State	CMSA/PMSA/MSA's in Non-Attainment Areas /2/	County	Ozone Desig.	Stage II Area?	State (on road) Throughput	NAA Throughput	mod+NAA Throughput	Stage II throughput	SZ NAA Throughput	Exemption (k gal/mo)	Waiver %	Stage II (w/ exemp.)	Metropolitan Model Plant 1	Metropolitan Model Plant 2	Metropolitan Model Plant 3	Metropolitan Model Plant 4	Metropolitan Model Plant 5	Nationwide Model Plant 1	Nationwide Model Plant 2	Nationwide Model Plant 3	Nationwide Model Plant 4	Nationwide Model Plant 5
1	CT	Entire State (56 FR 66444)	all	Ser/Sev	1	1.28E+09	1.28E+09	1.28E+09	1.28E+09	1.28E+09	10	5.28%	1.21E+09						1.12E+08	2.27E+08	3.51E+08	3.47E+08	2.40E+08
1	DC	Washington (56 FR 24037)	all	Serious	1	1.65E+08	1.65E+08	1.65E+08	1.65E+08	1.65E+08	10/50	10.00%	1.48E+08	4.61E+06	8.24E+06	2.04E+07	4.79E+07	8.34E+07					
1	DE	Philadelphia-Wilm-Trenton	Kent	Severe	1	3.28E+08	5.47E+07	5.47E+07	5.47E+07	5.47E+07	10	5.28%	5.18E+07						4.81E+06	9.73E+06	1.50E+07	1.49E+07	1.03E+07
1	DE	Philadelphia-Wilm-Trenton	New Castle	Severe	1	3.28E+08	2.18E+08	2.18E+08	2.18E+08	2.18E+08	10	5.28%	2.06E+08						1.92E+07	3.88E+07	5.99E+07	5.92E+07	4.09E+07
1	DE	Sussex Co (new)	Sussex	Marginal	1	3.28E+08	5.58E+07		5.58E+07	5.58E+07	10	5.28%	5.28E+07						4.91E+06	9.93E+06	1.53E+07	1.52E+07	1.05E+07
1	IL	Jersey Co (new)	Jersey	Marginal	0	4.40E+09	7.90E+06																
1	IL	Chicago-Gary-Lake County	Cook	Severe	1	4.40E+09	1.96E+09	1.96E+09	1.96E+09	1.96E+09	10	5.28%	1.86E+09	5.50E+07	9.82E+07	2.44E+08	5.71E+08	9.94E+08					
1	IL	Chicago-Gary-Lake County	Du Page	Severe	1	4.40E+09	3.01E+08	3.01E+08	3.01E+08	3.01E+08	10	5.28%	2.85E+08	8.42E+06	1.50E+07	3.73E+07	8.75E+07	1.52E+08					
1	IL	Chicago-Gary-Lake County	Grundy (all)	Severe	1	4.40E+09	1.24E+07	1.24E+07	1.24E+07	1.24E+07	10	5.28%	1.18E+07	3.48E+05	6.22E+05	1.54E+06	3.62E+06	6.29E+06					
1	IL	Chicago-Gary-Lake County	Kane	Severe	1	4.40E+09	1.22E+08	1.22E+08	1.22E+08	1.22E+08	10	5.28%	1.16E+08	3.42E+06	6.11E+06	1.51E+07	3.55E+07	6.18E+07					
1	IL	Chicago-Gary-Lake County	Kendall (all)	Severe	1	4.40E+09	1.52E+07	1.52E+07	1.52E+07	1.52E+07	10	5.28%	1.44E+07	4.25E+05	7.58E+05	1.88E+06	4.41E+06	7.67E+06					
1	IL	Chicago-Gary-Lake County	Lake	Severe	1	4.40E+09	1.99E+08	1.99E+08	1.99E+08	1.99E+08	10	5.28%	1.88E+08	5.56E+06	9.93E+06	2.46E+07	5.78E+07	1.01E+08					
1	IL	Chicago-Gary-Lake County	Mchenry	Severe	1	4.40E+09	7.05E+07	7.05E+07	7.05E+07	7.05E+07	10	5.28%	6.68E+07	1.97E+06	3.52E+06	8.74E+06	2.05E+07	3.57E+07					
1	IL	Chicago-Gary-Lake County	Will	Severe	1	4.40E+09	1.37E+08	1.37E+08	1.37E+08	1.37E+08	10	5.28%	1.30E+08	3.85E+06	6.87E+06	1.70E+07	4.00E+07	6.95E+07					
1	IL	St Louis	Madison	Moderate	1	4.40E+09	9.59E+07	9.59E+07	9.59E+07	9.59E+07	10/50	10.00%	8.63E+07	2.68E+06	4.79E+06	1.19E+07	2.79E+07	4.85E+07					
1	IL	St Louis	Monroe	Moderate	1	4.40E+09	8.63E+06	8.63E+06	8.63E+06	8.63E+06	10/50	10.00%	7.76E+06	2.42E+05	4.31E+05	1.07E+06	2.51E+06	4.36E+06					
1	IL	St Louis	St. Clair	Moderate	1	4.40E+09	1.01E+08	1.01E+08	1.01E+08	1.01E+08	10/50	10.00%	9.10E+07	2.83E+06	5.06E+06	1.25E+07	2.94E+07	5.12E+07					
1	IN	Louisville	Clark	Moderate	1	2.55E+09	2.19E+08	2.19E+08	2.19E+08	2.19E+08	10/50	10.00%	1.97E+08	6.13E+06	1.09E+07	2.71E+07	6.37E+07	1.11E+08					
1	IN	Louisville	Floyd	Moderate	1	2.55E+09	5.93E+07	5.93E+07	5.93E+07	5.93E+07	10/50	10.00%	5.34E+07	1.66E+06	2.97E+06	7.36E+06	1.73E+07	3.00E+07					
1	IN	South Bend-Elkhart	Elkhart	Marginal	0	2.55E+09	7.19E+07																
1	IN	South Bend-Elkhart	St.. Joseph	Marginal	0	2.55E+09	1.14E+08																
1	IN	Chicago-Gary-Lake County	Lake	Severe	1	2.55E+09	2.19E+08	2.19E+08	2.19E+08	2.19E+08	10/50	10.00%	1.97E+08	6.13E+06	1.09E+07	2.71E+07	6.37E+07	1.11E+08					
1	IN	Chicago-Gary-Lake County	Porter	Severe	1	2.55E+09	5.93E+07	5.93E+07	5.93E+07	5.93E+07	10/50	10.00%	5.34E+07	1.66E+06	2.97E+06	7.36E+06	1.73E+07	3.00E+07					
1	IN	Indianapolis	Marion	Marginal	0	2.55E+09	3.67E+08																
1	IN	Evansville (new)	Vanderburg	Marginal	0	2.55E+09	7.59E+07																
1	KY	Paducah (new)	Livingston	Marginal	0	1.75E+09	4.31E+06																
1	KY	Paducah (new)	Marshall	Marginal	0	1.75E+09	1.29E+07																
1	KY	Huntington-Ashland/1,6/	Boyd	Moderate	0	1.75E+09	2.43E+07	2.43E+07															
1	KY	Huntington-Ashland/1,6/	Greenup	Moderate	0	1.75E+09	1.75E+07	1.75E+07															
1	KY	Edmonson Co (new)	Edmonson	Marginal	0	1.75E+09	4.92E+06																
1	KY	Cincinnati-Hamilton	Boone	Moderate	1	1.75E+09	2.74E+07	2.74E+07	2.74E+07	2.74E+07	10	5.28%	2.59E+07	7.66E+05	1.37E+06	3.39E+06	7.96E+06	1.38E+07					
1	KY	Cincinnati-Hamilton	Campbell	Moderate	1	1.75E+09	3.98E+07	3.98E+07	3.98E+07	3.98E+07	10	5.28%	3.77E+07	1.12E+06	1.99E+06	4.94E+06	1.16E+07	2.02E+07					
1	KY	Cincinnati-Hamilton	Kenton	Moderate	1	1.75E+09	6.75E+07	6.75E+07	6.75E+07	6.75E+07	10	5.28%	6.39E+07	1.89E+06	3.37E+06	8.37E+06	1.96E+07	3.41E+07					
1	KY	Lexington-Fayette (new)	Fayette	Marginal	0	1.75E+09	1.07E+08																
1	KY	Lexington-Fayette (new)	Scott	Marginal	0	1.75E+09	1.13E+07																
1	KY	Louisville	Jefferson	Moderate	1	1.75E+09	3.16E+08	3.16E+08	3.16E+08	3.16E+08	10/50	10.00%	2.84E+08	8.85E+06	1.58E+07	3.92E+07	9.19E+07	1.60E+08					
1	KY	Owensboro (new)	Daviess	Marginal	0	1.75E+09	4.14E+07																
1	KY	Owensboro (new)	Hancock	Marginal	0	1.75E+09	3.74E+06																
1	MA	Entire State (56 FR 57986)	all	Serious	1	2.30E+09	2.30E+09	2.30E+09	2.30E+09	2.30E+09	10	5.28%	2.18E+09						2.03E+08	4.10E+08	6.34E+08	6.27E+08	4.33E+08
1	MD	Philadelphia-Wilm-Trenton	Cecil	Severe	1	1.98E+09	2.95E+07	2.95E+07	2.95E+07	2.95E+07	10/50	10.00%	2.66E+07										
1	MD	Washington	Calvert	Serious	1	1.98E+09	2.13E+07	2.13E+07	2.13E+07	2.13E+07	10/50	10.00%	1.91E+07	5.95E+05	1.06E+06	2.64E+06	6.19E+06	1.08E+07					
1	MD	Washington	Charles	Serious	1	1.98E+09	4.19E+07	4.19E+07	4.19E+07	4.19E+07	10/50	10.00%	3.77E+07	1.17E+06	2.09E+06	5.19E+06	1.22E+07	2.12E+07					
1	MD	Washington	Fredrick	Serious	1	1.98E+09	6.21E+07	6.21E+07	6.21E+07	6.21E+07	10/50	10.00%	5.59E+07	1.74E+06	3.11E+06	7.71E+06	1.81E+07	3.14E+07					
1	MD	Washington	Montgomer	Serious	1	1.98E+09	3.13E+08	3.13E+08	3.13E+08	3.13E+08	10/50	10.00%	2.82E+08	8.77E+06	1.57E+07	3.88E+07	9.11E+07	1.58E+08					
1	MD	Washington	Prince Geor	Serious	1	1.98E+09	3.02E+08	3.02E+08	3.02E+08	3.02E+08	10/50	10.00%	2.72E+08	8.45E+06	1.51E+07	3.74E+07	8.78E+07	1.53E+08					
1	MD	Baltimore	Anne Arude	Severe	1	1.98E+09	1.77E+08	1.77E+08	1.77E+08	1.77E+08	10/50	10.00%	1.59E+08	4.95E+06	8.84E+06	2.19E+07	5.14E+07	8.94E+07					
1	MD	Baltimore	Baltimore	Severe	1	1.98E+09	2.86E+08	2.86E+08	2.86E+08	2.86E+08	10/50	10.00%	2.58E+08	8.02E+06	1.43E+07	3.55E+07	8.33E+07	1.45E+08					
1	MD	Baltimore	Carrol	Severe	1	1.98E+09	5.10E+07	5.10E+07	5.10E+07	5.10E+07	10/50	10.00%	4.59E+07	1.43E+06	2.55E+06	6.33E+06	1.49E+07	2.58E+07					
1	MD	Baltimore	Hartford	Severe	1	1.98E+09	7.54E+07	7.54E+07	7.54E+07	7.54E+07	10/50	10.00%	6.78E+07	2.11E+06	3.77E+06	9.34E+06	2.19E+07	3.81E+07					
1	MD	Baltimore	Howard	Severe	1	1.98E+09	7.75E+07	7.75E+07	7.75E+07	7.75E+07	10/50	10.00%	6.98E+07	2.17E+06	3.88E+06	9.61E+06	2.26E+07	3.92E+07					
1	MD	Baltimore	Baltimore c	Severe	1	1.98E+09	3.05E+08	3.05E+08	3.05E+08	3.05E+08	10/50	10.00%	2.74E+08	8.53E+06	1.52E+07	3.78E+07	8.86E+07	1.54E+08					
1	MD	Kent & Queen Anne's Cos (n	Kent	Marginal	0	1.98E+09	7.38E+06																
1	MD	Kent & Queen Anne's Cos (n	Queen Ann	Marginal	0	1.98E+09	1.40E+07																
1	ME	Hancock & Waldo Cos/1/	Hancock	Marginal	0	5.78E+08	2.21E+07																
1	ME	Hancock & Waldo Cos/1/	Waldo	Marginal	0	5.78E+08	1.56E+07																
1	ME	Portland	Cumberland	Moderate	0	5.78E+08	9.44E+07	9.44E+07															
1	ME	Portland	Sagadahoc	Moderate	0	5.78E+08	1.58E+07	1.58E+07															
1	ME	Portland	York	Moderate	0	5.78E+08	9.73E+06	9.73E+06															
1	ME	Lewiston-Auburn	Androscogg	Moderate	0	5.78E+08	4.41E+07	4.41E+07															
1	ME	Lewiston-Auburn	Kennebec	Moderate	0	5.78E+08	5.46E+07	5.46E+07															
1	ME	Knox & Lincoln Cos	Knox	Moderate	0	5.78E+08	1.71E+07	1.71E+07															
1	ME	Knox & Lincoln Cos	Lincoln	Moderate	0	5.78E+08	2.48E+07	2.48E+07															
1	ME	Flankin County	Flankin Cou	Attainment	0	5.78E+08																	
1	ME	Oxford	Oxford	Attainment	0	5.78E+08																	
1	ME	Somerset	Somerset	Attainment	0	5.78E+08																	

Region	State	CMSA/PMSA/MSA's in Non-Attainment Areas /2/	County	Ozone Desig.	Stage II Area?	State (on road) Throughput	NAA Throughput	mod + NAA Throughput	Stage II throughput	52 NAA Throughput	Exemption (k gal/mo)	Waiver %	Stage II (w/ exemp.)	Metropolitan Model Plant 1	Metropolitan Model Plant 2	Metropolitan Model Plant 3	Metropolitan Model Plant 4	Metropolitan Model Plant 5	Nationwide Model Plant 1	Nationwide Model Plant 2	Nationwide Model Plant 3	Nationwide Model Plant 4	Nationwide Model Plant 5
1	MI	Detroit-Ann Arbor	Livingston	Moderate	0	4.14E+09	5.14E+07	5.14E+07															
1	MI	Detroit-Ann Arbor	Macomb	Moderate	0	4.14E+09	3.19E+08	3.19E+08															
1	MI	Detroit-Ann Arbor	Oakland	Moderate	0	4.14E+09	4.82E+08	4.82E+08															
1	MI	Detroit-Ann Arbor	Monroe	Moderate	0	4.14E+09	5.94E+07	5.94E+07															
1	MI	Detroit-Ann Arbor	St. Clair	Moderate	0	4.14E+09	6.48E+07	6.48E+07															
1	MI	Detroit-Ann Arbor	Washtenaw	Moderate	0	4.14E+09	1.26E+08	1.26E+08															
1	MI	Detroit-Ann Arbor	Wayne	Moderate	0	4.14E+09	9.39E+08	9.39E+08															
1	MI	Grand Rapids	Kent	Moderate	0	4.14E+09	2.23E+08	2.23E+08															
1	MI	Grand Rapids	Ottawa	Moderate	0	4.14E+09	8.35E+07	8.35E+07															
1	NH	Boston-Lawrence-Worcester	Hillsboroug	Serious	1	4.83E+08	7.73E+07	7.73E+07	7.73E+07	7.73E+07	10/50	10.00%	6.96E+07	2.16E+06	3.86E+06	9.58E+06	2.25E+07	3.91E+07					
1	NH	Boston-Lawrence-Worcester	Rockinghan	Serious	1	4.83E+08	3.15E+06	3.15E+06	3.15E+06	3.15E+06	10/50	10.00%	2.84E+06	8.82E+04	1.58E+05	3.91E+05	9.17E+05	1.59E+06					
1	NH	Manchester	Hillsboroug	Marginal	0	4.83E+08	5.78E+07																
1	NH	Manchester	Merrimack	Marginal	0	4.83E+08	5.84E+06																
1	NH	Manchester	Rockinghan	Marginal	0	4.83E+08	1.19E+07																
1	NH	Portsmouth-Dover-Rocheste	Rockinghan	Serious	1	4.83E+08	3.86E+07	3.86E+07	3.86E+07	3.86E+07	10/50	10.00%	3.48E+07	1.08E+06	1.93E+06	4.79E+06	1.12E+07	1.95E+07					
1	NH	Portsmouth-Dover-Rocheste	Strafford	Serious	1	4.83E+08	4.27E+07	4.27E+07	4.27E+07	4.27E+07	10/50	10.00%	3.84E+07	1.20E+06	2.13E+06	5.29E+06	1.24E+07	2.16E+07					
1	NJ	Philadelphia-Wilm-Trenton	Bulington	Severe	1	3.34E+09	1.70E+08	1.70E+08	1.70E+08	1.70E+08	10	5.28%	1.61E+08						1.50E+07	3.03E+07	4.68E+07	4.63E+07	3.20E+07
1	NJ	Philadelphia-Wilm-Trenton	Camden	Severe	1	3.34E+09	2.17E+08	2.17E+08	2.17E+08	2.17E+08	10	5.28%	2.05E+08						1.91E+07	3.86E+07	5.96E+07	5.90E+07	4.08E+07
1	NJ	Philadelphia-Wilm-Trenton	Cumberland	Severe	1	3.34E+09	5.95E+07	5.95E+07	5.95E+07	5.95E+07	10	5.28%	5.64E+07						5.24E+06	1.06E+07	1.64E+07	1.62E+07	1.12E+07
1	NJ	Philadelphia-Wilm-Trenton	Gloucester	Severe	1	3.34E+09	9.92E+07	9.92E+07	9.92E+07	9.92E+07	10	5.28%	9.40E+07						8.73E+06	1.77E+07	2.73E+07	2.70E+07	1.86E+07
1	NJ	Philadelphia-Wilm-Trenton	Mercer	Severe	1	3.34E+09	1.40E+08	1.40E+08	1.40E+08	1.40E+08	10	5.28%	1.33E+08						1.24E+07	2.50E+07	3.86E+07	3.82E+07	2.64E+07
1	NJ	Philadelphia-Wilm-Trenton	Salem	Severe	1	3.34E+09	2.81E+07	2.81E+07	2.81E+07	2.81E+07	10	5.28%	2.67E+07						2.48E+06	5.01E+06	7.74E+06	7.66E+06	5.29E+06
1	NJ	Atlantic City	Atlantic	Moderate	1	3.34E+09	9.67E+07	9.67E+07	9.67E+07	9.67E+07	10	5.28%	9.16E+07						8.51E+06	1.72E+07	2.66E+07	2.63E+07	1.82E+07
1	NJ	Atlantic City	Cape	Moderate	1	3.34E+09	4.10E+07	4.10E+07	4.10E+07	4.10E+07	10	5.28%	3.88E+07						3.61E+06	7.30E+06	1.13E+07	1.12E+07	7.71E+06
1	NJ	Allentown-Bethlehem-Easton	Warren	Marginal	1	3.34E+09	3.95E+07		3.95E+07	3.95E+07	10	5.28%	3.74E+07						3.48E+06	7.03E+06	1.09E+07	1.07E+07	7.42E+06
1	NJ	NY-N. NJ-Long Island	Bergen	Severe	1	3.34E+09	3.56E+08	3.56E+08	3.56E+08	3.56E+08	10	5.28%	3.37E+08						3.13E+07	6.33E+07	9.79E+07	9.68E+07	6.69E+07
1	NJ	NY-N. NJ-Long Island	Essex	Severe	1	3.34E+09	3.35E+08	3.35E+08	3.35E+08	3.35E+08	10	5.28%	3.18E+08						2.95E+07	5.97E+07	9.23E+07	9.13E+07	6.31E+07
1	NJ	NY-N. NJ-Long Island	Hudson	Severe	1	3.34E+09	2.38E+08	2.38E+08	2.38E+08	2.38E+08	10	5.28%	2.26E+08						2.10E+07	4.24E+07	6.56E+07	6.49E+07	4.48E+07
1	NJ	NY-N. NJ-Long Island	Hunterdon	Severe	1	3.34E+09	4.65E+07	4.65E+07	4.65E+07	4.65E+07	10	5.28%	4.40E+07						4.09E+06	8.27E+06	1.28E+07	1.26E+07	8.74E+06
1	NJ	NY-N. NJ-Long Island	Middlesex	Severe	1	3.34E+09	2.90E+08	2.90E+08	2.90E+08	2.90E+08	10	5.28%	2.74E+08						2.55E+07	5.16E+07	7.96E+07	7.88E+07	5.44E+07
1	NJ	NY-N. NJ-Long Island	Monmouth	Severe	1	3.34E+09	2.38E+08	2.38E+08	2.38E+08	2.38E+08	10	5.28%	2.26E+08						2.10E+07	4.24E+07	6.56E+07	6.49E+07	4.48E+07
1	NJ	NY-N. NJ-Long Island	Morris	Severe	1	3.34E+09	1.82E+08	1.82E+08	1.82E+08	1.82E+08	10	5.28%	1.72E+08						1.60E+07	3.23E+07	5.00E+07	4.94E+07	3.42E+07
1	NJ	NY-N. NJ-Long Island	Ocean	Severe	1	3.34E+09	1.91E+08	1.91E+08	1.91E+08	1.91E+08	10	5.28%	1.81E+08						1.68E+07	3.40E+07	5.25E+07	5.20E+07	3.59E+07
1	NJ	NY-N. NJ-Long Island	Passiac	Severe	1	3.34E+09	1.95E+08	1.95E+08	1.95E+08	1.95E+08	10	5.28%	1.85E+08						1.72E+07	3.48E+07	5.37E+07	5.31E+07	3.67E+07
1	NJ	NY-N. NJ-Long Island	Somerset	Severe	1	3.34E+09	1.04E+08	1.04E+08	1.04E+08	1.04E+08	10	5.28%	9.81E+07						9.12E+06	1.84E+07	2.85E+07	2.82E+07	1.95E+07
1	NJ	NY-N. NJ-Long Island	Sussex	Severe	1	3.34E+09	5.65E+07	5.65E+07	5.65E+07	5.65E+07	10	5.28%	5.35E+07						4.97E+06	1.00E+07	1.55E+07	1.54E+07	1.06E+07
1	NJ	NY-N. NJ-Long Island	Union	Severe	1	3.34E+09	2.13E+08	2.13E+08	2.13E+08	2.13E+08	10	5.28%	2.02E+08						1.87E+07	3.79E+07	5.85E+07	5.79E+07	4.00E+07
1	NY	Essex Co (Whiteface Mtn) (n	Essex	Marginal	0	5.67E+09	1.17E+07																
1	NY	Albany-Schenectady-Troy (n	Albany	Marginal	0	5.67E+09	9.23E+07																
1	NY	Albany-Schenectady-Troy (n	Greene	Marginal	0	5.67E+09	1.41E+07																
1	NY	Albany-Schenectady-Troy (n	Montgomer	Marginal	0	5.67E+09	1.64E+07																
1	NY	Albany-Schenectady-Troy (n	Rensseiaer	Marginal	0	5.67E+09	4.87E+07																
1	NY	Albany-Schenectady-Troy (n	Saratoga	Marginal	0	5.67E+09	5.72E+07																
1	NY	Albany-Schenectady-Troy (n	Schenectad	Marginal	0	5.67E+09	4.71E+07																
1	NY	NY-N. NJ-Long Island	Bronx	Severe	1	5.67E+09	3.80E+08	3.80E+08	3.80E+08	3.80E+08	10/50	10.00%	3.42E+08	1.06E+07	1.90E+07	4.71E+07	1.10E+08	1.92E+08					
1	NY	NY-N. NJ-Long Island	Kings	Severe	1	5.67E+09	7.25E+08	7.25E+08	7.25E+08	7.25E+08	10/50	10.00%	6.53E+08	2.03E+07	3.63E+07	9.00E+07	2.11E+08	3.67E+08					
1	NY	NY-N. NJ-Long Island	Nassau	Severe	1	5.67E+09	4.06E+08	4.06E+08	4.06E+08	4.06E+08	10/50	10.00%	3.65E+08	1.14E+07	2.03E+07	5.03E+07	1.18E+08	2.05E+08					
1	NY	NY-N. NJ-Long Island	New York	Severe	1	5.67E+09	4.69E+08	4.69E+08	4.69E+08	4.69E+08	10/50	10.00%	4.22E+08	1.31E+07	2.35E+07	5.82E+07	1.36E+08	2.37E+08					
1	NY	NY-N. NJ-Long Island	Orange	Severe	1	5.67E+09	9.70E+07	9.70E+07	9.70E+07	9.70E+07	10/50	10.00%	8.73E+07	2.72E+06	4.85E+06	1.20E+07	2.82E+07	4.91E+07					
1	NY	NY-N. NJ-Long Island	Putham	Severe	1	5.67E+09	2.65E+07	2.65E+07	2.65E+07	2.65E+07	10/50	10.00%	2.38E+07	7.41E+05	1.32E+06	3.28E+06	7.70E+06	1.34E+07					
1	NY	NY-N. NJ-Long Island	Queens	Severe	1	5.67E+09	6.15E+08	6.15E+08	6.15E+08	6.15E+08	10/50	10.00%	5.54E+08	1.72E+07	3.08E+07	7.63E+07	1.79E+08	3.11E+08					
1	NY	NY-N. NJ-Long Island	Richmond	Severe	1	5.67E+09	1.19E+08	1.19E+08	1.19E+08	1.19E+08	10/50	10.00%	1.08E+08	3.35E+06	5.97E+06	1.48E+07	3.48E+07	6.05E+07					
1	NY	NY-N. NJ-Long Island	Rockland	Severe	1	5.67E+09	8.37E+07	8.37E+07	8.37E+07	8.37E+07	10/50	10.00%	7.53E+07	2.34E+06	4.19E+06	1.04E+07	2.44E+07	4.24E+07					
1	NY	NY-N. NJ-Long Island	Suffolk	Severe	1	5.67E+09	4.17E+08	4.17E+08	4.17E+08	4.17E+08	10/50	10.00%	3.75E+08	1.17E+07	2.08E+07	5.17E+07	1.21E+08	2.11E+08					
1	NY	NY-N. NJ-Long Island	Westcheste	Severe	1	5.67E+09	2.76E+08	2.76E+08	2.76E+08	2.76E+08	10/50	10.00%	2.48E+08	7.72E+06	1.38E+07	3.42E+07	8.03E+07	1.40E+08					
1	NY	Poughkeepsie (new)	Dutchess	Marginal	0	5.67E+09	8.18E+07																
1	NY	Buffalo-Niagara Falls (new)	Erie	Marginal	0	5.67E+09	3.05E+08																
1	NY	Buffalo-Niagara Falls (new)	Niagra	Marginal	0	5.67E+09	6.96E+07																
1	NY	Jefferson Co (new)	Jefferson	Marginal	0	5.67E+09	3.50E+07																
1	OH	Cleveland-Akron-Lorain/1/	Ashtabula	Moderate	1	4.54E+09	4.18E+07	4.18E+07	4.18E+07	4.18E+07	10	5.28%	3.95E+07	1.17E+06	2.09E+06	5.18E+06	1.21E+07	2.11E+07					
1	OH	Cleveland-Akron-Lorain/1/	Cuyahoga	Moderate	1	4.54E+09	9.01E+07	9.01E+07	9.01E+07	9.01E+07	10	5.28%	8.54E+07	2.52E+06	4.51E+06	1.12E+07	2.62E+07	4.56E+07					
1	OH	Cleveland-Akron-Lorain/1/	Geauga	Moderate	1	4.54E+09	3.39E+07	3.39E+07	3.39E+07	3.39E+07	10	5.28%	3.21E+07	9.50E+05	1.70E+06	4.21E+06	9.87E+06	1.72E+07					
1	OH	Cleveland-Akron-Lorain/1/	Lake	Moderate	1	4.54E+09	9.01E+07	9.01E+07	9.01E+07	9.01E+07	10	5.28%	8.54E+07	2.52E+06	4.51E+06	1.12E+07	2.62E+07	4.56E+07					
1	OH	Cleveland-Akron-Lorain/1/	Lorain	Moderate	1	4.54E+09	1.13E+08	1.13E+08	1.13E+08	1.13E+08	10	5.28%	1.07E+08	3.18E+06	5.67E+06	1.41E+07	3.30E+07	5.74E+07					
1	OH	Cleveland-Akron-Lorain/1/	Medina	Moderate	1	4.54E+09	5.12E+07	5.12E+07	5.12E+07	5.12E+07	10	5.28%	4.85E+07	1.43E+06	2.56E+06	6.35E+06	1.49E+07	2.59E+07					

Region	State	CMSA/PMSA/MSA's in Non-Attainment Areas /2/	County	Ozone Desig.	Stage II Area?	State (on road) Throughput	NAA Throughput	mod+NAA Throughput	Stage II throughput	S2 NAA Throughput	Exemption (k gal/mo)	Waiver %	Stage II (w/ exemp.)	Metropolitan Model Plant 1	Metropolitan Model Plant 2	Metropolitan Model Plant 3	Metropolitan Model Plant 4	Metropolitan Model Plant 5	Nationwide Model Plant 1	Nationwide Model Plant 2	Nationwide Model Plant 3	Nationwide Model Plant 4	Nationwide Model Plant 5
1	OH	Cleveland-Akron-Lorain/1/	Portage	Moderate	1	4.54E+09	5.96E+07	5.96E+07	5.96E+07	5.96E+07	10	5.28%	5.65E+07	1.67E+06	2.98E+06	7.40E+06	1.74E+07	3.02E+07					
1	OH	Cleveland-Akron-Lorain/1/	Summit	Moderate	1	4.54E+09	2.15E+08	2.15E+08	2.15E+08	2.15E+08	10	5.28%	2.04E+08	6.03E+06	1.08E+07	2.67E+07	6.27E+07	1.09E+08					
1	OH	Dayton-Springfield	Clark	Moderate	1	4.54E+09	6.17E+07	6.17E+07	6.17E+07	6.17E+07	10/50	10.00%	5.55E+07	1.73E+06	3.09E+06	7.65E+06	1.80E+07	3.12E+07					
1	OH	Dayton-Springfield	Greene	Moderate	1	4.54E+09	5.72E+07	5.72E+07	5.72E+07	5.72E+07	10/50	10.00%	5.15E+07	1.60E+06	2.86E+06	7.09E+06	1.66E+07	2.89E+07					
1	OH	Dayton-Springfield	Miami	Moderate	1	4.54E+09	3.90E+07	3.90E+07	3.90E+07	3.90E+07	10/50	10.00%	3.51E+07	1.09E+06	1.95E+06	4.83E+06	1.13E+07	1.97E+07					
1	OH	Dayton-Springfield	Montgomer	Moderate	1	4.54E+09	2.40E+08	2.40E+08	2.40E+08	2.40E+08	10/50	10.00%	2.16E+08	6.72E+06	1.20E+07	2.98E+07	6.98E+07	1.21E+08					
1	OH	Columbus (new)	Deleware	Marginal	0	4.54E+09	2.80E+07																
1	OH	Columbus (new)	Franklin	Marginal	0	4.54E+09	4.02E+08																
1	OH	Columbus (new)	Licking	Marginal	0	4.54E+09	5.37E+07																
1	OH	Canton	Stark	Marginal	0	4.54E+09	1.54E+08																
1	OH	Toledo/1/	Lucas	Moderate	1	4.54E+09	1.93E+08	1.93E+08	1.93E+08	1.93E+08	10/50	10.00%	1.74E+08	5.41E+06	9.67E+06	2.40E+07	5.63E+07	9.79E+07					
1	OH	Toledo/1/	Wood	Moderate	1	4.54E+09	4.74E+07	4.74E+07	4.74E+07	4.74E+07	10/50	10.00%	4.26E+07	1.33E+06	2.37E+06	5.87E+06	1.38E+07	2.40E+07					
1	OH	Youngstown-Warren-Sharon	Mahoning	Marginal	0	4.54E+09	1.11E+08																
1	OH	Youngstown-Warren-Sharon	Trumbull	Marginal	0	4.54E+09	9.53E+07																
1	OH	Cincinnati-Hamilton	Butler	Moderate	1	4.54E+09	1.22E+08	1.22E+08	1.22E+08	1.22E+08	10/50	10.00%	1.10E+08	3.41E+06	6.10E+06	1.51E+07	3.55E+07	6.17E+07					
1	OH	Cincinnati-Hamilton	Clermont	Moderate	1	4.54E+09	6.28E+07	6.28E+07	6.28E+07	6.28E+07	10/50	10.00%	5.65E+07	1.76E+06	3.14E+06	7.79E+06	1.83E+07	3.18E+07					
1	OH	Cincinnati-Hamilton	Hamilton	Moderate	1	4.54E+09	3.62E+08	3.62E+08	3.62E+08	3.62E+08	10/50	10.00%	3.26E+08	1.01E+07	1.81E+07	4.49E+07	1.05E+08	1.83E+08					
1	OH	Cincinnati-Hamilton	Warren	Moderate	1	4.54E+09	4.76E+07	4.76E+07	4.76E+07	4.76E+07	10/50	10.00%	4.29E+07	1.33E+06	2.38E+06	5.91E+06	1.39E+07	2.41E+07					
1	PA	Reading	Berks	Moderate	1	4.47E+09	1.27E+08	1.27E+08	1.27E+08	1.27E+08	10/50	10.00%	1.14E+08	3.54E+06	6.33E+06	1.57E+07	3.68E+07	6.40E+07					
1	PA	Pittsburgh-Beaver Valley	Allegheny	Moderate	1	4.47E+09	5.02E+08	5.02E+08	5.02E+08	5.02E+08	10/50	10.00%	4.52E+08	1.41E+07	2.51E+07	6.23E+07	1.46E+08	2.54E+08					
1	PA	Pittsburgh-Beaver Valley	Armstrong	Moderate	1	4.47E+09	2.76E+07	2.76E+07	2.76E+07	2.76E+07	10/50	10.00%	2.49E+07	7.74E+05	1.38E+06	3.43E+06	8.04E+06	1.40E+07					
1	PA	Pittsburgh-Beaver Valley	Beaver	Moderate	1	4.47E+09	7.00E+07	7.00E+07	7.00E+07	7.00E+07	10/50	10.00%	6.30E+07	1.96E+06	3.50E+06	8.68E+06	2.04E+07	3.54E+07					
1	PA	Pittsburgh-Beaver Valley	Butler	Moderate	1	4.47E+09	5.72E+07	5.72E+07	5.72E+07	5.72E+07	10/50	10.00%	5.14E+07	1.60E+06	2.86E+06	7.09E+06	1.66E+07	2.89E+07					
1	PA	Pittsburgh-Beaver Valley	Fayette	Moderate	1	4.47E+09	5.46E+07	5.46E+07	5.46E+07	5.46E+07	10/50	10.00%	4.92E+07	1.53E+06	2.73E+06	6.78E+06	1.59E+07	2.77E+07					
1	PA	Pittsburgh-Beaver Valley	Washington	Moderate	1	4.47E+09	7.69E+07	7.69E+07	7.69E+07	7.69E+07	10/50	10.00%	6.92E+07	2.15E+06	3.85E+06	9.54E+06	2.24E+07	3.89E+07					
1	PA	Pittsburgh-Beaver Valley	Westmorela	Moderate	1	4.47E+09	1.39E+08	1.39E+08	1.39E+08	1.39E+08	10/50	10.00%	1.25E+08	3.90E+06	6.96E+06	1.73E+07	4.05E+07	7.05E+07					
1	PA	Lancaster	Lancaster	Marginal	0	4.47E+09	1.59E+08																
1	PA	Altoona (new)	Blair	Marginal	0	4.47E+09	4.91E+07																
1	PA	Allentown-Bethlehem-Easton	Carbon	Marginal	0	4.47E+09	2.14E+07																
1	PA	Allentown-Bethlehem-Easton	Lehigh	Marginal	0	4.47E+09	1.09E+08																
1	PA	Allentown-Bethlehem-Easton	Northhampt	Marginal	0	4.47E+09	9.29E+07																
1	PA	Erie	Erie	Marginal	0	4.47E+09	1.04E+08																
1	PA	Johnstown (new)	Cambria	Marginal	0	4.47E+09	6.13E+07																
1	PA	Johnstown (new)	Somerset	Marginal	0	4.47E+09	2.94E+07																
1	PA	Scranton-Wilkes-Barre	Columbia	Marginal	0	4.47E+09	2.38E+07																
1	PA	Scranton-Wilkes-Barre	Lackawanna	Marginal	0	4.47E+09	8.24E+07																
1	PA	Scranton-Wilkes-Barre	Luzerne	Marginal	0	4.47E+09	1.23E+08																
1	PA	Scranton-Wilkes-Barre	Monroe	Marginal	0	4.47E+09	3.60E+07																
1	PA	Scranton-Wilkes-Barre	Wyoming	Marginal	0	4.47E+09	1.06E+07																
1	PA	Youngstown-Warren-Sharon	Mercer	Marginal	0	4.47E+09	4.55E+07																
1	PA	Harrisburg-Lebanon-Carlisle	Cumberland	Marginal	0	4.47E+09	7.34E+07																
1	PA	Harrisburg-Lebanon-Carlisle	Dauphin	Marginal	0	4.47E+09	8.94E+07																
1	PA	Harrisburg-Lebanon-Carlisle	Lebanon	Marginal	0	4.47E+09	4.28E+07																
1	PA	Harrisburg-Lebanon-Carlisle	Perry	Marginal	0	4.47E+09	1.55E+07																
1	PA	York	Adams	Marginal	0	4.47E+09	2.94E+07																
1	PA	York	York	Marginal	0	4.47E+09	1.28E+08																
1	PA	Philadelphia-Wilm-Trenton	Bucks	Severe	1	4.47E+09	2.03E+08	2.03E+08	2.03E+08	2.03E+08	10/50	10.00%	1.83E+08	5.70E+06	1.02E+07	2.52E+07	5.92E+07	1.03E+08					
1	PA	Philadelphia-Wilm-Trenton	Chester	Severe	1	4.47E+09	1.42E+08	1.42E+08	1.42E+08	1.42E+08	10/50	10.00%	1.27E+08	3.96E+06	7.08E+06	1.75E+07	4.12E+07	7.16E+07					
1	PA	Philadelphia-Wilm-Trenton	Delaware	Severe	1	4.47E+09	2.06E+08	2.06E+08	2.06E+08	2.06E+08	10/50	10.00%	1.85E+08	5.77E+06	1.03E+07	2.55E+07	5.99E+07	1.04E+08					
1	PA	Philadelphia-Wilm-Trenton	Montgomer	Severe	1	4.47E+09	2.55E+08	2.55E+08	2.55E+08	2.55E+08	10/50	10.00%	2.29E+08	7.14E+06	1.27E+07	3.16E+07	7.42E+07	1.29E+08					
1	PA	Philadelphia-Wilm-Trenton	Philadelphi	Severe	1	4.47E+09	5.96E+08	5.96E+08	5.96E+08	5.96E+08	10/50	10.00%	5.37E+08	1.67E+07	2.98E+07	7.39E+07	1.73E+08	3.02E+08					
1	RI	Providence (all RI)	all	Serious	1	3.60E+08	3.60E+08	3.60E+08	3.60E+08	3.60E+08	10	5.28%	3.41E+08	1.01E+07	1.80E+07	4.46E+07	1.05E+08	1.82E+08					
1	VA	Smyth Co (new)	Smyth	Marginal	0	2.86E+09	1.50E+07																
1	VA	Richmond-Petersburg/1/	Charles City	Moderate	1	2.86E+09	2.91E+06	2.91E+06	2.91E+06	2.91E+06	10/50	10.00%	2.62E+06	8.14E+04	1.45E+05	3.60E+05	8.46E+05	1.47E+06					
1	VA	Richmond-Petersburg/1/	Chesterfield	Moderate	1	2.86E+09	9.68E+07	9.68E+07	9.68E+07	9.68E+07	10/50	10.00%	8.71E+07	2.71E+06	4.84E+06	1.20E+07	2.82E+07	4.90E+07					
1	VA	Richmond-Petersburg/1/	Colonial	Moderate	1	2.86E+09	7.43E+06	7.43E+06	7.43E+06	7.43E+06	10/50	10.00%	6.69E+06	2.08E+05	3.72E+05	9.22E+05	2.16E+06	3.76E+06					
1	VA	Richmond-Petersburg/1/	Hanover	Moderate	1	2.86E+09	2.93E+07	2.93E+07	2.93E+07	2.93E+07	10/50	10.00%	2.64E+07	8.20E+05	1.46E+06	3.63E+06	8.52E+06	1.48E+07					
1	VA	Richmond-Petersburg/1/	Henrico	Moderate	1	2.86E+09	1.01E+08	1.01E+08	1.01E+08	1.01E+08	10/50	10.00%	9.07E+07	2.82E+06	5.04E+06	1.25E+07	2.93E+07	5.10E+07					
1	VA	Richmond-Petersburg/1/	Hopewell	Moderate	1	2.86E+09	1.07E+07	1.07E+07	1.07E+07	1.07E+07	10/50	10.00%	9.62E+06	2.99E+05	5.34E+05	1.33E+06	3.11E+06	5.41E+06					
1	VA	Richmond-Petersburg/1/	Richmond	Moderate	1	2.86E+09	9.40E+07	9.40E+07	9.40E+07	9.40E+07	10/50	10.00%	8.46E+07	2.63E+06	4.70E+06	1.17E+07	2.73E+07	4.75E+07					
1	VA	Norfolk-Vir Beach-Newport N	Chesapeake	Marginal	0	2.86E+09	7.03E+07																
1	VA	Norfolk-Vir Beach-Newport N	Hampton	Marginal	0	2.86E+09	6.19E+07																
1	VA	Norfolk-Vir Beach-Newport N	James City	Marginal	0	2.86E+09	1.61E+07																
1	VA	Norfolk-Vir Beach-Newport N	Newport	Marginal	0	2.86E+09	7.87E+07																
1	VA	Norfolk-Vir Beach-Newport N	Norfolk	Marginal	0	2.86E+09	1.21E+08																

Region	State	CMSA/PMSA/MSA's in Non-Attainment Areas /2/	County	Ozone Desig.	Stage II Area?	State (on road) Throughput	NAA Throughput	mod+NAA Throughput	Stage II throughput	S2 NAA Throughput	Exemption (k gal/mo)	Waiver %	Stage II (w/ exemp.)	Metropolitan					Nationwide				
														Model Plant 1	Model Plant 2	Model Plant 3	Model Plant 4	Model Plant 5	Model Plant 1	Model Plant 2	Model Plant 3	Model Plant 4	Model Plant 5
1	VA	Norfolk-Vir Beach-Newport N	Poquoson	Marginal	0	2.86E+09	5.09E+06																
1	VA	Norfolk-Vir Beach-Newport N	Portsmouth	Marginal	0	2.86E+09	4.81E+07																
1	VA	Norfolk-Vir Beach-Newport N	Suffolk	Marginal	0	2.86E+09	2.41E+07																
1	VA	Norfolk-Vir Beach-Newport N	Virginia Bea	Marginal	0	2.86E+09	1.82E+08																
1	VA	Norfolk-Vir Beach-Newport N	Williamsbur	Marginal	0	2.86E+09	5.33E+06																
1	VA	Norfolk-Vir Beach-Newport N	York	Marginal	0	2.86E+09	1.96E+07																
1	VA	Washington	Arlington	Serious	1	2.86E+09	7.91E+07	7.91E+07	7.91E+07	7.91E+07	10/50	10.00%	7.12E+07	2.21E+06	3.95E+06	9.81E+06	2.30E+07	4.00E+07					
1	VA	Washington	Fairfax	Serious	1	2.86E+09	3.79E+08	3.79E+08	3.79E+08	3.79E+08	10/50	10.00%	3.41E+08	1.06E+07	1.89E+07	4.70E+07	1.10E+08	1.92E+08					
1	VA	Washington	Loudon	Serious	1	2.86E+09	3.99E+07	3.99E+07	3.99E+07	3.99E+07	10/50	10.00%	3.59E+07	1.12E+06	1.99E+06	4.94E+06	1.16E+07	2.02E+07					
1	VA	Washington	Prince Willi	Serious	1	2.86E+09	9.98E+07	9.98E+07	9.98E+07	9.98E+07	10/50	10.00%	8.98E+07	2.79E+06	4.99E+06	1.24E+07	2.90E+07	5.05E+07					
1	VA	Washington	Stafford	Serious	1	2.86E+09	2.83E+07	2.83E+07	2.83E+07	2.83E+07	10/50	10.00%	2.55E+07	7.93E+05	1.42E+06	3.51E+06	8.25E+06	1.43E+07					
1	VA	Washington	Alexandria (	Serious	1	2.86E+09	5.14E+07	5.14E+07	5.14E+07	5.14E+07	10/50	10.00%	4.63E+07	1.44E+06	2.57E+06	6.38E+06	1.50E+07	2.60E+07					
1	VA	Washington	Fairfax City	Serious	1	2.86E+09	9.08E+06	9.08E+06	9.08E+06	9.08E+06	10/50	10.00%	8.17E+06	2.54E+05	4.54E+05	1.13E+06	2.64E+06	4.59E+06					
1	VA	Washington	Falls Church	Serious	1	2.86E+09	4.43E+06	4.43E+06	4.43E+06	4.43E+06	10/50	10.00%	3.99E+06	1.24E+05	2.22E+05	5.50E+05	1.29E+06	2.24E+06					
1	VA	Washington	Manasas Ci	Serious	1	2.86E+09	7.17E+06	7.17E+06	7.17E+06	7.17E+06	10/50	10.00%	6.46E+06	2.01E+05	3.59E+05	8.90E+05	2.09E+06	3.63E+06					
1	VA	Washington	Manasas Pa	Serious	1	2.86E+09	3.02E+06	3.02E+06	3.02E+06	3.02E+06	10/50	10.00%	2.72E+06	8.45E+04	1.51E+05	3.74E+05	8.78E+05	1.53E+06					
1	VT	entire state	all	Attainment	0	2.75E+08																	
1	WI	Sheboygan	Sheboygan	Serious	1	2.01E+09	4.27E+07	4.27E+07	4.27E+07	4.27E+07	10	5.28%	4.05E+07	1.20E+06	2.14E+06	5.30E+06	1.24E+07	2.16E+07					
1	WI	Walworth Co (new)	Walworth	Marginal	0	2.01E+09	3.08E+07																
1	WI	Kewaunee Co (new)	Kewaunee	Moderate	1	2.01E+09	7.76E+06	7.76E+06	7.76E+06	7.76E+06	10	5.28%	7.35E+06	2.17E+05	3.88E+05	9.62E+05	2.26E+06	3.93E+06					
1	WI	Milwaukee-Racine	Kenosha	Severe	1	2.01E+09	5.27E+07	5.27E+07	5.27E+07	5.27E+07	10	5.28%	4.99E+07	1.48E+06	2.63E+06	6.53E+06	1.53E+07	2.67E+07					
1	WI	Milwaukee-Racine	Milwaukee	Severe	1	2.01E+09	3.94E+08	3.94E+08	3.94E+08	3.94E+08	10	5.28%	3.74E+08	1.10E+07	1.97E+07	4.89E+07	1.15E+08	2.00E+08					
1	WI	Milwaukee-Racine	Ozaukee	Severe	1	2.01E+09	2.99E+07	2.99E+07	2.99E+07	2.99E+07	10	5.28%	2.84E+07	8.38E+05	1.50E+06	3.71E+06	8.71E+06	1.52E+07					
1	WI	Milwaukee-Racine	Racine	Severe	1	2.01E+09	7.20E+07	7.20E+07	7.20E+07	7.20E+07	10	5.28%	6.82E+07	2.01E+06	3.60E+06	8.92E+06	2.09E+07	3.64E+07					
1	WI	Milwaukee-Racine	Wahington	Severe	1	2.01E+09	3.92E+07	3.92E+07	3.92E+07	3.92E+07	10	5.28%	3.71E+07	1.10E+06	1.96E+06	4.86E+06	1.14E+07	1.98E+07					
1	WI	Milwaukee-Racine	Waukesha	Severe	1	2.01E+09	1.25E+08	1.25E+08	1.25E+08	1.25E+08	10	5.28%	1.19E+08	3.51E+06	6.26E+06	1.55E+07	3.65E+07	6.34E+07					
1	WI	Manitowoc Co (new)	Manitowoc	Moderate	1	2.01E+09	3.31E+07	3.31E+07	3.31E+07	3.31E+07	10	5.28%	3.13E+07	9.26E+05	1.65E+06	4.10E+06	9.62E+06	1.67E+07					
1	WI	Door Co (new)	Door	Marginal	0	2.01E+09	1.06E+07																
1	WV	Parkersburg (new)	Wood	Moderate	0	8.03E+08	3.89E+07	3.89E+07															
1	WV	**Charleston (new)	Kanawha	Moderate	0	8.03E+08	9.29E+07	9.29E+07															
1	WV	**Charleston (new)	Putnam	Moderate	0	8.03E+08	1.92E+07	1.92E+07															
1	WV	Greenbrier Co (new)	Greenbrier	Marginal	0	8.03E+08	1.55E+07																
1	WV	Huntington-Ashland/1,6/	Cabell	Moderate	0	8.03E+08	4.33E+07	4.33E+07															
1	WV	Huntington-Ashland/1,6/	Wayne	Moderate	0	8.03E+08	1.86E+07	1.86E+07															
2	AL	Birmingham/1/	Jefferson	Marginal	0	2.01E+09	1.26E+09																
2	AL	Birmingham/1/	Shelby	Marginal	0	2.01E+09	1.92E+08																
2	AR	entire state	all	Attainment	0	1.19E+09																	
2	FL	Miami-Ft Laud.-W. Palm Bea	Broward	Moderate	1	5.83E+09	5.66E+08	5.66E+08	5.66E+08	5.66E+08	10	5.28%	5.36E+08	1.59E+07	2.83E+07	7.02E+07	1.65E+08	2.86E+08					
2	FL	Miami-Ft Laud.-W. Palm Bea	Dade	Moderate	1	5.83E+09	8.73E+08	8.73E+08	8.73E+08	8.73E+08	10	5.28%	8.27E+08	2.45E+07	4.37E+07	1.08E+08	2.54E+08	4.42E+08					
2	FL	Miami-Ft Laud.-W. Palm Bea	Palm Beach	Moderate	1	5.83E+09	3.89E+08	3.89E+08	3.89E+08	3.89E+08	10	5.28%	3.69E+08	1.09E+07	1.95E+07	4.83E+07	1.13E+08	1.97E+08					
2	FL	Tampa-St. Pet.-Clearwater	Hillsboroug	Marginal	0	5.83E+09	3.76E+08																
2	FL	Tampa-St. Pet.-Clearwater	Pinellas	Marginal	0	5.83E+09	3.84E+08																
2	GA	Atlanta/1/	Cherokee	Serious	1	3.38E+09	4.70E+07	4.70E+07	4.70E+07	4.70E+07	10/50	10.00%	4.23E+07	1.32E+06	2.35E+06	5.83E+06	1.37E+07	2.38E+07					
2	GA	Atlanta/1/	Clayton	Serious	1	3.38E+09	9.50E+07	9.50E+07	9.50E+07	9.50E+07	10/50	10.00%	8.55E+07	2.66E+06	4.75E+06	1.18E+07	2.76E+07	4.80E+07					
2	GA	Atlanta/1/	Cobb	Serious	1	3.38E+09	2.34E+08	2.34E+08	2.34E+08	2.34E+08	10/50	10.00%	2.10E+08	6.54E+06	1.17E+07	2.90E+07	6.80E+07	1.18E+08					
2	GA	Atlanta/1/	Coweta	Serious	1	3.38E+09	2.81E+07	2.81E+07	2.81E+07	2.81E+07	10/50	10.00%	2.53E+07	7.86E+05	1.40E+06	3.48E+06	8.17E+06	1.42E+07					
2	GA	Atlanta/1/	De Kalb	Serious	1	3.38E+09	2.85E+08	2.85E+08	2.85E+08	2.85E+08	10/50	10.00%	2.56E+08	7.97E+06	1.42E+07	3.53E+07	8.28E+07	1.44E+08					
2	GA	Atlanta/1/	Douglas	Serious	1	3.38E+09	3.71E+07	3.71E+07	3.71E+07	3.71E+07	10/50	10.00%	3.34E+07	1.04E+06	1.85E+06	4.60E+06	1.08E+07	1.88E+07					
2	GA	Atlanta/1/	Fayette	Serious	1	3.38E+09	3.26E+07	3.26E+07	3.26E+07	3.26E+07	10/50	10.00%	2.93E+07	9.11E+05	1.63E+06	4.04E+06	9.47E+06	1.65E+07					
2	GA	Atlanta/1/	Forsyth	Serious	1	3.38E+09	2.30E+07	2.30E+07	2.30E+07	2.30E+07	10/50	10.00%	2.07E+07	6.44E+05	1.15E+06	2.85E+06	6.69E+06	1.16E+07					
2	GA	Atlanta/1/	Fulton	Serious	1	3.38E+09	3.38E+08	3.38E+08	3.38E+08	3.38E+08	10/50	10.00%	3.05E+08	9.48E+06	1.69E+07	4.20E+07	9.85E+07	1.71E+08					
2	GA	Atlanta/1/	Gwinnett	Serious	1	3.38E+09	1.84E+08	1.84E+08	1.84E+08	1.84E+08	10/50	10.00%	1.66E+08	5.15E+06	9.20E+06	2.28E+07	5.36E+07	9.31E+07					
2	GA	Atlanta/1/	Henry	Serious	1	3.38E+09	3.06E+07	3.06E+07	3.06E+07	3.06E+07	10/50	10.00%	2.76E+07	8.58E+05	1.53E+06	3.80E+06	8.92E+06	1.55E+07					
2	GA	Atlanta/1/	Paulding	Serious	1	3.38E+09	2.17E+07	2.17E+07	2.17E+07	2.17E+07	10/50	10.00%	1.95E+07	6.08E+05	1.09E+06	2.69E+06	6.32E+06	1.10E+07					
2	GA	Atlanta/1/	Rockdale	Serious	1	3.38E+09	2.82E+07	2.82E+07	2.82E+07	2.82E+07	10/50	10.00%	2.54E+07	7.90E+05	1.41E+06	3.50E+06	8.21E+06	1.43E+07					
2	LA	Lake Charles	Calcasieu	Marginal	0	1.80E+09	7.15E+07																
2	LA	Baton Rouge/1/	Ascension	Serious	1	1.80E+09	2.48E+07	2.48E+07	2.48E+07	2.48E+07	10/50	10.00%	2.23E+07	6.93E+05	1.24E+06	3.07E+06	7.21E+06	1.25E+07					
2	LA	Baton Rouge/1/	East Baton	Serious	1	1.80E+09	1.62E+08	1.62E+08	1.62E+08	1.62E+08	10/50	10.00%	1.46E+08	4.53E+06	8.08E+06	2.01E+07	4.71E+07	8.18E+07					
2	LA	Baton Rouge/1/	Iberville	Serious	1	1.80E+09	1.32E+07	1.32E+07	1.32E+07	1.32E+07	10/50	10.00%	1.19E+07	3.70E+05	6.60E+05	1.64E+06	3.84E+06	6.68E+06					
2	LA	Baton Rouge/1/	Livingston	Serious	1	1.80E+09	3.00E+07	3.00E+07	3.00E+07	3.00E+07	10/50	10.00%	2.70E+07	8.40E+05	1.50E+06	3.72E+06	8.73E+06	1.52E+07					
2	LA	Baton Rouge/1/	Pointe Coup	Serious	1	1.80E+09	9.59E+06	9.59E+06	9.59E+06	9.59E+06	10/50	10.00%	8.63E+06	2.68E+05	4.79E+05	1.19E+06	2.79E+06	4.85E+06					
2	LA	Baton Rouge/1/	W. Baton R	Serious	1	1.80E+09	8.26E+06	8.26E+06	8.26E+06	8.26E+06	10/50	10.00%	7.43E+06	2.31E+05	4.13E+05	1.02E+06	2.40E+06	4.18E+06					
2	MS	entire state	all	Attainment	0	1.20E+09																	

Region	State	CMSA/PMSA/MSA's in Non-Attainment Areas /2/	County	Ozone Desig.	Stage II Area?	State (on road) Throughput	NAA Throughput	mod+NAA Throughput	Stage II throughput	SZ NAA Throughput	Exemption (k gal/mo)	Waiver %	Stage II (w/ exemp.)	Metropolitan Model Plant 1	Metropolitan Model Plant 2	Metropolitan Model Plant 3	Metropolitan Model Plant 4	Metropolitan Model Plant 5	Nationwide Model Plant 1	Nationwide Model Plant 2	Nationwide Model Plant 3	Nationwide Model Plant 4	Nationwide Model Plant 5
2	NC	Raleigh-Durham (new)	Durham	Moderate	0	3.16E+09	8.66E+07	8.66E+07															
2	NC	Raleigh-Durham (new)	Granville	Moderate	0	3.16E+09	1.83E+07	1.83E+07															
2	NC	Raleigh-Durham (new)	Wake	Moderate	0	3.16E+09	2.02E+08	2.02E+08															
2	NC	Charlotte-Gastonia	Gaston	Moderate	0	3.16E+09	8.34E+07	8.34E+07															
2	NC	Charlotte-Gastonia	Mecklenbur	Moderate	0	3.16E+09	2.44E+08	2.44E+08															
2	NC	Greensboro-Winston (new)	Davidson	Moderate	0	3.16E+09	6.03E+07	6.03E+07															
2	NC	Greensboro-Winston (new)	Davie	Moderate	0	3.16E+09	1.33E+07	1.33E+07															
2	NC	Greensboro-Winston (new)	Forsyth	Moderate	0	3.16E+09	1.27E+08	1.27E+08															
2	NC	Greensboro-Winston (new)	Guilford	Moderate	0	3.16E+09	1.65E+08	1.65E+08															
2	SC	Cherokee Co (new)	Cherokee	Marginal	0	1.77E+09	2.25E+07																
2	TN	Knoxville (new)	Knox	Marginal	0	2.36E+09	1.62E+08																
2	TN	Memphis	Shelby	Marginal	0	2.36E+09	4.00E+08																
2	TN	Nashville	Davidson	Moderate	1	2.36E+09	2.47E+08	2.47E+08	2.47E+08	2.47E+08	10/50	10.00%	2.22E+08	6.92E+06	1.24E+07	3.06E+07	7.19E+07	1.25E+08					
2	TN	Nashville	Rutherford	Moderate	1	2.36E+09	5.74E+07	5.74E+07	5.74E+07	5.74E+07	10/50	10.00%	5.16E+07	1.61E+06	2.87E+06	7.11E+06	1.67E+07	2.90E+07					
2	TN	Nashville	Sumner	Moderate	1	2.36E+09	5.00E+07	5.00E+07	5.00E+07	5.00E+07	10/50	10.00%	4.50E+07	1.40E+06	2.50E+06	6.20E+06	1.45E+07	2.53E+07					
2	TN	Nashville	Williamsbur	Moderate	1	2.36E+09	3.92E+07	3.92E+07	3.92E+07	3.92E+07	10/50	10.00%	3.53E+07	1.10E+06	1.96E+06	4.86E+06	1.14E+07	1.98E+07					
2	TN	Nashville	Wilson	Moderate	1	2.36E+09	3.27E+07	3.27E+07	3.27E+07	3.27E+07	10/50	10.00%	2.95E+07	9.17E+05	1.64E+06	4.06E+06	9.53E+06	1.66E+07					
3	AZ	Phoenix	Maricopa	Moderate	1	1.60E+09	9.28E+08	9.28E+08	9.28E+08	9.28E+08	10/50	10.00%	8.35E+08	2.60E+07	4.64E+07	1.15E+08	2.70E+08	4.70E+08					
3	NM	entire state	all	Attainment	0	7.68E+08																	
3	OK	entire state	all	Attainment	0	1.62E+09																	
3	TX	Beaumont-Port Aurthur/1/	Hardin	Serious	1	8.38E+09	2.04E+07	2.04E+07	2.04E+07	2.04E+07	10/50	10.00%	1.83E+07	5.71E+05	1.02E+06	2.53E+06	5.93E+06	1.03E+07					
3	TX	Beaumont-Port Aurthur/1/	Jefferson	Serious	1	8.38E+09	1.18E+08	1.18E+08	1.18E+08	1.18E+08	10/50	10.00%	1.06E+08	3.31E+06	5.91E+06	1.46E+07	3.44E+07	5.98E+07					
3	TX	Beaumont-Port Aurthur/1/	Orange	Serious	1	8.38E+09	3.97E+07	3.97E+07	3.97E+07	3.97E+07	10/50	10.00%	3.58E+07	1.11E+06	1.99E+06	4.93E+06	1.16E+07	2.01E+07					
3	TX	Dallas-Fort Worth/1/	Collin	Moderate	1	8.38E+09	1.30E+08	1.30E+08	1.30E+08	1.30E+08	10/50	10.00%	1.17E+08	3.65E+06	6.51E+06	1.62E+07	3.79E+07	6.59E+07					
3	TX	Dallas-Fort Worth/1/	Dallas	Moderate	1	8.38E+09	9.14E+08	9.14E+08	9.14E+08	9.14E+08	10/50	10.00%	8.23E+08	2.56E+07	4.57E+07	1.13E+08	2.66E+08	4.63E+08					
3	TX	Dallas-Fort Worth/1/	Denton	Moderate	1	8.38E+09	1.35E+08	1.35E+08	1.35E+08	1.35E+08	10/50	10.00%	1.21E+08	3.78E+06	6.75E+06	1.67E+07	3.93E+07	6.83E+07					
3	TX	Dallas-Fort Worth/1/	Tarrant	Moderate	1	8.38E+09	5.77E+08	5.77E+08	5.77E+08	5.77E+08	10/50	10.00%	5.20E+08	1.62E+07	2.89E+07	7.16E+07	1.68E+08	2.92E+08					
3	TX	El Paso	El Paso	Serious	1	8.38E+09	2.92E+08	2.92E+08	2.92E+08	2.92E+08	10/50	10.00%	2.63E+08	8.17E+06	1.46E+07	3.62E+07	8.49E+07	1.48E+08					
3	TX	Houston-Galveston-Brazoria	Brazoria	Severe	1	8.38E+09	9.46E+07	9.46E+07	9.46E+07	9.46E+07	10/50	10.00%	8.51E+07	2.65E+06	4.73E+06	1.17E+07	2.75E+07	4.79E+07					
3	TX	Houston-Galveston-Brazoria	Chambers	Severe	1	8.38E+09	9.91E+06	9.91E+06	9.91E+06	9.91E+06	10/50	10.00%	8.92E+06	2.78E+05	4.96E+05	1.23E+06	2.88E+06	5.02E+06					
3	TX	Houston-Galveston-Brazoria	Fort Bend	Severe	1	8.38E+09	1.11E+08	1.11E+08	1.11E+08	1.11E+08	10/50	10.00%	1.00E+08	3.11E+06	5.56E+06	1.38E+07	3.24E+07	5.63E+07					
3	TX	Houston-Galveston-Brazoria	Galveston	Severe	1	8.38E+09	1.07E+08	1.07E+08	1.07E+08	1.07E+08	10/50	10.00%	9.65E+07	3.00E+06	5.36E+06	1.33E+07	3.12E+07	5.43E+07					
3	TX	Houston-Galveston-Brazoria	Harris	Severe	1	8.38E+09	1.39E+09	1.39E+09	1.39E+09	1.39E+09	10/50	10.00%	1.25E+09	3.89E+07	6.95E+07	1.72E+08	4.05E+08	7.04E+08					
3	TX	Houston-Galveston-Brazoria	Liberty	Severe	1	8.38E+09	2.60E+07	2.60E+07	2.60E+07	2.60E+07	10/50	10.00%	2.34E+07	7.28E+05	1.30E+06	3.23E+06	7.57E+06	1.32E+07					
3	TX	Houston-Galveston-Brazoria	Montgomer	Severe	1	8.38E+09	8.99E+07	8.99E+07	8.99E+07	8.99E+07	10/50	10.00%	8.09E+07	2.52E+06	4.50E+06	1.11E+07	2.62E+07	4.55E+07					
3	TX	Houston-Galveston-Brazoria	Waller	Severe	1	8.38E+09	1.15E+07	1.15E+07	1.15E+07	1.15E+07	10/50	10.00%	1.04E+07	3.23E+05	5.77E+05	1.43E+06	3.36E+06	5.84E+06					
4	CO	entire state	all	Attainment	0	1.46E+09																	
4	ID	entire state	all	Attainment	0	4.69E+08																	
4	IOWA	entire state	all	Attainment	0	1.30E+09																	
4	KS	entire state	all	Attainment	0	1.18E+09																	
4	MN	entire state	all	Attainment	0	1.97E+09																	
4	MO	St Louis	Franklin	Moderate	1	2.60E+09	4.10E+07	4.10E+07	4.10E+07	4.10E+07	10	5.28%	3.89E+07	1.15E+06	2.05E+06	5.09E+06	1.19E+07	2.08E+07					
4	MO	St Louis	Jefferson	Moderate	1	2.60E+09	8.72E+07	8.72E+07	8.72E+07	8.72E+07	10	5.28%	8.26E+07	2.44E+06	4.36E+06	1.08E+07	2.54E+07	4.41E+07					
4	MO	St Louis	St. Charles	Moderate	1	2.60E+09	1.08E+08	1.08E+08	1.08E+08	1.08E+08	10	5.28%	1.03E+08	3.03E+06	5.42E+06	1.34E+07	3.15E+07	5.48E+07					
4	MO	St Louis	St. Louis	Moderate	1	2.60E+09	2.02E+08	2.02E+08	2.02E+08	2.02E+08	10	5.28%	1.91E+08	5.65E+06	1.01E+07	2.50E+07	5.87E+07	1.02E+08					
4	MO	St Louis	St. Louis Co	Moderate	1	2.60E+09	5.06E+08	5.06E+08	5.06E+08	5.06E+08	10	5.28%	4.79E+08	1.42E+07	2.53E+07	6.27E+07	1.47E+08	2.56E+08					
4	MT	entire state	all	Attainment	0	4.23E+08																	
4	ND	entire state	all	Attainment	0	3.33E+08																	
4	NE	entire state	all	Attainment	0	7.53E+08																	
4	OR	Portland-Vancouver AQMA	Clackamas	Marginal	1	1.29E+09	1.27E+08		1.27E+08	1.27E+08	10	5.28%	1.20E+08	3.55E+06	6.34E+06	1.57E+07	3.69E+07	6.42E+07					
4	OR	Portland-Vancouver AQMA	Multnomak	Marginal	1	1.29E+09	2.66E+08		2.66E+08	2.66E+08	10	5.28%	2.52E+08	7.44E+06	1.33E+07	3.29E+07	7.73E+07	1.34E+08					
4	OR	Portland-Vancouver AQMA	Washington	Marginal	1	1.29E+09	1.42E+08		1.42E+08	1.42E+08	10	5.28%	1.34E+08	3.97E+06	7.09E+06	1.76E+07	4.12E+07	7.17E+07					
4	SD	entire state	all	Attainment	0	3.73E+08																	
4	WA	Seattle-Tacoma (new)	King	Marginal	1	2.19E+09	6.77E+08		6.77E+08	6.77E+08	10	5.28%	6.41E+08	1.90E+07	3.39E+07	8.40E+07	1.97E+08	3.43E+08					
4	WA	Seattle-Tacoma (new)	Pierce	Marginal	1	2.19E+09	2.63E+08		2.63E+08	2.63E+08	10	5.28%	2.49E+08	7.37E+06	1.32E+07	3.27E+07	7.66E+07	1.33E+08					
4	WA	Seattle-Tacoma (new)	Snohomish	Marginal	1	2.19E+09	2.09E+08		2.09E+08	2.09E+08	10	5.28%	1.98E+08	5.86E+06	1.05E+07	2.59E+07	6.09E+07	1.06E+08					
4	WA	Portland-Vancouver AQMA	Clark	Marginal	1	2.19E+09	1.07E+08		1.07E+08	1.07E+08	10	5.28%	1.01E+08	2.99E+06	5.35E+06	1.33E+07	3.11E+07	5.41E+07					
4	WY	entire state	all	Attainment	0	2.91E+08																	
5	CA	San Diego	San Diego	Severe	1	1.26E+10	1.25E+09	1.25E+09	1.25E+09	1.25E+09	0		1.25E+09						1.10E+08	2.22E+08	3.43E+08	3.39E+08	2.34E+08

Region	State	CMSA/PMSA/MSA's in Non-Attainment Areas /2/	County	Ozone Desig.	Stage II Area?	State (on road) Throughput	NAA Throughput	mod+NAA Throughput	Stage II throughput	S2 NAA Throughput	Exemption (k gal/mo)	Waiver %	Stage II (w/ exemp.)
5	CA	LA-South Coast Air Basin	LA-1	Extreme	1	1.26E+10	3.75E+09	3.75E+09	3.75E+09	3.75E+09	0		3.75E+09
5	CA	LA-South Coast Air Basin	Orange	Extreme	1	1.26E+10	1.02E+09	1.02E+09	1.02E+09	1.02E+09	0		1.02E+09
5	CA	LA-South Coast Air Basin	Riverside-1	Extreme	1	1.26E+10	4.95E+08	4.95E+08	4.95E+08	4.95E+08	0		4.95E+08
5	CA	LA-South Coast Air Basin	San Bernar	Extreme	1	1.26E+10	6.00E+08	6.00E+08	6.00E+08	6.00E+08	0		6.00E+08
5	CA	San Joaquin Valley	Fresno	Serious	1	1.26E+10	2.82E+08	2.82E+08	2.82E+08	2.82E+08	0		2.82E+08
5	CA	San Joaquin Valley	Kern	Serious	1	1.26E+10	2.30E+08	2.30E+08	2.30E+08	2.30E+08	0		2.30E+08
5	CA	San Joaquin Valley	Kings	Serious	1	1.26E+10	4.29E+07	4.29E+07	4.29E+07	4.29E+07	0		4.29E+07
5	CA	San Joaquin Valley	Madera	Serious	1	1.26E+10	3.73E+07	3.73E+07	3.73E+07	3.73E+07	0		3.73E+07
5	CA	San Joaquin Valley	Merced	Serious	1	1.26E+10	7.54E+07	7.54E+07	7.54E+07	7.54E+07	0		7.54E+07
5	CA	San Joaquin Valley	San Joaquin	Serious	1	1.26E+10	2.03E+08	2.03E+08	2.03E+08	2.03E+08	0		2.03E+08
5	CA	San Joaquin Valley	Stanislaus	Serious	1	1.26E+10	1.57E+08	1.57E+08	1.57E+08	1.57E+08	0		1.57E+08
5	CA	San Joaquin Valley	Tulare	Serious	1	1.26E+10	1.32E+08	1.32E+08	1.32E+08	1.32E+08	0		1.32E+08
5	CA	San Francisco Bay Area	Alameda	Moderate	1	1.26E+10	5.41E+08	5.41E+08	5.41E+08	5.41E+08	0		5.41E+08
5	CA	San Francisco Bay Area	Conta Costa	Moderate	1	1.26E+10	3.40E+08	3.40E+08	3.40E+08	3.40E+08	0		3.40E+08
5	CA	San Francisco Bay Area	Marin	Moderate	1	1.26E+10	9.73E+07	9.73E+07	9.73E+07	9.73E+07	0		9.73E+07
5	CA	San Francisco Bay Area	Napa	Moderate	1	1.26E+10	4.68E+07	4.68E+07	4.68E+07	4.68E+07	0		4.68E+07
5	CA	San Francisco Bay Area	San Fransis	Moderate	1	1.26E+10	3.06E+08	3.06E+08	3.06E+08	3.06E+08	0		3.06E+08
5	CA	San Francisco Bay Area	San Mateo	Moderate	1	1.26E+10	2.75E+08	2.75E+08	2.75E+08	2.75E+08	0		2.75E+08
5	CA	San Francisco Bay Area	Santa Clara	Moderate	1	1.26E+10	6.33E+08	6.33E+08	6.33E+08	6.33E+08	0		6.33E+08
5	CA	San Francisco Bay Area	Solano	Moderate	1	1.26E+10	1.44E+08	1.44E+08	1.44E+08	1.44E+08	0		1.44E+08
5	CA	San Francisco Bay Area	Sonoma	Moderate	1	1.26E+10	1.64E+08	1.64E+08	1.64E+08	1.64E+08	0		1.64E+08
5	CA	Monterey Bay	Monterey	Moderate	1	1.26E+10	1.50E+08	1.50E+08	1.50E+08	1.50E+08	0		1.50E+08
5	CA	Monterey Bay	San Benito	Moderate	1	1.26E+10	1.55E+07	1.55E+07	1.55E+07	1.55E+07	0		1.55E+07
5	CA	Monterey Bay	Santa Cruz	Moderate	1	1.26E+10	9.72E+07	9.72E+07	9.72E+07	9.72E+07	0		9.72E+07
5	CA	Sacramento Metro	El Dorado	Serious	1	1.26E+10	5.33E+07	5.33E+07	5.33E+07	5.33E+07	0		5.33E+07
5	CA	Sacramento Metro	Placer	Serious	1	1.26E+10	7.31E+07	7.31E+07	7.31E+07	7.31E+07	0		7.31E+07
5	CA	Sacramento Metro	Sacramento	Serious	1	1.26E+10	4.40E+08	4.40E+08	4.40E+08	4.40E+08	0		4.40E+08
5	CA	Sacramento Metro	Sutter	Serious	1	1.26E+10	2.72E+07	2.72E+07	2.72E+07	2.72E+07	0		2.72E+07
5	CA	Sacramento Metro	Yolo	Serious	1	1.26E+10	5.97E+07	5.97E+07	5.97E+07	5.97E+07	0		5.97E+07
5	CA	Ventura County	Ventura Co	Severe	1	1.26E+10	2.83E+08	2.83E+08	2.83E+08	2.83E+08	0		2.83E+08
5	CA	Santa Barbara-Santa Maria-L	Santa Barba	Moderate	1	1.26E+10	1.56E+08	1.56E+08	1.56E+08	1.56E+08	0		1.56E+08
5	CA	Rest of State	0	Attainment	1	1.26E+10			4.13E+08		0		4.13E+08
5	NV	Reno (new)	Washoe	Marginal	0	6.17E+08	1.31E+08				10	5.28%	
5	NV	Las Vegas	Clark	Attainment	1	6.17E+08			3.80E+08		10	5.28%	3.60E+08
5	UT	Salt Lake City	Davis	Moderate	1	6.85E+08	7.48E+07	7.48E+07	7.48E+07	7.48E+07	10/50	10.00%	6.73E+07
5	UT	Salt Lake City	Salt Lake	Moderate	1	6.85E+08	2.89E+08	2.89E+08	2.89E+08	2.89E+08	10/50	10.00%	2.60E+08
											10/10 waiver	5.28%	
Totals:							5.92E+10	4.97E+10	4.85E+10	4.77E+10	avg. expt.	4.35%	4.57E+10
Percent							54.86%	46.06%	44.96%	44.22%	.av. expt.	5.75%	42.38%

County	Metropolitan Model Plant 1	Metropolitan Model Plant 2	Metropolitan Model Plant 3	Metropolitan Model Plant 4	Metropolitan Model Plant 5	Nationwide Model Plant 1	Nationwide Model Plant 2	Nationwide Model Plant 3	Nationwide Model Plant 4	Nationwide Model Plant 5
LA-1						3.30E+08	6.67E+08	1.03E+09	1.02E+09	7.05E+08
Orange						8.97E+07	1.81E+08	2.80E+08	2.77E+08	1.92E+08
Riverside-1						4.36E+07	8.81E+07	1.36E+08	1.35E+08	9.31E+07
San Bernar						5.28E+07	1.07E+08	1.65E+08	1.63E+08	1.13E+08
Fresno						2.48E+07	5.02E+07	7.76E+07	7.68E+07	5.31E+07
Kern						2.02E+07	4.09E+07	6.32E+07	6.25E+07	4.32E+07
Kings						3.78E+06	7.64E+06	1.18E+07	1.17E+07	8.07E+06
Madera						3.28E+06	6.63E+06	1.02E+07	1.01E+07	7.00E+06
Merced						6.64E+06	1.34E+07	2.07E+07	2.05E+07	1.42E+07
San Joaquin						1.79E+07	3.62E+07	5.59E+07	5.53E+07	3.82E+07
Stanislaus						1.38E+07	2.79E+07	4.31E+07	4.26E+07	2.95E+07
Tulare						1.16E+07	2.35E+07	3.63E+07	3.59E+07	2.48E+07
Alameda						4.76E+07	9.63E+07	1.49E+08	1.47E+08	1.02E+08
Conta Costa						2.99E+07	6.05E+07	9.35E+07	9.25E+07	6.39E+07
Marin						8.56E+06	1.73E+07	2.68E+07	2.65E+07	1.83E+07
Napa						4.12E+06	8.34E+06	1.29E+07	1.27E+07	8.81E+06
San Fransis						2.69E+07	5.45E+07	8.42E+07	8.33E+07	5.76E+07
San Mateo						2.42E+07	4.89E+07	7.56E+07	7.47E+07	5.17E+07
Santa Clara						5.57E+07	1.13E+08	1.74E+08	1.72E+08	1.19E+08
Solano						1.27E+07	2.56E+07	3.96E+07	3.92E+07	2.71E+07
Sonoma						1.44E+07	2.92E+07	4.52E+07	4.47E+07	3.09E+07
Monterey						1.32E+07	2.68E+07	4.14E+07	4.09E+07	2.83E+07
San Benito						1.37E+06	2.76E+06	4.27E+06	4.22E+06	2.92E+06
Santa Cruz						8.55E+06	1.73E+07	2.67E+07	2.64E+07	1.83E+07
El Dorado						4.69E+06	9.48E+06	1.47E+07	1.45E+07	1.00E+07
Placer						6.43E+06	1.30E+07	2.01E+07	1.99E+07	1.37E+07
Sacramento						3.88E+07	7.84E+07	1.21E+08	1.20E+08	8.28E+07
Sutter						2.40E+06	4.85E+06	7.49E+06	7.41E+06	5.12E+06
Yolo						5.25E+06	1.06E+07	1.64E+07	1.62E+07	1.12E+07
Ventura Co						2.49E+07	5.04E+07	7.78E+07	7.70E+07	5.32E+07
Santa Barba						1.38E+07	2.78E+07	4.30E+07	4.25E+07	2.94E+07
0 (Rest of State)						0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Washoe										
Clark	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00					
Davis	2.09E+06	3.74E+06	9.27E+06	2.18E+07	3.78E+07					
Salt Lake	8.09E+06	1.44E+07	3.58E+07	8.40E+07	1.46E+08					
Totals	7.91E+08	1.41E+09	3.50E+09	8.22E+09	1.43E+10	1.71E+09	3.46E+09	5.34E+09	5.28E+09	3.65E+09
Percent	31.64%	29.01%	39.62%	60.89%	79.66%	68.36%	70.99%	60.38%	39.11%	20.34%
Metro+Nat	5.25%	10.22%	18.55%	28.33%	37.65%					
# MP	16.831	5.886	8.341	10.540	6.498	36.357	14.402	12.714	6.771	1.659
M+N MP	53.189	20.288	21.055	17.312	8.157	120,001				
% MP	44.32%	16.91%	17.55%	14.43%	6.80%	100.00%				
% Metro	59.22%									
% NW	41.11%									

California	0	0	0	0	0	1E+09	2E+09	3E+09	3E+09	2E+09
	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	100.00%	100.00%	100.00%	100.00%
	8.79%	17.78%	27.47%	27.17%	18.78%					
	0	0	0	0	0	22.791	9.028	7.970	4.245	1.040
	22.791	9.028	7.970	4.245	1.040	45,074				
	50.56%	20.03%	17.68%	9.42%	2.31%	100.00%				

National	1.140E+11
Non-Road	5.4%
Tot. Nat'l.	1.079E+11
NAA TP	5.92E+10
%	54.86%
mod+ NAA T	4.97E+10
%	46.06%
S2 TP	4.85E+10
%	44.96%
S2 NAA TP	4.77E+10
%	44.22%
S2 NAAw/Exp	4.571E+10
%	42.38%
Calif. TP	1.259E+10
%	11.67%

		MP2	MP3	MP4	MP5
mod+ NAA +	5.047E+10				
%	46.79%				
nonS2 mod+	1.977E+09	1.178	412	584	455
%	1.83%				

Appendix B: Supporting Data for Chapter 4--Emission Reduction Benefits

TABLE B-1: County and State Populations by Ozone Attainment Status

Region	State	Area	County	O3 Desig.	Area Pop. /3/	State Pop. /4/	% State Pop.
1	CT	Entire State (56 FR 66444)	all	Ser/Sev	3,287,116	3,287,116	100.0%
1	DC	Washington (56 FR 24037)	all	Serious	606,900	606,900	100.0%
1	DE	Philadelphia-Wilm-Trenton	Kent	Severe	110,993	666,168	16.7%
1	DE	Philadelphia-Wilm-Trenton	New Castle	Severe	441,946	666,168	66.3%
1	DE	Sussex Co (new)	Sussex	Marginal	113,229	666,168	17.0%
1	IL	Jersey Co (new)	Jersey	Marginal	20,539	11,430,602	0.2%
1	IL	Chicago-Gary-Lake County	Cook	Severe	5,105,067	11,430,602	44.7%
1	IL	Chicago-Gary-Lake County	Du Page	Severe	781,666	11,430,602	6.8%
1	IL	Chicago-Gary-Lake County	Grundy (all)	Severe	32,337	11,430,602	0.3%
1	IL	Chicago-Gary-Lake County	Kane	Severe	317,471	11,430,602	2.8%
1	IL	Chicago-Gary-Lake County	Kendall (all)	Severe	39,413	11,430,602	0.3%
1	IL	Chicago-Gary-Lake County	Lake	Severe	516,418	11,430,602	4.5%
1	IL	Chicago-Gary-Lake County	Mchenry	Severe	183,241	11,430,602	1.6%
1	IL	Chicago-Gary-Lake County	Will	Severe	357,313	11,430,602	3.1%
1	IL	St Louis	Madison	Moderate	249,238	11,430,602	2.2%
1	IL	St Louis	Monroe	Moderate	22,422	11,430,602	0.2%
1	IL	St Louis	St. Clair	Moderate	262,852	11,430,602	2.3%
1	IL	Rest of state	--	Attainment			31.0%
1	IN	Louisville	Clark	Moderate	475,594	5,544,159	8.6%
1	IN	Louisville	Floyd	Moderate	128,932	5,544,159	2.3%
1	IN	South Bend-Elkhart	Elkhart	Marginal	156,198	5,544,159	2.8%
1	IN	South Bend-Elkhart	St,. Joseph	Marginal	247,052	5,544,159	4.5%
1	IN	Chicago-Gary-Lake County	Lake	Severe	475,594	5,544,159	8.6%
1	IN	Chicago-Gary-Lake County	Porter	Severe	128,932	5,544,159	2.3%
1	IN	Indianapolis	Marion	Marginal	797,159	5,544,159	14.4%
1	IN	Evansville (new)	Vanderburgh	Marginal	165,058	5,544,159	3.0%
1	IN	Rest of state	--	Attainment			53.6%
1	KY	Paducah (new)	Livingston	Marginal	9,062	3,685,296	0.2%
1	KY	Paducah (new)	Marshall	Marginal	27,205	3,685,296	0.7%
1	KY	Huntington-Ashland	Boyd	Moderate	51,150	3,685,296	1.4%
1	KY	Huntington-Ashland	Greenup	Moderate	36,742	3,685,296	1.0%
1	KY	Edmonson Co (new)	Edmonson	Marginal	10,357	3,685,296	0.3%
1	KY	Cincinnati-Hamilton	Boone	Moderate	57,589	3,685,296	1.6%
1	KY	Cincinnati-Hamilton	Campbell	Moderate	83,866	3,685,296	2.3%
1	KY	Cincinnati-Hamilton	Kenton	Moderate	142,031	3,685,296	3.9%
1	KY	Lexington-Fayette (new)	Fayette	Marginal	225,366	3,685,296	6.1%
1	KY	Lexington-Fayette (new)	Scott	Marginal	23,867	3,685,296	0.6%
1	KY	Louisville	Jefferson	Moderate	664,937	3,685,296	18.0%
1	KY	Owensboro (new)	Daviess	Marginal	87,189	3,685,296	2.4%
1	KY	Owensboro (new)	Hancock	Marginal	7,864	3,685,296	0.2%
1	KY	Rest of state	--	Attainment			61.3%
1	MA	Entire State (56 FR 57986)	all	Serious	6,016,425	6,016,425	100.0%
1	MD	Philadelphia-Wilm-Trenton	Cecil	Severe	71,347	4,781,468	1.5%
1	MD	Washington	Calvert	Serious	51,372	4,781,468	1.1%
1	MD	Washington	Charles	Serious	101,154	4,781,468	2.1%
1	MD	Washington	Fredrick	Serious	150,208	4,781,468	3.1%
1	MD	Washington	Montgomery	Serious	757,027	4,781,468	15.8%
1	MD	Washington	Prince George	Serious	729,268	4,781,468	15.3%
1	MD	Baltimore	Anne Arudel	Severe	427,239	4,781,468	8.9%

Table B-1 (continued)

Region	State	Area	County	O3 Desig.	Area Pop. /3/	State Pop. /4/	% State Pop.
1	MD	Baltimore	Baltimore	Severe	692,134	4,781,468	14.5%
1	MD	Baltimore	Carrol	Severe	123,372	4,781,468	2.6%
1	MD	Baltimore	Hartford	Severe	182,132	4,781,468	3.8%
1	MD	Baltimore	Howard	Severe	187,328	4,781,468	3.9%
1	MD	Baltimore	Baltimore city	Severe	736,014	4,781,468	15.4%
1	MD	Kent & Queen Anne's Cos (new)	Kent	Marginal	17,842	4,781,468	0.4%
1	MD	Kent & Queen Anne's Cos (new)	Qween Anne's	Marginal	33,953	4,781,468	0.7%
1	MD	Rest of state	–	Attainment			10.9%
1	ME	Hancock & Waldo Cos	Hancock	Marginal	46,948	1,227,928	3.8%
1	ME	Hancock & Waldo Cos	Waldo	Marginal	33,018	1,227,928	2.7%
1	ME	Portland	Cumberland	Moderate	200,443	1,227,928	16.3%
1	ME	Portland	Sagadahoc	Moderate	33,535	1,227,928	2.7%
1	ME	Portland	York	Moderate	20,652	1,227,928	1.7%
1	ME	Lewiston-Auburn	Androscoggin	Moderate	93,679	1,227,928	7.6%
1	ME	Lewiston-Auburn	Kennebec	Moderate	115,904	1,227,928	9.4%
1	ME	Knox & Lincoln Cos	Knox	Moderate	36,310	1,227,928	3.0%
1	ME	Knox & Lincoln Cos	Lincoln	Moderate	52,602	1,227,928	4.3%
1	ME	Flanklin County (56 FR 46119)	Flanklin County	Attainment	29,008	1,227,928	2.4%
1	ME	Oxford (56 FR 46119)	Oxford	Attainment	52,602	1,227,928	4.3%
1	ME	Somerset (56 FR 46119)	Somerset	Attainment	49,767	1,227,928	4.1%
1	ME	Rest of state	–	Attainment			37.7%
1	MI	Detroit-Ann Arbor	Livingston	Moderate	115,645	9,295,297	1.2%
1	MI	Detroit-Ann Arbor	Macomb	Moderate	717,400	9,295,297	7.7%
1	MI	Detroit-Ann Arbor	Oakland	Moderate	1,083,592	9,295,297	11.7%
1	MI	Detroit-Ann Arbor	Monroe	Moderate	133,600	9,295,297	1.4%
1	MI	Detroit-Ann Arbor	St. Clair	Moderate	145,607	9,295,297	1.6%
1	MI	Detroit-Ann Arbor	Washtenaw	Moderate	282,937	9,295,297	3.0%
1	MI	Detroit-Ann Arbor	Wayne	Moderate	2,111,687	9,295,297	22.7%
1	MI	Grand Rapids	Kent	Moderate	500,631	9,295,297	5.4%
1	MI	Grand Rapids	Ottawa	Moderate	187,768	9,295,297	2.0%
1	MI	Rest of state	–	Attainment			43.2%
1	NH	Boston-Lawrence-Worcester	Hillsborough-1	Serious	177,641	1,109,252	16.0%
1	NH	Boston-Lawrence-Worcester	Rockingham-1	Serious	7,243	1,109,252	0.7%
1	NH	Manchester	Hillsborough-2	Marginal	132,944	1,109,252	12.0%
1	NH	Manchester	Merrimack	Marginal	13,416	1,109,252	1.2%
1	NH	Manchester	Rockingham-2	Marginal	27,423	1,109,252	2.5%
1	NH	Portsmouth-Dover-Rochester	Rockingham-3	Serious	88,769	1,109,252	8.0%
1	NH	Portsmouth-Dover-Rochester	Strafford	Serious	98,111	1,109,252	8.8%
1	NH	Rest of state	all	Attainment			50.8%
1	NJ	Philadelphia-Wilm-Trenton	Bulington	Severe	395,066	7,740,188	5.1%
1	NJ	Philadelphia-Wilm-Trenton	Camden	Severe	502,824	7,740,188	6.5%
1	NJ	Philadelphia-Wilm-Trenton	Cumberland	Severe	138,053	7,740,188	1.8%
1	NJ	Philadelphia-Wilm-Trenton	Gloucester	Severe	230,082	7,740,188	3.0%
1	NJ	Philadelphia-Wilm-Trenton	Mercer	Severe	325,824	7,740,188	4.2%
1	NJ	Philadelphia-Wilm-Trenton	Salem	Severe	65,294	7,740,188	0.8%
1	NJ	Atlantic City	Atlantic	Moderate	224,327	7,740,188	2.9%
1	NJ	Atlantic City	Cape	Moderate	95,089	7,740,188	1.2%
1	NJ	Allentown-Bethlehem-Easton	Warren	Marginal	91,607	7,740,188	1.2%
1	NJ	NY-N. NJ-Long Island	Bergen	Severe	825,380	7,740,188	10.7%
1	NJ	NY-N. NJ-Long Island	Essex	Severe	778,206	7,740,188	10.1%
1	NJ	NY-N. NJ-Long Island	Hudson	Severe	553,099	7,740,188	7.1%

Table B-1 (continued)

Region	State	Area	County	O3 Desig.	Area Pop. /3/	State Pop. /4/	% State Pop.
1	NJ	NY-N. NJ-Long Island	Hunterdon	Severe	107,776	7,740,188	1.4%
1	NJ	NY-N. NJ-Long Island	Middlesex	Severe	671,780	7,740,188	8.7%
1	NJ	NY-N. NJ-Long Island	Monmouth	Severe	553,124	7,740,188	7.1%
1	NJ	NY-N. NJ-Long Island	Morris	Severe	421,353	7,740,188	5.4%
1	NJ	NY-N. NJ-Long Island	Ocean	Severe	443,203	7,740,188	5.7%
1	NJ	NY-N. NJ-Long Island	Passiac	Severe	453,060	7,740,188	5.9%
1	NJ	NY-N. NJ-Long Island	Somerset	Severe	240,279	7,740,188	3.1%
1	NJ	NY-N. NJ-Long Island	Sussex	Severe	130,943	7,740,188	1.7%
1	NJ	NY-N. NJ-Long Island	Union	Severe	493,819	7,740,188	6.4%
1	NY	Essex Co (Whiteface Mtn) (new)	Essex	Marginal	37,152	17,990,455	0.2%
1	NY	Albany-Schenectady-Troy (new)	Albany	Marginal	292,594	17,990,455	1.6%
1	NY	Albany-Schenectady-Troy (new)	Greene	Marginal	44,739	17,990,455	0.2%
1	NY	Albany-Schenectady-Troy (new)	Montgomery	Marginal	51,981	17,990,455	0.3%
1	NY	Albany-Schenectady-Troy (new)	Rensselaer	Marginal	154,429	17,990,455	0.9%
1	NY	Albany-Schenectady-Troy (new)	Saratoga	Marginal	181,276	17,990,455	1.0%
1	NY	Albany-Schenectady-Troy (new)	Schenectady	Marginal	149,285	17,990,455	0.8%
1	NY	NY-N. NJ-Long Island	Bronx	Severe	1,203,789	17,990,455	6.7%
1	NY	NY-N. NJ-Long Island	Kings	Severe	2,300,664	17,990,455	12.8%
1	NY	NY-N. NJ-Long Island	Nassau	Severe	1,287,348	17,990,455	7.2%
1	NY	NY-N. NJ-Long Island	New York	Severe	1,487,536	17,990,455	8.3%
1	NY	NY-N. NJ-Long Island	Orange	Severe	307,647	17,990,455	1.7%
1	NY	NY-N. NJ-Long Island	Putham	Severe	83,941	17,990,455	0.5%
1	NY	NY-N. NJ-Long Island	Qweens	Severe	1,951,325	17,990,455	10.8%
1	NY	NY-N. NJ-Long Island	Richmond	Severe	378,977	17,990,455	2.1%
1	NY	NY-N. NJ-Long Island	Rockland	Severe	265,475	17,990,455	1.5%
1	NY	NY-N. NJ-Long Island	Suffolk	Severe	1,321,864	17,990,455	7.3%
1	NY	NY-N. NJ-Long Island	Westchester	Severe	874,866	17,990,455	4.9%
1	NY	Poughkeepsie (new)	Dutchess	Marginal	259,462	17,990,455	1.4%
1	NY	Buffalo-Niagara Falls (new)	Erie	Marginal	968,532	17,990,455	5.4%
1	NY	Buffalo-Niagara Falls (new)	Niagra	Marginal	220,756	17,990,455	1.2%
1	NY	Jefferson Co (new)	Jefferson	Marginal	110,943	17,990,455	0.6%
1	NY	Rest of state	–	Attainment			22.5%
1	OH	Cleveland-Akron-Lorain	Ashtabula	Moderate	99,821	10,847,115	0.9%
1	OH	Cleveland-Akron-Lorain	Cuyahoga	Moderate	215,499	10,847,115	2.0%
1	OH	Cleveland-Akron-Lorain	Geauga	Moderate	81,129	10,847,115	0.7%
1	OH	Cleveland-Akron-Lorain	Lake	Moderate	215,499	10,847,115	2.0%
1	OH	Cleveland-Akron-Lorain	Lorain	Moderate	271,126	10,847,115	2.5%
1	OH	Cleveland-Akron-Lorain	Medina	Moderate	122,354	10,847,115	1.1%
1	OH	Cleveland-Akron-Lorain	Portage	Moderate	142,585	10,847,115	1.3%
1	OH	Cleveland-Akron-Lorain	Summit	Moderate	514,990	10,847,115	4.7%
1	OH	Dayton-Springfield	Clark	Moderate	147,548	10,847,115	1.4%
1	OH	Dayton-Springfield	Greene	Moderate	136,731	10,847,115	1.3%
1	OH	Dayton-Springfield	Miami	Moderate	93,182	10,847,115	0.9%
1	OH	Dayton-Springfield	Montgomery	Moderate	573,809	10,847,115	5.3%
1	OH	Columbus(new)	Deleware	Marginal	66,929	10,847,115	0.6%
1	OH	Columbus(new)	Franklin	Marginal	961,437	10,847,115	8.9%
1	OH	Columbus(new)	Licking	Marginal	128,300	10,847,115	1.2%
1	OH	Canton	Stark	Marginal	367,585	10,847,115	3.4%
1	OH	Toledo/1/	Lucas	Moderate	462,361	10,847,115	4.3%
1	OH	Toledo/1/	Wood	Moderate	113,269	10,847,115	1.0%
1	OH	Youngstown-Warren-Sharon	Mahoning	Marginal	264,806	10,847,115	2.4%

Table B-1 (continued)

Region	State	Area	County	O3 Desig.	Area Pop. /3/	State Pop. /4/	% State Pop.
1	OH	Youngstown-Warren-Sharon	Trumbull	Marginal	227,813	10,847,115	2.1%
1	OH	Cincinnati-Hamilton	Butler	Moderate	291,479	10,847,115	2.7%
1	OH	Cincinnati-Hamilton	Clermont	Moderate	150,187	10,847,115	1.4%
1	OH	Cincinnati-Hamilton	Hamilton	Moderate	866,228	10,847,115	8.0%
1	OH	Cincinnati-Hamilton	Warren	Moderate	113,909	10,847,115	1.1%
1	OH	Rest of state	–	Attainment		10,847,115	38.9%
1	PA	Reading	Berks	Moderate	336,523	11,881,643	2.8%
1	PA	Pittsburgh-Beaver Valley	Allegheny	Moderate	1,336,449	11,881,643	11.2%
1	PA	Pittsburgh-Beaver Valley	Armstrong	Moderate	73,478	11,881,643	0.6%
1	PA	Pittsburgh-Beaver Valley	Beaver	Moderate	186,093	11,881,643	1.6%
1	PA	Pittsburgh-Beaver Valley	Butler	Moderate	152,013	11,881,643	1.3%
1	PA	Pittsburgh-Beaver Valley	Fayette	Moderate	145,351	11,881,643	1.2%
1	PA	Pittsburgh-Beaver Valley	Washington	Moderate	204,584	11,881,643	1.7%
1	PA	Pittsburgh-Beaver Valley	Westmoreland	Moderate	370,321	11,881,643	3.1%
1	PA	Lancaster	Lancaster	Marginal	422,822	11,881,643	3.6%
1	PA	Altoona (new)	Blair	Marginal	130,542	11,881,643	1.1%
1	PA	Allentown-Bethlehem-Easton	Carbon	Marginal	56,846	11,881,643	0.5%
1	PA	Allentown-Bethlehem-Easton	Lehigh	Marginal	291,130	11,881,643	2.5%
1	PA	Allentown-Bethlehem-Easton	Northhampton	Marginal	247,105	11,881,643	2.1%
1	PA	Erie	Erie	Marginal	275,572	11,881,643	2.3%
1	PA	Johnstown (new)	Cambria	Marginal	163,029	11,881,643	1.4%
1	PA	Johnstown (new)	Somerset	Marginal	78,218	11,881,643	0.7%
1	PA	Scranton-Wilkes-Barre	Columbia	Marginal	63,202	11,881,643	0.5%
1	PA	Scranton-Wilkes-Barre	Lackawanna	Marginal	219,039	11,881,643	1.8%
1	PA	Scranton-Wilkes-Barre	Luzerne	Marginal	328,149	11,881,643	2.8%
1	PA	Scranton-Wilkes-Barre	Monroe	Marginal	95,709	11,881,643	0.8%
1	PA	Scranton-Wilkes-Barre	Wyoming	Marginal	28,076	11,881,643	0.2%
1	PA	Youngstown-Warren-Sharon	Mercer	Marginal	121,003	11,881,643	1.0%
1	PA	Harrisburg-Lebanon-Carlisle	Cumberland	Marginal	195,257	11,881,643	1.6%
1	PA	Harrisburg-Lebanon-Carlisle	Dauphin	Marginal	237,813	11,881,643	2.0%
1	PA	Harrisburg-Lebanon-Carlisle	Lebanon	Marginal	113,744	11,881,643	1.0%
1	PA	Harrisburg-Lebanon-Carlisle	Perry	Marginal	41,172	11,881,643	0.3%
1	PA	York	Adams	Marginal	78,274	11,881,643	0.7%
1	PA	York	York	Marginal	339,574	11,881,643	2.9%
1	PA	Philadelphia-Wilm-Trenton	Bucks	Severe	541,174	11,881,643	4.6%
1	PA	Philadelphia-Wilm-Trenton	Chester	Severe	376,396	11,881,643	3.2%
1	PA	Philadelphia-Wilm-Trenton	Delaware	Severe	547,651	11,881,643	4.6%
1	PA	Philadelphia-Wilm-Trenton	Montgomery	Severe	678,111	11,881,643	5.7%
1	PA	Philadelphia-Wilm-Trenton	Philadelphia	Severe	1,585,577	11,881,643	13.3%
1	PA	Rest of state	–	Attainment		11,881,643	15.3%
1	RI	entire state (56 FR 46119)	all	Serious	1,003,464	1,003,464	100.0%
1	VA	Smyth Co (new)	Smyth	Marginal	32,370	6,187,358	0.5%
1	VA	Richmond-Petersburg	Charles City	Moderate	6,282	6,187,358	0.1%
1	VA	Richmond-Petersburg	Chesterfield	Moderate	209,274	6,187,358	3.4%
1	VA	Richmond-Petersburg	Colonial	Moderate	16,064	6,187,358	0.3%
1	VA	Richmond-Petersburg	Hanover	Moderate	63,306	6,187,358	1.0%
1	VA	Richmond-Petersburg	Henrico	Moderate	217,881	6,187,358	3.5%
1	VA	Richmond-Petersburg	Hopewell	Moderate	23,101	6,187,358	0.4%
1	VA	Richmond-Petersburg	Richmond	Moderate	203,056	6,187,358	3.3%
1	VA	Norfolk-Vir Beach-Newport News (	Chesapeake	Marginal	151,976	6,187,358	2.5%
1	VA	Norfolk-Vir Beach-Newport News (	Hampton	Marginal	133,793	6,187,358	2.2%

Table B-1 (continued)

Region	State	Area	County	O3 Desig.	Area Pop. /3/	State Pop. /4/	% State Pop.
1	VA	Norfolk-Vir Beach-Newport News (	James City	Marginal	34,859	6,187,358	0.6%
1	VA	Norfolk-Vir Beach-Newport News (	Newport	Marginal	170,045	6,187,358	2.7%
1	VA	Norfolk-Vir Beach-Newport News (	Norfolk	Marginal	261,229	6,187,358	4.2%
1	VA	Norfolk-Vir Beach-Newport News (	Poquoson	Marginal	11,005	6,187,358	0.2%
1	VA	Norfolk-Vir Beach-Newport News (	Portsmouth	Marginal	103,907	6,187,358	1.7%
1	VA	Norfolk-Vir Beach-Newport News (	Suffolk	Marginal	52,141	6,187,358	0.8%
1	VA	Norfolk-Vir Beach-Newport News (	Virginia Beach	Marginal	393,069	6,187,358	6.4%
1	VA	Norfolk-Vir Beach-Newport News (	Williamsburg	Marginal	11,530	6,187,358	0.2%
1	VA	Norfolk-Vir Beach-Newport News (	York	Marginal	42,422	6,187,358	0.7%
1	VA	Washington	Arlington	Serious	170,936	6,187,358	2.8%
1	VA	Washington	Fairfax	Serious	818,584	6,187,358	13.2%
1	VA	Washington	Loudon	Serious	86,129	6,187,358	1.4%
1	VA	Washington	Prince William	Serious	215,686	6,187,358	3.5%
1	VA	Washington	Stafford	Serious	61,236	6,187,358	1.0%
1	VA	Washington	Alexandria City	Serious	111,183	6,187,358	1.8%
1	VA	Washington	Fairfax City	Serious	19,622	6,187,358	0.3%
1	VA	Washington	Falls Church City	Serious	9,578	6,187,358	0.2%
1	VA	Washington	Manasas City	Serious	15,505	6,187,358	0.3%
1	VA	Washington	Manasas Park City	Serious	6,524	6,187,358	0.1%
1	VA	Rest of state	–	Attainment		6,187,358	41.0%
1	VT	entire state	all	Attainment	562,758	562,758	100.0%
1	WI	Sheboygan	Sheboygan	Serious	103,877	4,891,769	2.1%
1	WI	Walworth Co (new)	Walworth	Marginal	75,000	4,891,769	1.5%
1	WI	Kewaunee Co (new)	Kewaunee	Moderate	18,878	4,891,769	0.4%
1	WI	Milwaukee-Racine	Kenosha	Severe	128,181	4,891,769	2.6%
1	WI	Milwaukee-Racine	Milwaukee	Severe	959,275	4,891,769	19.6%
1	WI	Milwaukee-Racine	Ozaukee	Severe	72,831	4,891,769	1.5%
1	WI	Milwaukee-Racine	Racine	Severe	175,034	4,891,769	3.6%
1	WI	Milwaukee-Racine	Wahington	Severe	95,328	4,891,769	1.9%
1	WI	Milwaukee-Racine	Waukesha	Severe	304,715	4,891,769	6.2%
1	WI	Manitowoc Co (new)	Manitowoc	Moderate	80,421	4,891,769	1.6%
1	WI	Door Co (new)	Door	Marginal	25,690	4,891,769	0.5%
1	WI	Rest of state	–	Attainment		4,891,769	58.3%
1	WV	Parkersburg (new)	Wood	Moderate	86,915	1,793,477	4.8%
1	WV	**Charleston (new)	Kanawha	Moderate	207,619	1,793,477	11.6%
1	WV	**Charleston (new)	Putnam	Moderate	42,835	1,793,477	2.4%
1	WV	Greenbrier Co (new)	Greenbrier	Marginal	34,693	1,793,477	1.9%
1	WV	Huntington-Ashland	Cabell	Moderate	96,827	1,793,477	5.4%
1	WV	Huntington-Ashland	Wayne	Moderate	41,636	1,793,477	2.3%
1	WV	Rest of state	–	Attainment		1,793,477	71.5%
2	AL	Birmingham	Jefferson	Marginal	651,525	1,040,587	62.6%
2	AL	Birmingham	Shelby	Marginal	99,358	1,040,587	9.5%
2	AL	Rest of state	–	Attainment		1,040,587	27.8%
2	AR	entire state	all	Attainment	2,350,725	2,350,725	100.0%
2	FL	Miami-Ft Laud.-W. Palm Beach	Broward	Moderate	1,255,488	12,937,926	9.7%
2	FL	Miami-Ft Laud.-W. Palm Beach	Dade	Moderate	1,937,094	12,937,926	15.0%
2	FL	Miami-Ft Laud.-W. Palm Beach	Palm Beach	Moderate	863,518	12,937,926	6.7%
2	FL	Tampa-St. Pet.-Clearwater	Hillsborough	Marginal	834,054	12,937,926	6.4%
2	FL	Tampa-St. Pet.-Clearwater	Pinellas	Marginal	851,659	12,937,926	6.6%

Table B-1 (continued)

Region	State	Area	County	O3 Desig.	Area Pop. /3/	State Pop. /4/	% State Pop.
2	FL	Rest of state	–	Attainment		12,937,926	55.6%
2	GA	Atlanta	Cherokee	Serious	90,204	6,478,216	1.4%
2	GA	Atlanta	Clayton	Serious	182,052	6,478,216	2.8%
2	GA	Atlanta	Cobb	Serious	447,745	6,478,216	6.9%
2	GA	Atlanta	Coweta	Serious	53,853	6,478,216	0.8%
2	GA	Atlanta	De Kalb	Serious	545,837	6,478,216	8.4%
2	GA	Atlanta	Douglas	Serious	71,120	6,478,216	1.1%
2	GA	Atlanta	Fayette	Serious	62,415	6,478,216	1.0%
2	GA	Atlanta	Forsyth	Serious	44,083	6,478,216	0.7%
2	GA	Atlanta	Fulton	Serious	648,951	6,478,216	10.0%
2	GA	Atlanta	Gwinnett	Serious	352,910	6,478,216	5.4%
2	GA	Atlanta	Henry	Serious	58,741	6,478,216	0.9%
2	GA	Atlanta	Paulding	Serious	41,611	6,478,216	0.6%
2	GA	Atlanta	Rockdale	Serious	54,091	6,478,216	0.8%
2	GA	Rest of state	–	Attainment		6,478,216	59.0%
2	LA	Lake Charles	Calcasieu	Marginal	168,134	4,219,973	4.0%
2	LA	Baton Rouge	Ascension	Serious	58,214	4,219,973	1.4%
2	LA	Baton Rouge	East Baton Rouge	Serious	380,105	4,219,973	9.0%
2	LA	Baton Rouge	Iberville	Serious	31,049	4,219,973	0.7%
2	LA	Baton Rouge	Livingston	Serious	70,526	4,219,973	1.7%
2	LA	Baton Rouge	Pointe Coupes	Serious	22,540	4,219,973	0.5%
2	LA	Baton Rouge	W. Baton Rouge	Serious	19,419	4,219,973	0.5%
2	LA	Rest of state	–	Attainment		4,219,973	82.2%
2	MS	entire state	all	Attainment	2,573,216	2,573,216	100.0%
2	NC	Raleigh-Durham (new)	Durham	Moderate	181,835	6,628,637	2.7%
2	NC	Raleigh-Durham (new)	Granville	Moderate	38,345	6,628,637	0.6%
2	NC	Raleigh-Durham (new)	Wake	Moderate	423,380	6,628,637	6.4%
2	NC	Charlotte-Gastonia	Gaston	Moderate	175,093	6,628,637	2.6%
2	NC	Charlotte-Gastonia	Mecklenburg	Moderate	511,433	6,628,637	7.7%
2	NC	Greensboro-Winston (new)	Davidson	Moderate	126,677	6,628,637	1.9%
2	NC	Greensboro-Winston (new)	Davie	Moderate	27,859	6,628,637	0.4%
2	NC	Greensboro-Winston (new)	Forsyth	Moderate	265,878	6,628,637	4.0%
2	NC	Greensboro-Winston (new)	Guilford	Moderate	347,420	6,628,637	5.2%
2	NC	Rest of state	–	Attainment		6,628,637	68.4%
2	SC	Cherokee Co(new)	Cherokee	Marginal	44,506	3,486,703	1.3%
2	SC	Rest of state	–	Attainment		3,486,703	98.7%
2	TN	Knoxville (new)	Knox	Marginal	335,749	4,877,185	6.9%
2	TN	Memphis	Shelby	Marginal	826,330	4,877,185	16.9%
2	TN	Nashville	Davidson	Moderate	510,784	4,877,185	10.5%
2	TN	Nashville	Rutherford	Moderate	118,570	4,877,185	2.4%
2	TN	Nashville	Sumner	Moderate	103,281	4,877,185	2.1%
2	TN	Nashville	Williamsburg	Moderate	81,021	4,877,185	1.7%
2	TN	Nashville	Wilson	Moderate	67,675	4,877,185	1.4%
2	TN	Rest of state	–	Attainment		4,877,185	58.1%
3	AZ	Phoenix	Maricopa	Moderate	2,122,101	3,665,228	57.9%
3	AZ	Rest of state	–	Attainment		3,665,228	42.1%
3	NM	entire state	all	Attainment	1,515,069	1,515,069	100.0%
3	OK	entire state	all	Attainment	3,145,585	3,145,585	100.0%
3	TX	Beaumont-Port Aurthur	Hardin	Serious	41,320	16,985,510	0.2%

Table B-1 (continued)

Region	State	Area	County	O3 Desig.	Area Pop. /3/	State Pop. /4/	% State Pop.
3	TX	Beaumont-Port Aurthur	Jefferson	Serious	239,397	16,985,510	1.4%
3	TX	Beaumont-Port Aurthur	Orange	Serious	80,509	16,985,510	0.5%
3	TX	Dallas-Fort Worth	Collin	Moderate	264,036	16,985,510	1.6%
3	TX	Dallas-Fort Worth	Dallas	Moderate	1,852,810	16,985,510	10.9%
3	TX	Dallas-Fort Worth	Denton	Moderate	273,525	16,985,510	1.6%
3	TX	Dallas-Fort Worth	Tarrant	Moderate	1,170,103	16,985,510	6.9%
3	TX	El Paso	El Paso	Serious	591,610	16,985,510	3.5%
3	TX	Houston-Galveston-Brazoria	Brazoria	Severe	191,707	16,985,510	1.1%
3	TX	Houston-Galveston-Brazoria	Chambers	Severe	20,088	16,985,510	0.1%
3	TX	Houston-Galveston-Brazoria	Fort Bend	Severe	225,421	16,985,510	1.3%
3	TX	Houston-Galveston-Brazoria	Galveston	Severe	217,399	16,985,510	1.3%
3	TX	Houston-Galveston-Brazoria	Harris	Severe	2,818,199	16,985,510	16.6%
3	TX	Houston-Galveston-Brazoria	Liberty	Severe	52,726	16,985,510	0.3%
3	TX	Houston-Galveston-Brazoria	Montgomery	Severe	182,201	16,985,510	1.1%
3	TX	Houston-Galveston-Brazoria	Waller	Severe	23,390	16,985,510	0.1%
3	TX	Rest of state	–	Attainment		16,985,510	51.5%
4	CO	entire state	all	Attainment	3,294,394	3,294,394	100.0%
4	ID	entire state	all	Attainment	1,006,749	1,006,749	100.0%
4	IOWA	entire state	all	Attainment	2,776,755	2,776,755	100.0%
4	KS	entire state	all	Attainment	2,477,574	2,477,574	100.0%
4	MN	entire state	all	Attainment	4,375,099	4,375,099	100.0%
4	MO	St Louis	Franklin	Moderate	80,603	5,117,073	1.6%
4	MO	St Louis	Jefferson	Moderate	171,380	5,117,073	3.3%
4	MO	St Louis	St. Charles	Moderate	212,907	5,117,073	4.2%
4	MO	St Louis	St. Louis	Moderate	396,685	5,117,073	7.8%
4	MO	St Louis	St. Louis County	Moderate	993,529	5,117,073	19.4%
4	MO	Rest of state	–	Attainment		5,117,073	63.7%
4	MT	entire state	all	Attainment	799,065	799,065	100.0%
4	ND	entire state	all	Attainment	638,800	638,800	100.0%
4	NE	entire state	all	Attainment	1,578,385	1,578,385	100.0%
4	OR	Portland-Vancouver AQMA	Clackamas	Marginal	278,850	2,842,321	9.8%
4	OR	Portland-Vancouver AQMA	Multnomak	Marginal	583,887	2,842,321	20.5%
4	OR	Portland-Vancouver AQMA	Washington	Marginal	311,554	2,842,321	11.0%
4	OR	Rest of state	–	Attainment		2,842,321	58.7%
4	SD	entire state	all	Attainment	696,004	696,004	100.0%
4	WA	Seattle-Tacoma (new)	King	Marginal	1,507,319	4,866,692	31.0%
4	WA	Seattle-Tacoma (new)	Pierce	Marginal	586,203	4,866,692	12.0%
4	WA	Seattle-Tacoma (new)	Snohomish	Marginal	465,642	4,866,692	9.6%
4	WA	Portland-Vancouver AQMA	Clark	Marginal	238,053	4,866,692	4.9%
4	WA	Rest of state	–	Attainment		4,866,692	42.5%
4	WY	entire state	all	Attainment	453,588	453,588	100.0%
5	CA	San Diego	San Diego	Severe	2,948,016	29,760,021	9.9%
5	CA	LA-South Coast Air Basin	LA-1	Extreme	8,863,164	29,760,021	29.8%
5	CA	LA-South Coast Air Basin	Orange	Extreme	2,410,556	29,760,021	8.1%
5	CA	LA-South Coast Air Basin	Riverside-1	Extreme	1,170,413	29,760,021	3.9%
5	CA	LA-South Coast Air Basin	San Bernardino-1	Extreme	1,418,380	29,760,021	4.8%
5	CA	San Joaquin Valley	Fresno	Serious	667,490	29,760,021	2.2%

Table B-1 (continued)

Region	State	Area	County	O3 Desig.	Area Pop. /3/	State Pop. /4/	% State Pop.
5	CA	San Joaquin Valley	Kern	Serious	543,477	29,760,021	1.8%
5	CA	San Joaquin Valley	Kings	Serious	101,469	29,760,021	0.3%
5	CA	San Joaquin Valley	Madera	Serious	88,090	29,760,021	0.3%
5	CA	San Joaquin Valley	Merced	Serious	178,403	29,760,021	0.6%
5	CA	San Joaquin Valley	San Joaquin	Serious	480,628	29,760,021	1.6%
5	CA	San Joaquin Valley	Stanislaus	Serious	370,522	29,760,021	1.2%
5	CA	San Joaquin Valley	Tulare	Serious	311,921	29,760,021	1.0%
5	CA	San Francisco Bay Area	Alameda	Moderate	1,279,182	29,760,021	4.3%
5	CA	San Francisco Bay Area	Conta Costa	Moderate	803,732	29,760,021	2.7%
5	CA	San Francisco Bay Area	Marin	Moderate	230,096	29,760,021	0.8%
5	CA	San Francisco Bay Area	Napa	Moderate	110,765	29,760,021	0.4%
5	CA	San Francisco Bay Area	San Fransisco	Moderate	723,959	29,760,021	2.4%
5	CA	San Francisco Bay Area	San Mateo	Moderate	649,623	29,760,021	2.2%
5	CA	San Francisco Bay Area	Santa Clara	Moderate	1,497,577	29,760,021	5.0%
5	CA	San Francisco Bay Area	Solano	Moderate	340,421	29,760,021	1.1%
5	CA	San Francisco Bay Area	Sonoma	Moderate	388,222	29,760,021	1.3%
5	CA	Monterey Bay	Monterey	Moderate	355,660	29,760,021	1.2%
5	CA	Monterey Bay	San Benito	Moderate	36,697	29,760,021	0.1%
5	CA	Monterey Bay	Santa Cruz	Moderate	229,734	29,760,021	0.8%
5	CA	Sacramento Metro	El Dorado	Serious	125,995	29,760,021	0.4%
5	CA	Sacramento Metro	Placer	Serious	172,796	29,760,021	0.6%
5	CA	Sacramento Metro	Sacramento	Serious	1,041,219	29,760,021	3.5%
5	CA	Sacramento Metro	Sutter	Serious	64,415	29,760,021	0.2%
5	CA	Sacramento Metro	Yolo	Serious	141,092	29,760,021	0.5%
5	CA	Ventura County	Ventura County	Severe	669,016	29,760,021	2.2%
5	CA	Santa Barbara-Santa Maria-Lomp	Santa Barbara	Moderate	369,608	29,760,021	1.2%
5	CA	Rest of state	–	Attainment	977,608	29,760,021	3.3%
5	NV	Reno (new)	Washoe	Marginal	254,667	1,201,833	21.2%
5	NV	Las Vegas	Clark	Attainment	741,459	1,201,833	61.7%
5	NV	Rest of state	–	Attainment		1,201,833	17.1%
5	UT	Salt Lake City	Davis	Moderate	187,941	1,722,850	10.9%
5	UT	Salt Lake City	Salt Lake	Moderate	725,956	1,722,850	42.1%
5	UT	Rest of state	–	Attainment		1,722,850	47.0%

TABLE B-2: Fuel Consumption in Nonattainment Areas, Attainment Areas, and Stage II Areas

(Effective During the Months June through September)

										Fuel Consumption as a Percent of Nationwide Fuel Consumption								
									State/	Nonattainment				Attainment	Stage II			
				RVP	O3	Reform	Stage II	% State	Nation	Areas				Areas	Areas			
Region	State	Area	County	Class	Desig.	Area?	Area?	Pop.	Thruput	6.7 RVP	7.0 RVP	7.8 RVP	9.0 RVP	9.0 RVP	6.7 RVP	7.0 RVP	7.8 RVP	9.0 RVP
1	CT	Entire State (56 FR 66444)	all	c	Ser/Sev	1	1	100.0%	1.18%	1.18%	0.00%	0.00%	0.00%	0.00%	1.18%	0.00%	0.00%	0.00%
1	DC	Washington (56 FR 24037)	all	b	Serious	1	1	100.0%	0.15%	0.15%	0.00%	0.00%	0.00%	0.00%	0.15%	0.00%	0.00%	0.00%
1	DE	Philadelphia-Wilm-Trenton	Kent	c	Severe	1	1	16.7%	0.30%	0.05%	0.00%	0.00%	0.00%	0.00%	0.05%	0.00%	0.00%	0.00%
1	DE	Philadelphia-Wilm-Trenton	New Castle	c	Severe	1	1	66.3%	0.30%	0.20%	0.00%	0.00%	0.00%	0.00%	0.20%	0.00%	0.00%	0.00%
1	DE	Sussex Co (new)	Sussex	c	Marginal	1	1	17.0%	0.30%	0.05%	0.00%	0.00%	0.00%	0.00%	0.05%	0.00%	0.00%	0.00%
1	IL	Jersey Co (new)	Jersey	c	Marginal	0	0	0.2%	4.08%	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%
1	IL	Chicago-Gary-Lake County	Cook	c	Severe	1	1	44.7%	4.08%	1.82%	0.00%	0.00%	0.00%	0.00%	1.82%	0.00%	0.00%	0.00%
1	IL	Chicago-Gary-Lake County	Du Page	c	Severe	1	1	6.8%	4.08%	0.28%	0.00%	0.00%	0.00%	0.00%	0.28%	0.00%	0.00%	0.00%
1	IL	Chicago-Gary-Lake County	Grundy (all)	c	Severe	1	1	0.3%	4.08%	0.01%	0.00%	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%
1	IL	Chicago-Gary-Lake County	Kane	c	Severe	1	1	2.8%	4.08%	0.11%	0.00%	0.00%	0.00%	0.00%	0.11%	0.00%	0.00%	0.00%
1	IL	Chicago-Gary-Lake County	Kendall (all)	c	Severe	1	1	0.3%	4.08%	0.01%	0.00%	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%
1	IL	Chicago-Gary-Lake County	Lake	c	Severe	1	1	4.5%	4.08%	0.18%	0.00%	0.00%	0.00%	0.00%	0.18%	0.00%	0.00%	0.00%
1	IL	Chicago-Gary-Lake County	Mchenry	c	Severe	1	1	1.6%	4.08%	0.07%	0.00%	0.00%	0.00%	0.00%	0.07%	0.00%	0.00%	0.00%
1	IL	Chicago-Gary-Lake County	Will	c	Severe	1	1	3.1%	4.08%	0.13%	0.00%	0.00%	0.00%	0.00%	0.13%	0.00%	0.00%	0.00%
1	IL	St Louis	Madison	c	Moderate	0	1	2.2%	4.08%	0.00%	0.00%	0.00%	0.09%	0.00%	0.00%	0.00%	0.00%	0.09%
1	IL	St Louis	Monroe	c	Moderate	0	1	0.2%	4.08%	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.01%
1	IL	St Louis	St. Clair	c	Moderate	0	1	2.3%	4.08%	0.00%	0.00%	0.00%	0.09%	0.00%	0.00%	0.00%	0.00%	0.09%
1	IL	Rest of state	--	c	Attainment	0	0	31.0%	4.08%	0.00%	0.00%	0.00%	0.00%	1.26%	0.00%	0.00%	0.00%	0.00%
1	IN	Louisville	Clark	c	Moderate	0	1	8.6%	2.36%	0.00%	0.00%	0.00%	0.20%	0.00%	0.00%	0.00%	0.00%	0.20%
1	IN	Louisville	Floyd	c	Moderate	0	1	2.3%	2.36%	0.00%	0.00%	0.00%	0.05%	0.00%	0.00%	0.00%	0.00%	0.05%
1	IN	South Bend-Elkhart	Elkhart	c	Marginal	0	0	2.8%	2.36%	0.00%	0.00%	0.00%	0.07%	0.00%	0.00%	0.00%	0.00%	0.00%
1	IN	South Bend-Elkhart	St,. Joseph	c	Marginal	0	0	4.5%	2.36%	0.00%	0.00%	0.00%	0.11%	0.00%	0.00%	0.00%	0.00%	0.00%
1	IN	Chicago-Gary-Lake County	Lake	c	Severe	1	1	8.6%	2.36%	0.20%	0.00%	0.00%	0.00%	0.00%	0.20%	0.00%	0.00%	0.00%
1	IN	Chicago-Gary-Lake County	Porter	c	Severe	1	1	2.3%	2.36%	0.05%	0.00%	0.00%	0.00%	0.00%	0.05%	0.00%	0.00%	0.00%
1	IN	Indianapolis	Marion	c	Marginal	0	0	14.4%	2.36%	0.00%	0.00%	0.00%	0.34%	0.00%	0.00%	0.00%	0.00%	0.00%
1	IN	Evansville (new)	Vanderburgh	c	Marginal	0	0	3.0%	2.36%	0.00%	0.00%	0.00%	0.07%	0.00%	0.00%	0.00%	0.00%	0.00%
1	IN	Rest of state	--	c	Attainment	0	0	53.6%	2.36%	0.00%	0.00%	0.00%	0.00%	1.27%	0.00%	0.00%	0.00%	0.00%
1	KY	Paducah (new)	Livingston	c	Marginal	0	0	0.2%	1.62%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1	KY	Paducah (new)	Marshall	c	Marginal	0	0	0.7%	1.62%	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%
1	KY	Huntington-Ashland	Boyd	c	Moderate	0	0	1.4%	1.62%	0.00%	0.00%	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%
1	KY	Huntington-Ashland	Greenup	c	Moderate	0	0	1.0%	1.62%	0.00%	0.00%	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%
1	KY	Edmonson Co (new)	Edmonson	c	Marginal	0	0	0.3%	1.62%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1	KY	Cincinnati-Hamilton	Boone	c	Moderate	0	1	1.6%	1.62%	0.00%	0.00%	0.00%	0.03%	0.00%	0.00%	0.00%	0.00%	0.03%
1	KY	Cincinnati-Hamilton	Campbell	c	Moderate	0	1	2.3%	1.62%	0.00%	0.00%	0.00%	0.04%	0.00%	0.00%	0.00%	0.00%	0.04%
1	KY	Cincinnati-Hamilton	Kenton	c	Moderate	0	1	3.9%	1.62%	0.00%	0.00%	0.00%	0.06%	0.00%	0.00%	0.00%	0.00%	0.06%
1	KY	Lexington-Fayette (new)	Fayette	c	Marginal	0	0	6.1%	1.62%	0.00%	0.00%	0.00%	0.10%	0.00%	0.00%	0.00%	0.00%	0.00%
1	KY	Lexington-Fayette (new)	Scott	c	Marginal	0	0	0.6%	1.62%	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%
1	KY	Louisville	Jefferson	c	Moderate	0	1	18.0%	1.62%	0.00%	0.00%	0.00%	0.29%	0.00%	0.00%	0.00%	0.00%	0.29%
1	KY	Owensboro (new)	Daviess	c	Marginal	0	0	2.4%	1.62%	0.00%	0.00%	0.00%	0.04%	0.00%	0.00%	0.00%	0.00%	0.00%
1	KY	Owensboro (new)	Hancock	c	Marginal	0	0	0.2%	1.62%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1	KY	Rest of state	--	c	Attainment	0	0	61.3%	1.62%	0.00%	0.00%	0.00%	0.00%	0.99%	0.00%	0.00%	0.00%	0.00%
1	MA	Entire State (56 FR 57986)	all	c	Serious	1	1	100.0%	2.14%	2.14%	0.00%	0.00%	0.00%	0.00%	2.14%	0.00%	0.00%	0.00%
1	MD	Philadelphia-Wilm-Trenton	Cecil	b	Severe	1	1	1.5%	1.83%	0.03%	0.00%	0.00%	0.00%	0.00%	0.03%	0.00%	0.00%	0.00%
1	MD	Washington	Calvert	b	Serious	1	1	1.1%	1.83%	0.02%	0.00%	0.00%	0.00%	0.00%	0.02%	0.00%	0.00%	0.00%
1	MD	Washington	Charles	b	Serious	1	1	2.1%	1.83%	0.04%	0.00%	0.00%	0.00%	0.00%	0.04%	0.00%	0.00%	0.00%
1	MD	Washington	Fredrick	b	Serious	1	1	3.1%	1.83%	0.06%	0.00%	0.00%	0.00%	0.00%	0.06%	0.00%	0.00%	0.00%
1	MD	Washington	Montgomery	b	Serious	1	1	15.8%	1.83%	0.29%	0.00%	0.00%	0.00%	0.00%	0.29%	0.00%	0.00%	0.00%
1	MD	Washington	Prince George	b	Serious	1	1	15.3%	1.83%	0.28%	0.00%	0.00%	0.00%	0.00%	0.28%	0.00%	0.00%	0.00%

Table B-2 (continued)

Region	State	Area	County	RVP Class	O3 Desig.	Reform Area?	Stage II Area?	% State Pop.	State/ Nation Thruput	Fuel Consumption as a Percent of Nationwide Fuel Consumption: Nonattainment Areas 6.7 RVP	Nonattainment Areas 7.0 RVP	Nonattainment Areas 7.8 RVP	Nonattainment Areas 9.0 RVP	Attainment Areas 9.0 RVP	Stage II Areas 6.7 RVP	Stage II Areas 7.0 RVP	Stage II Areas 7.8 RVP	Stage II Areas 9.0 RVP
1	MD	Baltimore	Anne Arudel	b	Severe	1	1	8.9%	1.83%	0.16%	0.00%	0.00%	0.00%	0.00%	0.16%	0.00%	0.00%	0.00%
1	MD	Baltimore	Baltimore	b	Severe	1	1	14.5%	1.83%	0.27%	0.00%	0.00%	0.00%	0.00%	0.27%	0.00%	0.00%	0.00%
1	MD	Baltimore	Carrol	b	Severe	1	1	2.6%	1.83%	0.05%	0.00%	0.00%	0.00%	0.00%	0.05%	0.00%	0.00%	0.00%
1	MD	Baltimore	Hartford	b	Severe	1	1	3.8%	1.83%	0.07%	0.00%	0.00%	0.00%	0.00%	0.07%	0.00%	0.00%	0.00%
1	MD	Baltimore	Howard	b	Severe	1	1	3.9%	1.83%	0.07%	0.00%	0.00%	0.00%	0.00%	0.07%	0.00%	0.00%	0.00%
1	MD	Baltimore	Baltimore city	b	Severe	1	1	15.4%	1.83%	0.28%	0.00%	0.00%	0.00%	0.00%	0.28%	0.00%	0.00%	0.00%
1	MD	Kent & Queen Anne's Cos (new)	Kent	b	Marginal	1	0	0.4%	1.83%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1	MD	Kent & Queen Anne's Cos (new)	Qween Anne's	b	Marginal	1	0	0.7%	1.83%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1	MD	Rest of state	--	c	Attainment	0	0	10.9%	1.83%	0.00%	0.00%	0.00%	0.00%	0.20%	0.00%	0.00%	0.00%	0.00%
1	ME	Hancock & Waldo Cos	Hancock	c	Marginal	1	0	3.8%	0.54%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1	ME	Hancock & Waldo Cos	Waldo	c	Marginal	1	0	2.7%	0.54%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1	ME	Portland	Cumberland	c	Moderate	1	0	16.3%	0.54%	0.09%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1	ME	Portland	Sagadahoc	c	Moderate	1	0	2.7%	0.54%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1	ME	Portland	York	c	Moderate	1	0	1.7%	0.54%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1	ME	Lewiston-Auburn	Androscoggin	c	Moderate	1	0	7.6%	0.54%	0.04%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1	ME	Lewiston-Auburn	Kennebec	c	Moderate	1	0	9.4%	0.54%	0.05%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1	ME	Knox & Lincoln Cos	Knox	c	Moderate	1	0	3.0%	0.54%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1	ME	Knox & Lincoln Cos	Lincoln	c	Moderate	1	0	4.3%	0.54%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1	ME	Flanklin County (56 FR 46119)	Flanklin County	c	Attainment	1	0	2.4%	0.54%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1	ME	Oxford (56 FR 46119)	Oxford	c	Attainment	1	0	4.3%	0.54%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1	ME	Somerset (56 FR 46119)	Somerset	c	Attainment	1	0	4.1%	0.54%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1	ME	Rest of state	--	c	Attainment	0	0	37.7%	0.54%	0.00%	0.00%	0.00%	0.00%	0.20%	0.00%	0.00%	0.00%	0.00%
1	MI	Detroit-Ann Arbor	Livingston	c	Moderate	0	0	1.2%	3.83%	0.00%	0.00%	0.00%	0.05%	0.00%	0.00%	0.00%	0.00%	0.00%
1	MI	Detroit-Ann Arbor	Macomb	c	Moderate	0	0	7.7%	3.83%	0.00%	0.00%	0.00%	0.30%	0.00%	0.00%	0.00%	0.00%	0.00%
1	MI	Detroit-Ann Arbor	Oakland	c	Moderate	0	0	11.7%	3.83%	0.00%	0.00%	0.00%	0.45%	0.00%	0.00%	0.00%	0.00%	0.00%
1	MI	Detroit-Ann Arbor	Monroe	c	Moderate	0	0	1.4%	3.83%	0.00%	0.00%	0.00%	0.06%	0.00%	0.00%	0.00%	0.00%	0.00%
1	MI	Detroit-Ann Arbor	St. Clair	c	Moderate	0	0	1.6%	3.83%	0.00%	0.00%	0.00%	0.06%	0.00%	0.00%	0.00%	0.00%	0.00%
1	MI	Detroit-Ann Arbor	Washtenaw	c	Moderate	0	0	3.0%	3.83%	0.00%	0.00%	0.00%	0.12%	0.00%	0.00%	0.00%	0.00%	0.00%
1	MI	Detroit-Ann Arbor	Wayne	c	Moderate	0	0	22.7%	3.83%	0.00%	0.00%	0.00%	0.87%	0.00%	0.00%	0.00%	0.00%	0.00%
1	MI	Grand Rapids	Kent	c	Moderate	0	0	5.4%	3.83%	0.00%	0.00%	0.00%	0.21%	0.00%	0.00%	0.00%	0.00%	0.00%
1	MI	Grand Rapids	Ottawa	c	Moderate	0	0	2.0%	3.83%	0.00%	0.00%	0.00%	0.08%	0.00%	0.00%	0.00%	0.00%	0.00%
1	MI	Rest of state	--	c	Attainment	0	0	43.2%	3.83%	0.00%	0.00%	0.00%	0.00%	1.66%	0.00%	0.00%	0.00%	0.00%
1	NH	Boston-Lawrence-Worcester	Hillsborough-1	c	Serious	1	1	16.0%	0.45%	0.07%	0.00%	0.00%	0.00%	0.00%	0.07%	0.00%	0.00%	0.00%
1	NH	Boston-Lawrence-Worcester	Rockingham-1	c	Serious	1	1	0.7%	0.45%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1	NH	Manchester	Hillsborough-2	c	Marginal	1	0	12.0%	0.45%	0.05%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1	NH	Manchester	Merrimack	c	Marginal	1	0	1.2%	0.45%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1	NH	Manchester	Rockingham-2	c	Marginal	1	0	2.5%	0.45%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1	NH	Portsmouth-Dover-Rochester	Rockingham-3	c	Serious	1	1	8.0%	0.45%	0.04%	0.00%	0.00%	0.00%	0.00%	0.04%	0.00%	0.00%	0.00%
1	NH	Portsmouth-Dover-Rochester	Strafford	c	Serious	1	1	8.8%	0.45%	0.04%	0.00%	0.00%	0.00%	0.00%	0.04%	0.00%	0.00%	0.00%
1	NH	Rest of state	all	c	Attainment	0	0	50.8%	0.45%	0.00%	0.00%	0.00%	0.00%	0.23%	0.00%	0.00%	0.00%	0.00%
1	NJ	Philadelphia-Wilm-Trenton	Bulington	c	Severe	1	1	5.1%	3.09%	0.16%	0.00%	0.00%	0.00%	0.00%	0.16%	0.00%	0.00%	0.00%
1	NJ	Philadelphia-Wilm-Trenton	Camden	c	Severe	1	1	6.5%	3.09%	0.20%	0.00%	0.00%	0.00%	0.00%	0.20%	0.00%	0.00%	0.00%
1	NJ	Philadelphia-Wilm-Trenton	Cumberland	c	Severe	1	1	1.8%	3.09%	0.06%	0.00%	0.00%	0.00%	0.00%	0.06%	0.00%	0.00%	0.00%
1	NJ	Philadelphia-Wilm-Trenton	Gloucester	c	Severe	1	1	3.0%	3.09%	0.09%	0.00%	0.00%	0.00%	0.00%	0.09%	0.00%	0.00%	0.00%
1	NJ	Philadelphia-Wilm-Trenton	Mercer	c	Severe	1	1	4.2%	3.09%	0.13%	0.00%	0.00%	0.00%	0.00%	0.13%	0.00%	0.00%	0.00%
1	NJ	Philadelphia-Wilm-Trenton	Salem	c	Severe	1	1	0.8%	3.09%	0.03%	0.00%	0.00%	0.00%	0.00%	0.03%	0.00%	0.00%	0.00%
1	NJ	Atlantic City	Atlantic	c	Moderate	1	1	2.9%	3.09%	0.09%	0.00%	0.00%	0.00%	0.00%	0.09%	0.00%	0.00%	0.00%
1	NJ	Atlantic City	Cape	c	Moderate	1	1	1.2%	3.09%	0.04%	0.00%	0.00%	0.00%	0.00%	0.04%	0.00%	0.00%	0.00%
1	NJ	Allentown-Bethlehem-Easton	Warren	c	Marginal	1	1	1.2%	3.09%	0.04%	0.00%	0.00%	0.00%	0.00%	0.04%	0.00%	0.00%	0.00%
1	NJ	NY-N. NJ-Long Island	Bergen	c	Severe	1	1	10.7%	3.09%	0.33%	0.00%	0.00%	0.00%	0.00%	0.33%	0.00%	0.00%	0.00%
1	NJ	NY-N. NJ-Long Island	Essex	c	Severe	1	1	10.1%	3.09%	0.31%	0.00%	0.00%	0.00%	0.00%	0.31%	0.00%	0.00%	0.00%
1	NJ	NY-N. NJ-Long Island	Hudson	c	Severe	1	1	7.1%	3.09%	0.22%	0.00%	0.00%	0.00%	0.00%	0.22%	0.00%	0.00%	0.00%

Table B-2 (continued)

										Fuel Consumption as a Percent of Nationwide Fuel Consumption								
									State/	Nonattainment Areas				Attainment Areas	Stage II Areas			
				RVP	O3	Reform	Stage II	% State	Nation									
Region	State	Area	County	Class	Desig.	Area?	Area?	Pop.	Thruput	6.7 RVP	7.0 RVP	7.8 RVP	9.0 RVP	9.0 RVP	6.7 RVP	7.0 RVP	7.8 RVP	9.0 RVP
1	NJ	NY-N. NJ-Long Island	Hunterdon	c	Severe	1	1	1.4%	3.09%	0.04%	0.00%	0.00%	0.00%	0.00%	0.04%	0.00%	0.00%	0.00%
1	NJ	NY-N. NJ-Long Island	Middlesex	c	Severe	1	1	8.7%	3.09%	0.27%	0.00%	0.00%	0.00%	0.00%	0.27%	0.00%	0.00%	0.00%
1	NJ	NY-N. NJ-Long Island	Monmouth	c	Severe	1	1	7.1%	3.09%	0.22%	0.00%	0.00%	0.00%	0.00%	0.22%	0.00%	0.00%	0.00%
1	NJ	NY-N. NJ-Long Island	Morris	c	Severe	1	1	5.4%	3.09%	0.17%	0.00%	0.00%	0.00%	0.00%	0.17%	0.00%	0.00%	0.00%
1	NJ	NY-N. NJ-Long Island	Ocean	c	Severe	1	1	5.7%	3.09%	0.18%	0.00%	0.00%	0.00%	0.00%	0.18%	0.00%	0.00%	0.00%
1	NJ	NY-N. NJ-Long Island	Passiac	c	Severe	1	1	5.9%	3.09%	0.18%	0.00%	0.00%	0.00%	0.00%	0.18%	0.00%	0.00%	0.00%
1	NJ	NY-N. NJ-Long Island	Somerset	c	Severe	1	1	3.1%	3.09%	0.10%	0.00%	0.00%	0.00%	0.00%	0.10%	0.00%	0.00%	0.00%
1	NJ	NY-N. NJ-Long Island	Sussex	c	Severe	1	1	1.7%	3.09%	0.05%	0.00%	0.00%	0.00%	0.00%	0.05%	0.00%	0.00%	0.00%
1	NJ	NY-N. NJ-Long Island	Union	c	Severe	1	1	6.4%	3.09%	0.20%	0.00%	0.00%	0.00%	0.00%	0.20%	0.00%	0.00%	0.00%
1	NY	Essex Co (Whiteface Mtn) (new)	Essex	c	Marginal	1	0	0.2%	5.26%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1	NY	Albany-Schenectady-Troy (new)	Albany	c	Marginal	1	0	1.6%	5.26%	0.09%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1	NY	Albany-Schenectady-Troy (new)	Greene	c	Marginal	1	0	0.2%	5.26%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1	NY	Albany-Schenectady-Troy (new)	Montgomery	c	Marginal	1	0	0.3%	5.26%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1	NY	Albany-Schenectady-Troy (new)	Rensselaer	c	Marginal	1	0	0.9%	5.26%	0.05%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1	NY	Albany-Schenectady-Troy (new)	Saratoga	c	Marginal	1	0	1.0%	5.26%	0.05%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1	NY	Albany-Schenectady-Troy (new)	Schenectady	c	Marginal	1	0	0.8%	5.26%	0.04%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1	NY	NY-N. NJ-Long Island	Bronx	c	Severe	1	1	6.7%	5.26%	0.35%	0.00%	0.00%	0.00%	0.00%	0.35%	0.00%	0.00%	0.00%
1	NY	NY-N. NJ-Long Island	Kings	c	Severe	1	1	12.8%	5.26%	0.67%	0.00%	0.00%	0.00%	0.00%	0.67%	0.00%	0.00%	0.00%
1	NY	NY-N. NJ-Long Island	Nassau	c	Severe	1	1	7.2%	5.26%	0.38%	0.00%	0.00%	0.00%	0.00%	0.38%	0.00%	0.00%	0.00%
1	NY	NY-N. NJ-Long Island	New York	c	Severe	1	1	8.3%	5.26%	0.43%	0.00%	0.00%	0.00%	0.00%	0.43%	0.00%	0.00%	0.00%
1	NY	NY-N. NJ-Long Island	Orange	c	Severe	1	1	1.7%	5.26%	0.09%	0.00%	0.00%	0.00%	0.00%	0.09%	0.00%	0.00%	0.00%
1	NY	NY-N. NJ-Long Island	Putham	c	Severe	1	1	0.5%	5.26%	0.02%	0.00%	0.00%	0.00%	0.00%	0.02%	0.00%	0.00%	0.00%
1	NY	NY-N. NJ-Long Island	Qweens	c	Severe	1	1	10.8%	5.26%	0.57%	0.00%	0.00%	0.00%	0.00%	0.57%	0.00%	0.00%	0.00%
1	NY	NY-N. NJ-Long Island	Richmond	c	Severe	1	1	2.1%	5.26%	0.11%	0.00%	0.00%	0.00%	0.00%	0.11%	0.00%	0.00%	0.00%
1	NY	NY-N. NJ-Long Island	Rockland	c	Severe	1	1	1.5%	5.26%	0.08%	0.00%	0.00%	0.00%	0.00%	0.08%	0.00%	0.00%	0.00%
1	NY	NY-N. NJ-Long Island	Suffolk	c	Severe	1	1	7.3%	5.26%	0.39%	0.00%	0.00%	0.00%	0.00%	0.39%	0.00%	0.00%	0.00%
1	NY	NY-N. NJ-Long Island	Westchester	c	Severe	1	1	4.9%	5.26%	0.26%	0.00%	0.00%	0.00%	0.00%	0.26%	0.00%	0.00%	0.00%
1	NY	Poughkeepsie (new)	Dutchess	c	Marginal	1	0	1.4%	5.26%	0.08%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1	NY	Buffalo-Niagara Falls (new)	Erie	c	Marginal	1	0	5.4%	5.26%	0.28%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1	NY	Buffalo-Niagara Falls (new)	Niagra	c	Marginal	1	0	1.2%	5.26%	0.06%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1	NY	Jefferson Co (new)	Jefferson	c	Marginal	0	0	0.6%	5.26%	0.00%	0.00%	0.00%	0.03%	0.00%	0.00%	0.00%	0.00%	0.00%
1	NY	Rest of state	–	c	Attainment	0	0	22.5%	5.26%	0.00%	0.00%	0.00%	0.00%	1.19%	0.00%	0.00%	0.00%	0.00%
1	OH	Cleveland-Akron-Lorain	Ashtabula	c	Moderate	0	1	0.9%	4.21%	0.00%	0.00%	0.00%	0.04%	0.00%	0.00%	0.00%	0.00%	0.04%
1	OH	Cleveland-Akron-Lorain	Cuyahoga	c	Moderate	0	1	2.0%	4.21%	0.00%	0.00%	0.00%	0.08%	0.00%	0.00%	0.00%	0.00%	0.08%
1	OH	Cleveland-Akron-Lorain	Geauga	c	Moderate	0	1	0.7%	4.21%	0.00%	0.00%	0.00%	0.03%	0.00%	0.00%	0.00%	0.00%	0.03%
1	OH	Cleveland-Akron-Lorain	Lake	c	Moderate	0	1	2.0%	4.21%	0.00%	0.00%	0.00%	0.08%	0.00%	0.00%	0.00%	0.00%	0.08%
1	OH	Cleveland-Akron-Lorain	Lorain	c	Moderate	0	1	2.5%	4.21%	0.00%	0.00%	0.00%	0.11%	0.00%	0.00%	0.00%	0.00%	0.11%
1	OH	Cleveland-Akron-Lorain	Medina	c	Moderate	0	1	1.1%	4.21%	0.00%	0.00%	0.00%	0.05%	0.00%	0.00%	0.00%	0.00%	0.05%
1	OH	Cleveland-Akron-Lorain	Portage	c	Moderate	0	1	1.3%	4.21%	0.00%	0.00%	0.00%	0.06%	0.00%	0.00%	0.00%	0.00%	0.06%
1	OH	Cleveland-Akron-Lorain	Summit	c	Moderate	0	1	4.7%	4.21%	0.00%	0.00%	0.00%	0.20%	0.00%	0.00%	0.00%	0.00%	0.20%
1	OH	Dayton-Springfield	Clark	c	Moderate	0	1	1.4%	4.21%	0.00%	0.00%	0.00%	0.06%	0.00%	0.00%	0.00%	0.00%	0.06%
1	OH	Dayton-Springfield	Greene	c	Moderate	0	1	1.3%	4.21%	0.00%	0.00%	0.00%	0.05%	0.00%	0.00%	0.00%	0.00%	0.05%
1	OH	Dayton-Springfield	Miami	c	Moderate	0	1	0.9%	4.21%	0.00%	0.00%	0.00%	0.04%	0.00%	0.00%	0.00%	0.00%	0.04%
1	OH	Dayton-Springfield	Montgomery	c	Moderate	0	1	5.3%	4.21%	0.00%	0.00%	0.00%	0.22%	0.00%	0.00%	0.00%	0.00%	0.22%
1	OH	Columbus(new)	Delaware	c	Marginal	0	0	0.6%	4.21%	0.00%	0.00%	0.00%	0.03%	0.00%	0.00%	0.00%	0.00%	0.00%
1	OH	Columbus(new)	Franklin	c	Marginal	0	0	8.9%	4.21%	0.00%	0.00%	0.00%	0.37%	0.00%	0.00%	0.00%	0.00%	0.00%
1	OH	Columbus(new)	Licking	c	Marginal	0	0	1.2%	4.21%	0.00%	0.00%	0.00%	0.05%	0.00%	0.00%	0.00%	0.00%	0.00%
1	OH	Canton	Stark	c	Marginal	0	0	3.4%	4.21%	0.00%	0.00%	0.00%	0.14%	0.00%	0.00%	0.00%	0.00%	0.00%
1	OH	Toledo/1/	Lucas	c	Moderate	0	1	4.3%	4.21%	0.00%	0.00%	0.00%	0.18%	0.00%	0.00%	0.00%	0.00%	0.18%
1	OH	Toledo/1/	Wood	c	Moderate	0	1	1.0%	4.21%	0.00%	0.00%	0.00%	0.04%	0.00%	0.00%	0.00%	0.00%	0.04%
1	OH	Youngstown-Warren-Sharon	Mahoning	c	Marginal	0	0	2.4%	4.21%	0.00%	0.00%	0.00%	0.10%	0.00%	0.00%	0.00%	0.00%	0.00%
1	OH	Youngstown-Warren-Sharon	Trumbull	c	Marginal	0	0	2.1%	4.21%	0.00%	0.00%	0.00%	0.09%	0.00%	0.00%	0.00%	0.00%	0.00%

Table B-2 (continued)

Region	State	Area	County	RVP Class	O3 Desig.	Reform Area?	Stage II Area?	% State Pop.	State/ Nation Thruput	Fuel Consumption as a Percent of Nationwide Fuel Consumption								
										Nonattainment Areas				Attainment Areas	Stage II Areas			
										6.7 RVP	7.0 RVP	7.8 RVP	9.0 RVP	9.0 RVP	6.7 RVP	7.0 RVP	7.8 RVP	9.0 RVP
1	OH	Cincinnati-Hamilton	Butler	c	Moderate	0	1	2.7%	4.21%	0.00%	0.00%	0.00%	0.11%	0.00%	0.00%	0.00%	0.00%	0.11%
1	OH	Cincinnati-Hamilton	Clermont	c	Moderate	0	1	1.4%	4.21%	0.00%	0.00%	0.00%	0.06%	0.00%	0.00%	0.00%	0.00%	0.06%
1	OH	Cincinnati-Hamilton	Hamilton	c	Moderate	0	1	8.0%	4.21%	0.00%	0.00%	0.00%	0.34%	0.00%	0.00%	0.00%	0.00%	0.34%
1	OH	Cincinnati-Hamilton	Warren	c	Moderate	0	1	1.1%	4.21%	0.00%	0.00%	0.00%	0.04%	0.00%	0.00%	0.00%	0.00%	0.04%
1	OH	Rest of state	--	c	Attainment	0	0	38.9%	4.21%	0.00%	0.00%	0.00%	0.00%	1.64%	0.00%	0.00%	0.00%	0.00%
1	PA	Reading	Berks	c	Moderate	1	1	2.8%	4.14%	0.12%	0.00%	0.00%	0.00%	0.00%	0.12%	0.00%	0.00%	0.00%
1	PA	Pittsburgh-Beaver Valley	Allegheny	c	Moderate	1	1	11.2%	4.14%	0.47%	0.00%	0.00%	0.00%	0.00%	0.47%	0.00%	0.00%	0.00%
1	PA	Pittsburgh-Beaver Valley	Armstrong	c	Moderate	1	1	0.6%	4.14%	0.03%	0.00%	0.00%	0.00%	0.00%	0.03%	0.00%	0.00%	0.00%
1	PA	Pittsburgh-Beaver Valley	Beaver	c	Moderate	1	1	1.6%	4.14%	0.06%	0.00%	0.00%	0.00%	0.00%	0.06%	0.00%	0.00%	0.00%
1	PA	Pittsburgh-Beaver Valley	Butler	c	Moderate	1	1	1.3%	4.14%	0.05%	0.00%	0.00%	0.00%	0.00%	0.05%	0.00%	0.00%	0.00%
1	PA	Pittsburgh-Beaver Valley	Fayette	c	Moderate	1	1	1.2%	4.14%	0.05%	0.00%	0.00%	0.00%	0.00%	0.05%	0.00%	0.00%	0.00%
1	PA	Pittsburgh-Beaver Valley	Washington	c	Moderate	1	1	1.7%	4.14%	0.07%	0.00%	0.00%	0.00%	0.00%	0.07%	0.00%	0.00%	0.00%
1	PA	Pittsburgh-Beaver Valley	Westmoreland	c	Moderate	1	1	3.1%	4.14%	0.13%	0.00%	0.00%	0.00%	0.00%	0.13%	0.00%	0.00%	0.00%
1	PA	Lancaster	Lancaster	c	Marginal	1	0	3.6%	4.14%	0.15%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1	PA	Altoona (new)	Blair	c	Marginal	1	0	1.1%	4.14%	0.05%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1	PA	Allentown-Bethlehem-Easton	Carbon	c	Marginal	1	0	0.5%	4.14%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1	PA	Allentown-Bethlehem-Easton	Lehigh	c	Marginal	1	0	2.5%	4.14%	0.10%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1	PA	Allentown-Bethlehem-Easton	Northhampton	c	Marginal	1	0	2.1%	4.14%	0.09%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1	PA	Erie	Erie	c	Marginal	1	0	2.3%	4.14%	0.10%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1	PA	Johnstown (new)	Cambria	c	Marginal	1	0	1.4%	4.14%	0.06%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1	PA	Johnstown (new)	Somerset	c	Marginal	1	0	0.7%	4.14%	0.03%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1	PA	Scranton-Wilkes-Barre	Columbia	c	Marginal	1	0	0.5%	4.14%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1	PA	Scranton-Wilkes-Barre	Lackawanna	c	Marginal	1	0	1.8%	4.14%	0.08%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1	PA	Scranton-Wilkes-Barre	Luzerne	c	Marginal	1	0	2.8%	4.14%	0.11%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1	PA	Scranton-Wilkes-Barre	Monroe	c	Marginal	1	0	0.8%	4.14%	0.03%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1	PA	Scranton-Wilkes-Barre	Wyoming	c	Marginal	1	0	0.2%	4.14%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1	PA	Youngstown-Warren-Sharon	Mercer	c	Marginal	1	0	1.0%	4.14%	0.04%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1	PA	Harrisburg-Lebanon-Carlisle	Cumberland	c	Marginal	1	0	1.6%	4.14%	0.07%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1	PA	Harrisburg-Lebanon-Carlisle	Dauphin	c	Marginal	1	0	2.0%	4.14%	0.08%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1	PA	Harrisburg-Lebanon-Carlisle	Lebanon	c	Marginal	1	0	1.0%	4.14%	0.04%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1	PA	Harrisburg-Lebanon-Carlisle	Perry	c	Marginal	1	0	0.3%	4.14%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1	PA	York	Adams	c	Marginal	1	0	0.7%	4.14%	0.03%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1	PA	York	York	c	Marginal	1	0	2.9%	4.14%	0.12%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1	PA	Philadelphia-Wilm-Trenton	Bucks	c	Severe	1	1	4.6%	4.14%	0.19%	0.00%	0.00%	0.00%	0.00%	0.19%	0.00%	0.00%	0.00%
1	PA	Philadelphia-Wilm-Trenton	Chester	c	Severe	1	1	3.2%	4.14%	0.13%	0.00%	0.00%	0.00%	0.00%	0.13%	0.00%	0.00%	0.00%
1	PA	Philadelphia-Wilm-Trenton	Delaware	c	Severe	1	1	4.6%	4.14%	0.19%	0.00%	0.00%	0.00%	0.00%	0.19%	0.00%	0.00%	0.00%
1	PA	Philadelphia-Wilm-Trenton	Montgomery	c	Severe	1	1	5.7%	4.14%	0.24%	0.00%	0.00%	0.00%	0.00%	0.24%	0.00%	0.00%	0.00%
1	PA	Philadelphia-Wilm-Trenton	Philadelphia	c	Severe	1	1	13.3%	4.14%	0.55%	0.00%	0.00%	0.00%	0.00%	0.55%	0.00%	0.00%	0.00%
1	PA	Rest of state	--	c	Attainment	0	0	15.3%	4.14%	0.00%	0.00%	0.00%	0.00%	0.64%	0.00%	0.00%	0.00%	0.00%
1	RI	entire state (56 FR 46119)	all	c	Serious	1	1	100.0%	0.33%	0.33%	0.00%	0.00%	0.00%	0.00%	0.33%	0.00%	0.00%	0.00%
1	VA	Smyth Co (new)	Smyth	b	Marginal	1	0	0.5%	2.65%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1	VA	Richmond-Petersburg	Charles City	b	Moderate	1	1	0.1%	2.65%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1	VA	Richmond-Petersburg	Chesterfield	b	Moderate	1	1	3.4%	2.65%	0.09%	0.00%	0.00%	0.00%	0.00%	0.09%	0.00%	0.00%	0.00%
1	VA	Richmond-Petersburg	Colonial	b	Moderate	1	1	0.3%	2.65%	0.01%	0.00%	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%
1	VA	Richmond-Petersburg	Hanover	b	Moderate	1	1	1.0%	2.65%	0.03%	0.00%	0.00%	0.00%	0.00%	0.03%	0.00%	0.00%	0.00%
1	VA	Richmond-Petersburg	Henrico	b	Moderate	1	1	3.5%	2.65%	0.09%	0.00%	0.00%	0.00%	0.00%	0.09%	0.00%	0.00%	0.00%
1	VA	Richmond-Petersburg	Hopewell	b	Moderate	1	1	0.4%	2.65%	0.01%	0.00%	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%
1	VA	Richmond-Petersburg	Richmond	b	Moderate	1	1	3.3%	2.65%	0.09%	0.00%	0.00%	0.00%	0.00%	0.09%	0.00%	0.00%	0.00%
1	VA	Norfolk-Vir Beach-Newport News	(Chesapeake	b	Marginal	1	0	2.5%	2.65%	0.07%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1	VA	Norfolk-Vir Beach-Newport News	(Hampton	b	Marginal	1	0	2.2%	2.65%	0.06%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1	VA	Norfolk-Vir Beach-Newport News	(James City	b	Marginal	1	0	0.6%	2.65%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1	VA	Norfolk-Vir Beach-Newport News	(Newport	b	Marginal	1	0	2.7%	2.65%	0.07%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

Table B-2 (continued)

Region	State	Area	County	RVP Class	O3 Desig.	Reform Area?	Stage II Area?	% State Pop.	State/ Nation Thruput	Fuel Consumption as a Percent of Nationwide Fuel Consumption: Nonattainment Areas 6.7 RVP	Nonattainment Areas 7.0 RVP	Nonattainment Areas 7.8 RVP	Nonattainment Areas 9.0 RVP	Attainment Areas 9.0 RVP	Stage II Areas 6.7 RVP	Stage II Areas 7.0 RVP	Stage II Areas 7.8 RVP	Stage II Areas 9.0 RVP
1	VA	Norfolk-Vir Beach-Newport News (Norfolk		b	Marginal	1	0	4.2%	2.65%	0.11%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1	VA	Norfolk-Vir Beach-Newport News (Poquoson		b	Marginal	1	0	0.2%	2.65%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1	VA	Norfolk-Vir Beach-Newport News (Portsmouth		b	Marginal	1	0	1.7%	2.65%	0.04%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1	VA	Norfolk-Vir Beach-Newport News (Suffolk		b	Marginal	1	0	0.8%	2.65%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1	VA	Norfolk-Vir Beach-Newport News (Virginia Beach		b	Marginal	1	0	6.4%	2.65%	0.17%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1	VA	Norfolk-Vir Beach-Newport News (Williamsburg		b	Marginal	1	0	0.2%	2.65%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1	VA	Norfolk-Vir Beach-Newport News (York		b	Marginal	1	0	0.7%	2.65%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1	VA	Washington	Arlington	b	Serious	1	1	2.8%	2.65%	0.07%	0.00%	0.00%	0.00%	0.00%	0.07%	0.00%	0.00%	0.00%
1	VA	Washington	Fairfax	b	Serious	1	1	13.2%	2.65%	0.35%	0.00%	0.00%	0.00%	0.00%	0.35%	0.00%	0.00%	0.00%
1	VA	Washington	Loudon	b	Serious	1	1	1.4%	2.65%	0.04%	0.00%	0.00%	0.00%	0.00%	0.04%	0.00%	0.00%	0.00%
1	VA	Washington	Prince William	b	Serious	1	1	3.5%	2.65%	0.09%	0.00%	0.00%	0.00%	0.00%	0.09%	0.00%	0.00%	0.00%
1	VA	Washington	Stafford	b	Serious	1	1	1.0%	2.65%	0.03%	0.00%	0.00%	0.00%	0.00%	0.03%	0.00%	0.00%	0.00%
1	VA	Washington	Alexandria City	b	Serious	1	1	1.8%	2.65%	0.05%	0.00%	0.00%	0.00%	0.00%	0.05%	0.00%	0.00%	0.00%
1	VA	Washington	Fairfax City	b	Serious	1	1	0.3%	2.65%	0.01%	0.00%	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%
1	VA	Washington	Falls Church City	b	Serious	1	1	0.2%	2.65%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1	VA	Washington	Manasas City	b	Serious	1	1	0.3%	2.65%	0.01%	0.00%	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%
1	VA	Washington	Manasas Park City	b	Serious	1	1	0.1%	2.65%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1	VA	Rest of state	--	c	Attainment	0	0	41.0%	2.65%	0.00%	0.00%	0.00%	0.00%	1.09%	0.00%	0.00%	0.00%	0.00%
1	VT	entire state	all	c	Attainment	0	0	100.0%	0.25%	0.00%	0.00%	0.00%	0.00%	0.25%	0.00%	0.00%	0.00%	0.00%
1	WI	Sheboygan	Sheboygan	c	Serious	0	1	2.1%	1.86%	0.00%	0.00%	0.00%	0.04%	0.00%	0.00%	0.00%	0.00%	0.04%
1	WI	Walworth Co (new)	Walworth	c	Marginal	0	0	1.5%	1.86%	0.00%	0.00%	0.00%	0.03%	0.00%	0.00%	0.00%	0.00%	0.00%
1	WI	Kewaunee Co (new)	Kewaunee	c	Moderate	0	1	0.4%	1.86%	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.01%
1	WI	Milwaukee-Racine	Kenosha	c	Severe	1	1	2.6%	1.86%	0.05%	0.00%	0.00%	0.00%	0.00%	0.05%	0.00%	0.00%	0.00%
1	WI	Milwaukee-Racine	Milwaukee	c	Severe	1	1	19.6%	1.86%	0.37%	0.00%	0.00%	0.00%	0.00%	0.37%	0.00%	0.00%	0.00%
1	WI	Milwaukee-Racine	Ozaukee	c	Severe	1	1	1.5%	1.86%	0.03%	0.00%	0.00%	0.00%	0.00%	0.03%	0.00%	0.00%	0.00%
1	WI	Milwaukee-Racine	Racine	c	Severe	1	1	3.6%	1.86%	0.07%	0.00%	0.00%	0.00%	0.00%	0.07%	0.00%	0.00%	0.00%
1	WI	Milwaukee-Racine	Wahington	c	Severe	1	1	1.9%	1.86%	0.04%	0.00%	0.00%	0.00%	0.00%	0.04%	0.00%	0.00%	0.00%
1	WI	Milwaukee-Racine	Waukesha	c	Severe	1	1	6.2%	1.86%	0.12%	0.00%	0.00%	0.00%	0.00%	0.12%	0.00%	0.00%	0.00%
1	WI	Manitowoc Co (new)	Manitowoc	c	Moderate	0	1	1.6%	1.86%	0.00%	0.00%	0.00%	0.03%	0.00%	0.00%	0.00%	0.00%	0.03%
1	WI	Door Co (new)	Door	c	Marginal	0	0	0.5%	1.86%	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%
1	WI	Rest of state	--	c	Attainment	0	0	58.3%	1.86%	0.00%	0.00%	0.00%	0.00%	1.09%	0.00%	0.00%	0.00%	0.00%
1	WV	Parkersburg (new)	Wood	c	Moderate	0	0	4.8%	0.74%	0.00%	0.00%	0.00%	0.04%	0.00%	0.00%	0.00%	0.00%	0.00%
1	WV	**Charleston (new)	Kanawha	c	Moderate	0	0	11.6%	0.74%	0.00%	0.00%	0.00%	0.09%	0.00%	0.00%	0.00%	0.00%	0.00%
1	WV	**Charleston (new)	Putnam	c	Moderate	0	0	2.4%	0.74%	0.00%	0.00%	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%
1	WV	Greenbrier Co (new)	Greenbrier	c	Marginal	0	0	1.9%	0.74%	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%
1	WV	Huntington-Ashland	Cabell	c	Moderate	0	0	5.4%	0.74%	0.00%	0.00%	0.00%	0.04%	0.00%	0.00%	0.00%	0.00%	0.00%
1	WV	Huntington-Ashland	Wayne	c	Moderate	0	0	2.3%	0.74%	0.00%	0.00%	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%
1	WV	Rest of state	--	c	Attainment	0	0	71.5%	0.74%	0.00%	0.00%	0.00%	0.00%	0.53%	0.00%	0.00%	0.00%	0.00%
									Totals	**22.04%**	**0.00%**	**0.00%**	**6.77%**	**12.23%**	**19.10%**	**0.00%**	**0.00%**	**2.73%**
2	AL	Birmingham	Jefferson	b	Marginal	0	0	62.6%	1.86%	0.00%	0.00%	1.16%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
2	AL	Birmingham	Shelby	b	Marginal	0	0	9.5%	1.86%	0.00%	0.00%	0.18%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
2	AL	Rest of state	--	c	Attainment	0	0	27.8%	1.86%	0.00%	0.00%	0.00%	0.00%	0.52%	0.00%	0.00%	0.00%	0.00%
2	AR	entire state	all	b	Attainment	0	0	100.0%	1.11%	0.00%	0.00%	0.00%	0.00%	1.11%	0.00%	0.00%	0.00%	0.00%
2	FL	Miami-Ft Laud.-W. Palm Beach	Broward	b	Moderate	0	1	9.7%	5.41%	0.00%	0.00%	0.52%	0.00%	0.00%	0.00%	0.00%	0.52%	0.00%
2	FL	Miami-Ft Laud.-W. Palm Beach	Dade	b	Moderate	0	1	15.0%	5.41%	0.00%	0.00%	0.81%	0.00%	0.00%	0.00%	0.00%	0.81%	0.00%
2	FL	Miami-Ft Laud.-W. Palm Beach	Palm Beach	b	Moderate	0	1	6.7%	5.41%	0.00%	0.00%	0.36%	0.00%	0.00%	0.00%	0.00%	0.36%	0.00%
2	FL	Tampa-St. Pet.-Clearwater	Hillsborough	b	Marginal	0	0	6.4%	5.41%	0.00%	0.00%	0.35%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
2	FL	Tampa-St. Pet.-Clearwater	Pinellas	b	Marginal	0	0	6.6%	5.41%	0.00%	0.00%	0.36%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
2	FL	Rest of state	--	c	Attainment	0	0	55.6%	5.41%	0.00%	0.00%	0.00%	0.00%	3.01%	0.00%	0.00%	0.00%	0.00%
2	GA	Atlanta	Cherokee	b	Serious	0	1	1.4%	3.13%	0.00%	0.00%	0.04%	0.00%	0.00%	0.00%	0.00%	0.04%	0.00%
2	GA	Atlanta	Clayton	b	Serious	0	1	2.8%	3.13%	0.00%	0.00%	0.09%	0.00%	0.00%	0.00%	0.00%	0.09%	0.00%

Table B-2 (continued)

Region	State	Area	County	RVP Class	O3 Desig.	Reform Area?	Stage II Area?	% State Pop.	State/ Nation Thruput	Fuel Consumption as a Percent of Nationwide Fuel Consumption: Nonattainment Areas 6.7 RVP	Nonattainment Areas 7.0 RVP	Nonattainment Areas 7.8 RVP	Nonattainment Areas 9.0 RVP	Attainment Areas 9.0 RVP	Stage II Areas 6.7 RVP	Stage II Areas 7.0 RVP	Stage II Areas 7.8 RVP	Stage II Areas 9.0 RVP
2	GA	Atlanta	Cobb	b	Serious	0	1	6.9%	3.13%	0.00%	0.00%	0.22%	0.00%	0.00%	0.00%	0.00%	0.22%	0.00%
2	GA	Atlanta	Coweta	b	Serious	0	1	0.8%	3.13%	0.00%	0.00%	0.03%	0.00%	0.00%	0.00%	0.00%	0.03%	0.00%
2	GA	Atlanta	De Kalb	b	Serious	0	1	8.4%	3.13%	0.00%	0.00%	0.26%	0.00%	0.00%	0.00%	0.00%	0.26%	0.00%
2	GA	Atlanta	Douglas	b	Serious	0	1	1.1%	3.13%	0.00%	0.00%	0.03%	0.00%	0.00%	0.00%	0.00%	0.03%	0.00%
2	GA	Atlanta	Fayette	b	Serious	0	1	1.0%	3.13%	0.00%	0.00%	0.03%	0.00%	0.00%	0.00%	0.00%	0.03%	0.00%
2	GA	Atlanta	Forsyth	b	Serious	0	1	0.7%	3.13%	0.00%	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%	0.02%	0.00%
2	GA	Atlanta	Fulton	b	Serious	0	1	10.0%	3.13%	0.00%	0.00%	0.31%	0.00%	0.00%	0.00%	0.00%	0.31%	0.00%
2	GA	Atlanta	Gwinnett	b	Serious	0	1	5.4%	3.13%	0.00%	0.00%	0.17%	0.00%	0.00%	0.00%	0.00%	0.17%	0.00%
2	GA	Atlanta	Henry	b	Serious	0	1	0.9%	3.13%	0.00%	0.00%	0.03%	0.00%	0.00%	0.00%	0.00%	0.03%	0.00%
2	GA	Atlanta	Paulding	b	Serious	0	1	0.6%	3.13%	0.00%	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%	0.02%	0.00%
2	GA	Atlanta	Rockdale	b	Serious	0	1	0.8%	3.13%	0.00%	0.00%	0.03%	0.00%	0.00%	0.00%	0.00%	0.03%	0.00%
2	GA	Rest of state	--	c	Attainment	0	0	59.0%	3.13%	0.00%	0.00%	0.00%	0.00%	1.85%	0.00%	0.00%	0.00%	0.00%
2	LA	Lake Charles	Calcasieu	b	Marginal	0	0	4.0%	1.66%	0.00%	0.00%	0.07%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
2	LA	Baton Rouge	Ascension	b	Serious	0	1	1.4%	1.66%	0.00%	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%	0.02%	0.00%
2	LA	Baton Rouge	East Baton Rouge	b	Serious	0	1	9.0%	1.66%	0.00%	0.00%	0.15%	0.00%	0.00%	0.00%	0.00%	0.15%	0.00%
2	LA	Baton Rouge	Iberville	b	Serious	0	1	0.7%	1.66%	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.01%	0.00%
2	LA	Baton Rouge	Livingston	b	Serious	0	1	1.7%	1.66%	0.00%	0.00%	0.03%	0.00%	0.00%	0.00%	0.00%	0.03%	0.00%
2	LA	Baton Rouge	Pointe Coupes	b	Serious	0	1	0.5%	1.66%	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.01%	0.00%
2	LA	Baton Rouge	W. Baton Rouge	b	Serious	0	1	0.5%	1.66%	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.01%	0.00%
2	LA	Rest of state	--	c	Attainment	0	0	82.2%	1.66%	0.00%	0.00%	0.00%	0.00%	1.37%	0.00%	0.00%	0.00%	0.00%
2	MS	entire state	all	b	Attainment	0	0	100.0%	1.11%	0.00%	0.00%	0.00%	0.00%	1.11%	0.00%	0.00%	0.00%	0.00%
2	NC	Raleigh-Durham (new)	Durham	b	Moderate	0	0	2.7%	2.93%	0.00%	0.00%	0.08%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
2	NC	Raleigh-Durham (new)	Granville	b	Moderate	0	0	0.6%	2.93%	0.00%	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
2	NC	Raleigh-Durham (new)	Wake	b	Moderate	0	0	6.4%	2.93%	0.00%	0.00%	0.19%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
2	NC	Charlotte-Gastonia	Gaston	b	Moderate	0	0	2.6%	2.93%	0.00%	0.00%	0.08%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
2	NC	Charlotte-Gastonia	Mecklenburg	b	Moderate	0	0	7.7%	2.93%	0.00%	0.00%	0.23%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
2	NC	Greensboro-Winston (new)	Davidson	b	Moderate	0	0	1.9%	2.93%	0.00%	0.00%	0.06%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
2	NC	Greensboro-Winston (new)	Davie	b	Moderate	0	0	0.4%	2.93%	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
2	NC	Greensboro-Winston (new)	Forsyth	b	Moderate	0	0	4.0%	2.93%	0.00%	0.00%	0.12%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
2	NC	Greensboro-Winston (new)	Guilford	b	Moderate	0	0	5.2%	2.93%	0.00%	0.00%	0.15%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
2	NC	Rest of state	--	c	Attainment	0	0	68.4%	2.93%	0.00%	0.00%	0.00%	0.00%	2.00%	0.00%	0.00%	0.00%	0.00%
2	SC	Cherokee Co(new)	Cherokee	b	Marginal	0	0	1.3%	1.64%	0.00%	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
2	SC	Rest of state	--	c	Attainment	0	0	98.7%	1.64%	0.00%	0.00%	0.00%	0.00%	1.62%	0.00%	0.00%	0.00%	0.00%
2	TN	Knoxville (new)	Knox	b	Marginal	0	0	6.9%	2.19%	0.00%	0.00%	0.15%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
2	TN	Memphis	Shelby	b	Marginal	0	0	16.9%	2.19%	0.00%	0.00%	0.37%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
2	TN	Nashville	Davidson	b	Moderate	0	1	10.5%	2.19%	0.00%	0.00%	0.23%	0.00%	0.00%	0.00%	0.00%	0.23%	0.00%
2	TN	Nashville	Rutherford	b	Moderate	0	1	2.4%	2.19%	0.00%	0.00%	0.05%	0.00%	0.00%	0.00%	0.00%	0.05%	0.00%
2	TN	Nashville	Sumner	b	Moderate	0	1	2.1%	2.19%	0.00%	0.00%	0.05%	0.00%	0.00%	0.00%	0.00%	0.05%	0.00%
2	TN	Nashville	Williamsburg	b	Moderate	0	1	1.7%	2.19%	0.00%	0.00%	0.04%	0.00%	0.00%	0.00%	0.00%	0.04%	0.00%
2	TN	Nashville	Wilson	b	Moderate	0	1	1.4%	2.19%	0.00%	0.00%	0.03%	0.00%	0.00%	0.00%	0.00%	0.03%	0.00%
2	TN	Rest of state	--	c	Attainment	0	0	58.1%	2.19%	0.00%	0.00%	0.00%	0.00%	1.27%	0.00%	0.00%	0.00%	0.00%
									Totals	**0.00%**	**0.00%**	**7.19%**	**0.00%**	**13.85%**	**0.00%**	**0.00%**	**3.60%**	**0.00%**
3	AZ	Phoenix	Maricopa	b	Moderate	0	1	57.9%	1.49%	0.00%	0.00%	0.86%	0.00%	0.00%	0.00%	0.00%	0.86%	0.00%
3	AZ	Rest of state	--	c	Attainment	0	0	42.1%	1.49%	0.00%	0.00%	0.00%	0.00%	0.63%	0.00%	0.00%	0.00%	0.00%
3	NM	entire state	all	b	Attainment	0	0	100.0%	0.71%	0.00%	0.00%	0.00%	0.00%	0.71%	0.00%	0.00%	0.00%	0.00%
3	OK	entire state	all	b	Attainment	0	0	100.0%	1.50%	0.00%	0.00%	0.00%	0.00%	1.50%	0.00%	0.00%	0.00%	0.00%
3	TX	Beaumont-Port Aurthur	Hardin	b	Serious	0	1	0.2%	7.77%	0.00%	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%	0.02%	0.00%
3	TX	Beaumont-Port Aurthur	Jefferson	b	Serious	0	1	1.4%	7.77%	0.00%	0.00%	0.11%	0.00%	0.00%	0.00%	0.00%	0.11%	0.00%
3	TX	Beaumont-Port Aurthur	Orange	b	Serious	0	1	0.5%	7.77%	0.00%	0.00%	0.04%	0.00%	0.00%	0.00%	0.00%	0.04%	0.00%
3	TX	Dallas-Fort Worth	Collin	b	Moderate	1	1	1.6%	7.77%	0.12%	0.00%	0.00%	0.00%	0.00%	0.12%	0.00%	0.00%	0.00%
3	TX	Dallas-Fort Worth	Dallas	b	Moderate	1	1	10.9%	7.77%	0.85%	0.00%	0.00%	0.00%	0.00%	0.85%	0.00%	0.00%	0.00%

Table B-2 (continued)

										Fuel Consumption as a Percent of Nationwide Fuel Consumption								
									State/	Nonattainment				Attainment	Stage II			
				RVP	O3	Reform	Stage II	% State	Nation	Areas				Areas	Areas			
Region	State	Area	County	Class	Desig.	Area?	Area?	Pop.	Thruput	6.7 RVP	7.0 RVP	7.8 RVP	9.0 RVP	9.0 RVP	6.7 RVP	7.0 RVP	7.8 RVP	9.0 RVP
3	TX	Dallas-Fort Worth	Denton	b	Moderate	1	1	1.6%	7.77%	0.13%	0.00%	0.00%	0.00%	0.00%	0.13%	0.00%	0.00%	0.00%
3	TX	Dallas-Fort Worth	Tarrant	b	Moderate	1	1	6.9%	7.77%	0.54%	0.00%	0.00%	0.00%	0.00%	0.54%	0.00%	0.00%	0.00%
3	TX	El Paso	El Paso	b	Serious	0	1	3.5%	7.77%	0.00%	0.00%	0.27%	0.00%	0.00%	0.00%	0.00%	0.27%	0.00%
3	TX	Houston-Galveston-Brazoria	Brazoria	b	Severe	1	1	1.1%	7.77%	0.09%	0.00%	0.00%	0.00%	0.00%	0.09%	0.00%	0.00%	0.00%
3	TX	Houston-Galveston-Brazoria	Chambers	b	Severe	1	1	0.1%	7.77%	0.01%	0.00%	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%
3	TX	Houston-Galveston-Brazoria	Fort Bend	b	Severe	1	1	1.3%	7.77%	0.10%	0.00%	0.00%	0.00%	0.00%	0.10%	0.00%	0.00%	0.00%
3	TX	Houston-Galveston-Brazoria	Galveston	b	Severe	1	1	1.3%	7.77%	0.10%	0.00%	0.00%	0.00%	0.00%	0.10%	0.00%	0.00%	0.00%
3	TX	Houston-Galveston-Brazoria	Harris	b	Severe	1	1	16.6%	7.77%	1.29%	0.00%	0.00%	0.00%	0.00%	1.29%	0.00%	0.00%	0.00%
3	TX	Houston-Galveston-Brazoria	Liberty	b	Severe	1	1	0.3%	7.77%	0.02%	0.00%	0.00%	0.00%	0.00%	0.02%	0.00%	0.00%	0.00%
3	TX	Houston-Galveston-Brazoria	Montgomery	b	Severe	1	1	1.1%	7.77%	0.08%	0.00%	0.00%	0.00%	0.00%	0.08%	0.00%	0.00%	0.00%
3	TX	Houston-Galveston-Brazoria	Waller	b	Severe	1	1	0.1%	7.77%	0.01%	0.00%	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%
3	TX	Rest of state	--	c	Attainment	0	0	51.5%	7.77%	0.00%	0.00%	0.00%	0.00%	4.00%	0.00%	0.00%	0.00%	0.00%
									Totals	**3.34%**	**0.00%**	**1.30%**	**0.00%**	**6.84%**	**3.34%**	**0.00%**	**1.30%**	**0.00%**
4	CO	entire state	all	b	Attainment	0	0	100.0%	1.36%	0.00%	0.00%	0.00%	0.00%	1.36%	0.00%	0.00%	0.00%	0.00%
4	ID	entire state	all	c	Attainment	0	0	100.0%	0.44%	0.00%	0.00%	0.00%	0.00%	0.44%	0.00%	0.00%	0.00%	0.00%
4	IOWA	entire state	all	c	Attainment	0	0	100.0%	1.21%	0.00%	0.00%	0.00%	0.00%	1.21%	0.00%	0.00%	0.00%	0.00%
4	KS	entire state	all	b	Attainment	0	0	100.0%	1.10%	0.00%	0.00%	0.00%	0.00%	1.10%	0.00%	0.00%	0.00%	0.00%
4	MN	entire state	all	c	Attainment	0	0	100.0%	1.82%	0.00%	0.00%	0.00%	0.00%	1.82%	0.00%	0.00%	0.00%	0.00%
4	MO	St Louis	Franklin	b	Moderate	0	1	1.6%	2.41%	0.00%	0.00%	0.04%	0.00%	0.00%	0.00%	0.00%	0.04%	0.00%
4	MO	St Louis	Jefferson	b	Moderate	0	1	3.3%	2.41%	0.00%	0.00%	0.08%	0.00%	0.00%	0.00%	0.00%	0.08%	0.00%
4	MO	St Louis	St. Charles	b	Moderate	0	1	4.2%	2.41%	0.00%	0.00%	0.10%	0.00%	0.00%	0.00%	0.00%	0.10%	0.00%
4	MO	St Louis	St. Louis	b	Moderate	0	1	7.8%	2.41%	0.00%	0.00%	0.19%	0.00%	0.00%	0.00%	0.00%	0.19%	0.00%
4	MO	St Louis	St. Louis County	b	Moderate	0	1	19.4%	2.41%	0.00%	0.00%	0.47%	0.00%	0.00%	0.00%	0.00%	0.47%	0.00%
4	MO	Rest of state	--	c	Attainment	0	0	63.7%	2.41%	0.00%	0.00%	0.00%	0.00%	1.54%	0.00%	0.00%	0.00%	0.00%
4	MT	entire state	all	c	Attainment	0	0	100.0%	0.39%	0.00%	0.00%	0.00%	0.00%	0.39%	0.00%	0.00%	0.00%	0.00%
4	ND	entire state	all	c	Attainment	0	0	100.0%	0.31%	0.00%	0.00%	0.00%	0.00%	0.31%	0.00%	0.00%	0.00%	0.00%
4	NE	entire state	all	c	Attainment	0	0	100.0%	0.70%	0.00%	0.00%	0.00%	0.00%	0.70%	0.00%	0.00%	0.00%	0.00%
4	OR	Portland-Vancouver AQMA	Clackamas	b	Marginal	0	1	9.8%	1.20%	0.00%	0.00%	0.12%	0.00%	0.00%	0.00%	0.00%	0.12%	0.00%
4	OR	Portland-Vancouver AQMA	Multnomak	b	Marginal	0	1	20.5%	1.20%	0.00%	0.00%	0.25%	0.00%	0.00%	0.00%	0.00%	0.25%	0.00%
4	OR	Portland-Vancouver AQMA	Washington	b	Marginal	0	1	11.0%	1.20%	0.00%	0.00%	0.13%	0.00%	0.00%	0.00%	0.00%	0.13%	0.00%
4	OR	Rest of state	--	c	Attainment	0	0	58.7%	1.20%	0.00%	0.00%	0.00%	0.00%	0.70%	0.00%	0.00%	0.00%	0.00%
4	SD	entire state	all	c	Attainment	0	0	100.0%	0.35%	0.00%	0.00%	0.00%	0.00%	0.35%	0.00%	0.00%	0.00%	0.00%
4	WA	Seattle-Tacoma (new)	King	c	Marginal	0	1	31.0%	2.03%	0.00%	0.00%	0.00%	0.63%	0.00%	0.00%	0.00%	0.00%	0.63%
4	WA	Seattle-Tacoma (new)	Pierce	c	Marginal	0	1	12.0%	2.03%	0.00%	0.00%	0.00%	0.24%	0.00%	0.00%	0.00%	0.00%	0.24%
4	WA	Seattle-Tacoma (new)	Snohomish	c	Marginal	0	1	9.6%	2.03%	0.00%	0.00%	0.00%	0.19%	0.00%	0.00%	0.00%	0.00%	0.19%
4	WA	Portland-Vancouver AQMA	Clark	c	Marginal	0	1	4.9%	2.03%	0.00%	0.00%	0.00%	0.10%	0.00%	0.00%	0.00%	0.00%	0.10%
4	WA	Rest of state	--	c	Attainment	0	0	42.5%	2.03%	0.00%	0.00%	0.00%	0.00%	0.86%	0.00%	0.00%	0.00%	0.00%
4	WY	entire state	all	c	Attainment	0	0	100.0%	0.27%	0.00%	0.00%	0.00%	0.00%	0.27%	0.00%	0.00%	0.00%	0.00%
									Totals	**0.00%**	**0.00%**	**1.37%**	**1.17%**	**11.04%**	**0.00%**	**0.00%**	**1.37%**	**1.17%**
5	CA	San Diego	San Diego	b	Severe	1	1	9.9%	11.67%	1.16%	0.00%	0.00%	0.00%	0.00%	1.16%	0.00%	0.00%	0.00%
5	CA	LA-South Coast Air Basin	LA-1	b	Extreme	1	1	29.8%	11.67%	3.48%	0.00%	0.00%	0.00%	0.00%	3.48%	0.00%	0.00%	0.00%
5	CA	LA-South Coast Air Basin	Orange	b	Extreme	1	1	8.1%	11.67%	0.95%	0.00%	0.00%	0.00%	0.00%	0.95%	0.00%	0.00%	0.00%
5	CA	LA-South Coast Air Basin	Riverside-1	b	Extreme	1	1	3.9%	11.67%	0.46%	0.00%	0.00%	0.00%	0.00%	0.46%	0.00%	0.00%	0.00%
5	CA	LA-South Coast Air Basin	San Bernardino-1	b	Extreme	1	1	4.8%	11.67%	0.56%	0.00%	0.00%	0.00%	0.00%	0.56%	0.00%	0.00%	0.00%
5	CA	San Joaquin Valley	Fresno	b	Serious	0	1	2.2%	11.67%	0.00%	0.26%	0.00%	0.00%	0.00%	0.00%	0.26%	0.00%	0.00%
5	CA	San Joaquin Valley	Kern	b	Serious	0	1	1.8%	11.67%	0.00%	0.21%	0.00%	0.00%	0.00%	0.00%	0.21%	0.00%	0.00%
5	CA	San Joaquin Valley	Kings	b	Serious	0	1	0.3%	11.67%	0.00%	0.04%	0.00%	0.00%	0.00%	0.00%	0.04%	0.00%	0.00%
5	CA	San Joaquin Valley	Madera	b	Serious	0	1	0.3%	11.67%	0.00%	0.03%	0.00%	0.00%	0.00%	0.00%	0.03%	0.00%	0.00%
5	CA	San Joaquin Valley	Merced	b	Serious	0	1	0.6%	11.67%	0.00%	0.07%	0.00%	0.00%	0.00%	0.00%	0.07%	0.00%	0.00%
5	CA	San Joaquin Valley	San Joaquin	b	Serious	0	1	1.6%	11.67%	0.00%	0.19%	0.00%	0.00%	0.00%	0.00%	0.19%	0.00%	0.00%

Table B-2 (continued)

Region	State	Area	County	RVP Class	O3 Desig.	Reform Area?	Stage II Area?	% State Pop.	State/ Nation Thruput	Fuel Consumption as a Percent of Nationwide Fuel Consumption: Nonattainment Areas 6.7 RVP	Nonattainment Areas 7.0 RVP	Nonattainment Areas 7.8 RVP	Nonattainment Areas 9.0 RVP	Attainment Areas 9.0 RVP	Stage II Areas 6.7 RVP	Stage II Areas 7.0 RVP	Stage II Areas 7.8 RVP	Stage II Areas 9.0 RVP
5	CA	San Joaquin Valley	Stanislaus	b	Serious	0	1	1.2%	11.67%	0.00%	0.15%	0.00%	0.00%	0.00%	0.00%	0.15%	0.00%	0.00%
5	CA	San Joaquin Valley	Tulare	b	Serious	0	1	1.0%	11.67%	0.00%	0.12%	0.00%	0.00%	0.00%	0.00%	0.12%	0.00%	0.00%
5	CA	San Francisco Bay Area	Alameda	b	Moderate	0	1	4.3%	11.67%	0.00%	0.50%	0.00%	0.00%	0.00%	0.00%	0.50%	0.00%	0.00%
5	CA	San Francisco Bay Area	Conta Costa	b	Moderate	0	1	2.7%	11.67%	0.00%	0.32%	0.00%	0.00%	0.00%	0.00%	0.32%	0.00%	0.00%
5	CA	San Francisco Bay Area	Marin	b	Moderate	0	1	0.8%	11.67%	0.00%	0.09%	0.00%	0.00%	0.00%	0.00%	0.09%	0.00%	0.00%
5	CA	San Francisco Bay Area	Napa	b	Moderate	0	1	0.4%	11.67%	0.00%	0.04%	0.00%	0.00%	0.00%	0.00%	0.04%	0.00%	0.00%
5	CA	San Francisco Bay Area	San Fransisco	b	Moderate	0	1	2.4%	11.67%	0.00%	0.28%	0.00%	0.00%	0.00%	0.00%	0.28%	0.00%	0.00%
5	CA	San Francisco Bay Area	San Mateo	b	Moderate	0	1	2.2%	11.67%	0.00%	0.25%	0.00%	0.00%	0.00%	0.00%	0.25%	0.00%	0.00%
5	CA	San Francisco Bay Area	Santa Clara	b	Moderate	0	1	5.0%	11.67%	0.00%	0.59%	0.00%	0.00%	0.00%	0.00%	0.59%	0.00%	0.00%
5	CA	San Francisco Bay Area	Solano	b	Moderate	0	1	1.1%	11.67%	0.00%	0.13%	0.00%	0.00%	0.00%	0.00%	0.13%	0.00%	0.00%
5	CA	San Francisco Bay Area	Sonoma	b	Moderate	0	1	1.3%	11.67%	0.00%	0.15%	0.00%	0.00%	0.00%	0.00%	0.15%	0.00%	0.00%
5	CA	Monterey Bay	Monterey	b	Moderate	0	1	1.2%	11.67%	0.00%	0.14%	0.00%	0.00%	0.00%	0.00%	0.14%	0.00%	0.00%
5	CA	Monterey Bay	San Benito	b	Moderate	0	1	0.1%	11.67%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%
5	CA	Monterey Bay	Santa Cruz	b	Moderate	0	1	0.8%	11.67%	0.00%	0.09%	0.00%	0.00%	0.00%	0.00%	0.09%	0.00%	0.00%
5	CA	Sacramento Metro	El Dorado	b	Serious	0	1	0.4%	11.67%	0.00%	0.05%	0.00%	0.00%	0.00%	0.00%	0.05%	0.00%	0.00%
5	CA	Sacramento Metro	Placer	b	Serious	0	1	0.6%	11.67%	0.00%	0.07%	0.00%	0.00%	0.00%	0.00%	0.07%	0.00%	0.00%
5	CA	Sacramento Metro	Sacramento	b	Serious	0	1	3.5%	11.67%	0.00%	0.41%	0.00%	0.00%	0.00%	0.00%	0.41%	0.00%	0.00%
5	CA	Sacramento Metro	Sutter	b	Serious	0	1	0.2%	11.67%	0.00%	0.03%	0.00%	0.00%	0.00%	0.00%	0.03%	0.00%	0.00%
5	CA	Sacramento Metro	Yolo	b	Serious	0	1	0.5%	11.67%	0.00%	0.06%	0.00%	0.00%	0.00%	0.00%	0.06%	0.00%	0.00%
5	CA	Ventura County	Ventura County	b	Severe	1	1	2.2%	11.67%	0.26%	0.00%	0.00%	0.00%	0.00%	0.26%	0.00%	0.00%	0.00%
5	CA	Santa Barbara-Santa Maria-Lompc	Santa Barbara	b	Moderate	0	1	1.2%	11.67%	0.00%	0.14%	0.00%	0.00%	0.00%	0.00%	0.14%	0.00%	0.00%
5	CA	Rest of state	--	b	Attainment	0	1	3.3%	11.67%	0.00%	0.38%	0.00%	0.00%	0.00%	0.00%	0.38%	0.00%	0.00%
5	NV	Reno (new)	Washoe	b	Marginal	0	0	21.2%	0.57%	0.00%	0.00%	0.12%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
5	NV	Las Vegas	Clark	c	Attainment	0	1	61.7%	0.57%	0.00%	0.00%	0.00%	0.00%	0.35%	0.00%	0.00%	0.00%	0.35%
5	NV	Rest of state	--	c	Attainment	0	0	17.1%	0.57%	0.00%	0.00%	0.00%	0.00%	0.10%	0.00%	0.00%	0.00%	0.00%
5	UT	Salt Lake City	Davis	b	Moderate	0	1	10.9%	0.64%	0.00%	0.00%	0.07%	0.00%	0.00%	0.00%	0.00%	0.07%	0.00%
5	UT	Salt Lake City	Salt Lake	b	Moderate	0	1	42.1%	0.64%	0.00%	0.00%	0.27%	0.00%	0.00%	0.00%	0.00%	0.27%	0.00%
5	UT	Rest of state	--	c	Attainment	0	0	47.0%	0.64%	0.00%	0.00%	0.00%	0.00%	0.30%	0.00%	0.00%	0.00%	0.00%
									Totals	6.85%	4.82%	0.46%	0.00%	0.75%	6.85%	4.82%	0.34%	0.35%

Table B-3
Dispensed Temperature Data for 5-Month Ozone Season

Region	May	Jun	Jul	Aug	Sep	Avg
1	66	74	78	78	72	74
2	84	87	90	91	88	88
3	76	82	83	84	79	81
4	63	74	88	85	83	79
5	72	77	83	83	79	79

Table B-4
Delta-T Data for 5-Month Ozone Season

Region	May	Jun	Jul	Aug	Sep	Avg
1	14.5	15.6	15.9	9.1	1.7	11.4
2	7.4	6.1	3.5	13	7.4	7.5
3	11.6	10	4.9	9.1	-0.8	7.0
4	7.6	19.3	15.5	11.2	6.3	12.0
5	11.9	3.7	0	6.3	3.9	5.2

Table B-5
Regional Dispensed Temperature Distributions

Radian Gasoline Temperature Data
Region = 1
Months = May - Sept

Td	Bin	Count	Percent
58	59	1	0.7%
60	61	6	3.9%
62	63	1	0.7%
64	65	5	3.3%
66	67	5	3.3%
68	69	8	5.2%
70	71	25	16.3%
72	73	12	7.8%
74	75	14	9.2%
76	77	21	13.7%
78	79	40	26.1%
80	81	15	9.8%

Radian Gasoline Temperature Data
Region = 2
Months = May-Sept21

Td	Bin	Count	Percent
74	75	0	0.0%
76	77	1	0.7%
78	79	0	0.0%
80	81	0	0.0%
82	83	20	13.9%
84	85	29	20.1%
86	87	15	10.4%
88	89	27	18.8%
90	91	24	16.7%
92	93	21	14.6%
94	95	7	4.9%
	Totals	144	100.0%

Radian Gasoline Temperature Data
Region = 3
Months = May - Sept

Td	Bin	Count	Percent
70	71	0	0.0%
72	73	2	1.3%
74	75	9	5.9%
76	77	19	12.4%
78	79	24	15.7%
80	81	6	3.9%
82	83	44	28.8%
84	85	41	26.8%
86	87	8	5.2%
	Totals	153	100.0%

Radian Gasoline Temperature Data
Region = 4
Months = May - Sept

Td	Bin	Count	Percent
56	57	2	1.3%
58	59	2	1.3%
60	61	2	1.3%
62	63	10	6.5%
64	65	12	7.8%
66	67	5	3.3%
68	69	6	3.9%
70	71	6	3.9%
72	73	3	2.0%
74	75	2	1.3%
76	77	3	2.0%
78	79	10	6.5%
80	81	3	2.0%
82	83	9	5.9%
84	85	19	12.4%
86	87	31	20.3%
88	89	20	13.1%
90	91	5	3.3%
92	93	1	0.7%
94	95	2	1.3%
	Totals	153	100.0%

Radian Gasoline Temperature Data
Region = 5
Months = May - Sept

Td	Bin	Count	Percent
70	71	6	4.0%
72	73	17	11.4%
74	75	8	5.4%
76	77	20	13.4%
78	79	23	15.4%
80	81	19	12.8%
82	83	28	18.8%
84	85	24	16.1%
86	87	1	0.7%
88	89	2	1.3%
90	91	1	0.7%
	Totals	149	100.0%

Appendix C: Sample Calculation of In-use ORVR Efficiency Estimates

Sample Calculation for ORVR Efficiency Estimates in Tables 4.7, 4.8, and 4.9

Table C-1 shows a sample calculation of in-use efficiency taking into account the distribution of fill amounts for in-use refueling events indicated in Figure 4-3. The inputs to the ATL equation for this particular run were: Td = 80°F, RVP = 9.0 psi, and ΔT = 11.4. As indicated in the table, the resulting uncontrolled emission factor predicted by the ATL equation is 4.38 g/gal.

For the 100 percent fill amount, the vapor generated during refueling, taking into consideration the effect of air entrainment, is:

Vapor generation = 20 gallons x 4.38 g/gal x 1.25 = 108.9 grams

Subtracting the canister working capacity (75 grams) from the vapor generation results in a vapor load of 33.9 grams past breakthrough. From the post-breakthrough efficiency equation corresponding to the efficiency curve in Figure 4-2, the vapor escaping the ORVR system was calculated to be 24.6 grams. Repeating this calculation for the other fill levels in the in-use refueling distribution and weighting the results produces a controlled emission factor of 0.372 g/gal. Comparing the uncontrolled emission factor (EFu) to controlled emission factor (EFc) results in a control efficiency of 91.5 percent.

This process was repeated for the rest of the in-use dispensed temperature distribution for region one. The results are shown in Table C-2. The weighted averages for EFu, EFc, and efficiency indicated in Table C-2 correspond to the values reported in Table 4.7 for 9.0 RVP fuel in region one.

Table C-1: Calculation of EFu, EFc and Efficiency for Td = 80 °F

Analysis: Inputs	Working Capacity	RVP	Td	Delt-T	ATL
	75	9	80	11.4	4.36

Analysis: Outputs	EFu	EFc	Reduct
	4.36	0.372	91.5%

In-use worst case (EFu*1.25)= 5.45 g/gal

Tank Fill	# of ref. (GM)	% of ref. (GM)	% of ref. (EPA-mod)	Vapor Load	Load > WC	Post-BT Emission	% of ref. *Emiss	% of ref *Gal
100%	68	5.74%	6.00%	108.93	33.9	24.6	1.5	1.200
90%	245	20.69%	19.00%	98.04	23.0	13.7	2.6	3.420
80%	100	8.45%	16.75%	87.14	12.1	3.9	0.7	2.680
70%	239	20.19%	13.35%	76.25	1.3	0.0	0.0	1.869
60%	110	9.29%	10.50%	65.36	0.0	0.0	0.0	1.260
50%	113	9.54%	9.30%	54.47	0.0	0.0	0.0	0.930
40%	106	8.95%	8.00%	43.57	0.0	0.0	0.0	0.640
30%	76	6.42%	7.00%	32.68	0.0	0.0	0.0	0.420
20%	77	6.50%	5.85%	21.79	0.0	0.0	0.0	0.234
10%	47	3.97%	4.00%	10.89	0.0	0.0	0.0	0.080
0%	3	0.25%	0.25%	0.00	0.0	0.0	0.0	0.000
Totals	1184	100%	100%				4.733746	12.733

Avg g/gal= **0.372**

Table C-2: Summary of EFu, EFc, and Efficiency for Td Distribution in Region 1

In-Use Conditions:

Region =	1
Fuel RVP =	9
Months for Td dist. =	May - Sept
Delta-T =	11.4

Efficiency of ORVR System

Td	Freq	EFu	EFc	Efficiency
58	0.7%	2.79	0.000	100.0%
60	3.9%	2.90	0.000	100.0%
62	0.7%	3.02	0.000	100.0%
64	3.3%	3.15	0.002	99.9%
66	3.3%	3.28	0.006	99.8%
68	5.2%	3.42	0.015	99.6%
70	16.3%	3.56	0.034	99.0%
72	7.8%	3.70	0.067	98.2%
74	9.2%	3.86	0.114	97.0%
76	13.7%	4.02	0.180	95.5%
78	26.1%	4.18	0.267	93.6%
80	9.8%	4.36	0.372	91.5%
Weighted Average	100.0%	3.84	0.153	96.3%

Appendix D: Supporting Data for Chapters 4, 5 and 7

Vehicle Sales and Use Data

Fuel Tank Configurations

Type	LDV	LDT	LHDGV	HHDGV
Single-Tank	0%	80%	80%	85%
Dual-Tank	0%	20%	20%	15%

EPA 1987 Projection

Projected Gasoline Vehicle Sales

Year	LDV	LDT	LHDGV	HHDGV
1998	10.600.000	5.280.000	448.000	78.300
1999	10.800.000	5.430.000	461.000	78.600
2000	11.000.000	5.590.000	474.000	78.600
2001	11.100.000	5.740.000	487.000	79.000
2002	11.300.000	5.890.000	500.000	79.900
2003	11.500.000	6.040.000	513.000	81.100
2004	11.700.000	6.200.000	519.000	82.400
2005	11,800.000	6.350.000	533.000	83.800
2006	12.000.000	6.500.000	548.000	85.100
2007	12.200.000	6.650.000	563.000	86.500
2008	12.400.000	6.800.000	577.000	88.200
2009	12.600.000	6.950.000	592.000	89.700
2010	12.800.000	7.110.000	605.000	91.900
2011	13.000.000	7.250.000	620.000	93.700
2012	13.200.000	7.400.000	636.000	95.800
2013	13.400.000	7.550.000	652.000	97.900
2014	13.600.000	7.700.000	667.000	100.000
2015	13.800.000	7.850.000	683.000	102.200
2016	14.000.000	7.990.000	697.000	104.200
2017	14.100.000	8.130.000	711.000	106.100
2018	14.300.000	8.270.000	725.000	108.100
2019	14.500.000	8.420.000	739.000	110.100
2020	14.700.000	8.560.000	752.000	112.200

Projected Sales Weightings

Type	LDV	LDT	HDGV	
2010	62.1%	34.5%	2.9%	0.4%
			LHDGV	HHDGV
% in Class	100%	100%	87%	13%
Total %	62.1%	34.5%	2.9%	0.4%

Based on M4.1 FCM projections

California Vehicle Sales	11.70%

AAMA Facts and Figures 1993 (U.S. DOT. FHwA)

Projected Gasoline Road Fuel Economy

Year	LDV	LDT	LHDGV	HHDGV
1996	22.94	17.42	10.81	5.80
1997	22.91	17.40	10.84	5.79
1998	22.88	17.37	10.87	5.79
1999	22.85	17.36	10.90	5.78
2000	22.82	17.32	10.92	5.78
2001	22.79	17.31	10.94	5.77
2002	22.77	17.28	10.97	5.77
2003	22.74	17.26	10.99	5.77
2004	22.71	17.24	11.01	5.77
2005	22.69	17.23	11.03	5.77
2006	22.66	17.20	11.05	5.77
2007	22.63	17.19	11.07	5.77
2008	22.61	17.16	11.08	5.77
2009	22.58	17.15	11.10	5.77
2010	22.55	17.12	11.11	5.77
2011	22.59	17.14	11.11	5.76
2012	22.57	17.12	11.13	5.76
2013	22.54	17.10	11.14	5.76
2014	22.52	17.08	11.15	5.76
2015	22.49	17.06	11.16	5.76
2016	22.48	17.05	11.17	5.76
2017	22.45	17.04	11.19	5.76
2018	22.43	17.02	11.20	5.76
2019	22.40	17.01	11.21	5.76
2020	22.38	17.00	11.22	5.76

From M4.1 FCM

Stage II, Efficiency and Emission Factor Data

Gasoline Thruput Fractions and Stage II Data

NAA Gasoline Thruput	54.9%
Stage II Gasoline Through	45.0%
NAA Stage II Gasoline Thru	44.2%
Stage II Efficiency	86.0%
Stage II Weighted Waiver	5.70%
California Fuel %	11.7%

Uncontrolled Emission Factors & Efficiency Data

Area	EFu g/gal	Theor. eff	In-Use eff	Final eff
All Areas	3.9	93.5%	92.3%	92.0%
NAA	3.4	97.4%	96.7%	96.5%
S2 Areas	3.3	98.0%	97.3%	97.1%
In use delta (I/M)			0.7%	0.9%
In use delta (no I/M)			1.8%	2.3%

*In-use includes failures (I/M dependant)

Vehicle Emission Factors (g/mi)

Area	LDV	LDT	LHDGV	HHDGV
All Areas	0.173	0.228	0.351	0.676
Nonattainment Areas	0.151	0.199	0.306	0.589
Stage II Areas	0.146	0.193	0.297	0.572

using 2010 projected fuel economy

Benefits (g/gal)*

	All Areas	NAA
With Stage II	2.42	1.19
Without Stage II	3.59	3.28

*Using 5 month ozone season EFu and ORVR efficiency

Hardware Cost Calculation

Hardware Cost, by Vehicle Weight Class

Component	LDV	LDT	LHDGV	HHDGV
Fillneck Seal(s)	$0.00	$0.00	$0.00	$9.20
Anti-Spitback Valve	$0.00	$0.00	$0.00	-$0.40
External Vent Line	-$1.45	-$2.05	-$2.05	$0.00
Vent/Rollover Valve(s)	$4.70	$5.65	$5.65	$5.45
Vapor Lines	$0.15	$0.20	$1.35	$2.40
Canister	$0.00	$0.00	$0.00	$0.00
Total Cost	$3.40	$3.80	$4.95	$16.65
RPE Markup	$0.88	$0.99	$1.34	$4.50
Total RPE	$4.28	$4.79	$6.29	$21.15

Vapor Vent Line Diameter and Length per tank (ft)

	LDV	LDT	LHDGV	HHDGV
ORVR Diameter	0.500	0.500	0.625	0.625
Evap Diameter	0.375	0.375	0.500	0.500
Steel Length	2.0	2.0	0.0	0.0
Rubber Length	1.0	1.0	8.0	15.0

from 1988 Cost memo

Vent Line Cost Calculation (per tank)

Item			LDV	LDT	LHDGV	HHDGV
ORVR	steel	length	2.0	2.0	0.0	0.0
		cost	$0.16	$0.16	$0.00	$0.00
	rubber	length	1.0	1.0	8.0	15.0
		cost	$0.53	$0.53	$0.67	$0.67
ORVR Vent Line Cost			$0.85	$0.85	$5.36	$10.05
Evap.	steel	length	2.0	2.0	0.0	0.0
		cost	$0.13	$0.13	$0.00	$0.00
	rubber	length	1.0	1.0	8.0	15.0
		cost	$0.43	$0.43	$0.53	$0.53
Evap. Vent Line Cost			$0.69	$0.69	$4.24	$7.95
Incremental Cost			$0.16	$0.16	$1.12	$2.10

Costs from 1988 analysis. adjusted for inflation

Other Items

Vent/ Rollover Valve Cost	$4.72	
(Fillneck seal)-(antispitback va	$8.00	
External Vent Line (LDV:LDT-IIb	-$1.45	-$1.70
Anti-Spitback Valve	-$0.35	

Fillneck Seal ?	LDV	LLDT	LDT	HDGV-IIb	HDGV-III-VIII
Y/N	N	N	N	N	Y

New Car Consumer Price Index with Added Safety & Emissions

to	from	1985	1986	1987	1988	1989	1990	1991	1992	*****
		107.2	112.1	116.2	119.2	122.2	126.2	133.0	136.7	0.0
1985	107.2	1.00	0.96	0.92	0.90	0.88	0.85	0.81	0.78	ERR
1986	112.1	1.05	1.00	0.96	0.94	0.92	0.89	0.84	0.82	ERR
1987	116.2	1.08	1.04	1.00	0.97	0.95	0.92	0.87	0.85	ERR
1988	119.2	1.11	1.06	1.03	1.00	0.98	0.94	0.90	0.87	ERR
1989	122.2	1.14	1.09	1.05	1.03	1.00	0.97	0.92	0.89	ERR
1990	126.2	1.18	1.13	1.09	1.06	1.03	1.00	0.95	0.92	ERR
1991	133.0	1.24	1.19	1.14	1.12	1.09	1.05	1.00	0.97	ERR
1992	136.7	1.28	1.22	1.18	1.15	1.12	1.08	1.03	1.00	ERR
1993	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	ERR

from AAMA Facts & Figure's 1993--based on U.S. Department of Labor. Bureau of Labor Stats.

Development Cost Calculation

Development and Production Costs, Per Vehicle

Item	LDV	LDT	LHDGV	HHDGV
Tank/Fillneck Mods	$0.50	$0.60	$0.60	$0.60
Packaging	$0.00	$0.00	$0.00	$0.00
Certification†	$0.15	$0.15	$0.15	$0.15
FMVSS 301 Testing	$0.15	$0.15	$0.15	$0.85
Facility Modification*	$0.40	$0.40	$0.40	$0.40
Systems Engineering*	$0.45	$0.80	$0.75	$1.60
Total Cost	$1.65	$2.10	$2.05	$3.60
RPE Markup	$0.43	$0.55	$0.55	$0.97
Total RPE	$2.08	$2.65	$2.60	$4.57

*Used costs from 1988 analysis. adjusted for inflation.

** from tech report "safety implications of onboard" LDV/LDT/llb0 .12 86$; Vl 0.70 87$

†Certification costs are best estimates based on $.15 for evap in 1993 for LDVs.

Operating Cost Calculation

Operating Cost Credit (incl. weight penalty and recovery credit) ($/gal)*

Area	LDV	LDT	LHDGV	HHDGV
All Areas	$0.000597	$0.000595	$0.000537	$0.000550
Nonattainment Areas	$0.000289	$0.000287	$0.000229	$0.000242
All Areas--Stage II discontinued	$0.000944	$0.000942	$0.000883	$0.000897
Nonattainment Areas--Stage II discontinued	$0.000798	$0.000796	$0.000737	$0.000751

*Using 5 month ozone season EFu and ORVR efficiency.

Operating Costs--All Areas (Attainment and Nonattainment Combined)

Item	LDV	LDT	LHDGV	HHDGV
Weight Penalty ($/gal)	$0.000005	$0.000007	$0.000066	$0.000052
Fuel Recovery Credit ($/gal)	$0.000603	$0.000603	$0.000603	$0.000603
Operating Cost ($/gal)	-$0.000597	-$0.000595	-$0.000537	-$0.000550
Projected 2010 Fuel Economy (mpg)	22.55	17.12	11.11	5.77
Projected Avg. Life (miles)	122,390	158,399	174,665	169,121
Lifetime Fuel Consumption (gal)	5,427	9,252	15,721	29,310
Lifetime Operating Cost ($)	-$3.24	-$5.51	-$8.44	-$16.13
Lifetime Per-Vehicle Operating Cost (NPV)	-$2.35	-$3.70	-$5.50	-$11.00

Operating Costs--Nonattainment Areas

Item	LDV	LDT	LHDGV	HHDGV
Weight Penalty ($/gal)	$0.000005	$0.000007	$0.000066	$0.000052
Fuel Recovery Credit ($/gal)	$0.000294	$0.000294	$0.000294	$0.000294
Operating Cost ($/gal)	-$0.000289	-$0.000287	-$0.000229	-$0.000242
Projected 2010 Fuel Economy (mpg)	22.55	17.12	11.11	5.77
Projected Avg. Life (miles)	122,390	158,399	174,665	169,121
Lifetime Fuel Consumption (gal)	5,427	9,252	15,721	29,310
Lifetime Operating Cost ($)	-$1.57	-$2.65	-$3.59	-$7.08
Lifetime Per-Vehicle Operating Cost (NPV)	-$1.15	-$1.80	-$2.35	-$4.85

Operating Costs--All Areas (After Stage II Discontinuation)

Item	LDV	LDT	LHDGV	HHDGV
Weight Penalty ($/gal)	$0.000005	$0.000007	$0.000066	$0.000052
Fuel Recovery Credit ($/gal)	$0.000949	$0.000949	$0.000949	$0.000949
Operating Cost ($/gal)	-$0.000944	-$0.000942	-$0.000883	-$0.000897
Projected 2010 Fuel Economy (mpg)	22.55	17.12	11.11	5.77
Projected Avg. Life (miles)	122,390	158,399	174,665	169,121
Lifetime Fuel Consumption (gal)	5,427	9,252	15,721	29,310
Lifetime Operating Cost ($)	-$5.12	-$8.71	-$13.89	-$26.28
Lifetime Per-Vehicle Operating Cost (NPV)	-$3.75	-$5.85	-$9.00	-$17.90

Operating Costs--Nonattainment Areas (After Stage II Discontinuation)

Item	LDV	LDT	LHDGV	HHDGV
Weight Penalty ($/gal)	$0.000005	$0.000007	$0.000066	$0.000052
Fuel Recovery Credit ($/gal)	$0.000803	$0.000803	$0.000803	$0.000803
Operating Cost ($/gal)	-$0.000798	-$0.000796	-$0.000737	-$0.000751
Projected 2010 Fuel Economy (mpg)	22.55	17.12	11.11	5.77
Projected Avg. Life (miles)	122,390	158,399	174,665	169,121
Lifetime Fuel Consumption (gal)	5,427	9,252	15,721	29,310
Lifetime Operating Cost ($)	-$4.33	-$7.36	-$11.59	-$22.00
Lifetime Per-Vehicle Operating Cost (NPV)	-$3.15	-$4.95	-$7.50	-$15.00

Weight Penalty

Item	LDV	LDT	LHDGV	HHDGV
Incremental Weight (g)	26	37	757	1473
X weight multipication factor of 1.1 (kg)	28.582	41.158	833.245	1620.270
Avg. Vehicle Weight (kg)	1,463	1,866	4,186	10,181
Change in Weight	0.002%	0.002%	0.020%	0.016%
Sensitivity Factor	-0.329	-0.402	-0.402	-0.402
Percent Change in FE (gal/gal)	-0.000643%	-0.000887%	-0.008003%	-0.006398%
Fuel Price (no taxes) ($/gal)	$0.82	$0.82	$0.82	$0.82
Weight Penalty ($/gal)	-$0.000005	-$0.000007	-$0.000066	-$0.000052

Fuel Recovery Credits

Item	Variable	All Areas	NAA Areas	All Ar. (S2 disc.)	NAA (S2 dic.)
5 month ozone season emission rate (g/gal)	EFu	3.90	3.30	3.90	3.30
Percent of areas with Stage II	Areas S2	45.00%	80.51%	0.00%	0.00%
Stage II Efficiency	effS2	86.00%	86.00%	86.00%	86.00%
Average Stage II Waivers	WaiversS2	5.70%	5.70%	5.70%	5.70%
5 month ozone season efficiency	effORVR	92.0%	97.1%	92.0%	92.0%
Equivalency Factor (Relative Heating Value)	Ev/Eg	0.90	0.90	0.90	0.90
gas cost--no taxes ($/gal)	Costgas	$0.82	$0.82	$0.82	$0.82
fuel desity (kg/gal)	rho	2.79	2.79	2.79	2.79
Gasoline Recovery Credits ($/gal)		$0.000603	$0.000294	$0.000949	$0.000803

Fuel Fraction in Given Year

Year	LDV	LDT	LHDV	HDGV
1	11.71%	9.59%	8.43%	10.17%
2	11.00%	9.04%	8.10%	9.51%
3	10.30%	8.50%	7.76%	8.87%
4	9.59%	7.98%	7.42%	8.25%
5	8.86%	7.45%	7.06%	7.64%
6	8.10%	6.92%	6.68%	7.03%
7	7.30%	6.38%	6.27%	6.43%
8	6.44%	5.84%	5.84%	5.82%
9	5.56%	5.29%	5.38%	5.22%
10	4.67%	4.74%	4.91%	4.63%
11	3.83%	4.21%	4.44%	4.07%
12	3.06%	3.71%	3.98%	3.55%
13	2.39%	3.25%	3.54%	3.08%
14	1.84%	2.82%	3.13%	2.66%
15	1.40%	2.45%	2.76%	2.29%
16	1.05%	2.12%	2.43%	1.97%
17	0.79%	1.82%	2.13%	1.69%
18	0.59%	1.57%	1.86%	1.44%
19	0.49%	1.35%	1.63%	1.24%
20	0.33%	1.16%	1.42%	1.06%
21	0.24%	1.00%	1.24%	0.91%
22	0.18%	0.86%	1.09%	0.78%
23	0.13%	0.74%	0.95%	0.66%
24	0.10%	0.64%	0.83%	0.57%
25	0.07%	0.55%	0.72%	0.49%
total	1.0000	1.0000	1.0000	1.0000
npv	0.7300	0.6710	0.6487	0.6814

Operating Cost Calculation (cont.)

Component Weights (g) or (g/cm)

	grams		
Old Vent/Rollover Valve	16.73		EPA Measurements
New Vent Rollover Valve	45.35		EPA Measurements
	rubber	steel	
5/16 Vapor Line	1.557	1.000 /cm	
3/8 Vapor Line	1.711	1.200 /cm	
1/2 Vapor Line	2.593	1.700 /cm	
5/8 Vapor Line	3.997	2.500 /cm	

1988 Cost Memo

Weight Increase Calculation (grams)

Item			LDV	LDT	LHDGV	HHDGV
ORVR	steel	length	2.0	2.0	0.0	0.0
		g/ft	51.82	51.82	51.82	51.82
	rubber	length	1.0	1.0	8.0	15.0
		g/ft	79.03	79.03	121.83	121.83
ORVR Vent Line Weight			182.67	219.20	1169.55	2101.54
ORVR Rollover Valve Weight			45.35	54.42	54.42	52.15
Fillneck Seal Weight			0.00	0.00	0.00	46.00
Evap.	steel	length	2.0	2.0	0.0	0.0
		g/ft	36.58	36.58	36.58	36.58
	rubber	length	1.0	1.0	8.0	15.0
		g/ft	52.15	52.15	52.15	52.15
Evap. Vent Line Weight			125.30	150.36	500.65	899.61
External Vent Line Weight			60.00	72.00	72.00	0.00
Evap. Rollover Valve Weight			16.73	20.08	20.08	19.24
Incremental Weight (g/tank)			25.98	31.18	631.25	1280.85
Incremental Weight (g)			25.98	37.42	757.50	1472.97

Recovery Credit Data

Ev/Eg	90.0%	1987 S&A document
Density of Gasoline	2.79 kg/gal	
Gas Price (no taxes)	$0.820 /gal	

Total Cost Results

Total Per Vehicle Costs of ORVR--Nonattainment Areas

Item	LDV	LDT	LHDGV	HHDGV
Hardware (RPE)	$4.28	$4.79	$6.29	$21.15
Development (RPE)	$2.08	$2.65	$2.60	$4.57
Operating	-$1.15	-$1.80	-$2.35	-$4.85
Total	$5.21	$5.64	$6.54	$20.87

Sales Weighted Cost--Nonattainment Areas

Item	LDV	LDT	LHDGV	HHDGV	Totals
Hardware (RPE)	$2.66	$1.65	$0.18	$0.08	$4.58
Development (RPE)	$1.29	$0.91	$0.08	$0.02	$2.30
Operating	-$0.71	-$0.62	-$0.07	-$0.02	-$1.42
Total	$3.24	$1.95	$0.19	$0.08	$5.45

Total Per Vehicle Costs of ORVR--All Areas

Item	LDV	LDT	LHDGV	HHDGV
Hardware (RPE)	$4.28	$4.79	$6.29	$21.15
Development (RPE)	$2.08	$2.65	$2.60	$4.57
Operating	-$2.35	-$3.70	-$5.50	-$11.00
Total	$4.01	$3.74	$3.39	$14.72

Sales Weighted Cost--All Areas

Item	LDV	LDV	LHDGV	HHDGV	Totals
Hardware (RPE)	$2.66	$1.65	$0.18	$0.08	$4.58
Development (RPE)	$1.29	$0.91	$0.08	$0.02	$2.30
Operating	-$1.46	-$1.28	-$0.16	-$0.04	-$2.94
Total	$2.49	$1.29	$0.10	$0.06	$3.94

Long-Term Per Vehicle Costs of ORVR--Nonattainment Areas

Item	LDV	LDT	LHDGV	HHDGV
Hardware (RPE)	$4.28	$4.79	$6.29	$21.15
Development (RPE)	$0.00	$0.00	$0.00	$0.00
Operating	-$3.15	-$4.95	-$7.50	-$15.00
Total	$1.13	-$0.16	-$1.21	$6.15

Long-Term Sales Weighted Cost--Nonattainment Areas

Item	LDV	LDT	LHDGV	HHDGV	Totals
Hardware (RPE)	$2.66	$1.65	$0.18	$0.08	$4.58
Development (RPE)	$0.00	$0.00	$0.00	$0.00	$0.00
Operating	-$1.96	-$1.71	-$0.22	-$0.06	-$3.94
Total	$0.70	-$0.06	-$0.04	$0.02	$0.64

Long-Term Per Vehicle Costs of ORVR--All Areas

Item	LDV	LDT	LHDGV	HHDGV
Hardware (RPE)	$4.28	$4.79	$6.29	$21.15
Development (RPE)	$0.00	$0.00	$0.00	$0.00
Operating	-$3.75	-$5.85	-$9.00	-$17.90
Total	$0.53	-$1.06	-$2.71	$3.25

Long-Term Sales Weighted Cost--All Areas

Item	LDV	LDV	LHDGV	HHDGV	Totals
Hardware (RPE)	$2.66	$1.65	$0.18	$0.08	$4.58
Development (RPE)	$0.00	$0.00	$0.00	$0.00	$0.00
Operating	-$2.33	-$2.02	-$0.26	-$0.07	-$4.68
Total	$0.33	-$0.37	-$0.08	$0.01	-$0.10

Total Cost Per Vehicle

	Hardware	Dev.	Operating† All Areas	
			S2 in place	S2 disc.
	($/veh)	($/veh)	($/gal)	($/gal)
LDV	$4.28	$2.08	-$0.000597	-$0.000944
LDT	$4.79	$2.65	-$0.000595	-$0.000942
LHDGV	$6.29	$2.60	-$0.000537	-$0.000883
HHDGV	$21.15	$4.57	-$0.000550	-$0.000897

†Using 5 month ozone season EFu and ORVR efficiency

Emission Benefit Rates (g/gal)*

	All Areas	NAA
With Stage II	2.42	1.19
Without Stage II	3.59	3.28

*Using 5 month ozone season EFu and ORVR efficiency

Total Cost Per Vehicle

	Hardware	Dev.	Operating†	
			All Areas	
			S2 in place	S2 disc.
	($/veh)	($/veh)	($/gal)	($/gal)
LDV	$4.28	$2.08	-$0.000597	-$0.000944
LDT	$4.79	$2.65	-$0.000595	-$0.000942
LHDGV	$6.29	$2.60	-$0.000537	-$0.000883
HHDGV	$21.15	$4.57	-$0.000550	-$0.000897

from ORVRCOST.WK4

†Using 5 month ozone season EFu and ORVR efficiency

NAA Fuel Thruput % 54.9%

LDV ORVR Costs and Benefits

Year	Projected Fleet Fuel Consumption	Projected ORVR Fuel Consumption	New ORVR Gasoline Vehicles	Nationwide Costs: Hardware (RPE)	Nationwide Costs: Development (RPE)	Nationwide Costs: All-Areas Operating: S2 in Place	Nationwide Costs: All-Areas Operating: S2 Discontinued	Benefits: All-Areas (Mg): with S2	Benefits: All-Areas (Mg): no S2	Benefits: NAA (Mg): with S2	Benefits: NAA (Mg): no S2
1998	7.33E+10	2.30E+09	4,240,000	$18,147,200	$8,819,200	-$1,375,901	-$2,175,629	5,577	8,274	1.506	4,150
1999	7.29E+10	8.26E+09	8,640.000	$36,979,200	$17,971,200	-$4,933,109	-$7,800,427	19,997	29,665	5,398	14,880
2000	7.28E+10	1.63E+10	11,000,000	$47,080,000	$22,880,000	-$9,754,599	-$15,424,358	39,541	58,658	10,675	29,423
2001	7.33E+10	2.45E+10	11,100,000	$47,508,000	$23,088,000	-$14,630,075	-$23,133,653	59,304	87,976	16,010	44,128
2002	7.42E+10	3.23E+10	11,300,000	$48,364,000	$23,504,000	-$19,289,608	-$30,501,491	78,192	115,996	21,109	58,183
2003	7.57E+10	3.99E+10	11,500,000	$49,220,000	$0	-$23,823,662	-$37,670,917	96,572	143,261	26,071	71,859
2004	7.74E+10	4.72E+10	11,700,000	$50,076,000	$0	-$28,156,365	-$44,521,957	114,135	169,315	30,812	84,928
2005	7.94E+10	5.35E+10	11,800,000	$50,504,000	$0	-$31,928,785	-$50,487,057	129,427	192,001	34,940	96,306
2006	8.14E+10	5.88E+10	12,000,000	$51,360,000	$0	-$35,112,471	-$55,521,228	142,332	211,145	38,424	105,909
2007	8.35E+10	6.36E+10	12,200,000	$52,216,000	$0	-$37,954,006	-$60,014.375	153,850	228,233	41.534	114,480
2008	8.56E+10	6.82E+10	12,400,000	$53.072,000	$0	-$40,703,620	-$64,362,173	164,996	244.767	44.543	122.774
2009	8.74E+10	7.28E+10	12,600,000	$53,928,000	$0	-$43,482,415	-$68,756,114	176.260	261,477	47.584	131,155
2010	8.89E+10	7.73E+10	12,800,000	$54,784,000	$0	-$46,164,182	-$72,996,629	187,131	277,604	50.518	139,244
2011	9.00E+10	8.12E+10	13,000,000	$55,640,000	$0	-$48,467,321	-$76,638,444	196,467	291,453	53.039	146,191
2012	9.14E+10	8.46E+10	13,200,000	$56,496,000	$0	-$50,490,319	-$79,837,288	204,668	303,618	55.253	152.293
2013	9.28E+10	8.74E+10	13,400,000	$57,352,000	$0	-$52,175,542	-$82.502,030	211,499	313.752	57,097	157,376
2014	9.42E+10	8.98E+10	13,600,000	$58,208,000	$0	-$53,630,233	-$84,802,244	217,396	322.500	58.689	161,764
2015	9.55E+10	9.21E+10	13,800,000	$59,064,000	$0	-$54,995.191	-$86,960,570	222,929	330.708	60;182	165,881
2016	9.67E+10	9.41E+10	14,000,000	$59,920,000	$0	-$56,154,421	-$88,793,590	227,628	337,679	61,451	169,378
2017	9.79E+10	9.59E+10	14,100,000	$60,348,000	$0	-$57,250,910	-$90,527,402	232,072	344,273	62,651	172,685
2018	9.91E+10	9.76E+10	14,300,000	$61,204,000	$0	-$58,264,962	-$92,130,862	236,183	350,371	63,761	175,744
2019	1.00E+11	9.92E+10	14,500,000	$62,060,000	$0	-$59,230,865	-$93,658,186	240,098	356,179	64,818	178,657
2020	1.02E+11	1.01E+11	14,700,000	$62,916,000	$0	-$60,168,317	-$95,140,521	243.898	361,816	65,843	181,485

LDT ORVR Costs and Benefits

Year	Projected Fleet Fuel Consumption	Projected ORVR Fuel Consumption	New ORVR Gasoline Vehicles	Nationwide Costs				Benefits			
				Hardware (RPE)	Development (RPE)	All-Areas Operating		All-Areas (Mg)		NAA (Mg)	
						S2 in Place	S2 Discontinued	with S2	no S2	with S2	no S2
1998	4.32E+10	1.36E+09	2,112,000	$10,116,480	$5,596,800	-$807,797	-$1,278,899	3,285	4,874	887	2,445
1999	4.57E+10	5.18E+09	4,344,000	$20,807,760	$11,511,600	-$3,084,316	-$4,883,068	12,545	18,610	3,387	9,334
2000	4.81E+10	1.08E+10	5,590,000	$26,776,100	$14,813,500	-$6,415,842	-$10,157,518	26,095	38,711	7,045	19,417
2001	4.99E+10	1.67E+10	5,740,000	$27,494,600	$15,211,000	-$9,918,235	-$15,702,482	40,340	59,843	10,890	30,017
2002	5.14E+10	2.24E+10	5,890,000	$28,213,100	$15,608,500	-$13,324,651	-$21,095,498	54,194	80,396	14,630	40,326
2003	5.24E+10	2.76E+10	6,040,000	$28,931,600	$0	-$16,443,867	-$26,033,820	66,881	99,216	18,055	49,766
2004	5.30E+10	3.23E+10	6,200,000	$29,698,000	$0	-$19,215,535	-$30,421,905	78,154	115,939	21,099	58,154
2005	5.34E+10	3.60E+10	6,350,000	$30,416,500	$0	-$21,411,346	-$33,898,300	87,085	129,188	23,510	64,800
2006	5.39E+10	3.89E+10	6,500,000	$31,135,000	$0	-$23,169,450	-$36,681,717	94,235	139,796	25,440	70,120
2007	5.45E+10	4.15E+10	6,650,000	$31,853,500	$0	-$24,673,072	-$39,062,242	100,351	148,868	27,091	74,671
2008	5.50E+10	4.39E+10	6,800,000	$32,572,000	$0	-$26,094,533	-$41,312,689	106,132	157,444	28,652	78,973
2009	5.59E+10	4.66E+10	6,950,000	$33,290,500	$0	-$27,710,127	-$43,870,487	112,703	167,192	30,426	83,862
2010	5.70E+10	4.96E+10	7,110,000	$34,056,900	$0	-$29,490,770	-$46,689,589	119,946	177,936	32,381	89,251
2011	5.81E+10	5.24E+10	7,250,000	$34,727,500	$0	-$31,174,711	-$49,355,593	126,795	188,096	34,230	94,348
2012	5.94E+10	5.50E+10	7,400,000	$35,446,000	$0	-$32,725,594	-$51,810,940	133,102	197,454	35,933	99,041
2013	6.07E+10	5.72E+10	7,550,000	$36,164,500	$0	-$34,048,898	-$53,905,986	138,485	205,438	37,386	103,046
2014	6.21E+10	5.92E+10	7,700,000	$36,883,000	$0	-$35,249,323	-$55,806,492	143,367	212,681	38,704	106,679
2015	6.35E+10	6.12E+10	7,850,000	$37,601,500	$0	-$36,430,117	-$57,675,917	148,170	219,805	40,000	110,253
2016	6.48E+10	6.31E+10	7,990,000	$38,272,100	$0	-$37,518,571	-$59,399,150	152,597	226,373	41,195	113,547
2017	6.61E+10	6.48E+10	8,130,000	$38,942,700	$0	-$38,545,222	-$61,024,537	156,772	232,567	42,323	116,654
2018	6.74E+10	6.64E+10	8,270,000	$39,613,300	$0	-$39,497,710	-$62,532,509	160,646	238,314	43,368	119,537
2019	6.87E+10	6.79E+10	8,420,000	$40,331,800	$0	-$40,411,662	-$63,979,472	164,363	243,828	44,372	122,303
2020	7.01E+10	6.94E+10	8,560,000	$41,002,400	$0	-$41,311,800	-$65,404,563	168,024	249,259	45,360	125,027

LHDGV ORVR Costs and Benefits

	Projected	Projected	New ORVR	Nationwide Costs				Benefits			
	Fleet Fuel	ORVR Fuel	Gasoline	Hardware	Development	All-Areas Operating		All-Areas (Mg)		NAA (Mg)	
Year	Consumption	Consumption	Vehicles	(RPE)	(RPE)	S2 in Place	S2 Discontinued	with S2	no S2	with S2	no S2
1998	5.13E+09	1.61E+08	179,200	$1,127,168	$465,920	-$86,620	-$142,431	390	579	105	290
1999	5.32E+09	6.03E+08	368,800	$2,319,752	$958,880	-$323,842	-$532,499	1,459	2,165	394	1,086
2000	5.58E+09	1.25E+09	474,000	$2,981,460	$1,232,400	-$672,783	-$1,106,271	3,032	4,498	819	2,256
2001	5.79E+09	1.94E+09	487,000	$3,063,230	$1,266,200	-$1,039,935	-$1,709,986	4,686	6,952	1,265	3,487
2002	5.97E+09	2.60E+09	500,000	$3,145,000	$1,300,000	-$1,394,783	-$2,293,470	6,286	9,325	1,697	4,677
2003	6.19E+09	3.27E+09	513,000	$3,226,770	$0	-$1,753,568	-$2,883,427	7,902	11,723	2,133	5,880
2004	6.49E+09	3.95E+09	519,000	$3,264,510	$0	-$2,122,688	-$3,490,379	9,566	14,191	2,582	7,118
2005	6.82E+09	4.59E+09	533,000	$3,352,570	$0	-$2,465,724	-$4,054,440	11,112	16,484	3,000	8,268
2006	7.13E+09	5.15E+09	548,000	$3,446,920	$0	-$2,766,926	-$4,549,713	12,469	18,498	3,366	9,278
2007	7.40E+09	5.64E+09	563,000	$3,541,270	$0	-$3,026,787	-$4,977,007	13,640	20,235	3,682	10,150
2008	7.62E+09	6.07E+09	577,000	$3,629,330	$0	-$3,258,595	-$5,358,173	14,685	21,785	3,964	10,927
2009	7.87E+09	6.56E+09	592,000	$3,723,680	$0	-$3,523,869	-$5,794,370	15,880	23,558	4,287	11,817
2010	8.18E+09	7.11E+09	605,000	$3,805,450	$0	-$3,819,658	-$6,280,741	17,213	25,536	4,647	12,808
2011	8.51E+09	7.67E+09	620,000	$3,899,800	$0	-$4,121,352	-$6,776,823	18,573	27,552	5,014	13,820
2012	8.82E+09	8.16E+09	636,000	$4,000,440	$0	-$4,382,689	-$7,206,545	19,751	29,300	5,332	14,696
2013	9.12E+09	8.59E+09	652,000	$4,101,080	$0	-$4,614,005	-$7,586,902	20,793	30,846	5,613	15,472
2014	9.41E+09	8.98E+09	667,000	$4,195,430	$0	-$4,822,189	-$7,929,223	21,731	32,238	5,867	16,170
2015	9.70E+09	9.36E+09	683,000	$4,296,070	$0	-$5,024,467	-$8,261,832	22,643	33,590	6,113	16,849
2016	9.95E+09	9.68E+09	697,000	$4,384,130	$0	-$5,200,660	-$8,551,551	23,437	34,768	6,327	17,439
2017	1.02E+10	9.98E+09	711,000	$4,472,190	$0	-$5,359,136	-$8,812,136	24,151	35,827	6,520	17,971
2018	1.04E+10	1.02E+10	725,000	$4,560,250	$0	-$5,503,339	-$9,049,252	24,801	36,791	6,695	18,454
2019	1.06E+10	1.05E+10	739,000	$4,648,310	$0	-$5,639,667	-$9,273,419	25,415	37,703	6,861	18,911
2020	1.08E+10	1.07E+10	752,000	$4,730,080	$0	-$5,769,598	-$9,487,066	26,001	38,571	7,019	19,347

HHDGV ORVR Costs and Benefits

	Projected	Projected	New ORVR	Nationwide Costs				Benefits			
	Fleet Fuel	ORVR Fuel	Gasoline	Hardware	Development	All-Areas Operating		All-Areas (Mg)		NAA (Mg)	
Year	Consumption	Consumption	Vehicles	(RPE)	(RPE)	S2 in Place	S2 Discontinued	with S2	no S2	with S2	no S2
1998	1.71E+09	5.38E+07	31,320	$662,418	$143,132	-$29,572	-$48,230	130	193	35	97
1999	1.77E+09	2.01E+08	62,880	$1,329,912	$287,362	-$110,560	-$180,314	486	722	131	362
2000	1.86E+09	4.18E+08	78,600	$1,662,390	$359,202	-$229,690	-$374,604	1,011	1,499	273	752
2001	1.93E+09	6.46E+08	79,000	$1,670,850	$361,030	-$355,037	-$579,033	1,562	2,317	422	1,162
2002	1.99E+09	8.66E+08	79,900	$1,689,885	$365,143	-$476,183	-$776,611	2,095	3,108	566	1,559
2003	2.06E+09	1.09E+09	81,100	$1,715,265	$0	-$598,673	-$976,381	2,634	3,908	711	1,960
2004	2.16E+09	1.32E+09	82,400	$1,742,760	$0	-$724,692	-$1,181,906	3,189	4,730	861	2,373
2005	2.27E+09	1.53E+09	83,800	$1,772,370	$0	-$841,805	-$1,372,908	3,704	5,495	1,000	2,756
2006	2.38E+09	1.72E+09	85,100	$1,799,865	$0	-$944,637	-$1,540,616	4,156	6,166	1,122	3,093
2007	2.47E+09	1.88E+09	86,500	$1,829,475	$0	-$1,033,354	-$1,685,306	4,547	6,745	1,227	3,383
2008	2.54E+09	2.02E+09	88,200	$1,865,430	$0	-$1,112,494	-$1,814,376	4,895	7,262	1,321	3,642
2009	2.62E+09	2.19E+09	89,700	$1,897,155	$0	-$1,203,059	-$1,962,080	5,293	7,853	1,429	3,939
2010	2.73E+09	2.37E+09	91,900	$1,943,685	$0	-$1,304,042	-$2,126,774	5,738	8,512	1,549	4,269
2011	2.84E+09	2.56E+09	93,700	$1,981,755	$0	-$1,407,041	-$2,294,757	6,191	9,184	1,671	4,607
2012	2.94E+09	2.72E+09	95,800	$2,026,170	$0	-$1,496,263	-$2,440,268	6,584	9,767	1,777	4,899
2013	3.04E+09	2.86E+09	97,900	$2,070,585	$0	-$1,575,234	-$2,569,064	6,931	10,282	1,871	5,157
2014	3.14E+09	2.99E+09	100,000	$2,115,000	$0	-$1,646,309	-$2,684,980	7,244	10,746	1,956	5,390
2015	3.23E+09	3.12E+09	102,200	$2,161,530	$0	-$1,715,367	-$2,797,608	7,548	11,197	2,038	5,616
2016	3.32E+09	3.23E+09	104,200	$2,203,830	$0	-$1,775,520	-$2,895,712	7,812	11,589	2,109	5,813
2017	3.39E+09	3.33E+09	106,100	$2,244,015	$0	-$1,829,624	-$2,983,951	8,050	11,942	2,173	5,990
2018	3.47E+09	3.42E+09	108,100	$2,286,315	$0	-$1,878,856	-$3,064,243	8,267	12,264	2,232	6,151
2019	3.54E+09	3.50E+09	110,100	$2,328,615	$0	-$1,925,398	-$3,140,150	8,472	12,568	2,287	6,304
2020	3.61E+09	3.58E+09	112,200	$2,373,030	$0	-$1,969,757	-$3,212,495	8,667	12,857	2,340	6,449

ORVR Truck Analysis Cost Scenarios (1993$)

Scenario	Nonattainment Areas Truck Analysis			All-Areas Truck Analysis		
Case	Baseline	Stage II Retention	Stage II Phase-Out	Baseline	Stage II Retention	Stage II Phase-Out
Cost	All-Areas (Truck)	All-Areas (Truck)	All-Areas (Truck)	All-Areas (Truck)	All-Areas (Truck)	All-Areas (Truck)
Benefit	NAA (Truck)	NAA (Truck)	NAA (Truck)	All-Areas (Truck)	All-Areas (Truck)	All-Areas (Truck)
Year	(No Stage II)	S2 forever	S2 stop in 2010	(no Stage II)	S2 forever	S2 stop in 2010
1998	$16,642,358	$17,187,929	$17,187,929	$16,642,358	$17,187,929	$17,187,929
1999	$31,619,384	$33,696,548	$33,696,548	$31,619,384	$33,696,548	$33,696,548
2000	$36,186,659	$40,506,736	$40,506,736	$36,186,659	$40,506,736	$40,506,736
2001	$31,075,408	$37,753,703	$37,753,703	$31,075,408	$37,753,703	$37,753,703
2002	$26,156,049	$35,126,011	$35,126,011	$26,156,049	$35,126,011	$35,126,011
2003	$3,980,006	$15,077,527	$15,077,527	$3,980,006	$15,077,527	$15,077,527
2004	-$388,921	$12,642,355	$12,642,355	-$388,921	$12,642,355	$12,642,355
2005	-$3,784,208	$10,822,564	$10,822,564	-$3,784,208	$10,822,564	$10,822,564
2006	-$6,390,262	$9,500,772	$9,500,772	-$6,390,262	$9,500,772	$9,500,772
2007	-$8,500,310	$8,491,032	$8,491,032	-$8,500,310	$8,491,032	$8,491,032
2008	-$10,418,478	$7,601,139	$7,601,139	-$10,418,478	$7,601,139	$7,601,139
2009	-$12,715,601	$6,474,280	$6,474,280	-$12,715,601	$6,474,280	$6,474,280
2010	-$15,291,069	$5,191,565	-$15,291,069	-$15,291,069	$5,191,565	-$15,291,069
2011	-$17,818,117	$3,905,951	-$17,818,117	-$17,818,117	$3,905,951	-$17,818,117
2012	-$19,985,143	$2,868,064	-$19,985,143	-$19,985,143	$2,868,064	-$19,985,143
2013	-$21,725,786	$2,098,028	-$21,725,786	-$21,725,786	$2,098,028	-$21,725,786
2014	-$23,227,264	$1,475,609	-$23,227,264	-$23,227,264	$1,475,609	-$23,227,264
2015	-$24,676,257	$889,149	-$24,676,257	-$24,676,257	$889,149	-$24,676,257
2016	-$25,986,352	$365,309	-$25,986,352	-$25,986,352	$365,309	-$25,986,352
2017	-$27,161,718	-$75,077	-$27,161,718	-$27,161,718	-$75,077	-$27,161,718
2018	-$28,186,138	-$420,039	-$28,186,138	-$28,186,138	-$420,039	-$28,186,138
2019	-$29,084,316	-$668,003	-$29,084,316	-$29,084,316	-$668,003	-$29,084,316
2020	-$29,998,615	-$945,644	-$29,998,615	-$29,998,615	-$945,644	-$29,998,615
Avg. Annual	-$6,942,552	$10,850,674	-$1,228,703	-$6,942,552	$10,850,674	-$1,228,703
1998 NPV	$20,464,348	$178,375,566	$96,179,248	$20,464,348	$178,375,566	$96,179,248

ORVR All Vehicles Cost Scenarios (1993$)

Scenario	Nonattainment Areas All Vehicles Analysis			All-Areas All Vehicles Analysis		
Case	Baseline	Stage II Retention	Stage II Phase-Out	Baseline	Stage II Retention	Stage II Phase-Out
Cost	All-Areas (all)	All-Areas (all)	All-Areas (all)	All-Areas (all)	All-Areas (all)	All-Areas (all)
Benefit	NAA (all)	NAA (all)	NAA (all)	All-Areas (all)	All-Areas (all)	All-Areas (all)
Year	(No Stage II)	S2 forever	S2 stop in 2010	(no Stage II)	S2 forever	S2 stop in 2010
1998	$41,433,129	$42,778,428	$42,778,428	$41,433,129	$42,778,428	$42,778,428
1999	$78,769,357	$83,713,839	$83,713,839	$78,769,357	$83,713,839	$83,713,839
2000	$90,722,301	$100,712,137	$100,712,137	$90,722,301	$100,712,137	$100,712,137
2001	$78,537,756	$93,719,629	$93,719,629	$78,537,756	$93,719,629	$93,719,629
2002	$67,522,557	$87,704,402	$87,704,402	$67,522,557	$87,704,402	$87,704,402
2003	$15,529,089	$40,473,864	$40,473,864	$15,529,089	$40,473,864	$40,473,864
2004	$5,165,122	$34,561,991	$34,561,991	$5,165,122	$34,561,991	$34,561,991
2005	-$3,767,265	$29,397,779	$29,397,779	-$3,767,265	$29,397,779	$29,397,779
2006	-$10,551,490	$25,748,301	$25,748,301	-$10,551,490	$25,748,301	$25,748,301
2007	-$16,298,685	$22,753,026	$22,753,026	-$16,298,685	$22,753,026	$22,753,026
2008	-$21,708,651	$19,969,519	$19,969,519	-$21,708,651	$19,969,519	$19,969,519
2009	-$27,543,715	$16,919,865	$16,919,865	-$27,543,715	$16,919,865	$16,919,865
2010	-$33,503,698	$13,811,383	-$33,503,698	-$33,503,698	$13,811,383	-$33,503,698
2011	-$38,816,561	$11,078,630	-$38,816,561	-$38,816,561	$11,078,630	-$38,816,561
2012	-$43,326,431	$8,873,746	-$43,326,431	-$43,326,431	$8,873,746	-$43,326,431
2013	-$46,875,816	$7,274,486	-$46,875,816	-$46,875,816	$7,274,486	-$46,875,816
2014	-$49,821,509	$6,053,376	-$49,821,509	-$49,821,509	$6,053,376	-$49,821,509
2015	-$52,572,827	$4,957,958	-$52,572,827	-$52,572,827	$4,957,958	-$52,572,827
2016	-$54,859,942	$4,130,888	-$54,859,942	-$54,859,942	$4,130,888	-$54,859,942
2017	-$57,341,120	$3,022,013	-$57,341,120	-$57,341,120	$3,022,013	-$57,341,120
2018	-$59,113,000	$2,518,998	-$59,113,000	-$59,113,000	$2,518,998	-$59,113,000
2019	-$60,682,502	$2,161,132	-$60,682,502	-$60,682,502	$2,161,132	-$60,682,502
2020	-$62,223,135	$1,802,039	-$62,223,135	-$62,223,135	$1,802,039	-$62,223,135
Avg. Annual	-$11,362,045	$28,875,540	$1,709,402	-$11,362,045	$28,875,540	$1,709,402
1998 NPV	$101,489,902	$460,005,463	$274,563,086	$101,489,902	$460,005,463	$274,563,086

ORVR Truck Analysis Benefit Scenarios (Mg)

Scenario	Nonattainment Areas Truck Analysis			All-Areas Truck Analysis		
Case	Baseline	Stage II Retention	Stage II Phase-Out	Baseline	Stage II Retention	Stage II Phase-Out
Cost	All-Areas (Truck)	All-Areas (Truck)	All-Areas (Truck)	All-Areas (Truck)	All-Areas (Truck)	All-Areas (Truck)
Benefit	NAA (Truck)	NAA (Truck)	NAA (Truck)	All-Areas (Truck)	All-Areas (Truck)	All-Areas (Truck)
Year	(No Stage II)	S2 forever	S2 stop in 2010	(no Stage II)	S2 forever	S2 stop in 2010
1998	2,832	1,027	1,027	5,646	3,806	3,806
1999	10,782	3,912	3,912	21,496	14,490	14,490
2000	22,425	8,136	8,136	44,708	30,137	30,137
2001	34,666	12,577	12,577	69,112	46,588	46,588
2002	46,562	16,893	16,893	92,828	62,575	62,575
2003	57,606	20,900	20,900	114,847	77,418	77,418
2004	67,645	24,542	24,542	134,860	90,909	90,909
2005	75,824	27,509	27,509	151,167	101,901	101,901
2006	82,492	29,928	29,928	164,459	110,861	110,861
2007	88,204	32,001	32,001	175,848	118,538	118,538
2008	93,542	33,938	33,938	186,491	125,712	125,712
2009	99,618	36,142	36,142	198,603	133,877	133,877
2010	106,329	38,577	106,329	211,983	142,897	211,983
2011	112,775	40,915	112,775	224,833	151,559	224,833
2012	118,637	43,042	118,637	236,520	159,437	236,520
2013	123,676	44,870	123,676	246,566	166,209	246,566
2014	128,240	46,526	128,240	255,664	172,342	255,664
2015	132,718	48,151	132,718	264,592	178,360	264,592
2016	136,799	49,632	136,799	272,730	183,846	272,730
2017	140,615	51,016	140,615	280,337	188,974	280,337
2018	144,142	52,296	144,142	287,369	193,714	287,369
2019	147,518	53,520	147,518	294,099	198,250	294,099
2020	150,823	54,719	150,823	300,688	202,692	300,688
Avg. Annual	92,368	33,512	73,469	184,150	124,134	164,878
1998 NPV	819,742	297,406	569,300	1,634,276	1,101,657	1,378,903

Cost Effectiveness

$/Mg	$25	$600	$169	$13	$162	$70
$/U.S. Ton	$27	$660	$186	$14	$178	$77

ORVR All Vehicles Benefit Scenarios (Mg)

Scenario	Nonattainment Areas All Vehicles Analysis			All-Areas All Vehicles Analysis		
Case	Baseline	Stage II Retention	Stage II Phase-Out	Baseline	Stage II Retention	Stage II Phase-Out
Cost	All-Areas (all)	All-Areas (all)	All-Areas (all)	All-Areas (all)	All-Areas (all)	All-Areas (all)
Benefit	NAA (all)	NAA (all)	NAA (all)	All-Areas (all)	All-Areas (all)	All-Areas (all)
Year	(No Stage II)	S2 forever	S2 stop in 2010	(no Stage II)	S2 forever	S2 stop in 2010
1998	6,982	2,533	2,533	13,920	9,383	9,383
1999	25,662	9,310	9,310	51,161	34,487	34,487
2000	51,848	18,811	18,811	103,366	69,678	69,678
2001	78,795	28,587	28,587	157,089	105,893	105,893
2002	104,745	38,002	38,002	208,825	140,768	140,768
2003	129,465	46,971	46,971	258,108	173,989	173,989
2004	152,572	55,354	55,354	304,176	205,043	205,043
2005	172,130	62,450	62,450	343,167	231,327	231,327
2006	188,401	68,353	68,353	375,604	253,193	253,193
2007	202,684	73,535	73,535	404,080	272,388	272,388
2008	216,316	78,480	78,480	431,258	290,709	290,709
2009	230,773	83,726	83,726	460,080	310,138	310,138
2010	245,574	89,095	245,574	489,587	330,028	489,587
2011	258,966	93,954	258,966	516,286	348,026	516,286
2012	270,930	98,295	270,930	540,138	364,104	540,138
2013	281,052	101,967	281,052	560,318	377,708	560,318
2014	290,003	105,215	290,003	578,164	389,738	578,164
2015	298,599	108,333	298,599	595,300	401,289	595,300
2016	306,177	111,082	306,177	610,409	411,473	610,409
2017	313,300	113,667	313,300	624,609	421,046	624,609
2018	319,886	116,056	319,886	637,740	429,897	637,740
2019	326,175	118,338	326,175	650,278	438,349	650,278
2020	332,308	120,563	332,308	662,504	446,591	662,504
Avg. Annual	208,841	75,769	165,612	416,355	280,663	372,275
1998 NPV	1,860,757	675,092	1,288,384	3,709,692	2,500,684	3,126,051

Cost Effectiveness

$/Mg	$55	$681	$213	$27	$184	$88
$/U.S. Ton	$60	$750	$234	$30	$202	$97

Summation of Fuel Recovery Credits Nationwide (Stage II Forever)*

Year	Gallons of Fuel Recovered					Dollar Value of Fuel Recovered†				
	LDV	LDT	LHDGV	HHDGV	All Classes	LDV	LDT	LHDGV	HHDGV	All Classes
1998	1,677,928	985,118	105,634	36,064	2,804,745	$1,375,901	$807,797	$86,620	$29,572	$2,299,891
1999	6,015,986	3,761,361	394,929	134,830	10,307,106	$4,933,109	$3,084,316	$323,842	$110,560	$8,451,827
2000	11,895,853	7,824,198	820,468	280,110	20,820,628	$9,754,599	$6,415,842	$672,783	$229,690	$17,072,915
2001	17,841,555	12,095,408	1,268,214	432,972	31,638,148	$14,630,075	$9,918,235	$1,039,935	$355,037	$25,943,281
2002	23,523,913	16,249,575	1,700,955	580,711	42,055,153	$19,289,608	$13,324,651	$1,394,783	$476,183	$34,485,226
2003	29,053,247	20,053,497	2,138,497	730,089	51,975,330	$23,823,662	$16,443,867	$1,753,568	$598,673	$42,619,771
2004	34,337,030	23,433,579	2,588,644	883,771	61,243,024	$28,156,365	$19,215,535	$2,122,688	$724,692	$50,219,279
2005	38,937,543	26,111,398	3,006,981	1,026,592	69,082,513	$31,928,785	$21,411,346	$2,465,724	$841,805	$56,647,661
2006	42,820,087	28,255,427	3,374,300	1,151,996	75,601,810	$35,112,471	$23,169,450	$2,766,926	$944,637	$61,993,484
2007	46,285,374	30,089,112	3,691,204	1,260,188	81,325,877	$37,954,006	$24,673,072	$3,026,787	$1,033,354	$66,687,219
2008	49,638,561	31,822,601	3,973,896	1,356,699	86,791,758	$40,703,620	$26,094,533	$3,258,595	$1,112,494	$71,169,241
2009	53,027,335	33,792,838	4,297,401	1,467,145	92,584,720	$43,482,415	$27,710,127	$3,523,869	$1,203,059	$75,919,470
2010	56,297,783	35,964,354	4,658,119	1,590,295	98,510,551	$46,164,182	$29,490,770	$3,819,658	$1,304,042	$80,778,652
2011	59,106,489	38,017,940	5,026,039	1,715,904	103,866,372	$48,467,321	$31,174,711	$4,121,352	$1,407,041	$85,170,425
2012	61,573,559	39,909,261	5,344,743	1,824,711	108,652,274	$50,490,319	$32,725,594	$4,382,689	$1,496,263	$89,094,864
2013	63,628,710	41,523,046	5,626,835	1,921,018	112,699,608	$52,175,542	$34,048,898	$4,614,005	$1,575,234	$92,413,679
2014	65,402,723	42,986,980	5,880,718	2,007,694	116,278,114	$53,630,233	$35,249,323	$4,822,189	$1,646,309	$95,348,054
2015	67,067,306	44,426,972	6,127,398	2,091,911	119,713,588	$54,995,191	$36,430,117	$5,024,467	$1,715,367	$98,165,142
2016	68,481,001	45,754,355	6,342,268	2,165,269	122,742,893	$56,154,421	$37,518,571	$5,200,660	$1,775,520	$100,649,172
2017	69,818,183	47,006,369	6,535,531	2,231,249	125,591,332	$57,250,910	$38,545,222	$5,359,136	$1,829,624	$102,984,892
2018	71,054,832	48,167,939	6,711,389	2,291,287	128,225,447	$58,264,962	$39,497,710	$5,503,339	$1,878,856	$105,144,867
2019	72,232,763	49,282,515	6,877,643	2,348,047	130,740,967	$59,230,865	$40,411,662	$5,639,667	$1,925,398	$107,207,593
2020	73,375,996	50,380,243	7,036,095	2,402,143	133,194,477	$60,168,317	$41,311,800	$5,769,598	$1,969,757	$109,219,471
avg	47,091,033	31,212,786	4,066,430	1,388,291	83,758,541	$38,614,647	$25,594,485	$3,334,473	$1,138,399	$68,682,003
sum	1,083,093,756	717,894,085	93,527,901	31,930,692	1,926,446,434	$888,136,880	$588,673,150	$76,692,879	$26,183,168	$1,579,686,076

* Assume: 45.0% of fuel is dispensed through areas with Stage I.

† with gasoline cost (no taxes included) of $0.82 per gallon

Summation of Fuel Recovery Credits Nationwide (Stage II Discontinued in 2010)*

	Gallons of Fuel Recovered					Dollar Value of Fuel Recovered†				
Year	LDV	LDT	LHDGV	HHDGV	All Classes	LDV	LDT	LHDGV	HHDGV	All Classes
1998	1,677,928	985,118	105,634	36,064	2,804,745	$1,375,901	$807,797	$86,620	$29,572	$2,299,891
1999	6,015,986	3,761,361	394,929	134,830	10,307,106	$4,933,109	$3,084,316	$323,842	$110,560	$8,451,827
2000	11,895,853	7,824,198	820,468	280,110	20,820,628	$9,754,599	$6,415,842	$672,783	$229,690	$17,072,915
2001	17,841,555	12,095,408	1,268,214	432,972	31,638,148	$14,630,075	$9,918,235	$1,039,935	$355,037	$25,943,281
2002	23,523,913	16,249,575	1,700,955	580,711	42,055,153	$19,289,608	$13,324,651	$1,394,783	$476,183	$34,485,226
2003	29,053,247	20,053,497	2,138,497	730,089	51,975,330	$23,823,662	$16,443,867	$1,753,568	$598,673	$42,619,771
2004	34,337,030	23,433,579	2,588,644	883,771	61,243,024	$28,156,365	$19,215,535	$2,122,688	$724,692	$50,219,279
2005	38,937,543	26,111,398	3,006,981	1,026,592	69,082,513	$31,928,785	$21,411,346	$2,465,724	$841,805	$56,647,661
2006	42,820,087	28,255,427	3,374,300	1,151,996	75,601,810	$35,112,471	$23,169,450	$2,766,926	$944,637	$61,993,484
2007	46,285,374	30,089,112	3,691,204	1,260,188	81,325,877	$37,954,006	$24,673,072	$3,026,787	$1,033,354	$66,687,219
2008	49,638,561	31,822,601	3,973,896	1,356,699	86,791,758	$40,703,620	$26,094,533	$3,258,595	$1,112,494	$71,169,241
2009	53,027,335	33,792,838	4,297,401	1,467,145	92,584,720	$43,482,415	$27,710,127	$3,523,869	$1,203,059	$75,919,470
2010	89,020,280	56,938,524	7,659,440	2,593,627	156,211,870	$72,996,629	$46,689,589	$6,280,741	$2,126,774	$128,093,733
2011	93,461,517	60,189,747	8,264,418	2,798,484	164,714,165	$76,638,444	$49,355,593	$6,776,823	$2,294,757	$135,065,616
2012	97,362,546	63,184,073	8,788,469	2,975,937	172,311,026	$79,837,288	$51,810,940	$7,206,545	$2,440,268	$141,295,041
2013	100,612,231	65,739,007	9,252,319	3,133,005	178,736,562	$82,502,030	$53,905,986	$7,586,902	$2,569,064	$146,563,981
2014	103,417,371	68,056,697	9,669,784	3,274,366	184,418,218	$84,802,244	$55,806,492	$7,929,223	$2,684,980	$151,222,939
2015	106,049,476	70,336,484	10,075,405	3,411,717	189,873,082	$86,960,570	$57,675,917	$8,261,832	$2,797,608	$155,695,927
2016	108,284,865	72,437,987	10,428,720	3,531,356	194,682,929	$88,793,590	$59,399,150	$8,551,551	$2,895,712	$159,640,002
2017	110,399,271	74,420,167	10,746,507	3,638,964	199,204,909	$90,527,402	$61,024,537	$8,812,136	$2,983,951	$163,348,025
2018	112,354,710	76,259,157	11,035,673	3,736,881	203,386,421	$92,130,862	$62,532,509	$9,049,252	$3,064,243	$166,776,865
2019	114,217,300	78,023,746	11,309,048	3,829,451	207,379,545	$93,658,186	$63,979,472	$9,273,419	$3,140,150	$170,051,227
2020	116,025,025	79,761,663	11,569,593	3,917,676	211,273,958	$95,140,521	$65,404,563	$9,487,066	$3,212,495	$173,244,645
avg	65,489,522	43,470,494	5,920,022	2,007,940	116,887,978	$53,701,408	$35,645,805	$4,854,418	$1,646,511	$95,848,142
sum	1,506,259,004	999,821,364	136,160,499	46,182,630	2,688,423,496	$1,235,132,383	$819,853,518	$111,651,609	$37,869,757	$2,204,507,267

* Assume: 45.0% of fuel is dispensed through areas with Stage II control until 2009, and then Stage II is discontinued.

† with gasoline cost (no taxes included) of $0.82 per gallon

Individual Vehicle Class Cost/Benefit Analysis

All Areas Analysis/Assumes Stage II Discontinuation in 2010.

	Costs				Benefits (Mg)			
	LDV	LDT	LHDGV	HHDGV	LDV	LDT	LHDGV	HHDGV
1998	$25,590,499	$14,905,483	$1,506,468	$775,978	5,577	3,285	390	130
1999	$50,017,291	$29,235,044	$2,954,790	$1,506,713	19,997	12,545	1,459	486
2000	$60,205,401	$35,173,758	$3,541,077	$1,791,902	39,541	26,095	3,032	1,011
2001	$55,965,925	$32,787,365	$3,289,495	$1,676,843	59,304	40,340	4,686	1,562
2002	$52,578,392	$30,496,949	$3,050,217	$1,578,845	78,192	54,194	6,286	2,095
2003	$25,396,338	$12,487,733	$1,473,202	$1,116,592	96,572	66,881	7,902	2,634
2004	$21,919,635	$10,482,465	$1,141,822	$1,018,068	114,135	78,154	9,566	3,189
2005	$18,575,215	$9,005,154	$886,846	$930,565	129,427	87,085	11,112	3,704
2006	$16,247,529	$7,965,550	$679,994	$855,228	142,332	94,235	12,469	4,156
2007	$14,261,994	$7,180,428	$514,483	$796,121	153,850	100,351	13,640	4,547
2008	$12,368,380	$6,477,467	$370,735	$752,936	164,996	106,132	14,685	4,895
2009	$10,445,585	$5,580,373	$199,811	$694,096	176,260	112,703	15,880	5,293
2010	-$18,212,629	-$12,632,689	-$2,475,291	-$183,089	277,604	177,936	25,536	8,512
2011	-$20,998,444	-$14,628,093	-$2,877,023	-$313,002	291,453	188,096	27,552	9,184
2012	-$23,341,288	-$16,364,940	-$3,206,105	-$414,098	303,618	197,454	29,300	9,767
2013	-$25,150,030	-$17,741,486	-$3,485,822	-$498,479	313,752	205,438	30,846	10,282
2014	-$26,594,244	-$18,923,492	-$3,733,793	-$569,980	322,500	212,681	32,238	10,746
2015	-$27,896,570	-$20,074,417	-$3,965,762	-$636,078	330,708	219,805	33,590	11,197
2016	-$28,873,590	-$21,127,050	-$4,167,421	-$691,882	337,679	226,373	34,768	11,589
2017	-$30,179,402	-$22,081,837	-$4,339,946	-$739,936	344,273	232,567	35,827	11,942
2018	-$30,926,862	-$22,919,209	-$4,489,002	-$777,928	350,371	238,314	36,791	12,264
2019	-$31,598,186	-$23,647,672	-$4,625,109	-$811,535	356,179	243,828	37,703	12,568
2020	-$32,224,521	-$24,402,163	-$4,756,986	-$839,465	361,816	249,259	38,571	12,857
Avg annu	$2,938,105	-$555,012	-$978,840	$305,149	207,397	137,989	20,167	6,722
1998 NPV	$178,383,838	$86,208,247	$2,422,260	$7,548,741	1,747,148	1,159,565	164,503	54,834

Cost Effectiveness

$/Mg	$102	$74	$15	$138
$/US Ton	$112	$82	$16	$151

Individual Vehicle Class Cost/Benefit Analysis

Nonattainment Areas Analysis/Assumes Stage II Discontinuation in 2010.

	Costs				Benefits (Mg)			
	LDV	LDT	LHDGV	HHDGV	LDV	LDT	LHDGV	HHDGV
1998	$25,590,499	$14,905,483	$1,506,468	$775,978	1,506	887	105	35
1999	$50,017,291	$29,235,044	$2,954,790	$1,506,713	19,997	12,545	1,459	486
2000	$60,205,401	$35,173,758	$3,541,077	$1,791,902	10,675	7,045	819	273
2001	$55,965,925	$32,787,365	$3,289,495	$1,676,843	16,010	10,890	1,265	422
2002	$52,578,392	$30,496,949	$3,050,217	$1,578,845	21,109	14,630	1,697	566
2003	$25,396,338	$12,487,733	$1,473,202	$1,116,592	26,071	18,055	2,133	711
2004	$21,919,635	$10,482,465	$1,141,822	$1,018,068	30,812	21,099	2,582	861
2005	$18,575,215	$9,005,154	$886,846	$930,565	34,940	23,510	3,000	1,000
2006	$16,247,529	$7,965,550	$679,994	$855,228	38,424	25,440	3,366	1,122
2007	$14,261,994	$7,180,428	$514,483	$796,121	41,534	27,091	3,682	1,227
2008	$12,368,380	$6,477,467	$370,735	$752,936	44,543	28,652	3,964	1,321
2009	$10,445,585	$5,580,373	$199,811	$694,096	47,584	30,426	4,287	1,429
2010	-$18,212,629	-$12,632,689	-$2,475,291	-$183,089	139,244	89,251	12,808	4,269
2011	-$20,998,444	-$14,628,093	-$2,877,023	-$313,002	146,191	94,348	13,820	4,607
2012	-$23,341,288	-$16,364,940	-$3,206,105	-$414,098	152,293	99,041	14,696	4,899
2013	-$25,150,030	-$17,741,486	-$3,485,822	-$498,479	157,376	103,046	15,472	5,157
2014	-$26,594,244	-$18,923,492	-$3,733,793	-$569,980	161,764	106,679	16,170	5,390
2015	-$27,896,570	-$20,074,417	-$3,965,762	-$636,078	165,881	110,253	16,849	5,616
2016	-$28,873,590	-$21,127,050	-$4,167,421	-$691,882	169,378	113,547	17,439	5,813
2017	-$30,179,402	-$22,081,837	-$4,339,946	-$739,936	172,685	116,654	17,971	5,990
2018	-$30,926,862	-$22,919,209	-$4,489,002	-$777,928	175,744	119,537	18,454	6,151
2019	-$31,598,186	-$23,647,672	-$4,625,109	-$811,535	178,657	122,303	18,911	6,304
2020	-$32,224,521	-$24,402,163	-$4,756,986	-$839,465	181,485	125,027	19,347	6,449
Avg annu	$2,938,105	-$555,012	-$978,840	$305,149	92,778	61,737	9,143	3,048
1998 NPV	$178,383,838	$86,208,247	$2,422,260	$7,548,741	731,836	485,071	70,101	23,367

Cost Effectiveness

$/Mg	$244	$178	$35	$323
$/US Ton	$268	$195	$38	$355

Individual Vehicle Class Cost/Benefit Analysis

All Areas Analysis/Assumes Stage II Continues Indefinitely

	Costs				Benefits (Mg)			
	LDV	LDT	LHDGV	HHDGV	LDV	LDT	LHDGV	HHDGV
1998	$25,590,499	$14,905,483	$1,506,468	$775,978	5,577	3,285	390	130
1999	$50,017,291	$29,235,044	$2,954,790	$1,506,713	19,997	12,545	1,459	486
2000	$60,205,401	$35,173,758	$3,541,077	$1,791,902	39,541	26,095	3,032	1,011
2001	$55,965,925	$32,787,365	$3,289,495	$1,676,843	59,304	40,340	4,686	1,562
2002	$52,578,392	$30,496,949	$3,050,217	$1,578,845	78,192	54,194	6,286	2,095
2003	$25,396,338	$12,487,733	$1,473,202	$1,116,592	96,572	66,881	7,902	2,634
2004	$21,919,635	$10,482,465	$1,141,822	$1,018,068	114,135	78,154	9,566	3,189
2005	$18,575,215	$9,005,154	$886,846	$930,565	129,427	87,085	11,112	3,704
2006	$16,247,529	$7,965,550	$679,994	$855,228	142,332	94,235	12,469	4,156
2007	$14,261,994	$7,180,428	$514,483	$796,121	153,850	100,351	13,640	4,547
2008	$12,368,380	$6,477,467	$370,735	$752,936	164,996	106,132	14,685	4,895
2009	$10,445,585	$5,580,373	$199,811	$694,096	176,260	112,703	15,880	5,293
2010	$8,619,818	$4,566,130	-$14,208	$639,643	187,131	119,946	17,213	5,738
2011	$7,172,679	$3,552,789	-$221,552	$574,714	196,467	126,795	18,573	6,191
2012	$6,005,681	$2,720,406	-$382,249	$529,907	204,668	133,102	19,751	6,584
2013	$5,176,458	$2,115,602	-$512,925	$495,351	211,499	138,485	20,793	6,931
2014	$4,577,767	$1,633,677	-$626,759	$468,691	217,396	143,367	21,731	7,244
2015	$4,068,809	$1,171,383	-$728,397	$446,163	222,929	148,170	22,643	7,548
2016	$3,765,579	$753,529	-$816,530	$428,310	227,628	152,597	23,437	7,812
2017	$3,097,090	$397,478	-$886,946	$414,391	232,072	156,772	24,151	8,050
2018	$2,939,038	$115,590	-$943,089	$407,459	236,183	160,646	24,801	8,267
2019	$2,829,135	-$79,862	-$991,357	$403,217	240,098	164,363	25,415	8,472
2020	$2,747,683	-$309,400	-$1,039,518	$403,273	243,898	168,024	26,001	8,667
Avg annu	$18,024,866	$9,496,308	$541,105	$813,261	156,528	104,099	15,027	5,009
1998 NPV	$281,629,897	$154,657,742	$12,724,933	$10,992,891	1,399,027	928,770	129,665	43,222

Cost Effectiveness

$/Mg	$201	$167	$98	$254
$/US Ton	$221	$183	$108	$280

Individual Vehicle Class Cost/Benefit Analysis

Nonattainment Areas Analysis/Assumes Stage II Continues Indefinitely

	Costs				Benefits (Mg)			
	LDV	LDT	LHDGV	HHDGV	LDV	LDT	LHDGV	HHDGV
1998	$25,590,499	$14,905,483	$1,506,468	$775,978	1,506	887	105	35
1999	$50,017,291	$29,235,044	$2,954,790	$1,506,713	5,398	3,387	394	131
2000	$60,205,401	$35,173,758	$3,541,077	$1,791,902	10,675	7,045	819	273
2001	$55,965,925	$32,787,365	$3,289,495	$1,676,843	16,010	10,890	1,265	422
2002	$52,578,392	$30,496,949	$3,050,217	$1,578,845	21,109	14,630	1,697	566
2003	$25,396,338	$12,487,733	$1,473,202	$1,116,592	26,071	18,055	2,133	711
2004	$21,919,635	$10,482,465	$1,141,822	$1,018,068	30,812	21,099	2,582	861
2005	$18,575,215	$9,005,154	$886,846	$930,565	34,940	23,510	3,000	1,000
2006	$16,247,529	$7,965,550	$679,994	$855,228	38,424	25,440	3,366	1,122
2007	$14,261,994	$7,180,428	$514,483	$796,121	41,534	27,091	3,682	1,227
2008	$12,368,380	$6,477,467	$370,735	$752,936	44,543	28,652	3,964	1,321
2009	$10,445,585	$5,580,373	$199,811	$694,096	47,584	30,426	4,287	1,429
2010	$8,619,818	$4,566,130	-$14,208	$639,643	50,518	32,381	4,647	1,549
2011	$7,172,679	$3,552,789	-$221,552	$574,714	53,039	34,230	5,014	1,671
2012	$6,005,681	$2,720,406	-$382,249	$529,907	55,253	35,933	5,332	1,777
2013	$5,176,458	$2,115,602	-$512,925	$495,351	57,097	37,386	5,613	1,871
2014	$4,577,767	$1,633,677	-$626,759	$468,691	58,689	38,704	5,867	1,956
2015	$4,068,809	$1,171,383	-$728,397	$446,163	60,182	40,000	6,113	2,038
2016	$3,765,579	$753,529	-$816,530	$428,310	61,451	41,195	6,327	2,109
2017	$3,097,090	$397,478	-$886,946	$414,391	62,651	42,323	6,520	2,173
2018	$2,939,038	$115,590	-$943,089	$407,459	63,761	43,368	6,695	2,232
2019	$2,829,135	-$79,862	-$991,357	$403,217	64,818	44,372	6,861	2,287
2020	$2,747,683	-$309,400	-$1,039,518	$403,273	65,843	45,360	7,019	2,340
Avg annu	$18,024,866	$9,496,308	$541,105	$813,261	42,257	28,103	4,057	1,352
1998 NPV	$281,629,897	$154,657,742	$12,724,933	$10,992,891	377,685	250,733	35,005	11,668

Cost Effectiveness

$/Mg	$746	$617	$364	$942
$/US Ton	$820	$679	$400	$1,036

Appendix E: Supporting Data for Chapter 7

	All Vehicles NAA (stage II phaseout)		Trucks only NAA (Stage II phaseout)	
	costs	benefits	costs	benefits
1998	$42,778,428	2,533	$17,187,929	1,027
1999	$83,713,839	9,310	$33,696,548	3,912
2000	$100,712,137	18,811	$40,506,736	8,136
2001	$93,719,629	28,587	$37,753,703	12,577
2002	$87,704,402	38,002	$35,126,011	16,893
2003	$40,473,864	46,971	$15,077,527	20,900
2004	$34,561,991	55,354	$12,642,355	24,542
2005	$29,397,779	62,450	$10,822,564	27,509
2006	$25,748,301	68,353	$9,500,772	29,928
2007	$22,753,026	73,535	$8,491,032	32,001
2008	$19,969,519	78,480	$7,601,139	33,938
2009	$16,919,865	83,726	$6,474,280	36,142
2010	-$132,138,330	245,574	-$140,758,148	106,329
2011	-$134,871,083	258,966	-$142,043,762	112,775
2012	-$137,075,968	270,930	-$143,081,649	118,637
2013	-$138,675,227	281,052	-$143,851,685	123,676
2014	-$139,896,337	290,003	-$144,474,104	128,240
2015	-$140,991,755	298,599	-$145,060,564	132,718
2016	-$141,818,825	306,177	-$145,584,405	136,799
2017	-$142,927,701	313,300	-$146,024,790	140,615
2018	-$143,430,715	319,886	-$146,369,753	144,142
2019	-$143,788,582	326,175	-$146,617,716	147,518
2020	-$144,147,674	332,308	-$146,895,357	150,823
avg. annual	-$40,926,496	165,612	-$58,951,363	73,469
1998-2020 NPV (1998	-$25,934,265	1,288,384	-$307,564,162	569,300
1998-2020 $/Mg	-$20		-$540	
$/US Ton	-$22		-$594	