208283

U.S. Department
of Transportation

**National Highway
Traffic Safety
Administration**

Memorandum

DEPT. OF TRANSPORTATION DOCKETS

02 DEC 13 PM 3:49

NHTSA-02-11419-57

Subject: ACTION: Preliminary Economic Assessment
CAFE Standard for MY 2005-2007 Light Trucks

Date: DEC -8 2002

From: Rose McMurray
Rose McMurray
Associate Administrator
for Planning, Evaluation, and Budget

Reply to
Attn. of:

To: Docket
Ofc of [illegible] (OSM) Ea
Thru: Jacqueline Glassman
Chief Counsel

Please submit the attached "Preliminary Economic Assessment, Corporate Average Fuel Economy Standards for MY 2005-2007 Light Trucks, December 2002" to the appropriate docket.

Attachment

cc:
Associate Administrator for Rulemaking
Associate Administrator for Enforcement
Chief Counsel

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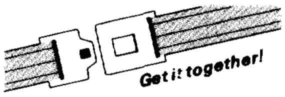
OFFICE OF CHIEF COUNSEL
2002 DEC 10 A 8:27



SAFETY BELTS SAVE LIVES

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PRELIMINARY ECONOMIC ASSESSMENT

CORPORATE AVERAGE FUEL ECONOMY STANDARDS FOR MY 2005-2007 LIGHT TRUCKS

Office of Regulatory Analysis and Evaluation
Plans and Policy
DECEMBER 2002

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EXECUTIVE SUMMARY

This assessment examines the costs and benefits of improving the fuel economy of light trucks for model years (MY) 2005-2007. It includes a discussion of the technologies that can improve fuel economy, the potential impact on light truck retail prices and lifetime discounted fuel savings, and the gallons of fuel that could be potentially saved. Based on data provided by some manufacturers to a request for comments, MY 2001 baseline data for manufacturers that did not respond to the request for comments with specific information, and analyses prepared by the National Academy of Sciences, the agency has examined each manufacturer individually and determined the manufacturers' capabilities and how they could meet the proposed standards. The agency projected very little reduction in performance and no reduction in weight compared to the manufacturer's plans.

Costs: Costs were estimated based on the specific technologies that were applied to improve each manufacturers' fuel economy up to the level of the proposed standard. Table 1 provides those cost estimates on an average per vehicle basis and Table 2 provides those estimates on a fleet-wide basis.

Benefits: Benefits are determined mainly from fuel savings over the lifetime of the vehicle. Table 1 also provides those estimates on a per vehicle basis and Table 2 provides them on a fleet-wide basis.

Net Benefits: Comparing the costs and benefits, the proposed fuel economy standards are cost beneficial on a societal basis.

Safety Impacts: The agency expects the manufacturers to meet the proposed fuel economy levels without weight reductions. Thus, there should not be a safety impact based on lowering weights for light trucks.

Table 3 provides the level of the proposed standards, an adjusted baseline weighted average fuel economy based on the manufacturers' product plans, and a weighted average fuel economy for the fleet after assuming increases in technology to bring the manufacturers average fuel economy up to the level of the standard. Some manufacturers already (in MY 2001) exceed the proposed standard levels, thus, the weighted average exceeds the proposed level. Finally, Table 3 shows the lifetime fuel savings in millions of gallons.

Table 1

Incremental Cost and Social Benefit Analysis
Per Vehicle - Over its Lifetime
(In Year 2000 Dollars)

	Costs	**Benefits**	**Net Benefits**
MY 2005	$14	$29	$15
MY 2006	$28	$66	$38
MY 2007	$47	$100	$53

Table 2

Incremental Total Cost Benefit Analysis
Over the Lifetime of the Fleet
(In Millions of Year 2000 Dollars)

	Costs	**Benefits**	**Net Benefits**
MY 2005	$108	$219	$111
MY 2006	$221	$513	$292
MY 2007	$373	$794	$421

Table 3
Savings in Millions of Gallons of Fuel

	Proposed Fuel Economy Standard (mpg)	**Adjusted Baseline Fuel Economy Level Pre-Standard (mpg)**	**Estimated Fuel Economy Level Post Standard (mpg)**	**Lifetime Fuel Savings (in Millions of Gallons) Undiscounted**	**Lifetime Fuel Savings Present Discounted Value**
MY 2005	21.0	21.21	21.35	361	207
MY 2006	21.6	21.49	21.82	893	480
MY 2007	22.2	21.83	22.35	1,293	740

I. INTRODUCTION

The purpose of this document is to analyze the effects of the proposed fuel economy standards for light trucks from MY 2005 to MY 2007. It includes a discussion of the technologies that can improve fuel economy, the potential impacts on light truck retail prices, lifetime discounted fuel savings, and the potential gallons of fuel saved. The standards apply to light trucks (pickups, vans, and sport utility vehicles) with a gross vehicle weight rating (GVWR) of 8,500 pounds or less.

Model Year (MY) 1979 was the first model year for which light truck fuel economy standards were established. Since that time the standards have slowly increased up to the level of 20.7 mpg. This level has remained in effect from MY 1996 to MY 2004. The agency was precluded by Congress from collecting information regarding potential changes in fuel economy standards from 1995 to December 2001 through a rider in DOT's annual appropriations act. This factor precluded the agency from performing the analysis required to set a standard other than 20.7 mpg. The Department of Transportation and Related Agencies Appropriations Act for FY 2002 (Public Law 107-87) was enacted on December 18, 2001, and does not contain a provision restricting the Secretary's authority to prescribe fuel economy standards. Thus, the ban on spending has been lifted and the agency is statutorily required to set fuel economy standards for light trucks.

The agency issued a final rule in December 2001, setting the CAFE standard applicable to light trucks for the 2004 MY at 20.7 mpg. The CAFE standard was the same as prior years due to the limited lead-time and data available.

In February 7, 2002 (67 FR 5767), the agency issued a Request for Comments, seeking data from which it could assess the viability of a reinvigorated CAFE program. The Request for Comments also sought comment on the recommendations arising from the National Academy of Sciences study[1] published in January 2002. The data provided by vehicle manufacturers in response to the Request for Comments and data from the NAS Report were used in developing the basis for the proposed levels.

The NAS report includes a substantial amount of information, including findings on past CAFE standards, analyses of future technology and their cost effectiveness, and recommendations for the future. These findings and recommendations are too numerous to summarize here. One of the reports findings (Finding #5) is that technologies exist for light trucks that would significantly reduce fuel consumption within 15 years. However, some of those technologies that can "significantly" improve fuel economy will not be available during the MY 2005 to MY 2007 time frame.

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[1] "Effectiveness and Impact of Corporate Average Fuel Economy (CAFE) Standards", National Research Council, 2002.

The proposed light truck fuel economy levels that will be analyzed in this Preliminary Economic Assessment are:

Table I-1
Proposed Fuel Economy Levels

	Miles per gallon
MY 2005	21.0
MY 2006	21.6
MY 2007	22.2

Throughout this document, confidential information is presented in brackets [ ].

II. NEED OF THE NATION TO CONSERVE ENERGY

Conserving energy, especially reducing the nation's dependence on petroleum, benefits the United States of America in several ways. Reducing total petroleum use and reducing petroleum imports decrease our economy's vulnerability to oil price shocks. Reducing dependence on oil imports from unstable regions enhances our energy security and can reduce the flow of oil profits to certain states now hostile to the U.S. Finally, conserving energy helps achieve the goal of decreasing our economy's greenhouse gas intensity, mitigating the potential risks of global climate change.

U.S. oil use has become increasingly concentrated in the transportation sector, the sector that has shown the least ability to substitute alternative energy sources for petroleum. In 1973, the U.S. transportation sector accounted for 51% of total U.S. petroleum use (8.4 of 16.5 million barrels per day (mmbd)). By 2001, transportation's share of U.S. oil use had increased to 69% (12.5 out of 18.1 mmbd) (USDOE/EIA, 2002a). Inadequacies in U.S. energy infrastructure have caused regional supply disruptions and price volatility. Domestic refining capacity has not kept pace with increases in demand, resulting in increased imports of petroleum products (NEPDG, 2001, ch. 7).

We believe that the continued development of advanced technology, such as fuel cell technology, and an infrastructure to support it, may help to achieve significant reductions in foreign oil dependence and stability in the world oil market. The continued infusion of hybrid propulsion vehicles and advanced diesels into the U.S. light truck fleet may also contribute to reduced dependence on petroleum. However, as noted above, these technologies are not likely to substantially infuse into the light truck market in the relative short term.

Trends and Outlook

The overall fuel efficiency of the new passenger car and light truck fleet remains approximately what it was in 1988. The increased market shareof light trucks, combined with the maintenance of the CAFE standards at the levels set for 1996, has led the combined average fuel economy of new light-duty vehicles to actually decline to 24.0 mpg in 2002 (Hellman and Heavenrich, 2001). Considering all light-duty vehicles on the road, average fuel economy has inched upward from 19.6 in 1991 to 20.1 in 2000, as the oldest, least efficient vehicles were retired. At the same time, vehicle travel increased at an average annual rate of 2.5% (Davis, 2002, table 6.5). By 2020, the Energy Information Administration projects that light duty vehicle travel will increase by an additional 50 percent over today's level. But light truck travel has been growing at a much faster rate of 4.9 percent per year, and light trucks are expected to dominate light-duty vehicle energy use in the future. When the Automotive Fuel Economy Standards were enacted in 1975, light trucks accounted for only 20 percent of light-duty vehicle energy use. Light trucks account for 40 percent today, and their share is projected to increase to 55 percent by 2020.

Increasing transportation oil consumption and declining domestic production have left the U.S. increasingly dependent on imported petroleum. Since 1985, U.S. net oil imports have grown from 4.3 million barrels per day (mmbd) to 10.1 mmbd. As a percent of U.S.

petroleum use, imports have also more than doubled: from 27% in 1985 to 55% in 2001, the highest level of import dependency in our history. Over the past two years our trade deficit in oil has averaged $100 billion per year.

Projections by the Energy Information Administration foresee further growth in U.S. import dependence and growing world dependence on OPEC oil producers.[1] By 2020, transportation petroleum use is projected to expand from 13.7 to 19.9 mmbd, accounting for 90% of the increase in total U.S. petroleum requirements. Light trucks alone are expected to account for almost half of the growth in transportation oil use over the next 20 years (USDOE/EIA, 2001b). From 2000 to 2020, total transportation petroleum use is projected to increase by 6.2 mmbd; light trucks are expected to account for 2.9 mmbd of this increase.

The Importance of Passenger Car and Light Truck Fuel Economy

Reducing petroleum use by light-duty vehicles is an important part of any comprehensive program to address the nation's dependence on foreign oil and meet our energy challenges. Transportation is the predominant petroleum consumer in the U.S. economy. The transportation sector alone requires 50% more oil than the U.S. produces, and because transportation consumes nearly all the high-value light products (motor gasoline and distillates) that drive the market, its economic importance is even greater than these statistics imply. Furthermore, transportation is 97% dependent on petroleum for energy (USDOE/EIA, 2001a). Within the transportation sector, passenger cars and light trucks (the

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[1] According to DOE's Transportation Energy Data Book, page I-9, net imports of petroleum have been steadily increasing, while OPEC's share of net imports has remained around 50% for the past 5-6 years. For the same time period, the Transportation Energy Data Book also shows that the net Persian Gulf share has been increasing from 19% to over 25%.

vehicles covered by fuel economy standards) account for almost 60% of petroleum consumption.

Increases in the fuel economy of new vehicles eventually raise the mpg of all vehicles, as older cars and trucks are scrapped. A nearly complete turnover of the light-duty vehicle stock requires about 15 years. Increasing fuel economy without increasing the price of fuel will lead to some additional vehicle travel, but this has been found to be a relatively minor effect. It is estimated that increasing fuel economy by 10% will produce an 8% to 9% reduction in fuel use (Greene, Kahn and Gibson, 1999).

Past fuel economy increases have had a major impact on U.S. petroleum use. The National Research Council determined that if fuel economy had not improved since the 1970s, U.S. gasoline consumption and oil imports would be about 2.8 million barrels per day higher than they are today (NRC, 2002, p.3).

Past reductions in U.S. petroleum consumption, similar reductions by other nations and increased non-OPEC oil supply helped to reduce U.S. oil imports and put downward pressure on world oil prices. From 1950 to 1973, U.S. consumption of petroleum products increased in every year, at an average annual rate of over 4%. From 1973 to 1985, U.S. petroleum consumption decreased from 17.3 to 15.7 mmbd and net imports of petroleum decreased from 6.0 mmbd to 4.3 mmbd. Petroleum conservation by the U.S. over this period played a major role in the collapse of oil prices in 1986, and the years of relatively low prices that ensued.

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III. IMPACT OF OTHER FEDERAL MOTOR VEHICLE STANDARDS ON LTV FUEL ECONOMY

Introduction

The Act requires that fuel economy standards be set at the maximum feasible level after taking into account the following criteria: technological feasibility, economic practicability, the impact of other Federal Motor Vehicle Standards on fuel economy, and the need of the Nation to conserve energy. This section discusses the effects of other government regulations on model year (MY) 2005-2007 light truck fuel economy.

Baseline weights

The average test weight (curb weight plus 300 pounds) of the light truck fleet in MY 2001 was 4,501 pounds. The average test weight for General Motors, Ford, and DaimlerChrysler light trucks subject to the standard for MY 2001 was 4,627 pounds. The average weight for these three manufacturers for MY 2007 is [ ] pounds. Thus, overall, the three largest manufacturers of light trucks expect weight to increase slightly over the time period. The change in weight includes all factors, such as changes in the fleet mix of vehicles, required safety improvements, voluntary safety improvements, and other changes for marketing purposes.

Weight Impacts of Required Safety Standards

The National Highway Traffic Safety Administration (NHTSA) has issued a number of proposed and final rules on safety standards that are proposed to be effective or are effective between the MY 2001 baseline and MY 2007. These have been analyzed for their potential impact on light truck fuel economy weights for MY 2005-2007:

1. FMVSS 138, tire pressure monitoring system (Final Rule)
2. FMVSS 139, tire upgrade (Proposed)
3. FMVSS 201, occupant protection in interior impact (Final Rule)
4. FMVSS 202, head restraints (Proposed)
5. FMVSS 208, occupant crash protection (Final Rule)
6. FMVSS 225, child restraint anchorage systems (Final Rule)
7. FMVSS 301, fuel system integrity (Proposed)

FMVSS 138, tire pressure monitoring system

As required by the Transportation Recall Enhancement, Accountability, and Documentation (TREAD) Act, NHTSA is requiring a Tire Pressure Monitoring System (TPMS) be installed in all passenger cars, multipurpose passenger vehicles, trucks and buses that have a Gross Vehicle Weight Rating of 10,000 pounds or less, effective in November 2003. We estimate the weight that would be added consists of electrical parts that would not weigh more than half a pound (0.23 kilograms or less).

FMVSS 139, tire upgrade

The Transportation Recall Enhancement, Accountability, and Documentation Act of 2000 mandated a rulemaking proceeding to revise and update our safety performance requirements for tires. A Preliminary Economic Assessment of the proposed tire upgrade indicated there would be added cost for the improved tires but no increased weight.

FMVSS 201, occupant protection in interior impact.

This standard specifies requirements to afford protection for occupants from impacts with interior parts of the vehicle. The new amendment relates to upper pillars, front and rear headers, the side roof rails and other upper interior parts. It applies to passenger cars and to multipurpose vehicles, trucks, and buses with a GVWR of 10,000 pounds (4,536 kilograms) or less. Additional padding could be added or pillars could be redesigned to pass the upgraded standard. We estimate the average weight gain would be 7.5 pounds (3.4 kilograms) for the light trucks affected by this fuel economy proposal.

FMVSS 202, head restraints.

This proposed regulation would improve front seat head restraints in passenger cars, pickups, vans, and utility vehicles and require head restraints in the rear outboard positions. Because many pickup trucks and some vans do not have back seats, the average weight increase for this standard is lower than for automobiles. We estimate the average weight gain across light trucks would be 4.3 pounds (1.94 kilograms).

FMVSS 208, occupant crash protection.

This rule amends our occupant crash protection standard to require that future air bags be designed to create less risk of serious air bag-induced injuries than current air bags, particularly for small women and young children; and provide improved frontal crash protection for all occupants, by means that include advanced air bag technology. Additional weight would come from sensors, switches, indicators, and associated electrical equipment. We estimate the average weight gain would be 3.4 pounds (1.54 kilograms).

FMVSS 225, child restraint anchorage systems.

The Final Economic Assessment (February 1999) for FMVSS 213 and 225 estimates the additional weight for improved anchorages would be less than 1 pound (0.45 kilogram).

FMVSS 301, fuel system integrity.

This proposal would amend the testing standards for rear end crashes and resulting fuel leaks Many vehicles already pass the more stringent standards, and those affected are not likely to be pick-up trucks or vans. It is estimated that weight added will be only light-weight items such as a flexible filler neck. We estimate the average weight gain across this vehicle class would be 0.24 pounds (0.11 kilograms).

The next two tables summarize estimates made by NHTSA and the truck manufacturers regarding the weight added to institute these standards between MY 2001 and MY 2007. Table III-1 presents the actions that are required of the manufacturers by changes in the safety standards. Table III-2 presents voluntary actions planned by the manufacturers, which do not have to be considered in setting the fuel economy standards. As is true in other sections of this report, figures in [ ] are confidential.

Table III-1
Weight additions due to required FMVSS regulations

Source of Estimates	**FMVSS 138 TPMS**	**FMVSS 139 tire upgrade**	**FMVSS 201 int., protection**	**FMVSS 202 head restraint**	**FMVSS 208 crash protect'n**	**FMVSS 225 restraint anchr.**	**FMVSS 301 fuel system**
NHTSA	**0.5 pounds**	**None**	**7.5 pounds**	**4.3 pounds**	**1.59 pounds**	**< 1.0 pound**	**0.25 pounds**
Daimler-Chrysler			[ ] pounds, CAFE impact nothing.	Mentioned[1] but no specific weight given.	[ ] pounds, CAFE impact [ ].	Mentioned[1] but no specific weight given.	Mentioned[1] but no specific weight given.
General Motors			[ ] pounds		[ ] pounds	[ ] pound	
Ford			[ ] pounds, CAFE impact [ ].		Mentioned[2] but no specific weight given.		
Honda	"Not possible to predict."						
Toyota	"In MY 2005 we expect about a [ ] FE penalty due to increased weight associated with safety features."						
Nissan	No figures given.						

[1] DaimlerChrysler estimated [ ] pounds, with a CAFE impact of [ ] mpg. This figure includes weight increases from many regulations lumped together: 225, 202, 301 (which will be in place around Model Year 2005-07), Offset Frontal Protection, Improved Door Latch Integrity, and Dynamic Roof Crush (which may not be in place). The [ ] pounds shown for FMVSS 208 must include some type of structural upgrade, which might occur with an offset frontal protection rule, but in our opinion would not be part of the advanced air bag rule.

[2] Ford made a weight estimate of [ ] pounds which included strengthening to improve FMVSS 208 protection, NCAP, and offset frontal protection.

Table III-2
Weight additions due to voluntary safety improvements

Vehicle Manufacturer	**Antilock Brakes**	**Side/Head Impact Air Bags**	**Reduce Rollover**	**Lap/shoulder belt in center rear seat**	**Improve ratings in NCAP and offset crash tests.**
DaimlerChrysler					[ ] pounds[4]
General Motors	[ ]	[ ] pounds		[ ] pounds	[ ] pounds[3]
Ford[2]	[ ] pounds	[6] pounds	[ ] pounds		[ ] pounds[2]
Honda					
Toyota	"In MY 2005 we expect about a [ ] F(uel) E(conomy) penalty due to increased weight associated with safety features."				
Nissan	No figures given				

[2] See footnote 2 from Table III-1.

[3] In their response to "question 8" of the information request, GM states the overall addition will be [ ] pounds for a full-sized truck or [ ] pounds for a full-sized van, with an effect of [ ] mpg or [ ] mpg.

[4] Includes Frontal NCAP, Side NCAP, Rollover Ratings, Offset Frontal Protection, Head Restraint Ratings, and Bumper Performance.

NHTSA's estimates come from Preliminary and Final Regulatory Evaluations for the respective standards. Estimates from the vehicle manufacturers come from NHTSA's requests for information and are confidential. The Japanese manufacturers gave either no information or very generalized information. Information from other manufacturers was sometimes specific but often combined several categories.

Honda stated that they would be able to minimize additional weight due to Federal safety requirements if they were given sufficient lead time. Toyota's entire response is given in the tables above. Nissan discussed known issues in fuel economy trade-offs without offering any specific or new information. DaimlerChrysler estimates that FMVSS 208 changes will add [ ] pounds on the average, for a CAFE impact of [ ] mpg. This effect will hold steady between

2005 and 2010. They estimate that FMVSS 201 will add [ ] pounds on the average, for a minimal CAFE impact. General Motors gave specific information on weights for various parts, all of which were safety related, but most of which were not required for the standards. Ford estimates that changes to FMVSS 208 (occupant crash protection) will add [ ] pounds, for a CAFE impact of [ ] mpg. Much of this may be due to strengthening to improve NCAP and frontal-offset crash ratings and is shown in the right hand column of Table III-2.

In summary, NHTSA estimates that weight additions required by FMVSS regulations that will be effective between the MY 2001 fleet and MY 2007 fleet to average about 17 pounds[1]. The agency has not used weight reduction as one of the technologies available to improve fuel economy. The agency has taken the manufacturer's predicted weights for MY 2005-2007 and made no changes in them. Thus, whatever assumptions the manufacturers have made for weight increases due to new safety standard requirements, or whatever voluntary safety improvements the manufacturers are planning, can occur without the manufacturers being penalized by having to reduce weight to meet a fuel economy standard.

The Impact of Emission Standards

1. Tier II Requirements

On February 10, 2000, the Environmental Protection Agency (EPA) published a final rule (65 FR 6698) establishing new federal emissions standards for passenger cars and light trucks. These new emissions standards, known as Tier 2 standards, are designed to focus on reducing the emissions most responsible for the ozone and particulate matter (PM) impact from these vehicles - nitrogen oxides (NO[ ]) and non-methane organic gases (NMOG), consisting primarily of hydrocarbons (HC) and contributing to ambient volatile organic compounds (VOC). For new passenger cars and light trucks, rated at less than 6000 pounds GVWR, the Tier 2 standards phase-in beginning in 2004, and are to be fully phased-in by 2007.

During the phase-in period from 2004-2007, all passenger cars and light trucks not certified to the primary Tier 2 standards must meet an interim standard equivalent to the current National Low Emission Vehicle NLEV standards for light duty vehicles. In addition to establishing new emissions standards for vehicles, the Tier 2 standards also establish standards for the sulfur content of gasoline.

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[1] This figure is determined by adding together the NHTSA estimated weights for the standards from Table III-1 with the exception of using [3.4 pounds from GM for FMVSS 208 and 1 pound for FMVSS 225] from the manufacturers confidential estimates.

When issuing the Tier 2 standards, EPA responded to comments regarding the Tier 2 standard and its impact on CAFE by indicating that it believed that the Tier 2 standards would not have an adverse effect on fuel economy.

2. Onboard Vapor Recovery

On April 6, 1994, EPA published a final rule (59 FR 16262) controlling vehicle-refueling emissions through the use of onboard refueling vapor recovery (ORVR) vehicle-based systems. These requirements applied to light-duty vehicles beginning in the 1998 model year, and phased- in over three model years. The ORVR requirements also apply to light-duty trucks with a GVWR of 6,000 pounds or less beginning in model year 2001 and phasing-in over three model years. For light-duty trucks with a GVWR of 6,001-8,500 lbs, the ORVR requirements first apply in the 2004 model year and phase-in over three model years.

The ORVR requirements impose a weight penalty on vehicles as they necessitate the installation of vapor recovery canisters and associated tubing and hardware. However, the operation of the ORVR system results in fuel vapors being made available to the engine for combustion while the vehicle is being operated. As these vapors provide an additional source of energy that would otherwise be lost to the atmosphere through evaporation, the ORVR requirements do not have a negative impact on fuel economy.

3. Supplemental Federal Test Procedure

On October 26, 1996, EPA issued a final rule (61 FR 54852) revising the tailpipe emission portions of the Federal Test Procedure (FTP) for light-duty vehicles (LDVs) and light-duty trucks (LDTs). The revision created a Supplement Federal Test Procedure (SFTP) designed to address shortcomings with the existing FTP in the representation of aggressive (high speed and/or high acceleration) driving behavior, rapid speed fluctuations, driving behavior following startup, and use of air conditioning. The SFTP also contains requirements designed to more accurately reflect real road forces on the test dynamometer. EPA chose to apply the SFTP requirements to trucks through a phase-in. Light-duty trucks with a gross vehicle weight rating (GVWR) up to 6,000 lbs were subject to a three-year phase-in ending in the 2002 model year. Heavy light-duty trucks, those with a GVWR greater than 6,000 lbs but not greater than 8,500 lbs, are subject to a phase-in schedule in which 40 percent of each manufacturer's production must meet the SFTP requirements in the 2002 model year, 80 percent in 2003, and 100 percent in the 2004 model year.

The 2004 model year represents the final phase-in year for light trucks subject to CAFE standards. Neither Ford nor GM indicated in their comments to the MY 2004 NPRM that the SFTP would have any impact on their ability to meet the proposed 2004 standard.

4. In their comments, DaimlerChrysler claimed that changes in the EPA test procedure would have a negative effect on the fuel economy values for light trucks.

NHTSA has, from time-to-time, included the effects of EPA's changes to the test procedures when setting CAFE standards for light trucks. However, in this case, EPA has determined that the net effect on fuel economy for the recent test procedure changes is near zero. Consequently there is no need to adjust the CAFE standards for these test procedure changes.

EPA's decision was based on the joint recommendation of the Alliance and AIAM that the net effect of all the test procedure changes was near zero and that "no adjustment" was appropriate[2]. EPA considered the effects of four test changes: single-roll electric dynamometer with full-speed load simulation, elimination of the 10% air conditioning load factor, elimination of the 5,500 maximum test weight for cars, and improved test equipment. While some changes decreased measured fuel economy, others raised it; with the net result of a near zero effect. This decision was based on the total fleet which is a mix of front wheel drive and rear wheel drive cars and trucks.

Considering trucks alone is not likely to change that decision. Trucks, as a sub-class, have a larger mix of rear wheel drive vehicles than the combined fleet. This would lead to slightly increased effect of the single roll dynamometer and thereby slightly lower measured fuel economy. However, the truck sub-class also has higher road load horsepower than the combined fleet. This would lead to slightly higher effects due to the elimination of the 10% air conditioning load and thereby slightly higher measured fuel economy. The net effect of the combined test procedure changes on the truck sub-class is still expected to be near zero.

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[2] EPA discussed the rationale for a net zero adjustment in an August 21, 2000 letter from Margo Oge to the Alliance and AIAM. A copy of the letter has been placed in the docket.

4. California Air Resources Board LEV II

The State of California Low Emission Vehicle II regulations (LEV II) will apply to passenger cars and light trucks in the 2004 model year. The LEV II amendments restructure the light-duty truck category so that trucks with gross vehicle weight rating of 8,500 pounds or lower are subject to the same low-emission vehicle standards as passenger cars. LEV II requirements also include more stringent emission standards for passenger car and light-duty truck LEVs and ultra low emission vehicles (ULEVs), and establish a four-year phase-in requirement that begins in 2004.

The agency notes that compliance with increased emission requirements is most often achieved through more sophisticated combustion management. The improvements and refinement in engine controls to achieve this end generally improve fuel efficiency and have a positive impact on fuel economy.

In summary, the agency believes there will be no impact from emissions standards on light truck fuel economy between the baseline MY 2001 and MY 2007 fleets.

IV. FUEL EFFICIENCY ENHANCING TECHNOLOGIES

Available Technologies

A variety of vehicle technologies could conceivably be applied in many potential combinations to increase the fuel economy of light trucks. In response to a Congressional directive in the FY 2001 DOT Appropriations Act, the National Academy of Sciences (NAS) recently completed a review of fuel economy standards. This review included an examination of technologies that could be used to increase the fuel economy of new light duty vehicles. The NAS did not discuss all possible technologies, but rather a list of about two-dozen specific technologies and groups of technologies. The NAS report has received extensive external review, and is considered to be a reasonably diverse and complete documentation on a range of technologies.

NHTSA's February 7, 2002 notice in the Federal Register requested comments on, among other things, the technologies included in this NAS report. Many respondents to NHTSA's Federal Register notice have provided estimates of the cost and efficiency characteristics of the same specific technologies. Some manufacturers indicated that the NAS approach to estimating the combined effects of multiple technologies was flawed because the report used a multiplicative approach to combining estimated fuel consumption reductions rather than performing system-level analysis. These manufacturers stated that the multiplicative approach could lead to fuel consumption reduction estimates that exceed theoretical limits, because energy losses of each specific type—in particular pumping losses—cannot be reduced by more than 100 percent. On the other hand, the Union of Concerned Scientists (UCS) indicated that the multiplicative approach used for the NAS study tended to underestimate fuel consumption reductions from specific technologies, compared to those using a system analysis approach developed by UCS.

The remainder of this section summarizes the nature of each technology considered, key findings of the NAS report, major related comments submitted in response to the NHTSA Federal Register notice, and resultant expectations applied here as the basis for projecting potential responses to changes in fuel economy standards. This chapter discusses the ranges of fuel economy in movements and costs for each technology. A summary of the estimates discussed in this chapter can be found in Table V-3. The pessimistic and optimistic footnotes in Table V-3 present a range, while the "expected" estimates is NHTSA's best judgment after assessing all of the available information. Methods for applying these expectations are presented in a later section.

Engine Technologies

Reduction of Engine Friction Losses

The amount of energy an engine loses to friction can be reduced in a variety of ways. Examples include low-tension piston rings, roller cam followers, and piston surface treatments, as well as lubricant friction reduction. The NAS report predicted that such technologies could reduce fuel consumption by 1 percent to 5 percent at a retail price equivalent (RPE) cost of $35 to $140. However, even without any changes to fuel economy standards, most MY 2005-2007 light trucks are likely to employ one or more such techniques, and manufacturers indicated smaller potential fuel consumption reductions. On the other hand, further incremental reductions of engine friction and other mechanical and hydrodynamic losses will likely remain available. Considering all of the information, our judgment is that fuel consumption reductions of 0.5 to 2.0 percent appear likely to be available at a RPE cost of $10 to $100.

Low-Friction Lubricants

The use of lower viscosity engine and transmission lubricants can reduce fuel consumption. The NAS report projected that low-friction lubricants could reduce fuel consumption by 1 percent at a RPE cost of $8 to $11. However, even without any changes to fuel economy standards, most MY 2005-2007 light trucks are likely to use 5W-30 motor oil, and some will use even less viscous oils, such as 5W-20 or possibly even 0W-20. Most manufacturers therefore attributed smaller potential fuel economy reductions and cost increases to lubricant improvements. For light trucks that would otherwise use 5W-30, our judgment is that incremental fuel consumption reductions of 0.3 to 1.0 percent appear likely to be available at a RPE cost of $1 to $10.

Multi-valve Overhead Camshaft Engine

Without changes to fuel economy standards, it appears likely that many MY 2005-2007 light trucks would use overhead valve (OHV) engines with pushrods and one intake and one exhaust valve per cylinder. Engines with overhead cams (OHC) and more than two valves per cylinder achieve increased airflow at high engine speeds and reduction of the valvetrain's moving mass and enable central positioning of spark plugs. Such engines, which are already used in some light trucks, typically develop higher power at high engine speeds. The NAS report projected that multi-valve OHC engines could reduce fuel consumption by 2 percent to 5 percent at a RPE cost of $105 to $140. However, some of this reduction is attributed to engine downsizing that would reduce available torque at low engine speeds. For multi-valve OHC engines, manufacturers provided fuel consumption reduction estimates that were similar and cost estimates that were more divergent. For light trucks that would otherwise use 2V OHV engines, our judgment is that incremental fuel consumption reductions of 2.0 to 3.5 percent appear likely to be available at a RPE cost of $105 to $500.

Variable Valve Timing

Some light trucks currently use variable valve timing (VVT), which is a system that provides for some optimization of valve opening and closing over the engine's operating region. VVT reduces pumping losses when the engine is lightly loaded by positioning the valve at the optimum position needed to sustain horsepower and torque. VVT can also improve thermal efficiency at higher engine speeds and loads. The NAS report projected that VVT could reduce fuel consumption by 2.0 to 3.0 percent at a RPE cost of $35 to $140. Manufacturers estimated considerably lower potential benefits, in part because of increases in engine friction, as well as theoretical limits on the amount of fuel consumption reduction that can be attributed to pumping loss reduction. Our judgment is that incremental fuel consumption reductions of 0.5 to 2.0 percent appear likely to be available at a RPE cost of $75 to $150.

Variable Valve Lift and Timing

Some light trucks use engines for which both valve timing and lift can be at least partially optimized based on engine operating conditions. Engines with variable valve timing and lift (VVLT) can achieve further reductions in pumping losses and further increases in thermal efficiency. The NAS report projected that VVLT could reduce fuel consumption by 1.0 to 2.0 percent over VVT alone at a RPE cost of $70 to 210. Some manufacturers estimated considerably higher significant potential fuel consumption reductions. However, manufacturers also estimated that VVLT would add costs somewhat higher than the range projected by the NAS. Our judgment is that incremental fuel consumption reductions of 1.0 to 2.5 percent appear likely to be available at a RPE cost of $150 to $350.

Cylinder Deactivation

For the vast majority of light trucks, each cylinder is always active while the engine is running. Under partial load conditions, the engine's specific fuel consumption could be reduced if some cylinders could be disabled, such that the active cylinders operate at higher load. Thus an eight-cylinder engine could disable four cylinders under light loads, such as when the vehicle is cruising at highway speed. This technology could be applied to four and six cylinder engines as well. Without changes to fuel economy standards, it appears that some light trucks would begin using cylinder deactivation by MY 2005 (also referred to as variable displacement or displacement-on-demand). The NAS report projected that cylinder deactivation could reduce fuel consumption by 3.0 to 6.0 percent at a RPE cost of $112 to $252. However, some manufacturers estimated considerably lower potential incremental fuel consumption improvements, in part because of theoretical limits on the amount of fuel consumption reduction that can be attributed to pumping loss reduction. Most manufacturers estimated that the application of cylinder deactivation would be much more expensive than the range projected by the NAS. Our judgment is that incremental fuel consumption reductions of 1.0 to 4.0 percent appear likely to be available at a RPE cost of $150 to $450.

Direct Injection Spark Ignition

With direct fuel injection, spark ignition engines can utilize well-controlled lean mixtures, resulting in higher thermodynamic efficiency. This technology yields 10 percent or more improvement in fuel consumption in European applications. Some passenger cars sold in Europe and in Japan use this technology. However, the more stringent NOx and particulate emissions standards in the U.S. limit the improvement to 6 percent. The NAS report had no cost estimate for the technology. Two manufacturers commented on it, estimating similar fuel consumption gains. Only one provided cost information ([ ]). Our judgment is that incremental fuel consumption gains of 2.0 to 4.0 percent are likely.

Direct Injection Diesel Engines

Direct injection (DI) diesel engines with turbochargers are widely used in Europe in light duty vehicles. These applications yield a fuel consumption improvement of 30 to 40 percent over two-valve spark ignition engines. As with direct injection spark ignition engines, NOx and particulate standards may be difficult to meet. DI diesels are currently offered in the U.S. on Volkswagen passenger cars and on Ford and DaimlerChrysler light trucks of over 8,500 lb GVWR. NAS suggests a RPE cost of $2,000 to $3,000 for this technology. One manufacturer provided a similar cost.

Engine Accessory Improvement

Internal combustion engines rely on a number of accessory components, such as coolant, oil, and power steering fluid pumps. Incremental improvements to such components could help to reduce overall fuel consumption. Further reductions could be achieved by replacing mechanically driven accessories with electrically powered counterparts. However, the potential for such replacement will be greater for vehicles with 42-Volt electrical systems. The NAS report projected that engine accessory improvement could reduce fuel consumption by 1.0 to 2.0 percent at a RPE cost of $84 to $112. Assuming incremental improvements to engine accessories, our judgment is that incremental fuel consumption reductions of 0.5 to 2.0 percent appear likely to be available at a RPE cost of $5 to $50, which is below the NAS-estimated range.

Engine Downsizing and Supercharging

The specific power of a naturally aspirated engine is limited, in part, by the rate at which the engine is able to draw air into the combustion chambers. By increasing the pressure differential between the atmosphere and the charging cylinders, superchargers and turbochargers increase this available airflow, and thereby the engine's specific power. Like other technologies that increase specific power, superchargers and turbochargers make it possible to reduce engine size while maintaining performance. Assuming such engine downsizing, the NAS report projected that supercharging could reduce fuel consumption by 5.0 to 7.0 percent at a RPE cost of $350 to $560. Some manufacturers estimated considerably lower available fuel consumption reductions, in part because of theoretical limits on the amount of fuel consumption reduction that can be attributed to pumping loss reduction. Most manufacturers estimated that supercharging and downsizing would entail considerably greater incremental cost penalties. Our judgment is that incremental fuel consumption reductions of 0.0 to 6.0 percent appear likely to be available at a RPE cost of $350 to $700.

Intake Valve Throttling

VVLT engines reducing pumping losses and increase thermal efficiency by providing some optimization of valve timing and lift. Intake valve throttling (IVT) would use more complex systems of sensors, electronic controls, and variable valve lifts to enable further optimization of valve timing and lift. The NAS report estimates that IVT engines could achieve a 3.0 to 6.0 percent reduction in fuel consumption at a RPE cost of $210 to $420 when compared to VVLT. Some manufacturers estimated much lower potential fuel consumption reductions when IVT is compared to VVLT. However, the same manufacturers also estimated that IVT would entail somewhat lower incremental costs. Our judgment is that incremental fuel consumption reductions of 0.5 to 3.0 percent appear likely to be available at a RPE cost of $110 to $400.

Camless Valve Actuation

When electromechanical actuators are used to replace cams and coupled with sensors and microprocessor controls, valve timing and lift can be optimized over all conditions. This level of control can enable even further incremental reductions in fuel consumption. The NAS report projected that camless valve actuation could reduce fuel consumption by 5.0 to 10.0 percent over VVLT at a RPE cost of $280 to $560. Although some manufacturers provided similar cost estimates for camless valve actuation, the same manufacturers estimated much smaller potential fuel consumption reductions when camless valve actuation is considered as an incremental improvement over IVT. Our judgment is that incremental fuel consumption reductions of 1.0 to 4.5 percent appear likely to be available at a RPE cost of $350 to $500.

Variable Compression Ratio

A spark-ignited engine's specific power is limited by the engine's compression ratio, which is, in turn, currently limited by engine's susceptibility to knock, particularly under high load conditions. Engines with variable compression ratio (VCR) could provide for higher compression ratios, and therefore greater efficiency, under partial load conditions. The NAS report projected that VCR could reduce fuel consumption by 2.0 to 6.0 percent over 4-valve VVT at a RPE cost of $210 to $490. Manufacturer estimates for VCR were approximately similar to those provided by NAS. Our judgment is that incremental fuel consumption reductions of 2.0 to 6.0 percent appear likely to be available at a RPE cost of $250 to $350.

Transmission Technologies

Five- and Six-Speed Automatic Transmissions

The number of available transmission speeds influences the width of gear ratio spacing and overall coverage and, therefore, the degree of transmission ratio optimization available under different operating conditions. In general, transmissions can offer a greater available degree of optimization and can therefore achieve higher fuel economy when the number of gears is increased. However, potential gains may be reduced by increases in transmission weight and rotating mass. Without changes in fuel economy standards, it appears that some trucks would use 5- or 6-speed transmissions. The NAS report projected that a 5-speed automatic transmission could reduce fuel consumption by 2.0 to 3.0 percent at a RPE cost of $70 to $154 (relative to a 4-speed automatic transmission), and that a 6-speed automatic transmission could further reduce fuel consumption by 1.0 to 2.0 percent at a RPE cost of $140 to $280.

Some manufacturers estimated slightly higher available fuel consumption reductions, and others estimated lower potential values based on increases in rotating mass as well as theoretical limits on the amount of reduction that can be attributed to pumping losses. Manufacturer cost estimates covered a considerably broader range than suggested by the NAS, particularly for 5-speed transmissions.

For upgrades of automatic transmissions from 4 to 5 speeds, our judgment is that incremental fuel consumption reductions of 0.5 to 3.0 percent appear likely to be available at a RPE cost of $75 to $300. For a further increase to 6 speeds, our judgment is that incremental fuel consumption reductions of 0.0 to 2.5 percent appear likely to be available at a RPE cost of $50 to $300.

Aggressive Shift Logic

Automatic transmission energy losses are lower when torque converter lock-up (if available) is engaged. Through partial lock-up under some operating conditions and early lock-up under others—that is, aggressive shift logic—automatic transmissions can achieve some reduction in overall fuel consumption. The NAS report projected that aggressive shift logic could reduce fuel consumption by 1.0 to 3.0 percent at a RPE cost of $0 to $70. The only manufacturer to provide detailed comments on aggressive shift logic indicated that this technology is [ ].

The same manufacturer provided cost estimates [ ].c Our judgment is that incremental fuel consumption reductions of 0.0 to 2.0 percent appear likely to be available at a RPE cost of $20 to $70.

Continuously Variable Transmission

Unlike manual and automatic transmissions with fixed transmission ratios, continuously variable transmissions (CVTs) provide, within their operating ranges, fully variable transmission ratios. This enables even finer optimization of the transmission ratio under different operating conditions and, therefore, some reduction of pumping and engine friction losses. Compared to 5-speed transmissions, the NAS report projected that CVTs could reduce fuel consumption by 4.0 to 8.0 percent at a RPE cost of $140 to $350. The NAS report also projected that torque requirements would limit the near-term applicability of CVTs to compact light trucks (less than or equal to 4,250 lbs. GVWR), but that higher-torque "advanced" CVTs could eventually further reduce fuel consumption by 0.0 to 2.0 percent at a RPE cost of $350 to $840.

Most manufacturers projected similar potential fuel consumption reductions for "conventional" CVTs. However, two manufacturers provided considerably lower estimates, citing the relative internal inefficiency of CVTs and theoretical limits on the amount of reduction that can be attributed to pumping losses. One manufacturer estimated much higher potential fuel consumption reductions for "advanced" CVTs, one agreed with the NAS report estimates, and one suggested that although "advanced" CVTs might increase CVT penetration rate, they would not achieve further fuel consumption reductions. Most manufacturer cost estimates for "conventional" CVTs were considerably higher than the range in the NAS report. Although only two manufacturers commented on the incremental cost of "advanced" CVTs, both of these manufacturers provided estimates significantly lower than in the NAS report.

For "conventional" CVTs, our judgment is that incremental fuel consumption reductions of 3.5 to 7.5 percent appear likely to be available at a RPE cost of $225 to $500.

Automatically Shifted Clutch Transmission

Unlike current manual transmissions, which drive through a positive clutch and gears, current automatic transmissions use hydraulic torque converters in place of the cutch, which are less mechanically efficient. Adding automatic electronic controls to a clutch transmission yields an "automatic shift manual transmission," or more precisely, an automatically shifted clutch transmission. The NAS report projected that such transmissions could reduce fuel consumption by 3.0 to 5.0 percent at a RPE cost of $70 to $280. Manufacturers who commented on this technology provided similar estimates of potential fuel consumption reductions, but widely divergent cost estimates. Our judgment is that incremental fuel consumption reductions of 2.0 to 5.0 percent appear likely to be available at a RPE cost of $0 to $350.

Vehicle Technologies

Aerodynamic Drag Reduction

A vehicle's size and shape determine the amount of power needed to push the vehicle through the air at different speeds. Changes in vehicle shape or frontal area can therefore reduce fuel consumption. For example, many modern freight tractors use fairings and somewhat rounded forward profiles to reduce aerodynamic drag at highway speeds. The NAS report projected that further reductions in light truck aerodynamic drag could reduce fuel consumption by 1.0 to 2.0 percent at a RPE cost of $0 to $140. Manufacturers provided similar estimates of available fuel consumption reductions and potential cost, but also suggested that these reductions could be limited by functional requirements and basic design characteristics of some light trucks. Our judgment is that incremental fuel consumption reductions of 0.5 to 2.0 percent appear likely to be available at a RPE cost of $0 to $150.

Rolling Resistance Reduction

Tire characteristics (e.g., materials, construction, tread design) influence durability, recycling costs, vehicle handling and comfort. They also influence rolling resistance and, therefore, fuel consumption. The NAS report projected that vehicles using tires with lower rolling resistance could achieve fuel consumption reductions of 1.0 to 1.5 percent at a RPE cost of $14 to $56. Manufacturer estimates of available incremental fuel consumption reductions and potential cost increases were considerably lower, in part because of the extent to which rolling resistance reductions have already been adopted. Our judgment is that incremental fuel consumption reductions of 0.0 to 1.0 percent appear likely to be available at a RPE cost of $0 to $30.

Forty-Two Volt Electrical System

Light trucks currently use 12 V electrical systems. At higher voltages, which appear to be under consideration to meet expected increases in on-board electrical demands, the power density of motors, solenoids, and other electrical components increases to the point that new and more efficient systems, such as electric power steering, may be feasible. The NAS report projected that 42 V electrical systems could reduce fuel consumption by 1.0 to 2.0 percent at a RPE cost of

$70 to $280. Two manufacturers estimated somewhat lower costs, and one manufacturer indicated much higher costs. However, because 42 V systems enable, but do not themselves yield fuel consumption reductions, three manufacturers estimated that 42 V systems would have little or no direct impact on fuel consumption. Assuming that 42 V systems might be accompanied by some further reductions in engine accessory loads, our judgment is that incremental fuel consumption reductions of 0.0 to 1.0 percent appear likely to be available at a RPE cost of $60 to $200.

Integrated Starter/Generator

In a vehicle with a 42 V electrical system, the alternator and starter could be integrated into one component that is powerful enough to quickly restart an idle engine, enabling the engine to be turned off while the vehicle is stopped (with the air conditioner off). Given sufficient battery capacity, an integrated starter/generator (ISG) could recapture some braking energy and provide some initial acceleration (i.e., launch). The NAS report projected that ISGs could reduce fuel consumption by 4.0 to 7.0 percent at a RPE cost of $210 to $350. Two manufacturers estimated that ISGs could achieve fuel consumption reductions in this range. However, because of theoretical limits on the extent to which further fuel consumption reductions can be attributed to reductions in pumping losses (at idle), one manufacturer estimated much lower available incremental fuel consumption reductions for ISGs. All responding manufacturers provided considerably higher incremental cost estimates for ISGs. Our judgment is that incremental fuel consumption reductions of 1.0 to 5.5 percent appear likely to be available at a RPE cost of $400 to $650.

Electric Power Steering

As mentioned above, in a vehicle with a 42 V electrical system, it may be feasible to replace a hydraulic power steering system that consumes energy even under straight-line driving conditions with a more efficient electric power steering system that only consumes energy when required to meet steering loads. The NAS report projected that electric power steering could reduce fuel consumption by 1.5 to 2.5 percent at a RPE cost of $105 to $150. Manufacturer estimates of available fuel consumption reductions were somewhat lower, although one manufacturer indicated that electric power steering would not likely be able to meet truck power requirements. Manufacturer cost estimates covered a somewhat wider range. Our judgment is that incremental fuel consumption reductions of 1.0 to 2.0 percent appear likely to be available at a RPE cost of $70 to $200.

Hybrid-Electric Vehicles

Hybrid-electric vehicles may be designed in several configurations. Generally, they will include electric motors, regenerative braking, integrated starter/generators, launch assist, and battery storage for regenerated energy. Depending on the sophistication of the system, the NAS report estimated a fuel consumption improvement of 15 to 30 percent at a RPE cost $3,000 to $5,000 for a "mild" hybrid, which does not utilize an electric motor to propel the vehicle. Honda is currently selling two "mild" hybrid passenger cars in the U.S., the Insight and a version of the Civic. Toyota is selling the Prius, which uses Toyota's Integrated Hybrid System and utilizes an electric motor in addition to all the components of a "mild" hybrid. In the Prius, the electric motor is used for vehicle propulsion at low speeds (under 15 mph) and to provide additional acceleration at highway speeds. GM (full-size pickups), Ford (Escape) and DaimlerChrysler

(Ram 1500, Durango) have announced plans or have shown prototype hybrid light trucks. These are believed to be "mild" hybrids. As noted above, the fuel consumption improvement and cost depends on the extent of the hybridization. Manufacturers provided ranges for fuel consumption improvements and cost for systems that are not necessarily comparable. The manufacturers' estimates range above and below the NAS estimate.

Effect of Weight and Performance Reductions on Light Truck Fuel Economy

Although the Agency's analysis includes the possibility that manufacturers may limit growth in horsepower/weight ratios, we believe that manufacturers will meet the proposed CAFE levels without any meaningful deviation from the planned performance and weight of their vehicles Additionally, we do not expect any manufacturers to engage in any meaningful type of mix shifting to meet these standards, other than those already being planned. The Agency's analysis does not include any CAFE gains through weight reduction not currently planned by manufacturers. Under this approach our CAFE standards will not adversely affect motor vehicle safety. However, we invite comments on this approach. Commenters are asked to provide data and analysis of the safety consequences if the Agency were to, in the final rule, include in its analysis the possibility of weight reduction to achieve additional fuel economy improvements. We did a small sensitivity analysis on the effects of weight and performance and ask for comments on the following analysis.

Weight Reduction

The term weight reduction encompasses a variety of techniques with a variety of costs and lead times. These include downsizing, material substitution, component redesign, and alternate configurations. Downsizing reduces the weight and vehicle size, such as overhang, width, or height, and may result in a cost savings. Material substitution involves using lower density materials in vehicle components, such as replacing steel parts with aluminum or plastic. Lead-time varies with application, and the new components may be more costly. Component redesign is an on-going process to reduce costs and/or weight of components, while improving performance and reliability. Alternate configurations include such things as unit bodies, and front-wheel drive designs. Alternate configurations are not always suitable for the load requirements or after-market body installations of light trucks and also require major vehicle redesigns.

Although not a technology for weight reduction, the model mix of the light truck fleet can affect its average weight. The shifting of the light truck fleet mix to different size and configurations has been significant in recent years. (See Table IV-1.) The popularity of compact vans and pickups and standard vans has diminished in favor of SUVs of all sizes. However, the total share of standard size vehicles has increased only slightly, but with a significant increase in average fleet weight.

Table IV-1
Light Truck Model Sales Mix (percent)

MY	Compact Vans	Standard Vans	Compact Pickups	Standard Pickups	Compact SUVs	Standard SUVs	Avg.Test Wt., lb.
1995	19.9	8.8	17.5	22.2	26.1	5.5	4338
2001	14.3	2.6	12.9	22.7	33.1	14.4	4501

The NAS report projected a fuel consumption reduction of 3 to 4 percent for each 5 percent weight reduction (while maintaining the same acceleration performance) at a RPE cost of $210 to $350. Some manufacturers projected lower fuel consumption improvements, apparently on the basis that the engines are sized for loaded vehicle performance and would not be reduced in size if vehicle weight were reduced. Cost estimates ranged on both sides of the NAS estimate. The cost of reducing weight is difficult to determine and is dependent upon the methods used For example, a change in design that reduces weight on a new model may or may not save money. On the other hand, material substitution can result in an increase in price per application of the technology if more expensive materials are used. For example, weight can be reduced by using more expensive aluminum body parts instead of steel.

Performance Reduction

Performance reduction is more of a technique than a technology. However, many of the fuel economy technologies that have been introduced into vehicles over the past 20 years have been at least partially employed to improve vehicle acceleration or other performance characteristics, rather than to increase fuel efficiency. There is often a trade-off between performance and fuel economy. A 10 percent reduction in engine horsepower to equivalent test weight ratio (with no change in overall drivetrain gearing) will result in about 2 percent reduction in fuel consumption and a 10 percent increase in 0-60 mph acceleration time for the average MY 2001 light truck. Small reductions in performance can be achieved with little engineering cost impact by reducing the overall drivetrain gear ratio. Larger reductions would entail reducing the size or performance of the engine. All of these tradeoffs necessarily involve costs to the extent that reduced engine size or performance reduces the value of the vehicle to the consumer. NHTSA has not attempted to value these performance reductions at this stage. We plan to do so in the event (and to the extent) that such tradeoffs will result from the final rule.

The agency examined the impact of some weight and performance reductions on light truck fuel economy as a sensitivity analysis. All of the estimates below were based on the MY 2005 GM fleet, since GM projects a relatively low average fuel economy, a full line of vehicles, and provided enough detailed information to make the estimates. Several scenarios were examined. These calculations are hypothetical in that it is likely not practical to achieve the changes in either weight or performance level in the lead time remaining before these vehicles go into production. They do show the relative magnitude of these types of changes in fleet characteristics, however.

1. Performance

If the value of the average engine horsepower times average N/V[1] divided by average test weight (HP*N/V /TWT)--a representation of vehicle performance that considers vehicle weight and gearing--for the GM projected MY 2005 fleet is returned to the MY 2001 level, the MY 2005 CAFE would increase by <u>0.67 mpg</u>.

In this case, the power density of GM engines would increase from 0.72 hp/cubic inch displacement in MY 2001, when the entire light truck fleet averaged 0.81 hp/cubic inch, to 0.91 hp/cubic inch in MY 2005.

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[1] N/V = Revolutions per minute (RPM) at top gear/mph. The lower the number the better.

Although returning the performance of GM's light truck fleet to MY 2001 levels can cause a significant increase to their MY 2005 projected CAFE level, the probability of GM being able to achieve the changes in either weight or performance level in the lead time remaining before these vehicles go into production is very small. The vast majority of GM's MY 2005 light truck designs are locked in.

2. Average Weight Reduction of 100 lbs on Entire Fleet

On average, a 10 percent reduction in weight results in a 3 percent fuel economy improvement if performance is not returned to the original level. On average, a 10 percent reduction in weight results in a 6 percent fuel economy improvement if performance is returned to the original level. If the entire MY 2005 fleet of GM light trucks was reduced in weight by 100 lbs and the performance of the fleet was not returned to the original level by reducing engine size, engine power, or gearing, the CAFE would increase by <u>0.12 mpg</u>.

If the performance were restored to the original level for MY 2005, CAFE would increase by <u>0.25 mpg</u>.

V. MANUFACTURER SPECIFIC CAFE CAPABILITIES

On February 7, 2002, NHTSA issued a Federal Register notice requesting information—including detailed information regarding manufacturer product plans—to assist the agency in developing a proposal regarding CAFE standards for some or all of model years 2005 to 2010. Manufacturers accounting for most light trucks sold in the U.S. provided information for MY 2005 to 2007, however significantly less specific information was provided for MY 2008 to 2010. For the remaining light truck manufacturers, we utilized information from a NHTSA database for the 2001 model year. We also made selective use of industry trade publications (*e.g.*, *Ward's Automotive*) to obtain some information regarding the technical characteristics (*e.g.*, gross vehicle weight rating, cylinder counts) of some light trucks in the 2001 model year

Table V-1 shows the market share assumed for the analysis for each of the manufacturers and it shows the MY 2001 CAFE levels for each of the manufacturers. In addition, it shows our estimates of the fuel economy levels for each manufacturer for MY 2005, MY 2006, and MY 2007 under three different assumptions. The first set of estimates show what we believe the manufacturers' fuel economy would be without them having any knowledge of the proposed fuel economy standards, and without taking into account fuel economy adjustments for alternative fueled vehicles. In other words, what would be their planned level of fuel economy, not counting alternative fueled vehicles, knowing that there will be CAFE standards, but not knowing what those fuel economy levels will be. Specific CAFE estimates were only provided by DaimlerChrysler, Ford, and GM. Some manufacturers provided pieces of information, but not an overall CAFE. In some cases we estimate that their CAFE will decline from the MY 2001 level because of new model introductions or market shifts. Other manufacturers provided no information, and their fuel economy was assumed to remain level at the MY 2001 level. Further information is requested from the manufacturers.

The second set of estimates is our baseline fuel economy levels for the analysis (called the **ADJUSTED BASELINE** throughout the analysis). These levels are the same as the numbers in the top part of Table V-1 for each manufacturer, except that we assumed for the analysis that each manufacturer below the current standard level of 20.7 mpg would apply technology to achieve 20.7 mpg[1]. Only the fleet average is shown in Table V-1, since each manufacturer's estimate is the same except that those below 20.7 mpg are raised up to 20.7 mpg. Our rationale for this adjustment of the baseline is that the costs and benefits of achieving 20.7 mpg have already been analyzed and estimated in previous analyses. The methodology in this analysis is to apply technologies to the manufacturers plans and get them up to 20.7 mpg. The costs of these technologies are estimated, but they are not considered part of this rule. We then estimate the costs and benefits of going from the adjusted baseline to the level of the standard (some manufacturers are above the level of the standard already and are assumed to remain at that level, and some technologies are applied to all models of a particular manufacturer so that the exact level for each manufacturer may be slightly higher than the level of the standard and costs and benefits are estimated to that level).

For the third set of estimates, the agency looked at each company individually, and determined their potential company CAFE by applying technologies that are available to the company, but

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were not being used in the company's plans. We analyzed their submissions to determine what technologies are planned for introduction in each model year, and determined what technologies were not being used but could be used. Finally, in a few instances we assumed a small fuel economy benefit for restricting the use of 6.0 liter or larger engines, and assumed smaller engines already available in the fleet would be used.

Our analysis of the potential effects of alternative CAFE standards was founded on two major elements: (1) projections of the technical characteristics and sales volumes of future product offerings and (2) estimates of the applicability and incremental cost and fuel savings associated with different hardware changes—technologies—that might be utilized in response to alternative CAFE standards.

The agency did not consider wholesale performance reductions or weight reductions. However, the manufacturers can choose to use these and/or any other approaches to get to the level of the standard. Another option available to the manufacturer is to pay CAFE fines, rather than make the investments to improve fuel economy.

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[1] Note that a manufacturer could be complying with the current standard of 20.7 mpg by using alternative fueled vehicles, but their average mpg in this analysis will not reflect that because the analysis must be done without considering alternative fueled vehicles impacts, since they are part of an incentive program.

Table V-1
Estimated Fuel Economy Levels*

Estimated mpg Before Standards are Known

	Sales %	**MY 2001**	**MY 2005 Estimate**	**MY 2006 Estimate**	**MY 2007 Estimate**
BMW	0.73	19.2	19.26	19.26	19.26
DC	24.57	19.9	21.24	21.53	22.24
Ford	27.54	20.3	20.89	21.64	22.08
GM	25.52	20	20.08	20.16	20.89
Honda	3.48	24.9	25.62	25.62	25.62
Hyundai	0.65	25.2	25.02	25.02	25.02
Isuzu	1.82	21.1	21.12	21.12	21.12
Kia	0.8	22.9	22.92	22.92	22.92
Nissan	5.2	20.7	20.69	20.69	20.69
Suzuki	0.63	22	22.01	22.01	22.01
Toyota	8.93	22.1	22.12	22.12	22.12
VW	0.14	20.5	20.46	20.46	20.46
Average		20.5	21.06	21.32	21.81
Adjusted Baseline	Assuming 20.7 Minimum mpg		21.21	21.49	21.83

Estimated mpg After Standards with Technology

	Sales %		**MY 2005 Estimate**	**MY 2006 Estimate**	**MY 2007 Estimate**
BMW	0.73		21.95	21.95	22.69
DC	24.57		21.24	21.60	22.24
Ford	27.54		21.02	21.64	22.20
GM	25.52		21.01	21.60	22.20
Honda	3.48		25.62	25.62	25.62
Hyundai	0.65		25.02	25.02	25.02
Isuzu	1.82		21.12	21.61	22.20
Kia	0.8		22.92	22.92	22.92
Nissan	5.2		21.00	21.65	22.31
Suzuki	0.63		22.01	22.01	22.21
Toyota	8.93		22.12	22.13	22.20
VW	0.14		21.16	22.20	22.28
Average			21.35	21.82	22.35
Proposed Standard Level			21	21.6	22.2

* All of the fuel economy estimates exclude the impacts of alternative fuel credits.

Sales Projections

Taken together, the sales projections provided by the individual companies to NHTSA yielded unrealistically high industry-wide light truck sales volumes (*e.g.*, more than nine million units in 2007). Therefore, we assumed that (1) overall sales volumes would match projections in the Department of Energy, Energy Information Administration (EIA's) Annual Energy Outlook 2002, (2) each manufacturer's share of the overall light truck market would match that manufacturer's share of the market for light trucks in the 2001 model year (as shown in Table V-1), and (3) as a share of the total projected light truck sales for each manufacturer, sales projections for each truckline would be the same as provided in response to NHTSA's *Federal Register* notice (or, for manufacturers who did not provide data requested in this notice, mid-year estimates for the 2001 model year).

Table V-2
Projected Sales

Model Year	Millions of vehicles
2005	7.654
2006	7.795
2007	7.921

Technology Assumptions –

Potential retail price equivalent (RPE) and fuel consumption impacts of different technologies are discussed in Chapter IV. Within the range of values anticipated for each technology, we selected RPE and fuel consumption impacts considered most plausible during the model years under consideration. These expected impacts are summarized in Table V-3, which also presents our expectations regarding the year in which technology might be available for widespread application to light trucks:

Table V-3

Expected Fuel Consumption and Cost (RPE) Impacts and Availability of Technologies

	FC (gpm)			Cost			Availability		
Technology	pessimistic	expected	optimistic	optimistic	expected	pessimistic	optimistic	expected	pessimistic
Production-Intent Engine Technology									
Engine Friction Reduction	0.5%	1.5%	2.0%	$10	$35	$100	2005	2005	2005
Low Friction Lubricants	0.3%	0.5%	1.0%	$1	$3	$10	2005	2005	2005
Multi-Valve, Overhead Camshaft	2.0%	2.5%	3.5%	$50	$232	$500	2005	2005	2007
Variable Valve Timing	0.5%	1.0%	2.0%	$75	$89	$150	2005	2005	2007
Variable Valve Lift & Timing	1.0%	2.0%	2.5%	$150	$222	$350	2005	2005	2005
Cylinder Deactivation	1.0%	3.5%	4.0%	$150	$221	$450	2005	2005	2008
Engine Accessory Improvement	0.5%	1.0%	2.0%	$5	$20	$50	2005	2005	2007
Engine Supercharging & Downsizing	0.0%	4.5%	6.0%	$350	$560	$700	2005	2005	2007
Production-Intent Transmission Technology									
5-Speed Automatic Transmission	0.5%	2.0%	3.0%	$75	$154	$300	2005	2005	2005
Continuously Variable Transmission	3.5%	5.0%	7.5%	$225	$398	$500	2005	2005	2005
Automatic Transmission w/ Aggressive Shift Logic	0.0%	0.5%	2.0%	$20	$35	$70	2005	2005	2007
6-Speed Automatic Transmission	0.0%	2.0%	3.0%	$20	$140	$200	2005	2005	2008
Production-Intent Vehicle Technology									
Aero Drag Reduction	0.5%	1.5%	2.0%	$0	$45	$150	2005	2005	2008
Improve Rolling Resistance	0.0%	0.5%	1.0%	$0	$11	$30	2005	2005	2005
Emerging Engine Technology									
Intake Valve Throttling	0.5%	1.0%	3.0%	$110	$315	$400	2005	2008	2011
Camless Valve Actuation	1.0%	2.0%	4.5%	$350	$420	$500	2008	2008	2011
Variable Compression Ratio	2.0%	3.5%	6.0%	$260	$300	$350	2008	2008	2011
Emerging Transmission Technology									
Automatic Shift Manual Transmission (AST/AMT)	2.0%	3.0%	5.0%	$0	$175	$350	2007	2007	2011
Advanced CVTs	0.0%	1.0%	2.5%	$130	$195	$240	2008	2008	2011
Emerging Vehicle Technology									
42 Volt Electrical Systems	0.0%	0.5%	1.0%	$60	$150	$200	2005	2005	2005
Integrated Starter/Generator	1.0%	4.5%	5.5%	$400	$534	$650	2005	2005	2005
Electric Power Steering	1.0%	2.0%	2.0%	$70	$150	$200	2005	2005	2008
Vehicle Weight Reduction									

These estimates represent incremental changes if a technology is applied to a truckline to which other technologies have already been applied. Thus, for example, changing from VVT to VVLT would be expected to reduce a truck's fuel consumption rate by 2.0% at an incremental cost penalty of $222.

We used the cost per percent improvement from Table VI-1 to determine the sequence that a manufacturer might follow when deciding which technologies to apply. Table V-4 presents this "application path". It provides the technologies in the order in which we chose them to be implemented into the vehicle fleet. First, we examined those technologies that are available in

MY 2005 and ranked them. Cost per percent improvement could not be used for every case, because some technologies are a prerequisite for other technologies. A five speed automatic transmission would probably be introduced before a six speed automatic transmission. A 42 Volt Electrical System is necessary for an integrated starter/generator, and a multi-valve, overhead camshaft is required before variable valve timing, which is required before variable valve lift and timing. Variable valve lift and timing (VVLT) is considered as a potential incremental improvement beyond (and, in this case, replacement for) variable valve timing (VVT). Weight reduction was not applied to any manufacturer's fleet.

We also applied a few explicit technical constraints on the applicability of some technologies When considering low-friction lubricants, we assumed that all light trucks will rely on 5W-30 or, where indicated by manufacturers, 5W-20 even if the CAFE standard remains at 20.7 MPG. For engines that would otherwise rely on 5W-20, we reduced the expected available reduction in fuel consumption by half. We assumed that cylinder deactivation would be not be applied to engines with fewer than eight cylinders. We assumed that several technologies, including multivalve OHC, VVT, VVLT, supercharging and downsizing, intake valve throttling, camless valve actuation, variable compression ratio, would only apply to gasoline engines. We assumed that transmission improvements, 42 Volt electrical systems, and integrated starter/generators would not be available as improvements to hybrid electric vehicles (HEVs).

Table V-4

Technology Application Path[2]

	Technology	Year Available	Cost per Percent Improvement
1	Low friction lubricants	2005	$6
2	Engine Accessory Improvement	2005	$20
3	Improve Rolling Resistance	2005	$22
4	Engine Friction Reduction	2005	$23
5	Aero Drag Reduction	2005	$30
6	Automatic Shift Manual Transmission (AST/AMT)	2007	$58
7	Cylinder Deactivation	2005	$63
8	Electric Power Steering	2005	$75
9	5-speed Automatic Transmission	2005	$77
10	6-speed Automatic Transmission	2005	$70
11	Automatic Transmission with Aggressive Shift Logic	2005	$70
12	Continuously Variable Transmission	2005	$80
13	Multi-valve overhead camshaft	2005	$93
14	Variable Valve Timing	2005	$89
15	Variable Valve Lift and Timing	2005	$111
16	Engine Supercharging and Downsizing	2005	$124
17	42 Volt Electrical Systems	2005	$300
18	Integrated Starter/Generator	2005	$119
?	Weight Reduction	2005	?
	Variable Compression Ratio	2008	$86
	Advanced CVT's	2008	$195
	Camless Valve Actuation	2008	$210
	Intake Valve Throttling	2008	$315

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[2] The technology application path does not always go from cheapest to most expensive technology. Some technologies are dependent upon other technologies and must come later. In other cases, the technologies follow a natural progression before introduction, a 5 speed comes before a 6 speed automatic transmission.

Technology Assumptions for DaimlerChrysler, Ford and GM

This section discusses various technologies that could be used to improve DaimlerChrysler, Ford, and GM's automotive fuel efficiency. These manufacturers have the largest share of the light truck market and offer a full line of vehicles. Some of these cited technologies have been used for over a decade, e.g., OHC, engine friction reduction, and low friction lubricants. Some have only recently been produced on passenger cars, e.g., 5-speed and 6-speed automatic transmissions and variable valve timing. Some have been under development for a number of years but have not been produced in quantity for an extended period, e.g., cylinder deactivation, variable valve lift and timing, continuously variable transmission (CVT), integrated starter generator and hybrid drivetrains.

The analysis used by NHTSA is not a rigid methodology to achieve these levels of fuel economy improvement. For instance, NHTSA estimates that replacing an overhead valve engine with a multi-valve overhead camshaft engine of the same displacement and replacing a 4-speed automatic transmission with a 5- or 6-speed automatic transmission offer about the same potential level of improvement. One of them may be more attractive to a particular manufacturer because of its cost, ease of manufacturing, or the model lines to which it would apply. Also, this analysis does not include the many minor types of improvements in electronic controls and engine valving changes that could result in further fuel economy gains because it is difficult to precisely determine which of these technologies have been included in the models that manufacturers plan to produce in MY 2005-2007.

The analysis is divided into three stages: a more conservative application of technologies which are deemed to be available for use by MY 2005 which would not require significant changes in transmission and/or engine technology (Stage I); a more aggressive application of transmission and/or engine technology - classified as Production-Intent by the recent NAS study – which is added on top of those applied to the first stage to develop the upper end of the range (Stage II); and a reallocation of the sales of models with 6.0L or larger engines to those of almost identical models equipped with 5.3L or larger engines (Stage III).

The Stage I analysis includes technologies that manufacturers state as being available for use by MY 2005 or earlier, but they are choosing not to use them in their product plans.

The Stage II analysis includes two major categories of technological improvements to the manufacturers fleets, tied as nearly as possible to planned model change and engine introduction years. The first of the categories is transmission improvements, which consists of the introduction of 5-speed and 6-speed transmissions in vehicle classes larger than compact pickup trucks and compact SUVs, and the introduction of CVTs in the compact pickup truck and compact SUV class. Replacing a 4-speed automatic transmission with a 5-speed or 6-speed transmission was estimated to yield a 3 percent fuel economy improvement, while replacing a 4-speed automatic transmission with a CVT estimated to yield a 6 percent fuel economy improvement.

The second category was engine improvements, and consists of gradually upgrading all light truck engines to include multi-valve overhead camshafts, introducing engines with more than 2-

valves per cylinder, applying variable valve timing or variable valve lift and timing to multi-valve overhead camshaft engines, and the introduction of integrated starter/generators. Considering that the individual benefits of some of these technology introductions may not be additive, replacing an overhead valve engine with multi-valve overhead camshafts was estimated to yield a 3 percent fuel economy improvement, using 3 or more valves on an existing overhead cam engine was estimated to yield a 2 percent fuel economy improvement, applying variable valve lift and timing to multi-valve overhead camshaft engines was estimated to yield an additional 2 percent fuel economy improvement, and the application of integrated starter/generators to existing engines was estimated to yield a 4 percent fuel economy improvement.

The Stage III analysis includes projections of the potential CAFE increase that could result from moving the sales of vehicles equipped with 6.0L or larger engines to almost identical models equipped with 5.3L or larger engines.

DaimlerChrysler

(a) Stage I and Stage II

In their submission, DaimlerChrysler described a variety of technologies that could be used to increase vehicle fuel economy. Each technology described included its estimated fuel economy benefit, the basis for the estimated fuel economy, the baseline technology it is measured against, when the technology would be available for use, its potential applications, where it is currently employed in DaimlerChrysler's light truck fleets, where the technology could potentially be used, and potential reasons that limit the implementation rate of the technology. NHTSA found that DaimlerChrysler has utilized an extensive amount of technology across its fleet. This use of technology results in DaimlerChrysler having an estimated CAFE value for MY 2005-2007 that either meets or exceeds those of Ford and GM. Thus, NHTSA is not recommending the use of additional technology in either Stage I or Stage II.

(b) Stage III

The Stage III analysis includes projections of the potential CAFE increase that could result from moving the sales of vehicles equipped with 6.0L or larger engines to almost identical models equipped with 5.3L or larger engines. DaimlerChrysler projects the sales of [ ] models with a 6.1 L engine as being [ ] in MY [ ] and [ ] in MY [ ]. This engine is not offered on any other light truck, although it probably will be offered on Ram 2500 pickups. NHTSA believes that the [ ] models equipped with the 6.1 L engines could be replaced with 5.7 L engines and that this replacement would not degrade the cargo and towing capacity of these vehicles.

The potential improvements to the DaimlerChrysler light truck CAFE are summarized in the following table. These improvements are very small, and due to rounding, do not change the levels that DaimlerChrysler provided in their docket submission (see Table V-1).

Table V-5
DaimlerChrysler Potential Technology
CAFE Improvements, mpg

Model Year	Baseline Mpg	Stage I Improvements	Stage II Improvements	Stage III Improvements	Total	Potential CAFE, mpg
2005	[					21.3
2006						21.6
2007					]	22.2

Ford

(a) Stage I

In their submission, Ford described a variety of technologies that could be used to increase vehicle fuel economy. For each technology described, Ford included its estimated fuel economy benefit, the basis for that estimate, the baseline technology it is measured against, when the technology would be available for use, its potential applications, where it is currently employed in Ford's light truck fleets, where the technology could potentially be used, and potential reasons that limit the implementation rate of the technology.

To determine which Stage I technologies Ford could employ, on which vehicles and/or engines they could be employed, and when they could be employed, NHTSA relied heavily on the Ford-provided descriptions. Our analysis showed that Ford could employ one technology by MY 2005 [ ], with an additional technology employed by MY 2007 [ ]. NHTSA used the Ford provided numbers for percentage increase in fuel economy in calculating the possible fuel economy increase attributable to each of these technologies.

Starting with MY 2005, Ford could use [ ], on all of its models that could utilize passenger car-like tires. This includes all Ford Escapes, Explorers, Rangers, Windstars; all Mercury Escapes and Mountaineers; all Lincoln Aviators; all Mazda B-Series pickups, MPVs and Tributes; and all Land Rover Freelanders. We did not carry over the benefits for this technology to further years due to the fact that Ford is redesigning many of these vehicles in MY [ ] and is believed to have accounted for the inclusion of [ ] in its fuel economy estimates.

Starting with MY [ ], Ford could use a [ ] on all of its models with 5.4 L engines.

The effect of these technology changes is summarized in the following table.

Table V-6
Ford Light Truck Stage I Improvements

MY	[ ]	[ ]	**Total mpg**
2005	.082	0	.082
2006	0	0	0
2007	0	.023	.023

A new Stage II analysis was performed for Ford

(b) Stage II

To determine which Stage II technologies Ford could employ, on which vehicles and/or engines they could be employed, and when they could be employed, NHTSA relied on its own engineering judgement and submissions from other manufacturers. In looking at these submissions, together with what Ford provided, NHTSA has analyzed which Stage II technologies could be applied to Ford's light truck fleet for MYs 2005-2007. Our analysis showed that by MY 2007, Ford could offer two technologies two years early, one of which requires the use of an additional complimentary technology, with all technologies carrying over into future model years. Our analysis also showed that instead of introducing one of its technologies two years early, that Ford could double the use of one technology by MY 2007.

It is possible that Ford could equip all of its 4.6 L F150 pickups with a [ ] by MY [ ]. Ford currently projects equipping all of their 4.6 L F150 pickups with a [ ] by MY [ ]. However, the specific [ ] that is projected to be on the 4.6 L F150 pickups by MY [ ], is projected to be included on the MY [ ] Ford Explorers and Mercury Mountaineers, and on the MY [ ] Ford Rangers, Ford Expeditions, and [ ].

Additionally, it is possible that Ford could offer [ ] on half of the F150 pickups equipped with a 5.4 L engine. Ford projects [ ] being introduced by MY [ ] on [ ] of its fleet. [ ] will be available on DCX' s and GM's large engines by MY 2005. According to Ford, [ ] will be offered in tandem with a [ ]. Thus, the same vehicles could be equipped with [ ].

The improvements discussed above for Stage II are summarized for the Ford light truck fleet in the following table.

Table V-7

[WHOLE TABLE CONFIDENTIAL
Ford Light Truck Stage II Engine Improvements

Model Year	Affected Vehicles	Technologies	Percent Improvement	CAFE Impr., mpg
	[ ]			
	[ ]			
	[ ]			

]

(c) Stage III

The Stage III analysis includes projections of the potential CAFE increase that could result from moving the sales of vehicles equipped with 6.0L or larger engines to almost identical models equipped with 5.3L or larger engines. Ford does not project the use of any engine larger than a [ ] engine. Thus, there are no potential CAFE increases resulting from Stage III.

The potential improvements to the Ford light truck CAFE are summarized in the following table. Due to rounding, the individual improvements may not equal the potential CAFE for Ford.

Table V-8

Potential Ford CAFE Improvements, mpg

Model Year	**Baseline Mpg**	**Stage I Improvements**	**Stage II Improvements**	**Stage III Improvements**	**Total**	**Potential CAFE, mpg.**
2005	[					20.98
2006						21.6
2007					]	22.2

GM

(a) Stage I

In their submission GM described a variety of technologies that could be used to increase vehicle fuel economy. Each technology described included its estimated fuel economy benefit, the basis for that estimate, whether the benefit was direct or interactive, a description of how the technology works and how it increases fuel economy, when the technology would be available for use, its potential applications, where it is currently employed in GM's light truck fleets, where the technology could potentially be used, risks in employing the technology, and potential impacts on NVH, safety, emissions, cargo and towing capacity.

To determine which Stage I technologies GM could employ, on which vehicles and/or engines they could be employed, and when they could be employed, NHTSA relied heavily on the GM-provided descriptions. Our analysis showed that GM could employ five technologies by MY 2005 with an additional three technologies employed by MY 2006. The five technologies would carryover to MY 2006-2007, while the additional three technologies available for MY 2006 would carryover to MY 2007. NHTSA used the GM provided numbers for percentage increase in fuel economy in calculating the possible fuel economy increase attributable to each of these technologies.

Starting with MY [ ], GM could use [ ]. GM could also utilize[ ] on all engines, except the 2.2L and 4.2L engines, which already employed [ ]. Additionally, GM could include [ ] on all [ ] models [ ].

Starting with MY [ ], GM could employ [ ] and a [ ] on all S/T trucks and SUVs, all C/K trucks and SUVs and all G vans. Additionally, GM could include [ ].

The Stage I improvements to the GM light truck CAFE are summarized in the following table

Table V-9
GM Stage I Technology CAFE Improvements, mpg

MY	[						]	Total mpg
2005	.099	.099	.199	.041	.001			.439
2006	.100	.100	.201	.041	.009	.342	.143	.936
2007	.104	.104	.208	.043	.010	.319	.133	.921

(b) Stage II

To determine which Stage II technologies GM could employ, on which vehicles and/or engines they could be employed, and when they could be employed, NHTSA relied on its own engineering judgment and submissions from other manufacturers. In looking at these submissions, together with what GM provided, NHTSA has analyzed which Stage II technologies could be applied to GM's light truck fleet for MYs 2005-2007. Our analysis showed that GM could employ two technologies by MY 2005, and an additional technology by MY 2006. One of the technologies introduced in MY 2005 would only carry over into MY 2006, because the vehicles that could use this technology are being redesigned in MY 2007, and indications are that this specific technology application is included in the vehicle redesign. The other technologies would carry over into in MY 2007 and would continue to be employed in future model years. To determine the possible fuel economy increase attributable to each of these technologies, NHTSA looked at the manufacturer-provided numbers for percentage increase in fuel economy for each technology. If a manufacturer had already introduced a specific technology or was introducing it by MY 2005, we placed more credence on that value, especially if was in the NAS range and if at least one other manufacturer estimated a similar value for the fuel economy potential of that technology.

Starting with MY [ ], GM could offer all its Suburbans, Yukon XLs, and Escalade XLs as being standardly equipped with [ ]. In its submission, GM indicates that the lead-time for [ ] is MY [ ]. All Suburbans, Yukon XLs, and Escalade XLs are equipped with either a 5.3 L or a 6.0 L V8 engine. Suburbans, Yukon XLs, and Escalade XLs were chosen because of their poor fuel economy; the fact that these vehicles often are used for passengers, not cargo like pickup trucks (thus, there isn't a need for optimum power all the time); and because we did not adjust any sales for the Suburbans, Yukon XLs, and Escalade XLs to account for 6.0 L engines being replaced by 5.3 L engines. Additionally, because these vehicles garner large profits for GM, the additional cost should be easier to handle on these vehicles.

Starting with MY [ ], GM could replace all of its [ ] used on the C/K trucks and SUVs, all S/T trucks and SUVs and all G Vans with [ ]. GM's main competitors for the above-mentioned model classes are projecting that they will offer [ ] and in some cases [ ] (SUVs) by MY [ ]. Given the short lead-time involved and the fact that many [ ] are acquired from suppliers, this potential change appears to be the Stage II technology that would be the easiest to introduce by MY 2005.

Starting with MY [ ], GM could add [ ]. In applying the [ ] to all of GM's [ ], we were looking for a way to increase GM's potential fuel economy for MY [ ], and beyond, without projecting the introduction of new or redesigned GM engines. The models offered with [ ] have a sufficiently large number of sales and an engine that could utilize the [ ]. By MY 2004, GM will be introducing parallel hybrid full-sized pickup trucks that use an [ ]. The [ ] can be added on to most engines provided space is available. Because the unit will already be used on full-sized pickup trucks by MY 2004, we feel that it is quite probable that the unit could be added to all of GM's 4.2 L engines by MY [ ].

The improvements discussed above for Stage II are summarized for the GM light truck fleet in the following table.

Table V-10
GM Light Truck Stage II w/Stage III
Improvements Accounted For

Whole Table Confidential

Model Year	Affected Engine/ Transmission	Technologies	Percent Impr.	CAFE Impr., mpg
2005	[			
2005				
2006				
2006				
2006				
2007				
2007				

]

(c) Stage III

The Stage III analysis includes projections of the potential CAFE increase that could result from moving the sales of vehicles equipped with 6.0L or larger engines to almost identical models equipped with 5.3L or larger engines. GM is projecting the sales of [ ] vehicles equipped with 6.0 L engines, some described as being High Output. The vast bulk of these are projected to be large SUVs, with about [ ] a year projected to be compact pickups. In looking at GM's fleet, it is evident that vehicles equipped with the 6.0 L engines have the lowest projected fuel economy. NHTSA believes that the bulk of GM models equipped with the 6.0 L engines could be replaced with 5.3 L engines and that this replacement would not degrade the cargo and towing capacity of these vehicles, though horsepower would be reduced somewhat. We did make an exception for the Suburban/Yukon XL/Escalade XL models, whose size and weight may require the additional horsepower provided by a 6.0 L for some applications. If this were the only change made to GM's light truck fleet, it would increase GM's projected CAFE by 0.1 mpg for MYs 2005-2007, resulting in projected values of 20.1, 20.2, and 20.9 mpg for MYs 2005, 2006 and 2007 respectively.

The potential improvements to the GM light truck CAFE are summarized in the following table. Due to rounding, the individual improvements may not equal the potential CAFE for GM.

Table V-11

Potential GM CAFE Improvements, mpg

Model Year	**Baseline Mpg**	**Stage I Improvements**	**Stage II Improvements**	**Stage III Improvements**	**Total**	**Potential CAFE, mpg.**
2005	[					20.973
2006						21.637
2007					]	22.288

Ranges for CAFE Standards

The above discussion represents a hypothetical look at technologies that DaimlerChrysler, Ford, and GM could use to improve their CAFEs. It includes some technologies its competitors project using or that may be appropriate for a special type of vehicle that the manufacturer produces. It includes a review of the potential technologies reviewed in Chapter IV, but it does not represent all technologies that may be available to improve fuel economy, particularly in the latter years of the period.

The range of CAFE values from the preceding six tables is summarized in the next table.

Table V-12

Range of Potential CAFE

Model Year	DaimlerChrysler	Ford	General Motors
2005	21.3-21.3	20.9-21.0	20.0-21.0
2006	21.6-21.6	21.6-21.6	20.1-21.6
2007	22.2-22.2	22.0-22.2	20.8-22.3

The above detailed analysis of the fuel economy potential for DaimlerChrysler, Ford and GM shows one way that these manufacturers could meet a certain level of fuel economy. The agency did not have as detailed information on the other manufacturers. However, we did develop a method to estimate a potential technology application path to get them up to the level of the proposal. This same methodology was applied uniformly to all manufacturers, including DaimlerChrysler, Ford and GM, to get a consistent estimate of the benefits and costs. The next section describes the model and algorithm used to apply technologies.

Technology Application Algorithm

In order to understand how manufacturers might respond to changes in CAFE standards, we developed an algorithm that applies technologies to different trucklines based on comparative estimated cost effectiveness.[2] Using the estimated technology characteristics presented above,

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[2] Two manufacturers have indicated plans to introduce light trucks with [6.0 liter engines]^c. Before applying this algorithm, we assumed that most of these models would be replaced by versions with [5.3 liter or similar engines]^c.

the algorithm repeatedly evaluates each technology that could be applied to each truckline in the manufacturer's product line and selects the application that is the most attractive in terms of the ratio between (1) the RPE increase that would result from applying a given technology to a given truckline, less the value of the resultant fuel savings and (2) the resultant change in CAFE fines. For this analysis we assumed that paying fines, rather than applying technologies to improve fuel efficiency, would not be used by the manufacturers, because we wanted to estimate the impact on cost and benefits of meeting the proposed standards.

Mathematically, this is expressed as follows:

$$\frac{S_j\left[C_{ij}-\frac{k_{MY}}{1-R_b}\left(\frac{1}{MPG_{i-1,j}}-\frac{1}{MPG_{i,j}}\right)\right]}{\Delta FINE} \qquad (0.1)$$

where

S_j is the sales for truck model j,
C_{ij} is the cost (RPE increase) to implement technology i on truckline j,
$MPG_{i-1,j}$ is the (rated) fuel economy after the previous technology application (i-1) to the current truckline j,
$MPG_{i,j}$ is the (rated) fuel economy after the current technology application (i) to the current truckline j,

R_b is the loss of fuel economy the vehicle buyer expects to observe under real-world driving conditions compared to the rated fuel economy, and

$\Delta FINE$ is the reduction in fines if technology i is applied to truckline j,

and k_{MY} is a constant that, for a given model year MY, estimates the value to the vehicle buyer of reductions in a vehicle's fuel consumption rate (gallons/mile). This constant is calculated as follows:

$$k_{MY} = \sum_{v=0}^{v=PB} \frac{SURV_v M_v P_{b,MY+v}}{\left(1+r_b\right)^{v+0.5}} \qquad (0.2)$$

where

v is the truck's vintage,

PB is the payback period that applies to the purchase decision,

M_v is the average annual mileage accumulation by a truck of vintage v,

$SURV_v$ is the probability that a truck of vintage v will remain in service,

r_b is the rate at which truck buyers discount future fuel savings, and

$P_{b,MY+v}$ is the fuel price the buyer expects to pay in year $MY+v$

To estimate k_{MY}, we assumed a payback period of 4.5 years and a discount rate of seven percent. The payback period only comes into consideration when we are trying to determine which model is going to get the technology first, not which technology comes first. Our assumptions regarding fuel prices and age-specific vehicle survival and mileage accumulation rates are discussed in Chapter VII.

Beginning with the first technology listed in Table V-4, the model repeatedly selects the technology application for the make/model which yields the lowest value. Once that technology has been applied to all models for that manufacturer, the evaluation process is repeated for the next technology in the list. Each time the algorithm applies a technology, it updates the technical description, incurred RPE increase, and fuel economy of the relevant vehicle, as well as the manufacturer's CAFE. The algorithm continues applying technologies until each manufacturer complies with the assumed CAFE standard. As the technology application algorithm iterates, it maintains running totals of RPE increases (at the truckline and corporate level). Final calculated levels are outputs of the algorithm.

Results for Proposed CAFE Standards

In order to estimate the potential net effects of the proposed standards, we applied the above-mentioned technology assumptions and technology application algorithm to the proposed standards (21.0, 21.6, and 22.2 MPG in MY 2005, 2006, and 2007, respectively). Not all of the manufacturers' fuel economy levels reached 20.7 mpg as shown in Table V-1 under "Estimated mpg before standards are known". Therefore, for those manufacturers, technologies were applied to get them up to the adjusted baseline of the current 20.7 mpg standard. Tables V-13 to V-15 for MY 2005, MY 2006, and MY 2007 respectively, show for several key technologies the calculated levels of utilization by each manufacturer to meet the current 20.7 mpg, without considering alternative fueled vehicles, and to get them to the level of the proposal for that particular model year. These summary results are based on projected technology utilization at the truckline level. The costs and benefits are only included in the analysis for those technologies that take the manufacturer's fleet average from the adjusted baseline to the level of the proposed standard.

Table V-13

Calculated Technology Utilization for MY 2005

MY 2005	Multivalve OHC		VVT		VVLT		Cylinder Deactivation		5-Speed Auto. Trans.		6-Speed Auto. Trans.		CVT		Reduced Aero. Drag		Reduced Rolling Res.	
CAFE Standard:	20.7	21.0	20.7	21.0	20.7	21.0	20.7	21.0	20.7	21.0	20.7	21.0	20.7	21.0	20.7	21.0	20.7	21.0
BMW	100%	100%	0%	0%	0%	33%	67%	100%	100%	67%	0%	33%	0%	0%	100%	100%	100%	100%
DaimlerChrysler	30%	30%	0%	0%	0%	0%	10%	10%	33%	33%	5%	5%	0%	0%	0%	0%	0%	0%
Ford	52%	52%	10%	10%	0%	0%	0%	0%	29%	29%	6%	6%	4%	4%	0%	0%	0%	0%
General Motors	24%	24%	0%	0%	0%	0%	0%	11%	12%	12%	0%	0%	2%	2%	0%	42%	80%	99%
Honda	100%	100%	0%	0%	100%	100%	0%	0%	58%	58%	0%	0%	0%	0%	0%	0%	0%	0%
Hyundai	100%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Isuzu	100%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Kia	100%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Nissan	64%	64%	100%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Suzuki	100%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Toyota	100%	100%	0%	0%	0%	0%	0%	0%	73%	73%	0%	0%	0%	0%	0%	0%	0%	0%
Volkswagen	35%	35%	0%	0%	0%	0%	0%	0%	93%	93%	0%	0%	0%	0%	0%	0%	0%	93%

Table V-14

Calculated Technology Utilization for MY 2006

MY 2006	Multivalve OHC		VVT		VVLT		Cylinder Deactivation		5-Speed Auto. Trans.		6-Speed Auto. Trans.		CVT		Reduced Aero. Drag		Reduced Rolling Res.	
CAFE Standard:	20.7	21.6	20.7	21.6	20.7	21.6	20.7	21.6	20.7	21.6	20.7	21.6	20.7	21.6	20.7	21.6	20.7	21.6
BMW	100%	100%	0%	0%	0%	33%	67%	100%	100%	67%	0%	33%	0%	0%	100%	100%	100%	100%
DaimlerChrysler	30%	30%	0%	0%	0%	0%	22%	22%	34%	34%	4%	4%	0%	0%	0%	0%	0%	0%
Ford	65%	65%	12%	12%	0%	0%	0%	0%	10%	10%	25%	25%	18%	18%	0%	0%	0%	0%
General Motors	24%	24%	0%	0%	0%	0%	16%	75%	11%	11%	0%	0%	2%	2%	0%	70%	61%	99%
Honda	100%	100%	0%	0%	100%	100%	0%	0%	58%	58%	0%	0%	0%	0%	0%	0%	0%	0%
Hyundai	100%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Isuzu	100%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	40%
Kia	100%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Nissan	64%	64%	100%	100%	0%	0%	0%	19%	0%	0%	0%	0%	0%	0%	0%	19%	0%	100%
Suzuki	100%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Toyota	100%	100%	0%	0%	0%	0%	0%	0%	73%	73%	0%	0%	0%	0%	0%	0%	0%	0%
Volkswagen	35%	35%	0%	0%	0%	0%	0%	93%	93%	93%	0%	0%	0%	0%	0%	93%	0%	100%

Table V-15

Calculated Technology Utilization for MY 2007

MY 2007	Multivalve OHC		VVT		VVLT		Cylinder Deactivation		5-Speed Auto. Trans.		6-Speed Auto. Trans.		CVT		Reduced Aero. Drag		Reduced Rolling Res.	
CAFE Standard:	20.7	22.2	20.7	22.2	20.7	22.2	20.7	22.2	20.7	22.2	20.7	22.2	20.7	22.2	20.7	22.2	20.7	22.2
BMW	100%	100%	0%	0%	0%	33%	33%	100%	33%	0%	0%	33%	0%	0%	100%	100%	00%	100%
DaimlerChrysler	41%	41%	12%	12%	0%	0%	24%	24%	33%	33%	5%	5%	11%	11%	0%	0%	0%	0%
Ford	74%	74%	24%	24%	0%	0%	0%	0%	5%	5%	37%	37%	22%	22%	0%	0%	0%	0%
General Motors	32%	32%	0%	0%	0%	0%	14%	17%	9%	0%	6%	5%	1%	1%	0%	64%	0%	100%
Honda	100%	100%	0%	0%	100%	100%	0%	0%	58%	58%	0%	0%	0%	0%	0%	0%	0%	0%
Hyundai	100%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Isuzu	100%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	33%	0%	100%
Kia	100%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Nissan	64%	64%	100%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	89%	0%	100%
Suzuki	100%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Toyota	100%	100%	0%	0%	0%	0%	0%	0%	73%	73%	0%	0%	0%	0%	0%	0%	0%	0%
Volkswagen	35%	35%	0%	0%	0%	0%	0%	6%	93%	0%	0%	0%	0%	0%	0%	100%	0%	100%

The following table contains the agency's proposed future light truck CAFE standards.

Table V-13
Proposed CAFE levels

Model Year	CAFE, mpg
2005	21.0
2006	21.6
2007	22.2

Potential Product Restrictions

Product restrictions are an alternative approach to CAFE improvement. By limiting or deleting production of particular larger light truck models and larger displacement engines, manufacturers can alter the composition of their fleets and thereby affect their corporate average fuel economy. The agency's adjustments in the companies' projected CAFE capabilities includes modifications to their projected sales of vehicles with 6.0L engines and larger when a slight reduction in the level of performance and equivalent cargo and towing capacity can be achieved through the sale of vehicles with 5.3L or larger engines.

Additional product restrictions, if made necessary by selection of a CAFE standard that is above manufacturers' capabilities, could result in consumers choosing to purchase vehicles over 8,500 pounds GVWR (beyond the purview of this CAFE regulation), precipitating an adverse effect on fuel economy. There are many alternatives available to consumers, if a manufacturer restricts the sales of particular models. Consumers may purchase a similar vehicle from a competitor.

Another potential consequence of product restriction is a further erosion of employment in the automotive sector, if consumers elected to retain older vehicles longer than usual, potentially by purchasing a used vehicle rather than a new vehicle.

To assess the possible impact of production restriction on General Motors (whose fleet requires the most adjustment to meet the proposed standard), the agency estimated the loss of production associated with sufficient production restrictions to raise its CAFE by 0.5 mpg. To estimate this effect, the agency eliminated production of GM's least fuel-efficient models until the desired improvement in CAFE was achieved.

To increase GM's light truck CAFE by an additional 0.5 mpg for MY 2005 through product restrictions, light truck production would have to be reduced by about 200,000 units by deleting [
].

To increase the CAFE by 0.5 mpg for MY 2006, about 194,000 units would have to be deleted. These would consist of the lowest fuel economy models: [
].

For MY 2007, about 251,000 units would have to be deleted, consisting of [
].

Product restrictions have the additional potential adverse effect of rendering light trucks, designed to meet CAFE requirements and not to meet consumer demand, less acceptable for business use. This could result either in the sale of larger, less fuel-efficient trucks to meet this demand or an increase in vehicle miles traveled (VMT) to account for the lower level of utility.

Similarly, potential production restrictions of some minivans and SUVs, designed to accommodate the transport of numerous passengers and associated cargo, could potentially lead to an increase in VMT to account for their smaller size.

Given these considerations, we have tentatively concluded that significant product restrictions are unnecessary to meet the proposed standards.

VI. COST IMPACTS AND LEAD TIME

Table VI-1 presents potential retail price impacts and fuel consumption impacts of different technologies. Within the range of values anticipated for each technology (as shown in Table V-3), we selected the "expected" cost impacts and fuel consumption impacts considered most plausible during the model years under consideration for the industry in general, and applied the technology application algorithm described in Chapter V. Some manufacturers might achieve more benefit than others using similar technologies or on specific vehicles. However, because NHTSA believes that technology characteristics are subject to greater uncertainty on a manufacturer-specific basis, this analysis assumes an equal impact from specific technologies for all manufacturers and vehicles. The technologies were ranked based on the cost per percentage point improvement in fuel economy and applied where available to each manufacturer's fleet in their order of rank.

Table VI-1

Available Technologies, Cost and Fuel Efficiency (Costs in $2000)

Technology	Fuel Economy Improvement	Cost Impact	Cost Per Percent Improvement
Production-Intent Engine Technology			
Engine Friction Reduction	1.5%	$35	$23
Low Friction Lubricants	0.5%	$3	$6
Multi-Valve, Overhead Camshaft	2.5%	$232	$93
Variable Valve Timing	1.0%	$89	$89
Variable Valve Lift & Timing	2.0%	$222	$111
Cylinder Deactivation	3.5%	$221	$63
Engine Accessory Improvement	1.0%	$20	$20
Engine Supercharging & Downsizing	4.5%	$560	$124
Production-Intent Transmission Technology			
5-Speed Automatic Transmission	2.0%	$154	$77
Continuously Variable Transmission	5.0%	$398	$80
Automatic Transmission w/Aggressive Shift Logic	0.5%	$35	$70
6-Speed Automatic Transmission	2.0%	$140	$70
Production-Intent Vehicle Technology			
Aero Drag Reduction	1.5%	$45	$30
Improve Rolling Resistance	0.5%	$11	$22
Emerging Engine Technology			
Intake Valve Throttling	1.0%	$315	$315
Camless Value Actuation	2.0%	$420	$210
Variable Compression Ratio	3.5%	$300	$86
Emerging Transmission Technology			
Automatic Shift Manual Transmission (AST/AMT)	3.0%	$175	$58
Advanced CVTs	1.0%	$195	$195
Emerging Vehicle Technology			
42 Volt Electrical Systems	0.5%	$150	$300
Integrated Starter/Generator	4.5%	$534	$119
Electric Power Steering	2.0%	$150	$75
Vehicle Weight Reduction	variable	variable	

The first row of Table VI-2 shows the average baseline mpg for the industry resulting from product plans submitted by vehicle manufacturers before knowing NHTSA's proposed CAFE standards for model years 2005-07. The second row of the table shows the industry average fuel economy level obtained by adjusting upward the baseline mpg levels of those manufacturers whose product plans resulted in mpg levels below the current standard of 20.7 mpg (before using fuel economy adjustments for sales of alternative fueled vehicles), called the "Adjusted Baseline" mpg level. The third row of Table VI-2 reports the estimated mpg level for the industry with the proposed CAFE standard of 21.0 mpg for MY 2005, 21.6 mpg for MY 2006 and 22.2 mpg for MY 2007 in effect. The estimated fleet average under the Adjusted Baseline exceeds the current CAFE standard because the fuel economy levels resulting from some manufacturers' product plans exceed 20.7 mpg. Similarly, the industry average fuel economy levels under the proposed standard exceed the mpg levels it would require because some manufacturers' projected fuel economy levels for future model years already exceed even the higher level of the proposal, and are assumed to remain at those higher levels for MYs 2005-07.

Table VI-2

Baseline and Estimated mpg Levels for the Proposal

	MY 2005	**MY 2006**	**MY 2007**
Baseline Manufacturers' Average	21.03 mpg	21.32 mpg	21.81 mpg
Adjusted Baseline With a 20.7 mpg Minimum	21.21 mpg	21.49 mpg	21.83 mpg
Estimated Levels after Proposed Standard	21.35 mpg	21.82 mpg	22.35 mpg
Proposed Std.	21.0 mpg	21.6 mpg	22.2 mpg

Tables VI-3 and VI-4 present two sets of estimated costs. Some of the manufacturers are not planning on meeting the current level of 20.7 mpg for MY 2005-07 without using fuel economy adjustments for alternative fueled vehicles. So, the first column in the tables are the estimated costs of using technology to bring the manufacturer's fleets up to 20.7 mpg. These costs have been estimated, but they are not considered to be part of the costs of meeting the proposed requirements. Those costs, and commensurate benefits, are considered part of the costs and benefits of complying with previously issued rules. The cost estimates to bring those manufacturers with fleet averages below 20.7 mpg up to the level of 20.7 mpg, on an average per vehicle basis, are $17 for MY 2005, $15 for MY 2006, and $1 for MY 2007. These are average industry cost estimates over all vehicles sold, not just for those manufacturers with a baseline below 20.7 mpg. The reason for decreases in the latter model years are that some manufacturers are planning to make improvements in fuel economy in the later model years, resulting in bringing them above 20.7 mpg. These estimates represent the costs to bring the manufacturer's plans that are below 20.7 mpg back up to 20.7 mpg, for each model year individually.

The second column under each model year heading in Tables VI-3 and VI-4 show the costs of applying technology necessary to move from each manufacturer's planned fuel economy levels up to the level of the proposed standard. Thus, if a manufacturer's product plans resulted in a fuel economy level of 20.2 mpg during each model year, this cost represents the cumulative cost of technologies necessary to bring that manufacturer's fleet average up to 21.0 mpg in MY 2005, 21.6 mpg in MY 2006 and 22.2 mpg in MY 2007. The difference between this cost and that for ensuring that each manufacturer meets the current 20.7 mpg standard is the estimated incremental cost to the industry for meeting the proposed standard during each model year.

Tables VI-3 and VI-4 show the costs of meeting the proposed standards as compared to a baseline of the manufacturers' plans before knowing NHTSA's proposal. Since the manufacturer's plans for MY 2005, 2006 and 2007 are different, the baseline changes in each year (as shown in Table V-2). Thus, we don't provide a cumulative number comparing MY 2007 to a baseline. Each individual year is analyzed compared to the manufacturers plans for that year (adjusted by bringing those manufacturers with an average mpg below 20.7 mpg, back up to 20.7 mpg).

The average incremental cost per vehicle is estimated to be $14 for MY 2005, $28 for MY 2006, and $47 for MY 2007. The total incremental cost is estimated to be $108 million for MY 2005, $221 million for MY 2006, and $373 million for MY 2007.

Table VI-3

Estimated Incremental Costs over Manufacturer's Plans

Average Cost per Vehicle

	MY 2005		MY 2006		MY 2007	
CAFE Std. (MPG)	20.7	21.0	20.7	21.6	20.7	22.2
BMW	$143	$443	$143	$443	$161	$532
Daimler Chrysler				$5		
Ford		$12				$11
General Motors	$62	$90	$53	$129		$122
Honda						
Hyundai						
Isuzu				$44		$100
Kia						
Nissan	$1	$26	$1	$89	$1	$149
Suzuki						$14
Toyota						$4
Volkswagen	$25	$68	$25	$158	$25	$171
Total Fleet Ave.	$17	$31	$15	$43	$1	$48
Incremental Cost of the Proposal		$14		$28		$47

Table VI-4
Total Incremental Cost
(In Millions)

	MY 2005		MY 2006		MY 2007	
CAFE Std. (MPG)	20.7	21.0	20.7	21.6	20.7	22.2
BMW	$8	$25	$8	$25	$9	$31
Daimler Chrysler				$11		
Ford		$25				$25
General Motors	$120	$176	$106	$256		$246
Honda						
Hyundai						
Isuzu				$6		$14
Kia						
Nissan	$1	$10	$1	$36	$1	$61
Suzuki						$1
Toyota						$3
Volkswagen	$0	$1	$0	$2	$0	$2
Total Fleet	$129	$237	$115	$336	$10	$383
Incremental Cost of the Proposal		$108		$221		$373

Lead time

Table V-4 provides the agency's estimate of when a particular technology is available to be used by some manufacturers. Even though a particular technology is defined as being available in MY 2005, or MY 2007, not all manufacturers can meet that date on all vehicles. Those are generic dates when technology is available for some manufacturers, not all. For some manufacturers, unless they had planned on using that technology, they are probably too far behind in its development to introduce that technology by the MY 2005 date.

In Chapter VIII, the marginal costs of improving fuel economy per percent improvement were discussed and estimated to be in the $42 to $44 range per percent improvement. Five technologies were below this cost per percent improvement range. These are low friction lubricants, engine accessory improvements, improving rolling resistance, engine friction reduction, and aerodynamic drag reductions.

Theoretically, one could argue that these five technologies should be applied across the board to all manufacturers in the MY 2005-2007 time frame. However, this is not possible in all cases. For example, aerodynamic drag reductions can only be achieved when the front end of a model is redesigned. Light trucks are not redesigned as often as passenger cars and one would only expect about half of the models to be redesigned in a three-year time frame, and a long lead time is needed for a front-end redesign. Certain engine improvements can only be included with other specific engine updates.

The agency also discussed the potential to improve fuel economy through performance reductions. Although returning the performance of GM's light truck fleet to MY 2001 levels can cause a significant increase to their MY 2005 projected CAFE level, the probability of GM being able to achieve the changes in either weight or performance level in the lead time remaining before these vehicles go into production is very small. The vast majority of GM's MY 2005 light truck designs are locked in. Additionally, to effect this significant of a change in its MY 2005 light truck CAFE, GM might be forced to delay the introduction of many of their best-selling vehicles, which could cause them to lose sales and have a negative economic effect on the company.

The agency judiciously chose which technologies it believed could be added by the manufacturers by specific dates having knowledge of their plans in some cases, knowledge of what other manufacturers are doing, etc. Marginal cost/benefit is only one of many rationales (applicability to the appropriate vehicles, lead time, capabilities, and competition) considered for choosing technologies that we thought the manufacturers could deploy.

Why did we not propose higher numbers?

In analyzing the data submissions in light of NHTSA's four statutory criteria, the importance of technological feasibility and economic practicability is very important. All manufacturers engage in multi-year product planning. This planning is evident in the detailed information that we received from DaimlerChrysler, Ford and GM. However, the specificity supplied by these manufacturers would not be possible without corporate commitments to the basic designs and production quantities of these vehicles. Because vehicle design and production have received commitments, there is only a finite number of changes that can occur to vehicle design and production quantities.

The agency's technical analysis, utilized its best engineering judgment to arrive at CAFE levels that it believes can be achieved by the light truck fleet within the time and design constraints that vehicle manufacturers operate under. Although others may believe that higher CAFE numbers can be achieved, NHTSA's engineering judgment of maximum feasible average fuel economy level must take into account the four statutory criteria. These criteria lead us to believe that given the short planning horizon that higher standards may have a negative economic effect on the automotive industry and may be beyond the industry's short-term technical potential.

Why did we not apply some technologies?

Not all technologies can apply to every light truck due to the capability of the technology, vehicle utility and costs. For example, it appears that CVT application is limited to smaller vehicles, such as compact SUVs, crossover vehicles and compact pick ups. Other technologies are more appropriate for specific vehicle classes or engine types, such as cylinder deactivation, which is more appropriate for 4- and 8-cylinder engines due to the need to balance possible engine vibrations that may occur during operation.

Two technologies, which are planned for introduction by MY 2005, were not applied to any additional vehicles due to technology uncertainties and costs. Diesel engines, which are more efficient than internal combustion engines and are included in a few manufacturer projections, were not applied to any additional vehicles due to the uncertainty surrounding the ability of diesel engines to permeate the market in a short lead time.

Hybrid drivetrains, which are much more efficient than conventional technology and are included in a few manufacturers projections, have a cost premium. NHTSA is highly encouraged by the manufacturers' plans and believes that more light trucks will be equipped with hybrid drivetrains in the near future. NHTSA also believes that other vehicles, currently included in manufacturers plan could employ hybrid technology. However, due to lead time considerations, the agency did not project any additional sales of these vehicles, nor did it project the inclusion of hybrid drivetrains on any other vehicle models.

Why is the MY 2005 average of the fleet higher than our proposed CAFE levels for MY 2005?

The fleet average is higher because of the assumption that those manufacturers that exceed the current 20.7 mpg CAFE standard will remain at those levels through MY 2005. It is expected that manufacturers that currently exceed the CAFE standard would not regress and that their overcompliance would continue to occur.

Why our lead times different than the National Academy of Science (NAS)?

NHTSA's technology assumptions, shown in Table V-3 represent the agency's engineering judgment about the fuel consumption impact, the potential retail price equivalent and the estimated year of availability for each technology on a manufacturer specific basis. The NAS estimates are more generic, particular technologies are available in a specific time period. However, those technologies might not be available for all manufacturers. Table V-3 takes into consideration both the NAS estimates and the confidential estimates that were provided by DaimlerChrysler, Ford, GM, Honda, Nissan and Toyota. To arrive at the numbers, NHTSA analyzed each manufacturer's estimate for a specific technology against the others that provided estimates and against the NAS estimate. If a manufacturer is currently including a specific technology in its light truck fleet, or planned to by MY 2005, the agency gave more credence to their estimates. As a result, the agency believes that estimates of the fuel consumption potential and the potential retail price equivalent shown in the table represent a good approximation of the potential for each technology while staying within the ranges set forth in the NAS report.

VII. CONSUMER BENEFITS

Economic and Environmental Impacts from Higher CAFE Standards

Economic and environmental impacts from adopting a tighter CAFE standard for light trucks were estimated separately for each model year over its life span in the U.S. vehicle fleet, extending from the initial year when a model year is offered for sale through the year when nearly all vehicles from that model year have been retired or scrapped (approximately 25 years). The underlying source of the economic and environmental impacts considered in this analysis is the reduction in gasoline use resulting from the improvement in fuel economy of new light-duty trucks produced. Each of these impacts is measured by the *difference* between a measure -- such as total gallons of fuel consumed by light trucks produced during a single model year over its entire 25-year life span in the fleet -- under the manufacturer plans compared to the fuel consumed with a stricter standard in effect. Future impacts are estimated in both undiscounted terms and by their present value discounted to the calendar year when each model was produced, using a 7 percent discount rate.

Forecasts of light truck sales for future years (see Table VII-1) were obtained from the Energy Information Administration's (EIA) *Annual Energy Outlook 2002* (*AEO 2002*), a standard government reference for forecasts of energy production and consumption in different sectors of the U.S. economy.[1] Actual fuel economy levels for each future model year's light trucks under the current CAFE standard and with alternative standards in effect were estimated using the model of fuel economy technology application described in Chapter IV. Under both the current

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[1] U.S. Department of Energy, Energy Information Administration, *Annual Energy Outlook 2002*, Table 45, http://www.eia.doe.gov/oiaf/aeo/supplement/index.html.

and proposed CAFE standards, the average actual fuel economy for all new light trucks manufactured during each model year slightly exceeds the standards. However, the actual fuel economy levels achieved by light trucks in on-road driving falls significantly short of the level measured under these test conditions, and the actual fuel economy performance of each future model year is adjusted to reflect the expected size of the fuel economy "gap" of 15 percent.

Table VII-1
Sales Projections

Model Year	Light Truck Sales Projection
2005	7,654,300
2006	7,795,300
2007	7,921,500

The number of light trucks manufactured during each model year that remains in service during each subsequent calendar year is estimated by applying estimates of the proportion of vehicles surviving to each age up to 25 years. These "survival rates" are estimated from the experience with recent model-year light trucks, adjusted to reflect expected continued improvements in the durability and economic lifetimes of future model year light-duty vehicles.[2] The survival rates are slightly different than the survival rates used in past NHTSA analyses, since they have been updated using newer information. The agency is examining more recent information on vehicle miles traveled and expects to update these estimates for the final rule. The total number of miles driven by light trucks during each year of its life span in the fleet with the base CAFE standard

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[2] U.S. Department of Energy, Oak Ridge National Laboratory, *Transportation Energy Data Book Number 21*, Table 6.10, http://www-cta.ornl.gov/data/Index.html

of 20.7 mpg in effect is estimated by multiplying age-specific estimates of annual miles driven per vehicle to the number of vehicles remaining in service at each age (see Table VII-2).

Table VII-3 provides the projected price of gasoline into the future, under the assumption that year 1 of the standard starts in year 2005. The economic value of annual fuel savings resulting from higher light truck CAFE standards is assessed by applying the Energy Information Administration's *AEO 2002* forecast of future fuel prices to each year's estimated fuel savings. These future fuel prices are the retail price of fuel per gallon including federal and state taxes. These fuel price estimates are adjusted for two factors to establish societal benefits. First, the value of Federal and state taxes are excluded from the social value of fuel savings because they don't represent a cost to society, but are a transfer payment instead. The revenues generated by state and federal fuel taxes will be exactly offset by reduced spending on the government programs they are used to finance (building and maintaining highways), and thus do not reflect a savings in resources to the economy but a transfer payment.[3]

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[3] There will also be an additional benefit in the form of a reduction in the "excess burden" associated with fuel taxation, which measures the cost to the economy of distortions in economic decisions by households and firms resulting from fuel taxation. However, this additional benefit is likely to be small because the reduction in fuel consumption represents a small proportion of fuel use with the base CAFE standard remaining in effect, and because the excess burden is estimated to be small for fuel taxes.

Second, the economic value of externalities generated during fuel production and use are converted into per-gallon equivalents and added to the pre-tax price of gasoline, simply because it is the easiest way to get them into the analysis on a per gallon basis.

The value of externalities will be discussed later in this chapter.

Consumer benefits are estimated by assuming that fuel economy improvements are valued over the lifetime of the vehicle. While the first owner might not realize the benefits of higher fuel economy, subsequent owners will.

Table VII-2

Vehicle Miles Traveled and Survival Rates
Light Trucks

Vehicle Age (years)	Vehicle Miles Traveled	Survival Probability	Weighted Vehicle Miles Traveled
-------	---------	-----------	---------
1	12,885	1.000	12,885
2	12,469	0.998	12,444
3	12,067	0.995	12,007
4	11,678	0.989	11,550
5	11,302	0.969	10,952
6	10,938	0.941	10,293
7	10,585	0.907	9,601
8	10,244	0.869	8,902
9	9,914	0.827	8,199
10	9,594	0.782	7,503
11	9,285	0.734	6,815
12	8,985	0.684	6,146
13	8,696	0.633	5,505
14	8,415	0.580	4,881
15	8,144	0.528	4,300
16	7,882	0.477	3,760
17	7,628	0.427	3,257
18	7,382	0.379	2,798
19	7,144	0.333	2,379
20	6,913	0.290	2,005
21	6,691	0.250	1,673
22	6,475	0.214	1,386
23	6,266	0.181	1,134
24	6,064	0.152	922
25	5,869	0.126	739

			152,032

Table VII-3
Projected Price of Gasoline, Gas Taxes,
And Value of Externalities
(in year 2000 economics)

AE 02002 Fuel Price Per gal/ (2000 dollars)	**Federal and State Taxes**	**Excluding Taxes Fuel Price per Gallon (2000 dollars)**	**Value of Reduced Externalities From Lower Oil Imports**	**Total Societal Value Per Gallon**
		Yr 1 = 2005		
1.37	0.377	0.99	0.083	1.08
1.39	0.377	1.01	0.083	1.10
1.39	0.377	1.01	0.083	1.10
1.39	0.377	1.01	0.083	1.10
1.40	0.377	1.02	0.083	1.11
1.40	0.377	1.02	0.083	1.11
1.40	0.377	1.02	0.083	1.11
1.40	0.377	1.02	0.083	1.11
1.40	0.377	1.02	0.083	1.11
1.40	0.377	1.02	0.083	1.11
1.40	0.377	1.02	0.083	1.11
1.40	0.377	1.02	0.083	1.11
1.40	0.377	1.02	0.083	1.11
1.40	0.377	1.02	0.083	1.11
1.40	0.377	1.02	0.083	1.11
1.40	0.377	1.02	0.083	1.11
1.40	0.377	1.02	0.083	1.11
1.40	0.377	1.02	0.083	1.11
1.40	0.377	1.02	0.083	1.11
1.40	0.377	1.02	0.083	1.11
1.40	0.377	1.02	0.083	1.11
1.40	0.377	1.02	0.083	1.11
1.40	0.377	1.02	0.083	1.11
1.40	0.377	1.02	0.083	1.11
1.40	0.377	1.02	0.083	1.11
1.40	0.377	1.02	0.083	1.11
1.40	0.377	1.02	0.083	1.11

The "Rebound Effect"

By reducing the cost of gasoline per mile driven, tighter CAFE standards are expected to result in a slight increase in annual miles driven per vehicle from the levels of annual vehicle use if the MY 2004 standard of 20.7 mpg remained in effect. This increase in the annual number of miles each vehicle is driven, usually referred to as the "rebound effect," also results in a corresponding increase in the *total* number of miles driven by light trucks of each model year during each calendar year that they remain in the fleet.[4] In this analysis, the magnitude of the rebound effect is estimated by applying a representative estimate of the elasticity of vehicle use with respect to fuel cost per mile driven to the reduction in that cost that would result from the proposed stricter CAFE standard.[5] With both the base standard and the proposed higher CAFE standard in effect, the average fuel cost per mile for operating light trucks of any model year during a subsequent calendar year is calculated by the forecast retail price of gasoline during that future year, divided by the average actual on-road fuel economy level achieved by light trucks of that model year.[6]

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[4] The rebound effect also produces additional benefits to vehicle owners in the form of consumer surplus from the increase in vehicle-miles driven, and may also cause slight increases in the costs associated with traffic congestion and motor vehicle crashes. These effects are likely to be very small by comparison to the other economic impacts of raising CAFE standards, but they will be analyzed in detail as part of the Final Rule.

[5] Recent estimates of the rebound effect resulting from higher fuel economy standards for light-duty vehicles indicate that a 10% reduction in fuel costs per mile results in a 1-2% increase in the number of miles driven. These estimates are derived from statistical estimates of the elasticity of miles driven per vehicle with respect to fuel cost per mile that range from approximately –0.10 to –0.20; see for example Greene, David L., "Vehicle Use and Fuel Economy: How Big is the Rebound Effect?" *The Energy Journal*, 13:1 (1992), 117-143; Greene, David L., James R. Kahn, and Robert C. Gibson, "Fuel Economy Rebound Effect for Household Vehicles," *The Energy Journal*, 20:3 (1999), 1-31; Jones, Clifton T., "Another Look at U.S. Passenger Vehicle Use and the 'Rebound' Effect from Improved Fuel Efficiency, *The Energy Journal*, 14:4 (1993), 99-110; and Goldberg, Pinelopi Koujianou Goldberg, "The Effects of the Corporate Average Fuel Efficiency Standards in the U.S.," *The Journal of Industrial Economics*, 46:1 (1998), 1-33. This study employs the midpoint of that range to estimate the rebound effect from tightening CAFE standards for light-duty trucks.

[6] Gasoline price forecasts are also obtained from U.S. Department of Energy, Energy Information Administration, *Annual Energy Outlook 2002*, Table 12, http://www.eia.doe.gov/oiaf/aeo/supplement/index.html.

When federal fuel economy standards first took effect, the overall fuel efficiency of the nation's light-duty vehicle fleet was low by comparison to today's levels, while gasoline prices were considerably higher (in "real" or constant-dollar terms). As a consequence, gasoline costs per mile driven – which are equal to the price of gasoline per gallon divided by the number of miles driven per gallon -- were quite high, and rapidly increasing fuel economy levels required by the CAFE standards resulted in significant declines in gasoline costs per mile driven. Some empirical estimates of the rebound effect derived from this experience thus concluded that it could offset a significant fraction – perhaps as much as half -- of the gasoline savings resulting directly from tighter fuel economy standards.

With the current combination of relatively low fuel prices and significantly improved fuel economy levels, however, gasoline costs per mile driven are quite low by historical standards, and the potential of continued improvements in fuel economy to further reduce them limited. At the same time, household incomes have increased significantly over the past two decades, thus raising the value that household members attach to time spent traveling. As a consequence of these developments, the share of gasoline costs in the total costs of driving has declined sharply, so that improving fuel economy will not produce a major reduction in the costs of motor vehicle travel. Hence it seems reasonable to expect that the rebound effect resulting from improvements in light-duty vehicle fuel economy is likely to be smaller in the current environment than in the 1970s and 1980s.

The magnitude of the rebound effect from higher fuel economy standards for light-duty vehicles is typically derived from econometric estimates of the elasticity of vehicle use (either per vehicle or for an entire vehicle fleet) with respect to either fuel cost per mile driven or fuel efficiency measured in miles per gallon. Most recent estimates of the magnitude of the rebound effect for light-duty vehicles fall in the relatively narrow range of 10% to 20%, which imply that increasing vehicle use will offset 10-20% of the fuel savings resulting directly from an improvement in fuel economy. In the analysis of benefits from tighter CAFE standards for light-duty trucks, a rebound effect of 15% -- the midpoint of the range spanned by most recent estimates – is employed.

With the base CAFE standard in effect, total fuel consumption by light trucks from a single model year during each calendar year they remain in service is calculated by dividing the total number of miles the surviving population of vehicles of that model year are estimated to be driven by the average on-road fuel economy level associated with the base standard of 20.7 mpg. If those same light trucks are assumed to meet a higher CAFE standard when sold, their total fuel consumption during each subsequent calendar year is calculated by dividing the increased number of miles they are driven as a result of the rebound effect by the higher on-road fuel economy level associated with that stricter CAFE standard.

Fuel Savings and Emissions Reductions

The difference between estimated total fuel use by light trucks of a given model year during each year with the base CAFE standard in effect and under a stricter standard represents the fuel savings attributable to tightening the standard to that higher level. The sum of these annual fuel savings over each calendar year that vehicles from a single model year remain in service represents the cumulative fuel savings resulting from applying a stricter CAFE standard to light trucks produced during that model year.

The entire reduction in fuel use resulting from higher light truck CAFE standards is assumed to result in lower U.S. imports of either crude petroleum or refined products. Specifically, 55 percent of the total fuel savings is assumed to be reflected in lower U.S. imports of refined gasoline, while the remaining 45 percent is assumed to be translated into reduced U.S. imports of crude petroleum and reduced domestic gasoline refining. The value of reducing petroleum imports to the U.S. economy -- in the form of lower crude oil prices and reduced risks of oil supply disruptions – is estimated by applying widely-cited estimates of the value of these benefits per barrel of petroleum imports to the estimated annual reduction in oil imports.[7]

Reduced fuel savings from stricter light truck CAFE standards also result in lower emissions of carbon dioxide, the main greenhouse gas emitted as a result of refining, distribution, and use of transportation fuels.[8] Lower fuel consumption reduces carbon dioxide emissions directly, because the primary source of these emissions is fuel combustion in internal combustion engines, which converts stored fuel energy into vehicle propulsion energy. Reductions in carbon dioxide emissions from vehicle operation are estimated by assuming that the entire carbon content of

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[7] Leiby, Paul N., Donald W. Jones, T. Randall Curlee, and Russell Lee, *Oil Imports: An Assessment of Benefits and Costs*, ORNL-6851, Oak Ridge National Laboratory, November 1, 1997.

[8] Carbon dioxide emissions account for more than 97% of total greenhouse gas emissions from the refining and use of transportation fuels; see U.S. Environmental Protection Agency, *Draft Inventory of GHG Emissions and Sinks (1990-1999)*, Tables ES-1 and ES-4, http://www.epa.gov/globalwarming/publications/emissions/us2001/energy.pdf; and Argonne National Laboratories, *The Greenhouse Gas and Regulated Emissions from Transportation (GREET) Model*, Version 1.6, February 2000, http://www.transportation.anl.gov/ttrdc/greet/index.html.

gasoline is converted to carbon dioxide in the combustion process.[9] At the same time, lower fuel consumption also reduces carbon dioxide emissions that result from fuel combustion and other energy use that occurs during the extraction, refining, and distribution of gasoline. Reductions in emissions from petroleum extraction and transportation, gasoline refining, and distribution are calculated using estimates of carbon dioxide emission rates in those activities extracted from Argonne National Laboratories' Greenhouse Gases and Regulated Emissions in Transportation (GREET) model.

Finally, stricter CAFE standards can result in higher or lower emissions of "criteria" pollutants, by-products of fuel combustion that are emitted in extremely small amounts by the internal combustion engines used to power light trucks, as well as in gasoline refining and distribution. Criteria pollutants emitted in significant quantities by light-duty motor vehicles such as the light trucks affected by proposed CAFE standards include carbon monoxide, various hydrocarbon compounds, nitrogen oxides, and fine particulate matter. On one hand, the increased use of light trucks that occurs through the effect of higher fuel economy on the fuel cost per mile driven (the "rebound effect") causes increased emissions of criteria pollutants, since federal standards limit permissible emissions of these pollutants on a per-mile basis. Additional emissions of these pollutants from vehicle operation are estimated by multiplying the increase in total miles driven by light trucks of each model year and age during a calendar year by per-mile emission rates estimated using the U.S. Environmental Protection Agency's MOBILE6.1/6.2 motor vehicle emissions factor model.

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[9] This assumption results is an overestimate of carbon dioxide emissions, since a small fraction of the carbon content of gasoline is emitted in the forms of carbon monoxide and unburned hydrocarbons. However, the

At the same time, however, reductions in gasoline consumption and refining from stricter light truck CAFE standards lower emissions of criteria pollutants that occur during refining, distribution, and retailing of gasoline. As with carbon dioxide emissions, reductions in criteria pollutant emissions from gasoline refining and distribution are calculated using emission rates obtained from Argonne National Laboratories' GREET model. On balance, emissions of some criteria pollutants are likely to increase as a result of stricter CAFE standards, as increased emissions during vehicle operation outweigh the reduction in emissions from gasoline refining and distribution, while the reverse situation occurs for other criteria pollutants, thus lowering their total emissions.

The impact of proposed changes in the light truck CAFE standard on emissions of criteria pollutants was calculated by assuming fuel savings leading to lower U.S. imports of refined gasoline do not affect emissions of these pollutants within the U.S. However, fuel savings that are assumed to reduce the volume of crude petroleum imported and refined within the U.S. are assumed to produce a corresponding reduction in refinery emissions of criteria pollutants. Based on the Energy Information Administration's (EIA's) *Annual Energy Outlook 2002*, we estimate that 55% of CAFE-related fuel savings would be reflected in lower U.S. imports of refined gasoline, while the remaining 45% would result in reduced U.S. imports of crude petroleum and reduced gasoline refining within the U.S.[10] A recent EIA report on potential increases to fuel economy standards suggests that, depending on the magnitude and timing of such increases, a similar share of CAFE related savings in gasoline consumption would be reflected in reduced

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magnitude of this overestimate is likely to be extremely small.

[10] Energy Information Administration, *Annual Energy Outlook 2002*, DOE/EIA-0383(2002) (Washington, DC, December 2001).

imports of gasoline.[11] Although available estimates of the response of gasoline imports and domestic refining to fuel savings from stricter CAFE standards are variable and highly uncertain, our analysis indicates that under any reasonable assumption, the magnitude of the net (*i.e.*, accounting for both the rebound effect and changes in refining emissions) change in criteria pollutant emissions is extremely low relative to their current total.

External Benefits from Reducing Oil Imports and Gasoline Use

Increasing oil imports into the United States may impose costs on households and businesses that are not reflected in the market price for imported oil or by consumers of petroleum products. These "external" (or " social") costs of importing oil can include a range of economic costs that stem from the central role played by the U.S. in the world oil market, from the exercise of market power by the OPEC cartel, and from the importance of oil imports as a component of total U.S petroleum consumption. Increasing oil imports into the U.S. may increase the magnitude of these external economic costs, thus increasing the true cost of importing additional oil supplies by an amount that exceeds the market price of increased oil purchases themselves.

In addition, U.S. oil use imposes costs for environmental damages that result from extracting, transporting, and refining petroleum, as well as from the distribution and consumption of refined petroleum products such as gasoline. Unlike the external economic costs of importing oil, the costs of environmental damages in petroleum extraction, refining, and consumption occur regardless of whether oil is produced domestically or imported. Like the external economic costs of importing additional oil, however, these environmental damage costs are not borne by

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[11] Energy Information Administration, *Analysis of Corporate Average Fuel Economy (CAFE) Standards for Light Trucks and Increased Alternative Fuel Use*, SR/OIAF/2002-05 (Washington, DC, March 2002).

purchasers of crude petroleum or consumers of petroleum products, so extracting, refining and consuming additional oil supplies can increase the true costs to the U.S economy by more than the market price of increased crude oil purchases or of increased supplies of refined products.

Conversely, *reducing* the quantity of petroleum that is imported, refined, and consumed in the U.S. may lower the magnitude of both the external economic costs of oil imports and the environmental costs associated with petroleum refining and use. By reducing domestic demand for gasoline, tighter CAFE standards may reduce petroleum imports, thus lowering the costs to the U.S. economy associated with importing oil. Any reduction in these costs should be included among the external benefits of such a policy, which adds to the private cost savings experienced directly by consumers of refined petroleum products such as gasoline.

The Oil Import Premium

The full economic cost of importing petroleum into the U.S. is most often said to include three components in addition to the purchase price of petroleum itself. These are (1) higher costs for oil imports resulting from the combined effect of U.S. import demand and OPEC market power on the world oil price; (2) the risk of reductions in U.S. economic output and disruption of the domestic economy caused by sudden reductions in the supply of imported oil to the U.S.; and (3) costs for maintaining a U.S. military presence to secure imported oil supplies from unstable regions, and for maintaining the strategic petroleum reserve (SPR) to cushion against resulting price increases. The following discussion reviews the nature of each of these costs, assesses the degree to which they are likely to vary in response to changes in the level of oil imports, and provides empirical estimates of each component drawn from recent research.

Demand Costs

Demand costs for imported oil (often termed market power or "monopsony" costs) arise because the world oil price appears to be partly determined through the exercise of market power by the OPEC cartel, and because the U.S. is a sufficiently large purchaser of foreign oil supplies that its purchases can affect the world price. The combination of OPEC market power and U.S. "monopsony" power means that increasing domestic petroleum demand that is met through higher oil imports can cause the world price of oil to rise, and conversely that declining U.S. imports can reduce the world price of oil. Thus one consequence of increasing U.S. oil imports is an increase in the price paid for all oil consumed by the U.S., which is borne not only by purchasers of the additional imports, but also by all oil purchasers of imported and domestically-produced petroleum. [Recall that the world oil price also affects the price of domestically-produced oil.]

This demand or price effect can be readily illustrated with an example. If the U.S. imports 10 million barrels per day at a world oil price of $20 per barrel, its total daily import bill is $200 million. If increasing imports to 11 million barrels per day causes the world oil price to rise to $21 per barrel, the daily U.S. import bill rises to $231 million. The resulting increase of $31 million per day is attributable to increasing daily imports by only 1 million barrels, which means that the incremental cost of importing each additional barrel is $31, or $10 more than the newly-increased world price of $21 per barrel. This additional $10 per barrel represents the cost imposed on all users of imported oil by those demanding the increased level of imports, a cost in excess of the price they pay to obtain those additional imports. Note, however, that this additional cost arises only because the increase in U.S. oil imports affects the world oil price.

The key determinants of the magnitude of this demand or price effect are the degree of monopoly power over foreign oil supplies that is exercised by the OPEC cartel, and the degree of monopsony power over world oil prices exerted by the U.S. Only if OPEC exercises some monopoly power over international oil supplies and U.S. import demand can affect the world price will changes in the level of U.S. petroleum imports influence world prices, thus creating the demand component of the economic cost of importing additional oil into the U.S. Under these same conditions, of course, reductions in U.S. demand for imported petroleum would reduce the world oil price, thus creating additional benefits for all domestic oil consumers beyond the savings they experience simply from purchasing less oil.

The degree of current OPEC monopoly power is subject to considerable debate, but appears to have declined somewhat since the 1970s. Nevertheless, the consensus appears to be that OPEC remains able to exercise some degree of control over the response of world oil supplies to variation in world oil prices, so that the world oil market does not behave competitively. The extent of U.S. monopsony power is determined by a complex set of factors including the relative importance of U.S. imports in the world oil market, and the sensitivity of petroleum supply and demand to its world price among other participants in the international oil market. Most evidence appears to suggest that variation in U.S. demand for imported petroleum continues to exert some influence on world oil prices, although this influence appears to be limited.

Empirical estimates have been made of the demand component of the economic cost of importing additional petroleum into the U.S. A particularly detailed and careful analysis by Leiby et al. (1993) estimated a range of values for this cost corresponding to approximately $1.00-3.00 per barrel in today's terms. Using the midpoint of this range, reducing the level of U.S. oil imports by tightening the CAFE standard to lower future gasoline use by light trucks would result in "social" cost savings to the U.S. economy of approximately $2.00 per barrel beyond the direct savings in gasoline costs. This figure is equivalent to about $0.048 per gallon ($2 per barrel/42 gallons per barrel) of gasoline saved by a more stringent light truck CAFE standard that is assumed to result in reduced domestic gasoline refining and lower imports of foreign oil.

Disruption Costs

The second component of the external economic costs of importing oil arises partly because the increase in oil prices triggered by a disruption in the supply of imported oil reduces the level of output that the U.S. economy can produce using its available resources. The resulting reduction in potential economic output depends on the extent and duration of any disruption in the supply of imported oil to the U.S., since these in turn determine the magnitude of the resulting increase in prices for petroleum products, as well as whether and how rapidly these prices return to their pre-disruption levels. Even if the price for imported oil returns to its original level, however, the nation's economic output will be at least temporarily reduced compared to the level that would have been possible without the disruption in oil supplies and consequent increase in energy prices.

Because supply disruptions and resulting price increases occur suddenly rather than gradually, they impose additional costs on businesses and households for adjusting their use of petroleum products and other sources of energy more rapidly than if the same price increase had occurred gradually over time. These adjustments temporarily reduce the level of economic output that can be achieved even below the level that would ultimately be reached once the economy's adaptation of output levels and energy use to higher petroleum prices was complete. The additional costs imposed on businesses and households for making these adjustments reflect their inability to adjust prices, output levels, and their use of energy and other resources quickly and smoothly in response to rapid changes in prices for petroleum products.

Since future disruptions in foreign oil supplies are an uncertain prospect, each of these two components of the disruption cost must be weighted or adjusted for the probability that the supply of imported oil to the U.S. will actually be disrupted. Thus the "expected value" of these costs – the product of the probability that an oil import disruption will occur and the sum of costs from reduced economic output and the economy's abrupt adjustment to sharply higher petroleum prices -- is the relevant measure of their magnitude. Further, only the *change* in their expected value that results from lowering the normal (pre-disruption) level of oil imports through a policy such as tightening CAFE standards is relevant when assessing its effect on the "true" cost of importing oil into the U.S.

While the vulnerability of the U.S. economy to oil price shocks is widely thought to depend on total petroleum consumption rather than on the level of oil imports, variation in imports is still likely to have some effect on the magnitude of the price increase resulting from any disruption of import supply. In addition, changing the quantity of petroleum imported into the U.S. may also affect the probability that such a disruption will occur. If either the size of the resulting price increase or the probability that U.S. oil imports will be disrupted is affected by the pre-disruption level of oil imports, the expected value of the costs stemming from supply disruptions will also vary in response to the level of oil imports.

A variety of market mechanisms, including oil futures markets, energy conservation measures, and technologies that permit rapid fuel switching– are now available within the U.S. economy for businesses and households to anticipate and "insure" themselves against the effects of petroleum price increases. By employing these mechanisms – for example, by investing in energy conservation measures or installing technologies that can operate using multiple fuel sources – business and households can reduce their costs for adjusting to sudden increases in oil prices. While their availability has undoubtedly reduced the potential costs that could be imposed by disruptions in the supply of imported oil, the remaining value of these costs is probably not reflected in the market price of imported oil. This is because consumers of petroleum products are unlikely to take account of the potential costs that a disruption in imported oil supplies imposes on other sectors of the U.S. economy. Thus changes in oil import levels probably continue to affect the expected cost to the U.S. economy from potential oil supply disruptions, although the value of this component of oil import costs is likely to be significantly smaller than those estimated by studies conducted in the wake of the oil supply disruptions that occurred during the 1970s.

Leiby et al. (1997) estimate that under reasonable assumptions about the probability that import supplies will be disrupted to varying degrees in the future, this component of the social cost of oil imports ranges from well under $1.00 to approximately $2.00 per additional barrel of oil imported by the U.S., with adjustment costs accounting for the largest share of this total. Less recent studies of expected costs from prospective oil supply disruptions generally reported somewhat higher estimates, ranging from $2.00-3.00 per additional barrel at current import levels, but as indicated previously these costs are likely to have declined over time.

Most other recent research focuses on the historical costs to the U.S. economy from actual supply disruptions, which seems unlikely to provide relevant evidence on the disruption costs associated with future variation in oil imports. While some recent studies estimate costs to the U.S. economy from hypothetical future oil supply disruptions that imply higher values, these studies generally do not estimate the changes in these costs that would result from higher or lower levels of oil imports.

Overall, an estimate of approximately $1.50 per barrel seems appropriate for the incremental disruption cost component of the full incremental cost of imported petroleum. Specifically, this implies that reductions in the level of oil imports resulting from gasoline savings in response to a tighter CAFE standard for light-duty trucks would reduce disruption costs by this amount, in addition to the value of savings in gasoline use itself. This figure is equivalent to about $0.035 per gallon ($1.50 per barrel/42 gallons per barrel) of gasoline saved that is assumed to be reflected in lower U.S. oil imports of crude petroleum.

Military Security and Strategic Petroleum Reserve Costs

The third component of the external economic costs of importing oil into the U.S. is usually identified as the costs to the U.S. taxpayers for maintaining a military presence to secure the supply of oil imports from potentially unstable regions of the world and protect the nation against their interruption. Some analysts also include the costs to federal taxpayers for maintaining the U.S. Strategic Petroleum Reserve (SPR), which is intended to cushion the U.S. economy against the consequences of disruption in the supply of imported oil, as additional costs of protecting the U.S. economy from such oil supply disruptions. Thus many analyses include part or all of the annual cost for U.S. military operations in the Persian Gulf (and occasionally other regions of the world), together with the full costs of stocking and maintaining the SPR, as additional economic costs associated with importing oil into the U.S.

The overall costs for U.S. military security and for maintaining the SPR may vary over time in response to long-term changes in the actual level of oil imports into the U.S., but these costs seem unlikely to decline from their current threshold level to a lower level in response to the reduction in the level of U.S. oil imports that would result from this particular rulemaking. In addition, military activities even in world regions that represent vital sources of oil imports undoubtedly serve a range of security and foreign policy objectives that is considerably broader than simply protecting oil supplies. Further, the scope and duration of any specific U.S. military activities that were undertaken for the purpose of protecting imported oil supplies seem unlikely to be tailored to the actual volume of petroleum imports from the regions where they take place. As a consequence, annual expenses to support U.S. military activities do not seem likely to vary closely in response to changes in the level of oil imports prompted by conservation efforts or other policies. More specifically, reductions in gasoline use resulting from stricter CAFE standards seem unlikely to result in savings in the military budget that could be included as additional benefits.

Similarly, while the optimal size of the SPR from the standpoint of its potential influence on domestic oil prices during a supply disruption may be related to the level of U.S. oil consumption and imports, its actual size has not appeared to vary in response to recent changes in the volume of oil imports. Thus while the budgetary costs for maintaining the Reserve are similar to other external costs in that they are not likely to be reflected in the market price for imported oil, these costs have not varied in response to changes in oil import levels (although in theory they might ideally do so). As a result, this analysis does not include any cost savings from maintaining a smaller SPR among the external benefits of reducing gasoline consumption and petroleum imports by means of a tighter CAFE standard for light-duty trucks.

Environmental Costs of Oil Refining and Consumption

Environmental damages and their associated costs occur primarily as a result of petroleum refining and the distribution and combustion of petroleum products such as gasoline. These damages are primarily a consequence of emissions of regulated air pollutants, airborne toxic substances, and greenhouse gases that occur during petroleum refining, as well as during the subsequent distribution and consumption of petroleum products. Tighter CAFE standards for light-duty trucks will reduce gasoline consumption and the amount of petroleum refined, which will in turn reduce emissions of air pollutants and greenhouse gases.

The estimates of benefits from stricter CAFE standards for light trucks include changes in economic damages from emissions of regulated (or "criteria") air pollutants. Reductions in gasoline use and refining from improving the fuel efficiency of new vehicles lead to lower emissions of regulated pollutants, while increased driving stemming from the "rebound" effect increases emissions of these pollutants. Thus on balance, emissions of criteria pollutants can rise or fall as a consequence of tightening CAFE standards, so the consideration of these emissions can add to or partially offset other benefits from reducing gasoline use. Because of differences in their relative importance as by-products of petroleum refining, fuel distribution, and motor vehicle use, emissions of some criteria pollutants may decline in response to tighter CAFE standards, while others may increase.

Because federal motor vehicle emissions regulations require that light-duty trucks have the same emission levels of regulated air pollutants regardless of their fuel economy, tighter CAFE standards will reduce emissions of these pollutants only from petroleum refining. In contrast, improving light truck fuel economy will reduce greenhouse gas emissions in both vehicle use and gasoline refining, since greenhouse gas emissions from vehicle operation depend directly on gasoline consumption. However, the increase in light truck use that is likely to accompany improvements in their fuel economy (called the rebound effect, discussed in detail above) will cause some increase in emissions of both regulated air pollutants and greenhouse gas emissions from vehicle use, which will partly offset reductions in these emissions due to reduced gasoline refining and consumption.

This analysis relies on estimates of air pollutant and greenhouse gas emissions from gasoline refining that are derived from Argonne National Laboratories' Greenhouse Gases and Regulated Emissions in Transportation (GREET) model. Reductions in emissions of carbon dioxide, the primary greenhouse gas emitted as a result of gasoline use, were estimated form technical specifications of gasoline obtained from the GREET model. Estimated emissions of regulated or criteria air pollutants from increased light truck use were derived from the most recent version of the U.S. Environmental Protection Agency's motor vehicle emission factor model (MOBILE6.1/6.2).

Estimates of the reduced economic value of damages to human health resulting from emissions of regulated air pollutants were obtained from a recent Report to Congress issued by the Office of Management and Budget, which in turn relied upon an analysis of air pollution damages conducted by the Environmental Protection Agency. These estimates are applied to the estimated changes in emissions of each criteria pollutant to determine the resulting change in damage costs caused by that pollutant, which may be negative (and thus constitute an additional economic benefit of tighter CAFE standards) or positive (and thus partly offset other economic benefits). Reductions in greenhouse gas emissions are reported only in terms of their equivalent carbon mass content.

Potential changes in CAFE standards and air pollutant emission regulations, notably the "Tier 2" emission standards for light-duty vehicles that are scheduled to take effect beginning in model year 2004, will cause emissions of greenhouse gases and air pollutants to vary among light trucks manufactured during different future model years. Because each future year's light truck fleet will consist of a different mix of vehicles from different model years, the benefits from reducing emissions of these pollutants through tighter CAFE standards will vary over the future when expressed per vehicle-mile of travel or per gallon of gasoline consumed.

Provided in Table VII-4 is the change in the value of criteria pollutant emissions. A negative value is a benefit, a reduction in the amount of emissions.

Table VII-4(a)
Value of Criteria Pollutant Emissions

MY 2005	Value of Emissions Savings $/ton or $/metric ton*	Change in Criteria Pollutant Emissions Assuming 45 Percent Domestic Refining (Thousand Tons)	Total Value	Present Discounted Value
Carbon Monoxide (CO)	$20	15.29	$305,800	$139,000
Volatile Organic Compounds (VOC)	$1,440	0.49	710,700	213,600
Nitrogen Oxides (NOx)	$1,440	0.13	190,400	-65,500**
Fine Particulate Matter (PM 2.5)	$11,539	-0.07	-815,400	-466,400
Total			**- $391,300**	**$-179,200**

* The mid-points of a range of values for some of the emission savings were used in the calculations for convenience. These values are a small part of the overall estimates in the analysis, so using mid-points does not affect the outcome. The range of values for emission savings for VOC and NOx are $519 to $2,360 per ton.

** Because there are two streams of benefits, some values are positive and some values relative, and discounting affects the first few years in the stream less than the last years, the (+-) signs can change from positive to negative after discounting, as with the nitrogen oxide (NO_x) values.

Table VII-4(b)
Value of Criteria Pollutant Emissions

MY 2006	**Value of Emissions Savings $/ton or $/metric ton**	**Change in Criteria Pollutant Emissions Assuming 45 Percent Domestic Refining (Thousand Tons)**	**Total Value**	**Present Discounted Value***
Carbon Monoxide (CO)	$20	33.26	$665,200	$299,300
Volatile Organic Compounds (VOC)	$1,440	1.04	1,496,500	410,800
Nitrogen Oxides (NOx)	$1,440	-0.11	-156,000	-445,900
Fine Particulate Matter (PM 2.5)	$11,539	-0.16	-1,891,600	-1,082,600
Total			**$114,200**	**$-818,500**

Table VII-4(c)
Value of Criteria Pollutant Emissions

MY 2007	**Value of Emissions Savings $/ton or $/metric ton**	**Change in Criteria Pollutant Emissions Assuming 45 Percent Domestic Refining (Thousand Tons)**	**Total Value**	**Present Discounted Value***
Carbon Monoxide (CO)	$20	49.51	$990,200	$444,800
Volatile Organic Compounds (VOC)	$1,440	1.50	2,155,400	566,400
Nitrogen Oxides (NOx)	$1,440	-0.59	-850,600	-991,800
Fine Particulate Matter (PM 2.5)	$11,539	-0.25	-2,906,900	-1,663,800
Total			**- $611,900**	**-$1,644,400**

A Summary of the Costs of Externalities

In total, the value of externalities added into this analysis are $0.083 per gallon of gasoline, comprised of $0.048 for monopsony effect, the effect of reducing the demand for gasoline on the world market price of gasoline, and $0.035 for reducing the threat of supply disruptions.

Table VII-5 shows the results of the analysis for the average value of fuel savings to consumers. Table VII-6 provides the aggregate savings in fuel over the vehicles' lifetime. Table VII-7 summarizes estimates of the social value of the estimated changes in fuel use and emissions. Incrementally, the estimated present discounted value of fuel saved from the social perspective over the lifetime of the fleet is estimated to be $28 in MY 2005, $63 in MY 2006, and $97 in MY 2007.

Table VII-5

Incremental Fuel Benefit to Consumers on a Societal Basis over the Vehicle's Lifetime Per Vehicle

Model Year	Estimated Fuel Economy Level (mpg)	Lifetime Fuel Cost ($2000) Present Discounted Value (7%)	Lifetime Fuel Savings ($2000) Present Discounted Value (7%)
Adjusted Baseline Manufacturer's Plans			
MY 2005	21.21	$4,952	
MY 2006	21.49	$4,922	
MY 2007	21.83	$4,862	
Proposed Level			
MY 2005	21.35	$4,924	$28
MY 2006	21.82	$4,858	$63
MY 2007	22.35	$4,765	$97

Table VII-6

Savings in Millions of Gallons of Fuel

Model Year	Estimated Fuel Economy Level (mpg)	Lifetime Fuel Use in Millions of Gallons	Lifetime Fuel Savings in Millions of Gallons (Undiscounted)	Lifetime Fuel Savings in Millions of Gallons (Discounted)
Adjusted Baseline Manufacturer's Plans				
MY 2005	21.21	64,544		
MY 2006	21.49	65,106		
MY 2007	21.83	65,130		
Proposed Level				
MY 2005	21.35	64,184	361	207
MY 2006	21.82	64,267	839	480
MY 2007	22.35	63,826	1,293	740

Total Present Value of Benefits Over the Lifetime of the Model Year

The total present value of benefits includes the value of fuel saved, the externalities, and the criteria pollutants. These are expressed in present value by model year in millions of year 2000 dollars.

Table VII-7
Present Value of Lifetime Social Benefits
(Millions of $2000)

Model Year	**Fuel Savings**	**Reduced Oil Import Externalities**	**Reduced Criteria Pollutant Emissions**	**Total Social Benefits**	**Social Benefits Per Vehicle**
MY 2005	$211.5	$7.8	$0.2	$219.4	$29
MY 2006	$494.5	$18.0	$0.8	$513.3	$66
MY 2007	$764.7	$27.8	$1.6	$794.1	$100

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VIII. NET BENEFITS/MARGINAL BENEFITS

This chapter adds together the costs on a per vehicle basis of technologies needed to make improvements in fuel economy to meet the proposed standards with the potential benefits. Table VIII-1 provides the estimated costs and benefits from Chapters VI and VII. These are average net benefits from a societal perspective over the fleet of all light trucks to which the standard is applicable. These are incremental costs and benefits compared to an adjusted baseline of manufacturers plans with each manufacturer at a minimum fuel economy level of 20.7 mpg. Table VIII-2 shows the total cost and benefits in millions of dollars for the projected fleet of sales for each model year.

Table VIII-1

Incremental Cost and Social Benefit Analysis
Per Vehicle - Over its Lifetime
(In Year 2000 Dollars)

	Costs	**Benefits**	**Net Benefits**
MY 2005	$14	$29	$15
MY 2006	$28	$66	$38
MY 2007	$47	$100	$53

Table VIII-2

Incremental Total Cost Benefit Analysis
Over the Lifetime of the Fleet
(In Millions of Year 2000 Dollars)

	Costs	**Benefits**	**Net Benefits**
MY 2005	$108	$219	$111
MY 2006	$221	$513	$292
MY 2007	$373	$794	$421

Table VIII-3 provides the discounted costs and discounted benefits compared to the discounted lifetime fuel savings.

Table VIII-3

Incremental Total Cost Benefit Analysis
Over the Lifetime of the Fleet
(In Millions of Year 2000 Dollars)

	Costs	**Benefits**	**Net Benefits**	**Fuel Saved***
MY 2005	$108	$219	$111	207
MY 2006	$221	$513	$292	480
MY 2007	$373	$794	$421	740
	Dollars per gallon of fuel saved			
MY 2005	$0.52	$1.06	$0.54	
MY 2006	$0.46	$1.07	$0.61	
MY 2007	$0.50	$1.07	$0.57	

* Millions of gallons of fuel saved

Marginal Benefits

This discussion pulls together the societal benefits and miles per gallon improvement of those societal benefits to determine the marginal benefits of additional improvements per percent improvement in mpg. These benefit estimates can then be compared to the "Cost per Percent Improvement" in Table V-4 or Table VI-1 to determine which technologies are cost beneficial in terms of marginal costs.

These calculations are:

The societal benefit of going from the MY 2005 baseline of 21.21 mpg to the proposed standard of 21.35 mpg is $29. The percent improvement in mpg is 21.35/21.21 = 1.0066. $29/0.66 mpg = $43.93 per 1 percent improvement.

The societal benefit of going from the MY 2006 baseline of 21.49 mpg to the proposed standard of 21.82 mpg is $66. The percent improvement in mpg is 21.82/21.49 = 1.0153. $66/1.53 mpg = $43.13 per 1 percent improvement.

The societal benefit of going from the MY 2007 baseline of 21.83 mpg to the proposed standard of 22.35 mpg is $100. The percent improvement in mpg is 22.35/21.83 = 1.0238. $100/2.38 mpg = $42.07 per 1 percent improvement.

Thus, any technology, which has a cost per percent improvement of less than $42 to $44, is cost beneficial for society. Table V-4 ranks the technologies on a cost per percent improvement in mpg basis and shows that there are five technologies that are cost/beneficial on a marginal cost basis. These are low friction lubricants, engine accessory improvements, improving rolling resistance, engine friction reduction, and aerodynamic drag reductions.

Many of the more expensive technologies (on a cost per percent improvement in mpg) that are applied in this analysis are already in the manufacturer's plans. Many of these technologies are applied because of their improvement to performance and not solely because of their fuel economy improvement. Thus, these planned technology implementations are not included in the incremental cost and benefits analysis. Most of the five technologies found at the margin to be cost beneficial are being applied by NHTSA over and above the manufacturers plans. Thus, there are incremental net benefits, over the manufacturers' plans.

IX. SMALL BUSINESS IMPACT

Regulatory Flexibility Act

The Regulatory Flexibility Act of 1980 (5 U.S.C. §601 et seq.) requires agencies to evaluate the potential effects of their proposed and final rules on small businesses, small organizations and small governmental jurisdictions. According to the Small Business Administration's small business size standards (see CFR 121.201), an automobile manufacturer (NAICS code 336111) must have less than 1,000 employees to qualify as a small business.

The agency knows of no small businesses that produce light trucks. All of the manufacturers of light trucks have thousands of employees.