Alliance OF AUTOMOBILE MANUFACTURERS

May 8, 2002

Docket Section
National Highway Traffic Safety Administration
400 Seventh Street, SW
Washington, DC 20590

Subject: Request for Comments; National Academy of Science Study and Future Fuel Economy Improvements Model Years 2005-2010

Docket No. 2002-11419, RIN 2127-AI70

The Alliance of Automobile Manufacturers (Alliance) is a trade association of 12 car and light truck manufacturers who account for more than 90 percent of U.S. vehicle sales. Member companies, which include BMW Group, DaimlerChrysler, Fiat, Ford Motor Company, General Motors, Isuzu, Mazda, Mitsubishi Motors, Nissan, Porsche, Toyota, and Volkswagen, employ about 600,000 Americans at 250 facilities in 35 states.

Attached are the Alliance's comments on the February 7, 2002 "Request for Comments on the National Academy of Science Study and Future Fuel Economy Improvements of Light Duty Trucks for the 2005 through 2010 model years." The setting of future standards is a complex issue that can have detrimental effects on industry, the economy and consumer choice, if done without proper consideration of all issues. The National Academy of Science contributed to this analysis, but much more information is needed to determine the appropriate CAFE standards for light trucks.

The Alliance appreciates the opportunity to respond to this request for comments. We look forward to working with NHTSA to establish light truck CAFE standards for the 2005 model year and beyond. If you have any questions concerning these comments, please contact me at (248) 357-4717.

Sincerely,

Casimer J. Andary

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Director, Regulatory Programs

DEPARTMENT OF TRANSPORTATION
National Highway Traffic Safety Administration
49 CFR Part 533
[Docket No. 2002-11419]
RIN 2127-AI70
Request for Comments National Academy of Science Study and Future Fuel Economy Improvements Model Years 2005-2010

The Alliance of Automobile Manufacturers (Alliance) and its member companies are taking a proactive leadership role in researching and developing advanced fuel economy technologies for passenger cars and light trucks. We believe incentives to spur the development of these advanced technologies are the best long-term solution to addressing energy issues. We look forward to working with NHTSA to establish light truck CAFE standards for 2005 model year and beyond.

The setting of future standards is a complex issue that can have detrimental effects on industry, the economy and consumer choice if done without proper consideration of all issues. The National Academy of Science (NAS) contributed to this analysis in their 2002 publication "Effectiveness and Impact of Corporate Average Fuel Economy (CAFE) Standards" (NAS Report), but much more information is needed to determine the appropriate CAFE standards for light trucks.

Alliance member companies will provide confidential data in responding to the questions asked by NHTSA. However, we are consolidating some of the answers from our members into a single response.

Questions and Answers

1. The NAS Study found that the CAFE program, as currently structured, has contributed to traffic fatalities and injuries. As an agency whose primary responsibility is safety and is therefore deeply concerned about the NAS finding, NHTSA requests comments on this NAS finding. Among our questions are:

(a) Is the safety impact understated or overstated?

Answer:
The Alliance agrees with the NAS Report that the downweighting/downsizing that took place in the late 1970's, early 1980's led to increased traffic casualties, as compared to what would have been the case had vehicle size/weight remained the same. There can be no serious disagreement with this finding as the highway safety literature is rich in the relationship of size/weight to occupant safety.

NHTSA itself, in 1977, when the passive restraint standard was reissued, stated in the preamble to the automatic occupant protection requirements of FMVSS 208 that one of the reasons for the re-issuance of that standard "…was the **certainty** that an increasing proportion of the passenger car fleet will be small cars, in response to…the automotive fuel economy program…The introduction of these new, smaller vehicles…holds the prospect of an increase in the fatality and injury rate…The trend toward smaller cars to improve fuel economy…contains a potential for increased hazard to the vehicle's occupants." (Emphasis added). Thus, the agency itself, as it embarked on fuel economy rulemaking, recognized that (1) downsizing/downweighting was necessary to improve passenger car CAFE at that period in time; and (2) it could result in increased highway deaths and injuries.

Additional studies since that time have come to the same conclusion and have quantified the results, all of which closely agree with those of the NAS Report. For example, in a 1989 NHTSA report, "An Evaluation of Door Locks and Roof Crush Resistance of Passenger Cars," NHTSA stated that downsizing led to an additional 1,340 fatalities per year due to increased propensity of smaller/lighter vehicles to roll over. In 1991, NHTSA stated "Evaluation [of the weight/size/safety issue] led NHTSA to the conclusion…that the 1,000 pound reduction in average car curb weight…results in nearly 2,000 additional fatalities and 20,000 additional serious injuries per year." ("Effect of Car Size on Fatality and Injury Risk")

The agency's 1997 study, "Relationship Between Vehicle Size and Fatality Risk" by Kahane, which served as the basis for the NAS committee's analysis, concluded that a 100 lb. reduction in passenger car vehicle weight would increase fatalities between 214 and 390 per year (2-sigma confidence bounds), which, for a 1,000 pound reduction that actually took place, would result in at least 2,000 additional deaths annually.

A 1989 Brookings-Harvard study estimated that CAFE caused a 14 to 27 percent increase in occupant fatalities—an annual toll of 2,200 to 3,900 deaths. An independent USA Today analysis in 1999 concluded that, over its lifetime, CAFE resulted in 46,000 additional fatalities, or more than 2,000 annually.

Other studies by Leonard Evans from General Motors and the Insurance Institute for Highway Safety ("Where is Safety in the Fuel Economy Debate," 1990), the Office of Technology Assessment, and many others have all reaffirmed the relationship between size and weight and motor vehicle safety.

In reviewing the literature, NAS came to the same, well-founded conclusion, not once, but twice. First, in its 1992 study, the NAS concluded that "fuel economy is adversely linked to safety through reductions in size and weight…any major reduction in vehicle weight carries the potential for reduced safety…" The Committee further concluded that after evaluating previous studies, "The overall conclusion of previous analyses is that the historical changes in the fleet—downsizing and/or downweighting—have been accompanied by increased risk of occupant injury." They concluded that "There is likely to be a safety cost if downweighting is used to improve fuel economy…" and urged NHTSA to conduct a comprehensive analysis on the subject, which culminated in the Kahane study cited above and which served as the basis for the new NAS evaluation on this issue.

The most recent NAS Report evaluated these previous studies and concluded, "the evidence is clear that past downweighting and downsizing of the light-duty fleet, while resulting in significant fuel savings, has also resulted in a safety penalty. In 1993, it would appear that the safety penalty included between 1,300 and 2,600 motor vehicle crash deaths that would not have occurred had vehicles been as large and heavy as in 1976." In addition, the Report estimates that there were an additional 13,000 to 26,000 additional moderate to critical injuries.

Given the consistent findings in the safety literature, from such diverse sources as NHTSA, NAS, universities, and Insurance Institute for Highway Safety (IIHS), we agree with the finding of the NAS Report that prior downsizing/downweighting has resulted in a safety penalty and the magnitude in the Report of 1,300 to 2,600 additional deaths per year appears reasonable.

(b) Would NAS' proposed changes to CAFE reduce this safety penalty?

Answer:
It is assumed that the question refers to the NAS' recommended consideration of attribute-based standards, and, in particular, a weight-based standard. The pros and cons of such alternative systems of fuel economy improvements are discussed elsewhere in this response. Well-thought out and researched CAFE levels, even under the current program design, if based on industry technological capability, exclusive of downsizing and downweighting, can result in improved fuel economy from the new vehicle fleet and limit adverse safety consequences.

(c) Could CAFE standards be modified so that manufacturers are encouraged to achieve improved fuel economy through application of technology instead of through downsizing and downweighting?

Answer:
We believe that any change in the current CAFE system needs to be viewed not just in terms of fuel savings and safety but also competitive effects, jobs, consumer choice in the marketplace, costs, and other issues raised in these comments.

There are already incentives to avoid downsizing vehicles, because in general the public wants larger vehicles and more features. However, manufacturers may be forced to downsize if CAFE standards are set at such a stringent level that other technology solutions are not readily available or are cost-prohibitive.

(d) NHTSA requests comments on the extent to which increases in light truck fuel efficiency are feasible during MYs 2005-2010 and on whether any of these increases would involve means—such as significant weight and size reduction—that could adversely affect safety.

Answer:
Alliance members' plans for improvements in fuel efficiency are noted in their responses.

(e) We note that the NAS found that if future weight reductions occur in only the heaviest of the light-duty vehicles, that can produce overall improvements in vehicle safety. If there would be adverse effects, how could they be mitigated?

Answer:
We believe the question refers to the research conducted by IIHS, which is referenced on page 72 of the NAS Report. That research suggested that if all pickups and SUVs weighing more than 4,000 lbs. were replaced with similar vehicles weighing between 3,500 and 4,000 lbs. that there could be a net reduction in total fatalities by about 0.26 percent. There was no mention in the original IIHS research or the NAS Report as to how much light truck fleet CAFE might improve with such a hypothetical action.

We believe this question raises several questions and issues.

First, just as the NAS committee urged NHTSA to re-examine the size/weight/safety issue, we believe this concept should be part of that re-analysis. The existence of such a hypothetical threshold has not been well established. It has certainly not withstood the test of time as we have seen with the numerous studies that have established the detrimental effect of general mass reduction on safety.

Second, the issue of vehicle compatibility is extremely complex, as the Agency well knows, given its intensive research into this area. It involves more than mass; including also the geometry and stiffness of both struck and striking vehicles. Thus, it has not been shown that simply reducing mass of vehicles above a specified weight will improve societal safety or whether safety can be improved through other means, without reducing such mass.

Third, the NAS Report is clear that reducing mass always reduces the protection to the occupants of that vehicle. Thus, NHTSA needs to consider both societal safety and individual safety. For single vehicle accidents, the societal and individual results are one and the same. For multiple vehicle accidents, the literature generally indicates societal and individual impacts are similar. That is, weight reduction of either vehicle increases safety risk to both vehicle occupants. If studies prove otherwise, then this raises public policy issues that we believe NHTSA needs to fully air. Should, hypothetically, weights of certain types of vehicles be limited so as to reduce the harm they cause to lighter vehicles with which they may collide, then those occupants would suffer additional harm. In essence, such actions, should they ever occur, would be lessening the safety of those in heavier vehicles to better protect those in lighter vehicles. Consumers should be fully aware of such a trade-off, was it ever to be required. We are not aware of any NHTSA action that, knowingly, sacrificed one portion of the motoring public so as to benefit another.

We also note that the IIHS research and the NAS Report both concluded that safety is improved more significantly not by reducing weight of the heaviest vehicles but by increasing the weight of the lightest ones. The safety benefits of eliminating the lightest cars and/or the lightest cars and SUVs had five times the safety benefits compared to reducing the weight of the heaviest trucks, according to the IIHS research. And, contrary to what most advocates of radically higher CAFE standards argue, even if the disparity among weights of just light-duty vehicles were reduced, crashes of like vehicles, but smaller and lighter than those of today, would actually increase casualties. Thus, from a pure safety perspective, *increasing the weights of the lightest vehicles would yield the greatest safety benefits.* Of course, NHTSA has the unenviable task of considering the tradeoffs among mass, safety and fuel economy.

The Alliance also believes that a question NHTSA needs to address in its current updating of Kahane's 1997 study is whether the past is prologue. That is, some have argued that vehicles are much safer now than they were even ten years ago and a study based on prior year models may not be relevant to future vehicles. Thus, these groups argue, that the improvements in safety negate the past negative relationship between size, weight and safety. We would agree that vehicles continue to improve in safety but we also would note that the laws of physics have not changed. While the magnitude of the relationship between size/weight and safety may change, we believe the direction of the relationship will not; i.e., decreases in size/weight will have adverse safety effects, although perhaps at a smaller (or larger) magnitude than was previously found. We agree with the NAS Report which stated that "although it is possible that the weight, size, and safety relationships in future fleets *could* be different from those in the 1993 fleet studied by Kahane (1997), there appears to be no empirical reason to expect those relationships *will* be different." (pages 28-29)

2. What is the technological feasibility and economic practicability of various fuel efficiency enhancing technologies that fall under the general headings of engine, vehicle and transmission technologies? In answering this question, please address, for each of these technologies, as well as any other relevant/related technologies:
   (a) the impact on fuel efficiency;
   (b) costs and benefits to the consumer;
   (c) manufacturer costs;
   (d) lead time;
   (e) degree of current use in passenger cars and light trucks;
   (f) impacts on safety, including injuries and fatalities; and
   (g) potential fleet penetration.
   (h) effects of environmental (especially vehicles emissions standards) and other regulations on their application/penetration.

Answer:
Each manufacturer will address this in detail in their individual submissions. However, the Alliance can comment on the general aspects of technology introduction and penetration. The impacts of safety and emission regulations are detailed in the answer to Question 8.

Today, all manufacturers are actively working on advanced technology programs to improve vehicle fuel efficiency, lower emissions, and increase occupant protection. Hybrids are an example of technology that improves fuel efficiency, yet has issues with cost and widespread consumer acceptance. At the same time, fuel-efficient technologies such as lean burn and diesel engines are constrained by emission regulations, notwithstanding the anticipated availability of ultra-low sulfur diesel fuel in 2006. For all these advanced technologies, however, the relatively cheap price of fuel in the U.S. decreases consumer fuel savings and undermines the marketability of these technologies.

Many manufacturers have been implementing the technologies included in the list of technologies in this question and identified by the NAS as production intent technologies and will continue to do so with or without additional CAFE regulations. Use of these technologies varies among manufacturers, vehicle types, and market segments. Of the production intent technologies, their existing penetration must be considered when determining the potential of these technologies to increase the fuel economy of the fleet.

> Weight reduction – The low hanging fruit was picked years ago. Increased safety standards will add weight and require expensive offsets just to keep weight constant.
> Multi-valve engines – 65% of the 2002 models already have multi-valve technology according to the 2002 MY EPA mileage guide.
> Variable valve timing – According to EPA, this technology is already employed on many vehicles including 36% of the cars and 13% of the trucks.
> Engine supercharging with downsized engine – This technology is used on 80 models today according to the 2002 MY data.
> 5-speed automatic transmissions – 66% of the 2002 model SUV already employ transmissions with 5 or more forward gears.

Many of the other technologies are considered "emerging technologies" and have not yet been developed fully for incorporation into the light truck fleet. As noted in the NAS Report, there are uncertainties with the implementation of these technologies due to cost, application, drivability, and durability. It is uncertain if these obstacles will be overcome or the expected fuel economy benefit will be realized when the technology is implemented. Some of the qualifiers that NAS identified with these emerging technologies included:

> Continuously Variable Transmission (CVT) – Application is limited to smaller, lightweight vehicles with limited trailer tow capability. "However, production costs, torque limitations, and customer acceptance of the system's operational characteristics must be addressed." (NAS - 38)
> Automatic Transmission (ATX) with aggressive shift logic – limited applicability. "However, these will be highly affected by customer perceptions in the United States and may require quite some time for significant acceptance." (NAS - 38)
> Drag reduction "However, vehicle styling and crashworthiness have significant influences on the ultimate levels that can be achieved. As drag coefficients proceed below about 0.30, however, the

design flexibility becomes limited and the relative cost of the vehicle can increase dramatically." (NAS - 39)

Improved rolling resistance – Limited by constraints of winter and foul weather driving conditions. "The impacts on performance, comfort, durability, and safety must be evaluated." (NAS - 39)

Automatic shift/manual transmission (ADM/AMT) "However, increased cost, control system complexity, durability, and realizable fuel consumption gain versus acceptable shift quality for U.S. customers must be addressed." (NAS - 38)

Integrated starter/generator (ISG) – Real world gains are limited by the need to operate the engine when the air conditioning or heater is operational.

Engine friction – Most engines have been incorporating friction-reducing techniques for 20 years now. There remain some opportunities, but it is at the low end of the NAS assessment or approximately 1%.

Electric power steering – Some potential for use impact approximately 1 to 2%, but when combined with other features that require power, incorporation of the technology requires a 42-Volt system.

Cylinder deactivation - "However, engine transient performance, idle quality, noise and vibration can limit efficiency gains and must be addressed." (NAS - 36)

Intake Valve Throttling (IVT) - "However, significant cost and complexity in actuation, electronic control, and system calibration are to be expected." (NAS - 37)

As NHTSA considers the benefits of production intent and emerging technologies, lead-time and manufacturers' cycle time must be considered. Technologies cannot be incorporated in every vehicle at the same time, due to capital costs, differing vehicle and powertrain planning cycles, and engineering resource constraints both at the manufacturer and supplier level. The incorporation of production intent technologies is dependent on the business case, customer acceptance, and cost effectiveness.

For emerging technologies, those not yet fully developed, a time period of at least three to five years is needed to prove the technology in production through low volume introduction. This time is required to not only validate the technology in the field, but to test customer acceptance of the technology's characteristics. Once the technology receives acceptance, phase-in of the technology can be accomplished across some vehicle lines. It is estimated that this process spans another ten to fifteen years. This assumes that consumers deem the technology cost effective or desirable and that another technology is not introduced that is more viable.

Cost-effective technology has been and will continue to be introduced by manufacturers to improve fuel economy. However, with relatively low fuel prices, consumers' preference for larger vehicles, additional content and higher performance has offset much of these efficiency gains.

3. What is the cost-effectiveness of each technology identified in Question 2, as well as any other relevant technologies, assuming alternative plausible gasoline prices forecast for MY 2005-2010, and assuming alternative payback periods ranging from 3 years to 10 years?

Answer:
Answering this question involves some discussion of confidential business information. Therefore, Alliance members plan to address this question in detail in their own individual responses.

4. Taking into account the response to Question 2, and the statements recently made by Ford and General Motors about the fuel economy of their vehicles by 2005, and DaimlerChrysler's response, indicate the ability of each manufacturer to improve its light truck CAFE for each model year during the MY 2005-2010 timeframe. Specify the fuel economy improvements on a vehicle-by-vehicle basis that will result in the achievement of the manufacturers fuel economy pledges. For each vehicle, please list the specific technologies that will be employed and the increase in fuel economy attributed to such technology. By what model year would maximum penetration of all current fuel economy enhancing technologies be feasible? Why wouldn't such maximum penetration be feasible earlier than that model year?

Answer:
The individual manufacturers will address this question in their responses, as applicable.

5. What analyses of manufacturer light truck fuel economy capabilities for MY 2005-2010 are available? What are the strengths and weaknesses of each such analysis?

Answer:
Several studies have been published in the last few years that address future light truck fuel economy capabilities. Most of the more technical studies examine the time period from 2010 to 2020 or a time span of 10 to 15 years in the future. Many of the studies include both near term and emerging technologies and some include advanced technology, similar to the NAS Report. Most studies overstate the benefits and understate the costs and therefore conclude that much higher fuel economy levels are feasible and cost effective. Some reports, such as the "Drilling in Detroit," incorrectly use the information in these studies of future capabilities to conclude that technology exists today to significantly increase fuel economy. Attachment 1 summarizes a number of studies and presents our comments on them. The Alliance does not believe any of these studies should be used in NHTSA's rulemaking since their authors have not had access to detailed, proprietary product plan, technology, financial information, and have no experience producing salable vehicles. On the other hand, the purpose of this Request for Comments is exactly that – to provide NHTSA with the necessary data and input so the agency can find the proper balance among all the competing factors.

6. What data are available on the usage characteristics of light trucks, i.e., how many passengers and/or how much cargo the different types of light trucks typically carry? What survey and other data are available on the importance that consumers place on the fuel economy of light trucks relative to other vehicle attributes?

Answer:
Studies have shown that a large share of truck buyers use trucks for their truck utility features. Truck buyers use their vehicles to carry bulky, heavy, wet or dirty cargo, as well as for recreational activities. For example, some key findings from the July 1998 J. D. Power and Associates "Light Duty Truck Reference Guide" on usage patterns, are summarized below:

- *"Over half of all light duty truck owners use their vehicle to tow either a boat or trailer."*
- *"…it is the combination of favorable functional attributes as well as safety components (four-wheel drive and improved visibility) coupled with styling and image that attract buyers."*
- *"Along with the improvements in quality, consumer's satisfaction and corresponding sales were enhanced by core attributes such as functionality, including towing capacity and cargo space."*

In addition to the consumers who use these vehicles for personal use (and were surveyed by J. D. Power) a significant number of these vehicles are also purchased for commercial use, including small business, farming and skilled trades, etc. The important contribution these vehicles make to society and the economy when used in these roles cannot be ignored.

7. By their nature, fuel economy standards lower the marginal cost of driving. What effect does this cost difference have on vehicle miles traveled?

Answer:
As fuel economy increases, the cost to drive decreases. This increased driving results in an increase in fuel consumed and is said to "take-back" or "rebound" the fuel saving that would have otherwise occurred without the increased VMT.

In David Green's 1999 report "Fuel Economy Rebound Effect for U.S. Household Vehicles," an econometric estimation of the rebound effect for household vehicle travel in the United States was studied. Based on the data collected by the EIA over 15 years, the authors estimate a long term "take back" of about 20 percent of potential energy savings. Consumer responses to changes in fuel economy and fuel price per gallon appear to be equal and opposite.

The International Energy Agency estimates a rebound effect in the order of 0.1 to 0.3, or 10 to 30 percent of the fuel savings from efficiency improvements is lost to increased vehicle travel. In Europe, where diesel fuel is priced low, the rebound effect due to increased fuel economy is between 20 to 30 percent (source: "Fuel Economy Improvement, Policies and Measures to Save Oil and Reduce CO_2 Emissions," Fulton, November 2000, p 38).

The 1994 Cartalk dialogue on fuel economy agreed upon a 35% take-back effect, or an increase in miles driven of 3.5% with every 10% reduction in the cost per mile. Here, the relevant metric is price per mile of travel. Over the entire national vehicle fleet, there will be no difference between a 10% reduction in fuel consumption per mile, and a 10% reduction in fuel cost per mile. VMT will increase from the reduction in dollars spent per mile.

The following table demonstrates this concept. A hypothetical 10% reduction in fuel consumption (or an 11.1% increase in fuel economy) will increase miles driven by 3.5%. The net effect is only a 7% reduction in fuel consumption, not a 10% reduction since the 10% reduction of fuel consumption per mile results in a 3.5% VMT increase.

		Note
Base fuel consumption	0.0454 gal/mile	(22.0 mpg)
Hypothetical new fuel consumption	0.0409 gal/mile	(24.4 mpg)
Reduction in consumption	0.0045 gal/mile	10.0%
Base miles driven	15000 miles	
Increase in miles driven	525 miles	3.5%
Actual miles driven	15525 miles	
Base fuel consumption	681.8 gal	
“No rebound” fuel consumption	613.7 gal	
“No rebound” fuel saved	68.1 gal	10%
Actual fuel consumption	635.3 gal	
Actual fuel saved	46.5 gal	7%

8. To what extent are other Federal standards likely to affect manufacturers' CAFE capabilities in MYs 2005-2010? Answers to this question should include not only the effects of such standards when first implemented, but also the prospect for reducing those effects subsequently.

Answer:
While improving the efficiency of motor vehicles is a worthy goal, imposition of fuel economy requirements cannot be undertaken without considering competing priorities. Automobile manufacturers’ efforts to increase fuel economy are often frustrated by equally challenging requirements to improve emission controls, meet new safety requirements, and by insufficient attention or lack of action in other areas, such as fuel quality standards. Other regulatory programs also take away from the funding, time and engineering resources available for research on fuel economy. The following is a review of each of these competing policies and their impacts on fuel economy.

- Any changes in fuel economy standards must reflect a balance between the equally important goals of protection of the environment and safety.
- Motor vehicle standards for safety and vehicle emissions often decrease fuel economy by necessitating the addition of additional equipment to vehicles and additional electrical current required by that equipment. This additional equipment and its power requirements add weight to the vehicle and may, in some circumstances, preclude use of more advanced fuel efficiency technologies. For example, as discussed in more detail below, the recently promulgated LEV II and Tier 2 standards have limited the technology that can be used to improve fuel economy. Further increases in the stringency in the standards (SFTP enhancements, LEV III, etc.) will further tax research and development resources and may prevent further implementation of fuel-efficient technologies. In the area of safety, new equipment and standards requiring higher and higher levels of crashworthiness in vehicles. For example, manufacturers must meet the side impact standards of FMVSS 214. In order to comply with such standards, steel beams are often used to reinforce doors and side panels. This additional weight detracts from fuel economy gains achieved through technology.

- Fuel quality issues also must be resolved in order to allow some fuel-efficient technologies to be introduced.

A. Emission Standards

Over the past several years, the U.S. Environmental Protection Agency (EPA) has put into place the most ambitious emission standards ever developed in the world. These new requirements are scheduled to be phased in over the ensuing seven years. In order to meet the new stringent standards, manufacturers will be required to rapidly develop and implement innovative and advanced new exhaust and evaporative emission control technologies. Development of these new advanced emission control technologies requires considerable resources. For example, EPA estimates that the vehicle manufacturing industry will likely need to spend as much as $5 million in research and development for <u>each vehicle line certified</u> to meet the new Tier 2 emission standards. Such expenditures compete directly with resources needed to meet more stringent fuel economy requirements. In addition, the new standards may not be compatible with fuel-efficient engines and technologies. In fact, oftentimes, the price of improved emissions is a loss of fuel economy. This "price" in fuel economy may be due to a number of factors including the weight added by new emission control technologies, their impact on the combustion process and other similar causes. In fact, as noted by the 1992 NAS study regarding emission control technology and fuel economy, NAS acknowledged that the earlier "Tier 1" standards had a 0.5 mpg negative impact on fuel economy. In that same study, NAS also acknowledged that the new Tier 2 standards may preclude additional advance technologies in fuel economy.

NAS' recognition of the negative impact of new emissions standards on fuel economy was more recently reiterated in the 2002 NAS Report. In that report, NAS recognized that two new technologies can vastly improve fuel economy in vehicles – new diesel combustion technologies and gasoline direct-injection engines that operate under lean-burn combustion. Both of these new technologies, however, will be subject to the stringent requirements of Tier 2 standards sharply limiting all vehicle emissions. Thus, NAS expressed its belief that neither technology can be implemented currently given the new more stringent emission limits imposed by the Tier 2 emission standards. As noted in the Report with regard to diesel technology:

> In general, the committee believes that the Tier 2 NO_x and PM standards will inhibit, or possibly preclude, the introduction of diesels in vehicles under 8,500 lbs. unless cost-effective, reliable, and regulatory-compliant exhaust gas aftertreatment technology develops rapidly. (page 35.)

Likewise, with respect to gasoline direct-injection NAS noted that:

> These same factors have caused the committee to conclude that major market penetration of gasoline direct-injection engines that operate under lean-burn combustion, which is another emerging technology for improving fuel economy, is unlikely without major emissions-control advances. (Id.)

Nor did NAS limit the negative impact of new emissions standards to fuel economy on the federal level. NAS specifically mentioned California's new super ultra low emission vehicle (SULEV) standards and partial zero emission vehicle (PZEV) programs as posing significant hurdles for the introduction of new fuel efficient technologies such as the new clean diesel technology. In addition to SULEV tailpipe emissions, PZEV vehicles must meet "zero" fuel evaporative emissions requirements which require significant improvements in fuel system components and controls to better manage fuel vapor (modifications which must be complementary to the SULEV tailpipe controls), improved heat management, and changes in fuel system materials and connections to, as much as feasible, eliminate permeation emissions and leaks. Additional hardware, such as bleed canisters and carbon traps in the air intake system, may be required. Because of the clear and negative impact more stringent emission standards have on fuel economy, the degradations caused by these new emission standards must be considered in any proposal that affects mandated fuel economy levels.

EPA recently adopted new regulations that will provide cleaner fuels that will help enable these vehicle technologies to some extent but do not solve the problem. Sulfur in gasoline and diesel fuel is the major impediment to the advanced aftertreatment systems that these technologies will require. EPA's ultra-low sulfur diesel regulation will cap sulfur in diesel fuel at 15 ppm by September 2006, just barely in time for the 2007 model year when all light duty vehicles under 6,000 pounds will have to meet the stringent new Tier 2 emission standards. Automakers are still developing the new aftertreatment systems needed for these vehicles and while hopeful, even if successful, the averaging requirements of the emissions standards, are such that manufacturers will not be able to introduce large numbers of these vehicles. For lean-burn gasoline vehicles, the sulfur levels in gasoline are still too high to enable any introduction of vehicles under the Tier 2 emission standards. EPA's Tier 2 low sulfur gasoline regulation only capped sulfur at 80 ppm by 2006, with extensions allowed for some refiners until 2010. These sulfur levels will poison the emission control systems needed for these engines (see below for additional discussion).

B. Safety Standards

Title 49 of the United States Code, Chapter 301, requires that motor vehicles comply with prescribed safety standards that meet the need for motor vehicle safety in the United States. Automobile manufacturers not only meet, but often exceed these standards by incorporating technologies such as front air bags, safety belts with pretensioners and load-limiters, "safety cages," reinforced roof structures, side impact crash beams, and safety glass. These additional technologies often add weight to the vehicle resulting in a negative impact on fuel economy. This burden increases as manufacturers and NHTSA continue efforts to improve the safety of motor vehicles.

The last decade saw numerous manufacturer-added technologies, during the same time that NHTSA extended additional passenger car standards to light trucks, sport utility vehicles, and vans. According to NHTSA, these new light truck, SUV, and van standards alone can add up to 100 lbs to the average light-duty truck. This added weight adds a measurable penalty to fuel economy. In addition, many of these components require an active source of power. Airbag monitors, for example, require electricity to monitor deceleration and/or crash forces in order to determine whether to deploy the airbag. Deployment itself is a pyrotechnic event that must be triggered by an external power source. Because of the power demands of these new safety devices required to meet applicable federal motor vehicle safety standards, larger alternators and other electrical components must be added to the vehicle to feed the demand. This power draw results in lower fuel economy through diversion of power from the drivetrain and from the increased weight of the supporting power structure. Accordingly, the need for new safety technologies and the weight and power of these devices and their impact of fuel economy must be taken into consideration.

The requirements of crash avoidance and crash worthiness are increasing. For example, NHTSA has recently issued new dynamic side impact requirements, an upgraded head protection requirement to reduce injuries associated with contacting vehicle interiors, and an advanced air bag requirement, all of which will add additional weight and power needs to all light-duty vehicles. In order to comply with these new regulations, many current and future safety enhancements on vehicles utilize sophisticated electronic sensors and data processing modules. This push to ever more sophisticated safety systems is one of the considerations pointing the auto industry to the use of 42-volt electrical systems. These systems have an inherent fuel economy penalty due to the increased load on the engine. NHTSA has also proposed, or is considering, new/revised safety standards associated with upgraded fuel system protection, new and additional head restraints, a new offset frontal test requirement, and even more stringent side impact protection standard, all of which will add weight. We also expect the new TREAD Act will have some effect on either tire rolling resistance or vehicle weight. As these regulatory developments move forward, they and their impact to fuel economy must be taken into consideration as regulation of fuel economy standards develops.

Because of the constantly evolving safety standards (including new and revised standards) and the demand by consumers for higher and higher levels of safety, automobile manufacturers are under constant pressure to develop and apply advanced fuel economy improving technologies simply to maintain the previous level of fuel economy of vehicles while preventing significant decreases in fuel economy caused by the addition of safety equipment. NHTSA must keep these factors in mind when developing new fuel economy standards for future model years.

C. Fuel Standards

Fuel quality has a direct impact on the fuel economy achieved by any particular vehicle. For example, current levels of sulfur in fuels limit the introduction of some of the technologies that may improve fuel economy, such as the lean-burn technology and NO_x adsorbing catalysts. Before this technology can be made available, numerous issues must be addressed. By way of illustration, ultra-low levels of sulfur in fuel are absolutely necessary in order for the NO_x adsorbing catalyst to be effective. Tier 2 fuel standards allow fuel sulfur to be as high as 80 ppm. However, until fuel sulfur levels are lowered to near-zero levels (i.e., 0 to 3 ppm), lean-burn is not a viable technology. Accordingly, any change in fuel economy requirements must take into account available fuels and the regulations that allow impurities and their impact on fuel economy. On road fuel economy improvements can be achieved simply through tighter regulation of fuel content.

High distillation index (DI) is another fuel quality concern that limits fuel savings. A high DI leads to incomplete combustion, higher emissions and vehicle performance problems. In order to mask these real problems, some manufacturers will introduce a rich bias in the calibration, thus effectively using more fuel than is necessary in order to prevent problems. The Alliance has petitioned EPA for a reduction in the distillation index of fuels.

9. In setting CAFE standards, the agency takes into consideration that there are often ***technological risks*** associated with actually achieving the full potential fuel economy improvement from a particular type of technology. How should the agency take technological risks into account in setting these light truck CAFE standards? What technological risks are associated with gaining the full potential fuel economy improvements from any of the available types of fuel economy enhancing technologies? What are the prospects for overcoming those risks or offsetting their effects on CAFE capability?

Answer:
NHTSA must take technological feasibility into account when setting light truck CAFE standards by considering both the probability that the technology may not be successful in meeting the emissions, fuel economy or safety criteria and the potential that the technology will be unacceptable to consumers. An example of this was the two-stroke technology from the 1992 NAS study. Areas of technical risk include:

- Consumer acceptance
- Timing
- Technology interaction and attribute tradeoffs
- Program specific risks
- Competing resource priorities

Alliance members will address this question in more detail in their individual comments.

10. Please comment on the idea of an attribute-based system. Provide feedback on which attribute(s) such a system should be based on and the specific classes of vehicles that might fall under each class. In addition, please suggest the fuel economy level associated with each specific class of that attribute-based system (e.g., vehicles weighing from 2,000 lbs. GVWR to 2,500 GVWR would have to meet an average of xx.x MPG).

Answer:
Any program to regulate fuel economy will have different effects on different manufacturers. When considering alternatives to the current CAFE system, NHTSA should be cognizant of this fact. Manufacturers who produce significant numbers of inherently lower fuel economy vehicles (due to their large size or performance/luxury characteristics) are more constrained by stricter CAFE standards than manufacturers whose fleets have relatively fewer of these vehicles.

Vehicle weight has been discussed as a basis for an attribute system. A weight-based system could be designed to address some of the safety and equity concerns of the current system and to recognize that because of their increased utility, heavier vehicles require more fuel to travel the same distance. Further, among the attribute systems being debated, vehicle weight has been shown to have the best correlation to vehicle fuel consumption. However, the design of a weight-based system would have to consider the merits of continuous versus discrete attribute systems, credit trading between classes (which would be required under a discrete system), and how standards would be set at each weight.

There are also significant uncertainties that would completely undermine the advantages of an attribute system. For example, advantages of a weight system would be lost if this system were implemented on top of today's CAFE program. In addition, because of many differences between cars and trucks, such as the ability to adopt certain technologies due to unique utility, an attribute system for trucks cannot have the same targets as cars. The development of an attribute system, along with any other significant change to fuel economy targets, should be carefully studied. In any change to the method for determining compliance to a fuel economy standard, sufficient lead-time is critical.

11. Please comment on the possibility of tradable fuel economy credits and the potential cost and benefits to each manufacturer.

Answer:
A credit trading approach would require fuel economy standards that provide a level playing field, so that no manufacturer is given an inherent initial advantage and the potential to enrich itself through the sale of credits. In addition, we believe the government would need to be the seller of credits, so that manufacturers would not be forced to bargain directly with one another over credit transfers. There are many downsides to providing "funding" to competitors in exchange for CAFE credits, even indirectly. A scheme that required Manufacturer A to compensate Manufacturer B directly would not likely be used.

The creation of new flexibility mechanisms cannot be the basis for justifying standards that are more stringent than allowed by the limits of cost-effectiveness or the technological feasibility. With that in mind, we are willing to evaluate potential inter-manufacturer trading systems if a specific proposal is developed.

12. Please comment on the effect that elimination of the two-fleet rule would have on manufacturers, consumers, employment, the U.S. marketplace, and on the automotive industry in general.

Answer:
The domestic/non-domestic passenger car CAFE fleet distinction was never intended to have an impact on fuel economy. While originally designed to keep small car production in the U.S. and protect American jobs, some evidence to date suggests that this scheme has encouraged the sourcing of non-domestic parts and inhibited some manufacturers from increasing the procurement of U.S parts and materials.

13. Please provide suggestions for modifications of the vehicle classification. These suggestions should be as detailed as possible and should state the logic and rationale for the modification, as well as suggested definitions. An analysis of the pros and cons of each suggested modification should also be provided.

Answer:
The issue of vehicle classifications can generally be viewed in two ways; 1) the distinction between cars and trucks (passenger automobiles and light trucks), and 2) the distinction among various light trucks.

Regarding the distinction between cars and trucks, the differences in function and utility of these vehicles dictates that the existing distinction be retained. As we stated in our response to Question 6, there are distinct differences between the usage characteristics and priorities of light truck and car owners. Light trucks, including SUVs, minivans, and pickup trucks are purchased and used for different purposes than cars, including towing, hauling, cargo carrying, and transporting large groups of people. Fifty percent of trucks (SUVs and pickups) are used for towing some time in their useful life, and SUVs and minivans provide increased cargo carrying capacity not available in passenger cars. Further, vehicles designed to perform these functions are physically different than vehicles not designed to perform these functions. For example, they are typically heavier, less aerodynamic, and more powerful. Modifying classification definitions in such a way that moves some vehicles currently classified as trucks into the car category would negatively impact both car and truck CAFE compliance, and may negatively impact safety if it leads to downsizing vehicles in both fleets. We urge NHTSA to carefully consider the utility and use differences between cars and light trucks prior to implementing any vehicle classification modification. The current system was put in place because the CAFE legislation's authors recognized that the more demanding utility requirements on light trucks made them unable to meet the same fuel economy standards as cars, and the same applies today.

Regarding the possible distinction among various types of trucks, i.e., SUVs and vans, the Alliance does not believe it is necessary or productive to establish different CAFE standards for different truck classes. First, the range of functions and uses of trucks is generally no more or less varied than that of cars. Within the car class, there are mini-compacts, two-seaters, sports cars, wagons, luxury cars, large cars, etc. There are vehicles that can easily be driven over 180 mph, yet there are also cars that need over 13 seconds to accelerate through a standing quarter mile. There are cars that can carry six passengers, and a moderate amount of cargo. But there are also cars that only seat two people, or that cannot carry more than a minimal amount of cargo. Despite the diversity in passenger car design, utility and performance, a single passenger car CAFE standard provides a degree of flexibility to manufacturers. Increasing the number of classes would solve few of the problems inherent with the current CAFE system and it would serve to limit flexibility thereby increasing compliance costs. The same situation holds true for the truck category. NHTSA is required to set the truck CAFE standard to the maximum feasible level considering such factors as lead time, safety, etc. Obviously, the composition of the fleet is another factor that must be considered.

14. Please provide comments on the possibility of raising the maximum gross vehicle weight rating and on the effects that this would have on manufacturers, consumers, U.S. automotive industry employment and the automotive industry in general.

Answer:
Because of the differences in function and utility, the current maximum gross vehicle weight rating should be retained. The majority of the vehicles over 8,500 lbs. Gross Vehicle Weight Rating (GVWR) are commercial pickup trucks, cargo vans, and passenger vans able to carry more than 6 people. A small fraction of this population are heavy duty SUVs, many purchased to tow very large loads.

The vehicles in the truck segment with a GVWR over 8,500 lbs. GVWR fill a unique utility need (passenger carrying capability/towing/capacity). Section 32901 (a) (3) of the CAFE legislation lists two conditions that must occur for this class of vehicles to be included in the CAFE regulations:

> (3)(B) more than 6,000 but less than 10,000 pounds gross vehicle weight, if the Secretary decides by regulation that:
>
> > (i) an average fuel economy standard under this chapter for the vehicle is feasible: and
> > (ii) an average fuel economy standard under this chapter for the vehicle will result in significant energy conservation or the vehicle is substantially used for the same purpose as a vehicle rated at not more than 6,000 pounds gross vehicle weight.

The class of vehicles with a GVWR over 8,500 lbs. are used for significantly different functions than the class of trucks under 8500 lbs. GVWR. They are used significantly more for towing, hauling, and transporting large numbers of people. According to a 2001 New Vehicle Customer Study, trucks over 8,500 lbs. GVWR are used for towing four times as often as trucks under 8,500 lbs. GVWR, and are used for hauling twice as often. The data also show that heavy-duty SUVs, such as the Chevrolet Suburban or Ford Excursion, are used for towing 80 percent more often than large SUVs. We therefore believe that these vehicle are not "substantially used for the same purpose as a vehicle rated at not more than 6,000 pounds gross vehicle weight," and should not be incorporated into the truck CAFE fleet.

Adding trucks over 8,500 lbs. GVWR to the light truck fleet would also create a competitive disadvantage for full-line vehicle manufacturers. Companies that do not build heavy-duty trucks would be able to meet the truck CAFE standard without spending the substantial amount of capital and engineering resources a full-line manufacturer would have to spend to offset the fuel economy penalty impact of their over 8,500 lbs. GVWR trucks. Truck buyers, particularly heavy-duty truck buyers, value utility more than fuel economy, so the less CAFE-constrained manufacturer could use its CAFE advantage to build more types of vehicles, leaving the full-line manufacturer at a comparative disadvantage.

The NAS Report, in its discussion of potential modifications of and alternatives to CAFE, did not contemplate the inclusion of 8,500 lbs. GVWR to 10,000 lbs. GVWR vehicles into CAFE, and we believe that NHTSA should not implement this policy. These vehicles serve a vital function in our society, providing the means to accomplish tasks requiring a level of towing, hauling, cargo carrying, and people transporting ability not attainable by cars and light trucks. It is important that they be excluded from the CAFE mix so that their vital utility and functionality can be maintained.

15. NHTSA requests comments on the above possible modifications to the CAFE program and other modifications that have been discussed, such as those mentioned in the National Academy of Sciences study. In addressing these possible modifications, please identify their positives and negatives; their estimated costs and benefits; their effect on manufacturers, suppliers, employees, and consumers; and the policy implications of each. The agency requests that each manufacturer specify how much lead time would be needed to respond to each possible modification and provide that information in terms of product planning cycles. To assist NHTSA, please be as specific as possible and provide any information that you believe will be helpful.

Answer:
There are a myriad of important details for any given fuel economy regulatory framework so the following comments are general in nature. No method listed below ensures energy savings or a fair distribution of tasks. Each structure has unintended consequences and non-trivial impacts on the automobile sector and

consumer. Except for energy demand reduction policies, each alternative alters the existing system and creates new winners and losers.

In addition to those modifications discussed in Questions 10 through 14, Attachment 2 provides a discussion of the following CAFE modifications:

- Simple feebate
- Size or interior volume approaches
- Performance based attribute approaches
- Uniform percent increases
- Carbon tax
- Carbon cap and trade
- Gasoline tax

16. In examining the three paths that were chosen, please comment on whether they represent likely scenarios for technology bundling. If not, please comment on which technologies are likely to be bundled together and please identify the specific vehicle types and vehicles/models that might include them. In addition, please comment on the technologies already included on the vehicle types/models, the projected vehicle weight and the percent of total model sales anticipated for each model (i.e., CVT - 45%, 5-Speed Automatic - 40%, 5-Speed Manual – 5%). Finally, please comment on the assumptions the NAS made in evaluating the three paths. Are there more plausible alternative assumptions?

Answer:
The Alliance's position on the NAS Report was detailed in the October 5, 2001 hearing.

The NAS Report made a critical error in its failure to examine system-level effects when combining technologies
The primary flaw – a failure to examine system-level effects – is sufficiently serious that the fuel consumption results in the Report should not be used as a basis from which to establish CAFE standards. An SAE Paper was presented at the SAE World Congress and Exposition in March 2002. The paper reviews the technical content of the NAS Report and highlights issues with the method used in the Report. A primary conclusion of this published, peer-reviewed paper is that the NAS Report over-counts the aggregated effects of technologies by using a simple "shopping-cart" approach which fails to consider the fact that losses in any given energy category (such as pumping losses) can only be reduced or eliminated once. The fuel consumption reduction projected in the Report for Paths 2 and 3 fail an energy balance test, i.e., the simple addition of all of the various technologies identified to address pumping losses in the engine would more than reduce all of the actual losses that occur. This is unrealistic even on a theoretical basis and certainly cannot be achieved in the real world of engine design. This error occurred in all paths and all vehicle segments, because the same method was used throughout the Report. Five of six members of an SAE World Congress panel – including three National Academy of Engineering members – agreed with the content and conclusions of this SAE paper

Some technologies that are applied are already in volume production
Because the Report includes the benefits of these technologies in vehicle segments where they are already applied, it double-counts the fleet impact of these technologies. In its baseline assumptions for the 1999 model year, the Report only accounts for technologies that are at least 50 percent incorporated into the current fleet. By ignoring current usage while adding technologies to some vehicle segments, the Report overstates the potential fleet fuel economy gain.

An example of this is multi-valve OHC technology. The Report assumes the baseline technology for four vehicle segments is 2-valve technology, when in fact; there is significant 4-valve OHC technology already in production in those segments. Sales volume fraction data for those segments is shown in Table 16.1. The result of this inaccurate baseline is an over-estimate of the improvement of adding multi-valve OHC technology to the five vehicle segments listed. This inaccurate baseline is used in all three NAS development paths.

A similar situation exists for transmissions and VVT technology. The Report assumes that the baseline technology content for all vehicle segments is 4-speed automatic transmission technology, when in fact, in 1999 there was significant usage of manual transmissions, as is shown in Table 16.2. Replacing a manual transmission with either a 5-speed or a 6-speed automatic transmission would not improve fuel consumption. The Report itself makes this judgment when it credits automated shift manual transmission with a 3% - 5% fuel consumption reduction relative to 6-speed automatic transmission. Tables 16.3 and 16.4, which show sales volume fractions for 5-speed automatic transmissions and VVT engines, illustrate two other cases where the Report does not account for technologies already in production.

Segment	Percent with 4V engines
Midsize SUV	26.0%
Large SUV	4.7%
Minivan	15.8%
Small Pickup	20.3%

Table 16.1: Model Year 1999 vehicle segments with 4-valve engines [Source: EPA]

Segment	Percent with Manual Trans
All Cars	13.7%
All Trucks	13.4%

Table 16.2: Model Year 1999 vehicles with manual transmissions [Source: EPA]

Segment	Percent with 5-Speed Auto Trans
All Cars	4.3%
SUVs	15.4%
Pickups	1.8%

Table 16.3: Model Year 1999 vehicles with 5-speed automatic transmissions [Source: EPA]

Segment	Percent with VVT
All Cars	36%
All Trucks	13%

Table 16.4: Estimate of Model Year 2001 vehicles with variable valve timing

This issue taken together with other technical and methodological items in the NAS Report could lead readers to an incorrect conclusion about the fuel economy improvements that are technically achievable.

Specific concerns with the NAS analysis are summarized in SAE paper SAE 2002-01-0628.

17. Should hybrid and fuel cell vehicles have been included in the paths? If so, which ones and which specific vehicle types? What technologies would be included with these types of vehicles?

Answer:
We agree with the NAS' decision to omit these technologies in their estimates of technological feasibility. There are several hybrids on the road today and several more are expected to be introduced in the near future. However, hybrids and other advanced technologies cost more, and in the foreseeable future are unlikely to have an impact on the industry's ability to increase CAFE. For example, NAS estimated the cost of the hybrid system to be between $3,000 and $5,000. At this cost, the savings in fuel expenses do not offset the initial cost of the technology even if 14 years of fuel savings (i.e. over 160,000 miles) is assumed. Thus, we believe NHTSA should not include hybrids in this rulemaking.

The barriers of fuel cell technologies are even greater. Currently, only prototype fuel cell vehicles are on the road. The technology for use in these vehicles is still in the development stages and significant work will need to be done to develop a system that is efficient and cost effective. The new FreedomCAR program is designed to focus on long-term research and development of fuel cells and moving toward a hydrogen infrastructure. The development of an infrastructure will be a major barrier to the incorporation of fuel cell vehicles in the on-road fleet.

Inclusion of technologies such as hybrid and fuel cell technology in the new vehicle fleet will not significantly improve the fuel economy of the in-use fleet for at least twenty years. Until the affordability issue of hybrid electric vehicles is addressed, these vehicles will not provide any net savings to customers.

18. Do you believe that the NAS study over or under estimated the fuel economy benefits from specific technologies? If so, which ones and why? Please provide NHTSA with your data that suggest a different benefit resulting from the application of these technologies.

Answer:
In general we believe NAS' assessment on many technologies was too optimistic. Member companies are providing specific responses on these technologies.

19. Do you agree with the figures derived in the NAS break-even analysis? If not, why? Please address specific areas of differences, explain your reason(s) why, and provide supporting data for your reasons and arguments.

Answer:
As noted in our answers to Questions 16 and 18, there are significant issues with NAS' assessment of technologies and how the panel combined them. This directly affects the break-even analysis, resulting in incorrect conclusions. In addition as the Alliance members reviewed the revised report we are finding some additional errors in the calculations. For example, the cost and the fuel economy benefit for the large car Path 2 results are incorrectly calculated resulting in an overstatement in fuel economy potential.

Additionally, the break-even analysis does not account for other societal and economic issues that must be considered when determining CAFE standards. Finally, it should be noted that NAS did not intend the values determined in their cost effectiveness analysis to be used as CAFE values. Setting of the CAFE standards involves analysis of many other factors.

20. For the forthcoming rulemaking and future CAFE rulemakings, benefit analysis will play an important role in NHTSA decision-making. NHTSA therefore seeks comments on the following specific benefit issues: Can you provide, in addition to the material in the NAS Report, any methods and data that would be helpful in identifying, quantifying, and expressing in dollar units the potential benefits of alternative CAFE standards (including energy security, environmental, and other considerations)? Are there any ancillary studies that NHTSA or other federal agencies should commission to provide a stronger technical foundation for making benefit estimates in future CAFE rulemakings?

Answer:
The Alliance has not done an independent analysis of the numerous studies of the externalities of fuel economy standards. Samples of studies of externalities are: "Short- and Long-Range Impacts of Increases in the Corporate Average Fuel Economy (CAFE) Standard" by Andrew N. Kleit; "The Effect of Fuel Economy on Safety" by R. Crandall and J. Graham; and "The Economics of Energy Security" by D. Bohi and M. Toman. Individual Alliance members may provide separate comments.

Comments on Recent Fuel Economy Improvement Studies (Question 5)

"On the Road in 2020: A Life-Cycle Analysis of New Automobile Technologies," M.A. Weiss, J.B. Heywood, E.M. Drake, A. Schafer, and F.F. AuYoung, 2000. MIT Report # MIT EL 00-003.

Summary
The study makes a set of assumptions about vehicle component content, efficiencies, masses, and costs for a baseline 1996 midsize car, an "evolved baseline" 2020 midsize car, and several advanced 2020 midsize cars. No vehicle types other than midsize car are considered. A set of assumptions is used to provide inputs to a vehicle simulation, which is run to determine vehicle fuel economy for the baseline vehicles and the advanced vehicles.

The study says that it assumes similar acceleration, drivability, range, refueling ease, driver space, trunk space, and assumes meeting safety and emissions standards. However, it also states "we acknowledge that our various technology combinations do not necessarily provide equal value in all these different drivability and performance areas."

The study uses an "evolved baseline" 2020 vehicle which has 14% reduced mass, 28% reduced engine size, and 35% improved fuel economy, all relative to the 1996 baseline vehicle. The cost of the evolved baseline vehicle is put at only 5% higher than the cost of the $17,200 1996 baseline vehicle. The study indicates that the evolved baseline vehicle "represents the likely average passenger car technology in 2020 that will not incur extra costs other than those necessary to keep up with the market."

The advanced 2020 vehicles described by this study include:
- a conventional powertrain (-21% mass, -34% engine size, +43% fuel economy, +13% cost)
- a hybrid vehicles with SI and CI engines (-17% mass, +66% fuel economy, +28% cost for the CI vehicle)
- a fuel cell vehicles (-9% mass, +70% fuel economy, +28% cost for the direct hydrogen vehicle).

Issues with the MIT Study
While the study uses a vehicle simulation as the means to predict vehicle fuel consumption, it uses a faulty set of inputs and assumptions for the simulation. In some cases, these inputs and assumptions fail to consider the content of current vehicles, and in other cases overestimate the impact of future developments. These inputs and assumptions are critical to the results shown for the "evolved" baseline and "advanced" vehicles in the study. Because the inputs and assumptions are so questionable, the results become questionable.

Some of the simulation inputs severely limit the scope of vehicles over which this study applies. Also, there is little evidence of the application of real world constraints to the simulation methodology, which is likely to reduce the fuel economy and overestimate the performance and drive quality of all of the simulated vehicles.

There is nothing "evolved" or "baseline" about the vehicles in the MIT study. They include new body structure technology, completely different engine/transmission families and technologies (some technologies still classified as emerging), and are smaller (10% less frontal area). The "evolved baseline" characterization makes it sound like this will happen without any changes being implemented; this is simply not true. Further, it does not consider consumer preference.

The MIT study assumes application of downsized 3 and 4-cylinder engines in place of a 6-cylinder engine. This input ignores the loss of drive quality, the increased engine speed that will be required, and increased need of NVH measures required to satisfy the baseline customer requirements. The assumed higher-speed three and four cylinder engines will require remedies such as balance shafts, active engine mounts, and increased low and high frequency noise isolation and attenuation. The study ignores these needs, and as a result, ignores the resulting impact of cost, mass, and losses associated with these needs.

The MIT study uses a 1,306 kg (2,883 lbs.) midsize car as its baseline vehicle curb mass. This vehicle mass is at the very low end, perhaps below the low end, of 1996 midsize vehicles. This input to the study makes it easy for the authors to replace the baseline six-cylinder engine with four and three cylinder engines in the evolved baseline and advanced vehicles, respectively. However, the actual midsize vehicle segment is not highly populated with vehicles close to this mass range. So the conclusions of the study, which the authors admit is limited only to midsize vehicles, should more appropriately be applied to only the lowest end of the midsize vehicle segment.

The MIT study applies auto-clutch transmissions in place of more conventional automatic transmissions, without making any statement as to the level of refinement that is lost or the need for increased ratio coverage with such transmissions. There is no mention of the added cost and content such as an additional clutch making such transmissions market-acceptable. Additionally, this single-dry-clutch transmission will be very troublesome for U.S. drivers to manage. This is because the U.S. market is mainly adjusted to automatic-type transmissions with very smooth driving characteristics. The driving experience with this single-clutch is very much like driving a manual transmission vehicle with the exception that the driver has no indication when a shift is going to occur.

The MIT study assumes a 14% mass reduction for the evolved baseline vehicle, assuming a high strength steel structure, reduced number of cylinders, and auto-clutch transmission. These assumptions are too aggressive. However, industry-accepted numbers for this technology are estimated to be 5% vehicle mass reduction. This 5% could be further reduced since the estimate does not account for the high strength steel already in use in some portions of the body structure (double counting). The replacement of a 2.5L V6 110 kW@5000rpm engine with a 1.8L GDI+VVTL 93 kW@6000rpm L4 engine is assumed to provide a 79 kg mass reduction. The replacement of a 4-speed automatic transmission with an auto-clutch transmission is assumed in the study to provide 34 kg of mass reduction. Both of these are overstated.

The MIT study assumes 21% mass reduction for the advanced vehicle assuming an aluminum structure, a further reduction in the number of cylinders, and the use of an auto-clutch transmission. These assumptions are too aggressive. An aluminum structure by itself is assumed in the study to provide a 19% vehicle mass reduction, which is too aggressive. The advanced conventional powertrain is assumed to be a 1.6L GDI+VVTL 85 kW@6000rpm L3 engine that provides 87 kg of mass reduction, again too aggressive. The 34-kg of mass reduction assumed for the auto-clutch transmission would in reality be much less.

The MIT study assumes large increases in maximum engine speed and engine specific output due to addition of technologies such as variable valve actuation, gasoline direct injection, and the unsupported assumption that engine speeds will increase. There are some fundamental problems with these assumptions. Most of the VVA technologies that improve fuel economy are maximum speed-limited, due to the inherently higher mass and lower stiffness than conventional valve trains. Direct-injection technology is also limited in its maximum speed capability, because of the need for adequate mixing of the directly injected fuel with air in the cylinder. In some cases, transmission technology may be a limiting factor for engine speed. Also, low-speed engine friction will increase as maximum engine speed is raised. Consequently, the study overestimates the expected increase in realized engine specific output and it underestimates the cost and content needed.

The MIT study assumes aggressive vehicle and powertrain mass reductions combined with an assumption of 50% higher engine power-per-mass to justify very aggressive engine downsizing. While engine downsizing and vehicle mass reduction are certainly “synergistic” (go together), it is unrealistic to combine aggressive mass reduction assumptions (see above) with aggressive specific output assumptions (see above) and expect to achieve the synergistic results.

The MIT study assumes constant indicated efficiency and constant friction mean effective pressure over the complete engine speed-load range. This is a poor assumption since it does not account for the reduced operating efficiency of the higher speed and more heavily loaded engines used in the study. The result will be an over-prediction of fuel economy benefits and under-prediction of performance and drive quality capability. The study should be revised to comprehend the real world variation of engine efficiency with speed and load in order to comprehend the effects of aggressive engine downsizing.

The MIT study assumes constant transmission efficiency over the speed-load range. This is a poor assumption since it does not account for the increased spin losses present with the higher speed and more heavily loaded engines used in the study. The result will be an over-prediction of the fuel economy benefits. The study should be revised to comprehend the real world variation of transmission spin losses with speed and load in order to comprehend the effects of aggressive engine downsizing.

The MIT study does not mention of any real-world constraints applied to the vehicle simulations. Constraints such as minimum firing frequency allowed in the vehicle under drive conditions will have a significant impact on the predicted fuel consumption, and the impact grows with aggressively downsized engine. The result will be a significant over-prediction of the benefits of engine downsizing and cylinder count reduction. The study should be revised to use real world minimum firing frequency constraints in the simulation methodology.

The MIT study makes no mention of any attempt to maintain final drive ratios or shift patterns that provide equivalent drivability, even though such constraints are critical to the application of aggressively downsized, higher speed engines. The result will be a significant over-prediction of both the fuel economy and performance benefits of engine downsizing. The study should be revised to use real world customer drive quality requirements as part of the simulation methodology.

The MIT study makes no mention of adjustments made to engine idle speed with the aggressively downsized engines driving higher accessory loads. It is likely that some of the chosen downsized engines are insufficient for real-world accessory loads. Adjustment of engine sizes to ensure satisfactory accessory load performance should also be included in the simulation methodology.

The MIT study also makes no mention of the numerous studies that indicate that weight reductions such as these would produce large unfavorable impacts on traffic safety.

"Alternative and Future Technologies for Reducing Greenhouse Gas Emissions from Road Vehicles," Sierra Research, July 8, 1999.

Method

Sierra Research combined the potential for reducing new vehicle fuel consumption with the information on full fuel cycle emissions to determine the potential effect on greenhouse gas emissions with a range of alternative vehicle technologies and fuels. The basis for the combining technologies was vehicle simulation modeling that accounted for the application of multiple technologies and the interactions between them. In addition, countermeasures to mitigate adverse attribute impacts of the new technologies were factored in the cost estimates in cases where they were cost effective. The data used in the study was taken from the 1997 unpublished study "Automotive Fuel Economy Improvement Potential Using Cost-Effective Design Changes," which was based on confidential improvement and cost data from DC, GM and Ford. Updates to the information were supplied from manufacturers in 1999.

Assumptions

In their analysis, Sierra Research assumed:

- No change in fuel prices
- No change in the policies effecting fuel consumption
- Consistent US and Canada policies
- Adoption of Tier 2 emission standards

Sierra Research Results

Technology is available to increase the fuel efficiency of cars and light trucks without downsizing or lowering performance. However, Corporate Average Fuel Consumption (CAFC) levels cannot be reduced below current targets before the cost exceeds the economic benefit to motorists.

Market driven changes are projected to improve car CAFC to 7.9 l/100km (29.6 mpg) by 2010, and 7.2 l/100km (32.6 mpg) by 2020. The projected improvement for trucks is 21.9 mpg by 2010 and 22.6 mpg by 2020.

Drilling in Detroit, "Tapping Automaker Ingenuity to Build Safe and Efficient Automobiles," Union of Concerned Scientists, June 2001

Method

The Union of Concerned Scientists (UCS) report "Drilling in Detroit, Tapping Automaker Ingenuity to Build Safe and Efficient Automobiles" uses the information from the study "Technical Options for Improving the Fuel Economy of U.S. Cars and Trucks by 2010-2015." The UCS used the study's Advanced Technology Package, where the main basis for the reductions and the application of technology in this study is a reduction in vehicle mass of 20% for non-compact cars and 33% for trucks. The Alliance members consider weight reduction one of the more costly methods of improving fuel economy. Also, as discussed earlier, weight reduction increases the safety risks. Without this weight reduction, many of the technologies suggested by the study, such as CVT and engine size reduction cannot be implemented. The study also proposes technologies such as full implementation of stoichiometric GDI and 42 volt batteries with ISG.

Concerns

Union of Concerned Scientists stated that a 40 mpg Explorer sized SUV could be produced for an incremental cost of $2037 using existing technology. However,

- The NAS determined a midsize SUV cost-efficient breakpoint (14 year customer payback on fuel savings) was 28 mpg at a cost of $1,254 and 22.7 mpg (3 year payback) at a cost of $407.
- Using the NAS methodology and technology costs, one could apply the UCS technology to an existing midsize SUV, discounting for technology already on the market. The resultant cost effective breakpoint is only 22.2 MPG at a cost of $367, not the 40 mpg claimed.

Union of Concerned Scientists stated that a 45-mpg family car could be produced for an incremental cost of $1292 using existing technology. However,

- The NAS concluded that the midsize car cost-efficient breakpoint (14 year customer payback on fuel savings) was 32.6 MPG at a cost of $791 and 26.8 mpg (3 year payback) at a cost of $76.
- Using the NAS methodology and technology costs, one could apply the UCS technology to an existing family car, discounting for technology already on the market. The resultant cost effective breakpoint is only 32 MPG not the 45 MPG claimed.

"Technical Options for Improving the Fuel Economy of U.S. Cars and Trucks by 2010-2015," DiCicco, An, Ross, 2001

Method

The ACEEE study "Technical Options for Improving the Fuel Economy of U.S. Cars and Trucks by 2010-2015," examines four technology packages ranging from 10% weight reductions with GDI and ISG to a package that includes full hybrids. They consider current, emerging, and advanced technologies in their analysis. The study's fundamental efficiency improvement strategy is mass reduction. With this weight reduction, ACEEE was able to incorporate significant engine downsizing and expanded use of CVT.

Concerns

The Alliance believes that the costs used in this study overestimates the technology benefits and understates the costs. For example, a significant percent of the mass reduction is considered to have no cost.

Because the first action ACEEE suggested was significant weight reductions, they were able to downsize the engine and use CVTs in more vehicles. The use of mass reduction for trucks also limits the functionality of trucks, since it will decrease towing capacity significantly. Further, numerous studies indicate that weight reductions such as these would produce large unfavorable impacts on traffic safety.

Due to Tier 2 emission standards, lean burn GDI was not incorporated, but stoichiometric GDI was used. Without the benefit of lean operation, it is debatable if this technology would be cost effective as a fuel economy technology.

The study also incorporates an integrated starter generator (ISG) for the Moderate and Advanced packages. This technology will require the addition of a 42-volt battery. Real world benefits from this technology are limited by the need to operate the engine when the heater and air conditioner systems.

"Analysis of Corporate Average Fuel Economy (CAFE) Standards for Light Trucks and Increased Alternative Fuel Use," Energy Information Agency, 2002

Method
The Energy Information Agency (EIA) analyzed the economic impacts of CAFE provisions of several bills and amendments in Congress:

- The House energy bill (H.R. 4),
- The Kerry-Hollings Senate energy bill (S. 517, AM 2917) CAFE provisions that raise standards to 35 mpg by 2013, and
- The Feinstein bill (S. 804) to raise truck CAFE standards to 27.5 mpg by 2008.

The analysis includes the Kerry-Hollings and Feinstein bills' inclusion of various trucks in the 8,500 lbs. GVWR to 10,000 lbs. GVWR range.

Importantly, the analysis does not include the Kerry-Hollings "Truth-in-Testing" provision, which would change CAFE test procedures to, in effect, increase the standards at least an additional 18%, to over 40 mpg instead of the claimed 35 mpg.

The analysis used the Department of Energy's National Energy Modeling System (NEMS) database, which includes "explicit representations of energy technologies and their characteristics." (p. 3) NEMS is a computer-based, energy-economic model of the U.S. energy system for the mid-term forecast horizon, through 2020. NEMS projects production, imports, conversion, consumption, and prices of energy, subject to assumptions about macroeconomic and financial factors, world energy markets, resource availability and costs, behavioral and technological choice criteria, cost and performance characteristics of energy technologies, and demographics.

<u>EIA Results</u>

Feinstein (S. 804)

- Manufacturers cannot meet the requirements of the Feinstein bill. "As a result, light truck manufacturers would pay almost $10 billion in CAFE fines over the projection period" (i.e., through 2020). (p. 5)
- The bill results in a "net increase in cost to consumers." Additional light truck costs are hundreds of dollars per vehicle greater than the value of the fuel saved. (p. 5)
- The nation's economy feels the negative impact of this bill such that GDP falls by a cumulative $134 billion through 2020, discounted back into today's dollars. (p. 5)
- U.S. employment declines by about 200,000 jobs. (p. 38)
- The U.S. trade balance "deteriorates" - savings in imported oil do not offset the negative macroeconomic impacts of the Feinstein bill. (p. 40)

Kerry-Hollings (S. 517)

- Manufacturers cannot meet the requirements of the Kerry-Hollings bill. "Vehicle manufacturers would pay a projected $40 billion in CAFE fines over the projection period" (i.e., through 2020). (p. 6)
- The bill results in a "net increase in cost to consumers." Additional vehicle costs are hundreds of dollars per vehicle greater than the value of the fuel saved. (p. 6)
- The nation's economy feels the negative impact of this bill such that GDP falls by a cumulative $170 billion through 2020, discounted back into today's dollars. (p. 6)
- U.S. employment declines by between about 300,000 and 450,000 jobs. (p. 7)
- The U.S. trade balance "deteriorates" - savings in imported oil do not offset the negative macroeconomic impacts of the Kerry-Hollings bill. (p. 42)
- The Kerry-Hollings CAFE requirements would result in weight reductions of hundreds of pounds for both cars and trucks, compared to current vehicles. Numerous studies indicate that weight reductions such as these would produce large unfavorable impacts on traffic safety.

Comments On Other Possible Fuel Economy Improvement Measures (Question 15)

SIMPLE FEEBATE
Set a trigger point for fuel economy, vehicles that exceed trigger receive rebates and those that fall below pay fees

Positives:
- None

Negatives:
- Another form of CAFE (subsidize small cars and penalize large cars to affect market mix)
- Removes a manufacturer's flexibility by externally imposing mix-shifts that may not help meet the standard
- Less efficient than full cost energy pricing (e.g., carbon or gasoline taxes)
- Feebate schemes are often misconstrued as a market-based system that addresses concerns with CAFE
- Burdens families, farmers, car poolers, and small businesses that require larger cars and trucks to meet their needs
- Focuses only on new vehicles and does not affect driver behavior - less efficient than full cost energy pricing (e.g., carbon or gasoline taxes)

Competitive Impacts:
- Transfers revenues from full line manufacturers to manufacturers concentrated at the small end of the market

Implementation Issues:
- Requires a new implementation bureaucracy and temptation will be to create revenue rather than maintain "revenue neutral" system

SIZE OR INTERIOR VOLUME BASED ATTRIBUTE APPROACH
Segment fleet by EPA size class (or some utility-based metric) with each class having its own fuel economy standard

Positives:
- Potential to insulate full line producers against segment mix shifts
- Market incentives can be targeted at a specific model that is above the standard in its size class.
- Aligns with customer desires for more interior space

Negatives:
- Not all customer-desired vehicle attributes are tied to interior volume (e.g., vehicle performance, towing capability, 4-wheel drive)
- Current EPA truck segmentation is not suitable for this purpose -- new classifications would have to be developed.
- Since it is a class-based approach and not a continuous measure, have undesired affect of rewarding packages moved into next higher size class.
- Class-based approach lumps vehicles and sets standards that do not fully account for vehicle differences
- Does not guarantee fleet fuel economy improvement and therefore is not an improvement over CAFE
- Focuses only on new vehicles and does not affect driver behavior - less efficient than full cost energy pricing (e.g., carbon or gasoline taxes)

Competitive Impacts:
- Specific models could be unfairly penalized (e.g., a 4-wheel drive SUV could have equivalent interior volume to a FWD sedan)

PERFORMANCE BASED ATTRIBUTE APPROACH (horsepower or displacement)
Segment fleet into horsepower classes with each class having its own fuel economy standard

Positives:
- Aligns with customer desires for more powerful engines
- Potential to reward highly efficient variations of a model while not rewarding the less efficient variations
- With classes based on powertrains, not models, high and low fuel-efficient vehicles would be more differentiated leading to greater focus on powertrain efficiency and less on aerodynamics, rolling resistance, etc.

Negatives:
- Not all customer-desired vehicle attributes are tied to performance (e.g., interior volume, 4-wheel drive)
- Currently no accepted classes based on engine displacement or power
- Class-based approaches, compared to continuous measures, have undesired affect of rewarding packages moved into next higher horsepower class
- Removes flexibility to improve fuel economy by lowering the mix of more powerful engines for any given model
- Class-based approach lumps vehicles and sets standards that do not fully account for vehicle differences
- Does not guarantee fleet fuel economy improvement and therefore is not an improvement over CAFE
- Focuses only on new vehicles and does not affect driver behavior - less efficient than full cost energy pricing (e.g., carbon or gasoline taxes)

Competitive Impacts:
- Specific models would be unfairly penalized
- Favors manufacturers with higher power to weight ratios – creates different winners and losers

UNIFORM PERCENT INCREASES

Positives:
- Every manufacturer has to improve

Negatives:
- Potential to penalize fuel economy leaders for early improvements
- Does not account for fleet mix changes
- Focuses only on new vehicles and does not affect driver behavior - less efficient than full cost energy pricing (e.g., carbon or gasoline taxes)

Competitive Impacts:
- Manufacturers impacted differently – creates different winners and losers

CARBON TAX

Controls applied upstream at the mine mouth or well head of the energy source -ultimately translate to increased fuel prices for all energy-use streams, based on the carbon content of the fuel.

Positives:
- Market-based, cost-effective option causing minimum economic disruption -- market will determine how best to use energy
- Provides largest CO_2 reductions at lowest cost (approximately 2,000 energy providers/sources worldwide)
- Economic studies have shown carbon taxes to be much more cost effective than CAFE system for reducing CO_2 emissions
- Other industries (such as oil and utilities) and consumers forced to share CO_2 reduction burden
- Incremental restrictions (controls) on energy would allow marketplace to learn and adjust
- Affects all energy users - applies to entire vehicle park, not just new vehicles
- Reduces vehicle miles traveled, encourages more energy-efficient driver behavior, and leads to the purchase of higher fuel economy vehicles

Negatives:
- Policies would have to be developed to help lower income families who pay higher percentage of income for energy.

Competitive Impacts:
- Assuming slow price increases, does not burden one manufacturer over another
- Market pulls full line manufacturers towards smaller vehicles or requires added technology, which now becomes cost effective

Implementation Issues:
- Any shift from application upstream to downstream quickly becomes unworkable and less efficient
- Most effectively applied at international level
- Slow increases in fuel prices would allow manufacturers and consumers to adjust to changing market conditions

CARBON CAP AND TRADE

Controls applied upstream at the mine mouth or well head of the energy source; ultimately translate to increased fuel prices for all energy-use streams; trading allowed between fuel providers. Same as carbon tax – except trading allows upstream energy providers additional flexibility

GASOLINE TAX

Controls applied at the fuel pump

Positives:
- Economic studies have shown gasoline taxes to be much more cost effective than CAFE system for reducing CO_2 emissions
- Incremental restrictions (controls) on gasoline would allow marketplace to learn and adjust
- Affects all gasoline users - applies to entire vehicle park, not just new vehicles
- Reduces vehicle miles traveled, encourages more energy-efficient driver behavior, and leads to the purchase of higher fuel economy vehicles
- Could be structured to speed the introduction of cleaner fuels that will enable more fuel efficient vehicle technologies.

Negatives:
- Less economically efficient than carbon tax - does not capture other business sector’s fossil fuel use
- Policies would have to be developed to help lower income families pay higher percentage of income for energy

Competitive Impacts:
- Assuming slow price increases, does not burden one manufacturer over another
- Market pulls full line manufacturers towards smaller vehicles or requires added technology, which now becomes cost effective

Implementation Issues:
- Slow increases in fuel prices would allow manufacturers and consumers to adjust to changing market conditions.