Original: 2523

**Gelnett, Wanda B.**

**From:** Jewett, John H.
**Sent:** Wednesday, April 12, 2006 8:57 AM
**To:** IRRC
**Cc:** Wyatte, Mary S.; Stephens, Michael J.; Harris, Mary Lou; Gelnett, Wanda B.; Kathy Cooper; Hoffman, Stephen F.
**Subject:** FW: Pennsylvania Clean Vehicles Program - Adoption of California Emission Regulations

GM PA overnote.pdf (65 KB　　PA coversheet.pdf (18 KB)　　GM PA )mments.pdf (176 K

Please file this email and its attachments in "proposed comments" for file #2523. Thanks!

-----Original Message-----
From: LCampbell@eckertseamans.com [mailto:LCampbell@eckertseamans.com]
Sent: Wednesday, April 12, 2006 8:54 AM
To: Jewett, John H.; Wyatte, Mary S.
Cc: mary@greenleepartners.com; robert.babik@gm.com; Kiley, James; Ehlmann, James
Subject: Fw: Pennsylvania Clean Vehicles Program - Adoption of California Emission Regulations

For your information, here's a copy of General Motors' comments submitted to the EQB on the Clean Vehicles Program regulation.

Let me know if you need to discuss this further, and I can arrange a conference call with the appropriate persons at GM/

Hap

Loudon L. Campbell
Eckert Seamans Cherin & Mellott, LLC
PO Box 1248
Harrisburg, PA 17108-1248
(717) 237-6028 / FAX (717) 237-6019
lcampbell@eckertseamans.com
www.eckertseamans.com


----- Forwarded by Loudon L Campbell/ESCM on 04/12/2006 08:49 AM -----

james.ehlmann@gm.com

04/11/2006 04:02 PM

To
robert.babik@gm.com, jim.kiley@gm.com, Loudon L Campbell/ESCM@ESCM

cc

Subject
Pennsylvania Clean Vehicles Program - Adoption of California Emission Regulations

FYI - GM comments on PA DEP's proposed CA LEV/CO2 regulations.
----- Forwarded by James S. Ehlmann/US/GM/GMC on 04/11/2006 03:59 PM -----

Fred S. Sciance

To: regcomments@state.pa.us

04/11/2006 02:26 PM

cc: Timothy C. McCann/US/GM/GMC@GM, David W. Schrumpf/US/GM/GMC@GM, James S. Ehlmann/US/GM/GMC@GM

Subject: Pennsylvania Clean Vehicles Program - Adoption of California Emission Regulations

Attached are General Motors comments regarding Pennsylvania adoption of California emissions standards. Please call me at 313-665-2962 if there are any problems with the transmission of these documents. I can be e-mailed at fred.sciance@gm.com. Thank you for your assistance.

(See attached file: GM PA covernote.pdf) (See attached file: PA coversheet.pdf) (See attached file: GM PA Comments.pdf)

(See attached file: GM PA covernote.pdf)(See attached file: PA coversheet.pdf)(See attached file: GM PA Comments.pdf)

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General Motors

Public Policy Center

April 11, 2006

Environmental Quality Board
P.O. Box 8477
Harrisburg, PA 17105-8477

**GM Comments on Rulemaking to Adopt California Emission Standards**

Dear Board Members:

Please find attached General Motors' comments on the proposed adoption of California emissions standards for new automobiles.

If you have any questions, please contact me at 313-665-2957 or Timothy McCann of the General Motors Legal Staff at 313-665-4878.

Sincerely,

Alan R. Weverstad
Executive Director
Mobile Emissions and Fuel Economy
General Motors Public Policy Center

Attachment

File: SM3037

*General Motors Corporation* *300 Renaissance Center* *MC 482-C27-C22* *P.O. Box 300* *Fax (313) 665-0746* *Detroit, Michigan 48265* *Phone (313) 665-2957*

**State of Pennsylvania**
**Environmental Quality Board**

# Comments of General Motors Corporation On the Proposed Rulemaking to Adopt California Emission Standards for Motor Vehicles

**April 11, 2006**

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**Comments of General Motors Corporation**
**On the Proposed Pennsylvania Rulemaking to Adopt California**
**Emission Standards for Motor Vehicles**

## Introduction

General Motors is pleased to have the opportunity to provide input to the State of Pennsylvania on its proposed adoption of the California motor vehicle emission regulations. Many of the comments in this submission were previously provided to the California Air Resources Board (ARB) in the course of its greenhouse gas rulemaking process, as well as to other states considering adoption of the California greenhouse gas regulation. Additional comments are also included concerning NMOG and other California LEV II requirements. It is of particular importance for the Environmental Quality Board (the Board) to make an independent assessment of the issues presented by the ARB greenhouse gas rule, because there are many flaws in the California regulation as well as the technical analysis that was performed by ARB to justify that regulation. Several of these flaws are so severe that they put the regulation in violation of federal law, as well as in violation of California law, and these violations are being challenged in court. We believe it is not necessary for Pennsylvania to adopt the greenhouse gas regulation as a part of its adoption of other California motor vehicle emission regulations, and so we devote most of our comments to the greenhouse gas portion of the California program.

We strongly oppose adoption of the proposed regulations for myriad reasons discussed in our comments and in the comments of the Alliance of Automobile Manufacturers (Alliance). We support the Alliance comments and recommendations and incorporate them by reference. The greenhouse gas regulation in particular will impose substantial costs on Pennsylvania consumers that far exceed any perceived benefits, and will not improve the quality of the environment in Pennsylvania or elsewhere. Among the regulation's many additional flaws, it will create gross competitive inequities that advantage certain automobile manufacturers while penalizing General Motors and the other domestic manufacturers, and it fails to comply with the requirements of federal law. Adoption of this regulation by Pennsylvania will result in restrictions in the number and types of new vehicles that General Motors will be able to offer our dealers for sale in Pennsylvania. Product restrictions and higher vehicle prices will lead to large U.S. employment losses. Consequently, we urge the Pennsylvania Environmental Quality Board to use the discretion that it has under the Clean Air Act and not adopt the separate and severable California greenhouse gas regulation.

## Regulatory Background

Several preliminary comments are necessary. First, it is important for the Board to recognize that the California greenhouse gas regulation would place Pennsylvania and any other State adopting the California rule in the business of regulating motor vehicle fuel economy. Fuel economy regulations at the national level have significant effects on

General Motors and its customers, which would be magnified at the state level. General Motors supports voluntary, consumer-oriented programs intended to address the issue of greenhouse gases, but not regulatory programs like that adopted by California, which conflict with federal regulation. A prime example of potentially promising voluntary programs which help define the difference between the California rule and market-oriented alternatives is the recent agreement between several vehicle manufacturers (including General Motors) and the Government of Canada. The Canadian voluntary agreement is reviewed below, following the initial discussion of how the California greenhouse gas rule and other fuel economy regulations affect consumers and the industry.

**Fuel Economy and Carbon Dioxide**

The primary greenhouse gas emission from motor vehicles is carbon dioxide, and regulating carbon dioxide at the levels of stringency required by the California rule is tantamount to regulating fuel economy. Carbon dioxide ($CO_2$) is an inevitable product of combustion of any hydrocarbon fuel. It is formed in direct proportion to the amount of gasoline burned. Because of this direct chemical relationship, fuel economy is measured most precisely by measuring tailpipe emissions of $CO_2$ and calculating the amount of fuel burned based on a carbon balance equation. That is how fuel economy tests are performed for vehicle labeling, for advertising, and for compliance with federal fuel economy standards. Measurement of carbon dioxide emissions and fuel economy are one and the same. It is for that reason that we believe that the California greenhouse gas emissions standards are preempted under federal law.

Unlike criteria pollutant emissions regulated under the Clean Air Act, fuel economy is a function of the design and operation of the entire vehicle. There are no aftertreatment technologies such as catalytic converters to remove carbon dioxide from the exhaust stream. Therefore, fuel economy regulation has major implications for virtually all vehicle attributes, such as size, features, safety and performance. The adverse impacts of the regulation on automobile manufacturers and Pennsylvania consumers can be expected to be the largest of any motor vehicle regulation ever adopted by Pennsylvania.

**Federal CAFE Regulation**

The Corporate Average Fuel Economy (CAFE) program established by the Energy Policy and Conservation Act of 1975 (EPCA) requires the National Highway Traffic Safety Administration (NHTSA) to set maximum feasible fuel economy standards when setting annual truck CAFE standards and when amending the car CAFE standard set by Congress. The regulatory process to establish CAFE standards is required under EPCA to consider technical feasibility, economic practicability, the impact of other regulations and the need of the nation to conserve energy. Impacts on traffic safety and U.S. employment are also evaluated. This is all accomplished through careful consideration of detailed submissions by automobile manufacturers and an appropriate period for public comment. Given this extensive process and NHTSA's 30 years of experience with fuel economy regulations, it should give pause to the Board that ARB's evaluation of "maximum feasible" fuel economy levels is so radically different than evaluations over many years of "maximum feasible" levels by the U.S. government.

Unlike some of its foreign competitors, General Motors has always complied with federal CAFE standards and has therefore never paid a fine for CAFE noncompliance. However, as gasoline prices declined in the mid-1980's, compliance became very difficult and costly for CAFE constrained manufacturers that produced vehicles for the full range of market segments. Because General Motors was historically especially successful in segments for larger cars as well as larger trucks, CAFE became most constraining on General Motors. Even though we lead in more model-to-model fuel economy comparisons of comparable vehicles than other manufacturers, our sales mix often leaves us with fleet average fuel economy uncomfortably close to the CAFE standards.

For example, in model year 2004, General Motors had higher fuel economy in 39 of the 60 passenger car model-to-model comparisons in which GM had a similar model competing against other manufacturers, representing higher fuel economy in 65% of the direct comparisons of similar vehicles. In the light truck segments in which GM competed, GM had the best 2004 model-to-model fuel economy in 38 out of 62 comparisons, winning 61% of the matchups. Despite this, GM's domestic passenger car CAFE of 29.0 mpg and light truck CAFE of 21.2 mpg were below the industry averages, based on the most recent reports from NHTSA (NHTSA Summary of Fuel Economy Performance Report, March 2005).

While we struggled to maintain CAFE compliance, manufacturers that had previously specialized in smaller vehicle segments were given a competitive advantage that was exploited aggressively. Aided by this competitive advantage, these manufacturers expanded rapidly into larger vehicle segments. We see this dynamic being repeated in this rulemaking, to the detriment of employment in Pennsylvania and elsewhere in the U.S. The California greenhouse gas standards are grossly unfair for General Motors in particular, because we continue to have the heaviest fleet average weight due to the mix of vehicles purchased by our customers, coupled with the much more lenient standards applied by California to certain of our competitors, as described below.

For perspective, larger light duty trucks (above 4,900 lbs. curb weight but below 8,500 lbs. GVWR) represented 40% of GM truck sales in 2002 model year, and GM had a 55% market share in this category. In that year, 100% of GM's light duty trucks were assembled in North America, with an average domestic content of 90%, which was the highest in the industry. Although foreign-based competitors have exploited CAFE advantages to expand into larger vehicle segments somewhat, and although they have established some U.S. manufacturing facilities, dramatically higher fuel economy standards such as those created by the California greenhouse gas regulation would repeat the mistakes of the past by disadvantaging domestic producers and harming overall U.S. employment.

**Canadian Memorandum of Understanding**

As indicated above, the California rule stands in sharp contrast to collaborative, government-industry voluntary programs that deal more realistically with the issue of greenhouse gases. On April 5, 2005, General Motors and other companies in the

Canadian automobile industry voluntarily signed a memorandum of understanding with the Government of Canada that is intended to reduce greenhouse gas emissions in the auto sector by 5.3 million tons of $CO_2$ equivalent in 2010, compared to the "reference case" forecast of national greenhouse gas emissions in 2010 that the Canadian government estimated in 1999. The agreement includes all greenhouse gases from vehicles, including carbon dioxide ($CO_2$), nitrous oxide ($N_2O$), methane ($CH_4$) and hydrofluorocarbons (HFCs).

This agreement differs in important respects from the California regulation. It builds upon a long history of many successful, similar voluntary Canadian industry-government programs. The agreement is voluntary, nationwide and auto industry wide, and it is consistent with other voluntary auto industry efforts to reduce greenhouse gases. In contrast, the California regulation creates sharply different regulatory obligations for different manufacturers, and brings myriad regulatory burdens associated with a regulatory program.

It should also be noted that the specific elements of the Canadian MOU are suited to the Canadian market. It meets the government's target for auto sector emissions needed for compliance with the Kyoto Protocol, which Canada has ratified. Because of its unique attributes, it does not lend support to the California regulation or to more stringent U.S. CAFE standards. Indeed, Canada considered vehicle greenhouse gas regulations in Parliament in 2005 and rejected the regulatory approach.

While continuous and voluntary improvements in fuel economy are one component of the agreement, and a variety of factors already leads to a more fuel efficient sales mix in Canada, the agreement is not expected to require vehicle fuel economy increases beyond the rate of increase in the U.S. market. This rate of increase is far less than would be required by the California regulation. The 1999 Canadian "reference case" forecast that forms the baseline for the MOU was developed using assumptions that were described as "conservative" -- where "conservative" means that the reference case forecast tends toward high emissions estimates. The industry is believed to be on track to outperform those forecast assumptions in Canada, but the California standards far exceed industry technical capabilities. The MOU is not expected to require vehicles in Canada that are different from vehicles sold in the U.S., nor is it expected to require major changes in vehicle pricing or sales mix, including the cancellation or restriction of certain vehicle models in Canada. In contrast, the California regulation is expected to result in each of those adverse outcomes.

## Regulatory Compliance Issues

Although General Motors' comments to ARB opposed the adoption of the greenhouse gas rule, we also offered extensive information to ARB on specific regulatory issues and problems that were created by their regulation. Because ARB made no adjustments to correct these problems, this section is repeated for the Board so that it can understand some of the compliance problems that its adoption of the regulation will exacerbate.

### Differential Treatment of Manufacturers

The California regulation applies stringent requirements on the six largest automakers beginning in 2009 model year (MY), but would delay any requirements on small and mid-sized manufacturers, with annual California sales under 60,000 vehicles, until seven years later, in 2016 MY. The requirements that would be imposed on these smaller manufacturers in 2016 would remain much less stringent than the regulations that apply to larger manufacturers, with the mid-sized manufacturers given a choice of meeting the standard that had applied to comparable vehicles from their larger competitors in 2012 or, if easier, meeting a percentage improvement target applied to their 2002 baseline fleet average. There appears to be an intention, as revealed by the design of these provisions, to permanently maintain less demanding requirements for small and mid-sized manufacturers. Pennsylvania has proposed giving the same unfair advantage to manufacturers that are classified by California, according to the California volume thresholds, as small, low and intermediate volume manufacturers.

The companies that currently fall under the 60,000 vehicle threshold based on California sales include major global competitors such as Volkswagen and BMW that have no inherent weaknesses that would justify this degree of regulatory preference. In addition, new entrants are expected in the U.S. automobile market from emerging economies such as China and India. These new entrants would be handed a huge competitive advantage to help them become established in the U.S. market. The seven-year holiday from greenhouse gas standards coupled with permanently less demanding requirements provide an overwhelming competitive advantage and are grossly unfair to General Motors and the other domestic manufacturers.

### Equity Ownership Provision

The California regulation requires that automobile manufacturers be grouped together for compliance purposes in cases where one company has at least a 10% equity ownership interest in the other, or in cases where a third party owns at least 10% of the equity in two or more automobile manufacturers. This provision would affect several General Motors business relationships. The 10% threshold is far below the level that would normally be considered necessary to give any significant degree of management control in a company. Yet the experience with federal CAFE regulation has shown that tight control of product design decisions, pricing, production scheduling and many other areas of business decisionmaking is required to manage fleet average fuel economy.

Indeed, comprehensive coordination with these companies in some areas such as the numbers of vehicles offered for sale and product pricing could potentially be unlawful. Yet comprehensive coordination would be necessary to manage fleet average emission levels.

In addition, publicly owned corporations have no control over investor trading in their own shares which could trigger the third party provisions of the regulation. Because of these equity ownership provisions, sudden, unexpected situations could develop that put manufacturers out of compliance with the regulation through developments that are not within the control of the manufacturers.

The 10% threshold is so low that a situation could be created where multiple automobile manufacturers would be required to include the vehicles from another manufacturer in their fleets. This situation could develop, for example, if two large manufacturers each owned over 10% of a third manufacturer. The equity ownership provisions apply a huge penalty to any smaller automaker in which GM invests. This creates a significant barrier to GM's ability to create normal business alliances and collaborations worldwide, to the detriment of GM's ability to compete in all markets worldwide and to meet the needs of our customers.

**Commercial Vehicles**

Despite claims to the contrary, California makes no realistic provision in its regulation for continued availability of commercial vehicles -- vehicles that are essential for Pennsylvania businesses and the health and competitiveness of the Pennsylvania economy. Initially, the ARB justified this omission with the claim that sales of commercial vehicles are "a small portion of the light duty fleet". That is untrue: commercial vehicles are a substantial part of the market and designing for work requirements has a large impact on average fleet fuel economy. Because vehicles used in commerce often have below average fuel economy, they are in the most threatened category for restricted availability should Pennsylvania adopt the California greenhouse gas regulation.

In a subsequent action, ARB clarified that vehicles in the Option I LEV II NOx category are exempted from the greenhouse gas regulation. In its commentary, ARB stated that "this post-hearing modification clarifies the original intent of the proposal, which is to exempt light-duty work trucks from greenhouse gas emissions requirements." (p. 14, October 19 ARB Proposed Modified Text, Attachment 1)

GM has never produced a vehicle in this category and, to our knowledge, the only vehicle ever produced in the Option I LEV II NOx category has been a single low volume variant of the Ford F-Series pickup. This near absence of vehicles in that category is inherent in the design of the criteria for the category -- vehicles must be LDT2 trucks having a base payload of 2,500 lbs. or more, yet not exceed 8,500 lbs. Gross Vehicle Weight Rating. This implies that the unloaded, curb weight of those trucks cannot exceed 6,000 lbs. (8,500-2,500). Yet trucks built sturdy enough to carry a load of at least 2,500 lbs. usually weigh more than 6,000 lbs. curb weight. It should be noted that 2,500 lbs. payload is a heavy payload, so that only a small proportion of the current sales of pickup trucks provide such high capability, and these trucks are all classified as medium duty vehicles that are typically exempted from the greenhouse gas regulation without the use of the Option I LEV II NOx exemption. But the vast majority of light duty trucks, as well as passenger cars, that are currently used in commerce receive no exemption or special consideration whatsoever in the California regulation.

Because the Option I LEV II NOx exemption applies to virtually no current work trucks, the ARB's claim that it exempts work trucks from the greenhouse gas regulation is false. In order to fit into this category, the curb weight of current medium duty trucks would need to be reduced below the 6,000 lbs. curb weight threshold (if possible without sacrificing payload), which would violate the mandate of the California law that the regulations not require "a reduction in vehicle weight" (as well as ARB's claim that they do not require weight reductions).

In addition, the Option I LEV II NOx provisions limit the vehicles in this category to 4% of a manufacturer's LDT2 truck fleet sales. Even if the aforementioned problems with this exemption did not exist, this 4% restriction on sales volume is sufficient to nullify the claim that work trucks are exempted from greenhouse gas regulations by the Option I LEV II provision. Customer usage and customary industry practice would indicate that far in excess of 4% of current LDT2 sales warrant the term "work truck".

It is highly misleading for ARB to claim that work trucks are exempted from the greenhouse gas regulations when virtually no current or past vehicles would qualify as work trucks under their definition, and no more than 4% of full-size, light-duty truck sales would ever be allowed to be classified under the ARB work truck exemption. ARB makes no provision in its regulations for identification and exemption of commercial vehicles, even though commercial vehicles are a substantial fraction of total vehicle sales.

**Alternative Compliance Mechanisms**

California's motor vehicle greenhouse gas law (AB1493) expressly requires regulations that "provide flexibility, to the maximum extent feasible". It is sensible to pursue perceived environmental benefits at the minimum cost possible. In interpreting this provision, however, ARB created flexibility mechanisms that are sharply limited in order that they would play a "minimal role". The same philosophy of sharply limited potential availability was applied to early action credits. From a realistic standpoint, this provides essentially no compliance flexibility to protect the automobile market from costly and disruptive market distortions.

**Greenhouse Gas Emission Test Vehicle Selection**

The ARB created an approach for selecting test vehicles for determining the $CO_2$ equivalent emissions (CO2E) fleet average that is based on testing worst-case vehicle configurations. As a result, a manufacturer's CO2E fleet average will be over-estimated by a wide margin. To achieve a CO2E fleet average representative of the true average, a manufacturer would need to test all vehicle configurations. The result is that hundreds more vehicle tests would be required at General Motors annually beyond current testing requirements. Furthermore, ARB based its standards on a "maximum feasible" analysis of data based on representative vehicles (using the NHTSA CAFE database, which has the high volume configurations), so that requiring manufacturers to comply using worst-case vehicles creates a condition whereby the standards automatically are beyond ARB's estimation of maximum feasibility unless all vehicle configurations are tested.

## Comments on ARB's Analyses

### Overview

General Motors is pursuing an aggressive near, mid and long-term plan to bring to market technologies to improve fuel efficiency, reduce emissions and provide additional value and benefits to our customers. This program already includes implementation of most of the fuel economy improvement technologies for conventional gasoline-powered vehicles that could be considered feasible and practical for the relevant time period. This program also includes research and development related to the advanced technologies that ARB used in its technical analysis, so that we are knowledgeable about the state of development, potential market introduction timing, cost levels, side effects and other impacts of the technologies ARB used to justify its regulation.

We have evaluated strategies for compliance with the California regulation in view of the short lead time until the first requirements in 2009-2011 model year and the rapid rate of increase in the stringency of the standards through 2016. Technical and financial resource cadence constraints mean that a manufacturer can only update 16 to 20% of its product lines in a single year, and engineering lead times require that work on 2009 model products already be underway. These evaluations show that, even with an immediate crash program to implement the most expensive and cost-ineffective technologies, compliance with the California regulation requires severe restrictions in the product lines provided to dealers in the states subject to this regulation, both in the initial years of the rule and in later years.

The vast disagreement between General Motors compliance planning and ARB's determinations comes about through a variety of flaws in ARB's engineering and financial evaluations. The next few sections comment on ARB's engineering and financial analysis in their Initial Statement of Reasons (ISOR), which provided the technical justification for the regulation. This is followed by a critique of a subsequent technical analysis released by ARB in which two General Motors vehicles, a Buick LaCrosse and Chevrolet Silverado, are specifically evaluated for their fuel economy improvement potential.

To the extent the Board's proposed adoption of the California greenhouse gas rule is predicated on these fatally flawed ARB findings, as discussed in the next section, the the Board proposal for Pennsylvania is similarly flawed. Accordingly, the Board proposal should be withdrawn, and Pennsylvania should align itself with the federal regulatory programs related to emissions and fuel economy.

**Retail Price Equivalent**

The ARB initially relied on an interim report by the Northeast States Center for a Clean Air Future (NESCCAF) issued in March 2004 as the basis for its financial and technical analysis, although ARB made significant adjustments to the NESCCAF estimates. (Note that the final NESCCAF report released in September 2004 did not materially change from the interim report, and the following discussion based on the interim draft therefore still applies.) ARB inappropriately used the NESCCAF report with the result that significant degradations in vehicle performance in the NESCCAF computer simulations were overlooked, significant categories of costs were omitted, and the costs to consumers of the California regulation were significantly underestimated.

The NESCCAF report explains its cost estimates, compiled by the Martec consulting group, as follows (NESCCAF, p. II-17):

> "As noted at the outset of this section, Martec's cost estimates do not attempt to capture all costs to the manufacturer of incorporating new technologies, nor do they include estimates of cost impacts at the consumer level as reflected in the purchase price of a new vehicle. Additional manufacturer-level costs that were not captured in this analysis but that could be associated with the use of new technologies include:
>
> - Engineering costs, including advanced R&D, vehicle design and development engineering for integrating new technologies and software development;
> - Warranty and possible recall costs;
> - Factory capital costs associated with vehicle-level technology changes;
> - Manufacturing costs for powertrain or vehicle assembly.
>
> The costs described by Martec represent an estimate of the cost to the manufacturer for the hardware needed to incorporate a given GHG-reducing technology on a high-volume production vehicle. Associated system-level material content such as wires, control module drivers, etc. are included in these estimates - if purchased from a supplier, these all represent a variable cost to the automaker. However, the estimates do not necessarily capture the complete set of variable costs that might be associated with the introduction of new technologies - for example, applying some technologies might require body and chassis re-designs that would in turn incur additional costs."

This cost methodology is also described in discussing mobile air conditioners:

> "In accordance with the costing methods for other portions of this study, alternative A/C system costs include only the high volume variable costs of components and do not consider the fixed costs of system introduction (e.g., engineering, and any incremental production, manufacturing, or assembly plant costs)." (NESCCAF Appendix D-20)

These descriptions make clear that important whole categories of cost have been excluded from the estimates supplied to NESCCAF by the Martec consulting group. More precisely, the Martec assessments comprehend the price that an automobile manufacturer such as GM would pay to a component supplier to purchase the component hardware to implement these technologies. However, the costs to an automobile manufacturer to implement a technology only begin with the purchase of component hardware. There is usually additional assembly labor and related costs in our powertrain factories and our vehicle assembly factories -- costs which are specifically mentioned in the NESCCAF report as not comprehended (NESCCAF p. II-17). In addition, there are often significant vehicle integration costs specific to each technology/vehicle combination which involve engineering the technology onto the vehicle, and possibly modifying other hardware on the vehicle. In essence, the analysis on which ARB and the Board rely to justify the adoption of the greenhouse gas rule is inherently flawed, and it grossly underestimates the cost of that rule to Pennsylvania citizens.

Furthermore, the technologies analyzed in these studies cover a wide range of dissimilar items, and one cannot generalize with precision about their specific implementation cost structures. A program to evaluate implementation by an automobile manufacturer would always involve much more specific attention to the details of implementation of each technology onto a specific engine or transmission, in a specific set of powertrain factories, applied to specific vehicles with their own unique implementation/integration issues, etc. Warranty costs would be estimated based on experience and expectations for each technology on a case-by-case basis. In short, there would be specific engineering and financial attention to the cost categories that were ignored in the NESCCAF and ARB analyses.

Without offering an analysis, NESCCAF and ARB apply a "retail price equivalent" (RPE) mark-up of 40 percent" (NESCCAF p. II-24, ISOR p. 80) to convert the Martec-supplied costs into the price paid by consumers. This 40% RPE factor is of tremendous importance to this analysis since it must account for all the engineering, investment, labor, material, overhead and other manufacturing costs not comprehended by Martec, as well as service and warranty costs, automobile manufacturer profit to achieve an adequate return on investment, costs and profits in the distribution network, especially the dealership markup, and any other items.

As justification for its 1.4 RPE factor, ARB cited two studies: 1) USEPA "Progress Report on Clean and Efficient Automotive Technologies Under Development at EPA: Interim Technical Report", January 2004; and 2) "Comparison of Indirect Cost Multipliers for Vehicle Manufacturing", Vyas, A., Dan Santini, Roy Cuenca, Argonne National Lab, April 2000. ARB stated that 1.4 is between the RPE factors of 1.26 in the EPA paper and the factors of 1.5 and above in the Argonne (ANL) paper (ISOR, p. 80).

Examination of these sources reveals that the EPA paper offers no justification for the 1.26 RPE factor, simply asserting that it is used "when implementing new emissions regulations" (ISOR, p. 65) and "in regulatory development, EPA uses a retail price equivalent mark-up factor of 1.26 to adjust a manufacturing price increase to a retail price increase. This factor accounts for manufacturer overhead and profit" (p. 63). An examination of GM's cost structure reveals that 1.26 is far too low to fill that role.

The ANL paper offers an analysis of RPE factors from three sources, ANL, Energy and Environment Analysis (EEA), as quoted in a 1995 report from the U.S. Office of Technology Assessment, and a 1996 presentation by an automobile company executive, Chris Borroni-Bird, at a technology conference. The ANL RPE's derived from these sources are as follows (p. 7):

| Multiplier for | **ANL** | **Borroni-Bird** | **EEA** |
|---|---|---|---|
| In-House Components | 2.00 | 2.05 | 2.14 |
| Outsourced Components | 1.50 | 1.56 | 1.56 |

The difference between the "in-house component" RPE and "outsourced component" RPE is that, for the case of outsourced components, ANL removed from the RPE costs for freight, warranty, amortization and depreciation, and engineering. ANL assumed that, for outsourced components, the supplier would incur these costs. However, the Martec cost estimates that form the basis of the NESCCAF and ARB analyses do not include these costs in the underlying technology cost estimates -- costs such as warranty and engineering are specifically mentioned as excluded, as are large pieces of the required capital investment that forms the basis for depreciation and amortization. Therefore, the RPE's of approximately 1.5 calculated for outsourced components are not applicable to the cost estimates provided by Martec, even if the components were ultimately outsourced. The higher RPE's of 2.0 or above would apply, in this ANL analysis, to a cost basis that did not include warranty, etc., with the difference between 1.5 and 2.0 covering these categories of cost.

Based on an analysis of General Motors cost structure and supported by the Argonne Lab study, ARB should have used a retail price equivalent factor of not less than 2.0 for this analysis. This would increase ARB's cost assessment by approximately 50% and would change their estimates of the economically feasible emissions standards significantly. ARB's use of a 1.4 RPE results in the omission of significant categories of manufacturer costs, and substantial underestimation of consumer costs related to the proposed regulation.

NESCCAF released to ARB its final report on September 23, 2004 at the ARB hearing to approve the greenhouse gas regulations. NESCCAF's final report uses the same 1.4 retail price equivalent (RPE) factor, but cites the 2002 National Research Council's report on "Effectiveness and Impact of Corporate Average Fuel Economy Standards" (NRC p. 41). The NRC report, in turn, cites a 2001 report by Energy and Environment Analysis, Inc. as the basis for the 1.4 RPE number. (The report is "Technology and Cost of Future Fuel Economy Improvements for Light Duty Vehicles".) However, the 1.4 number cannot be found in the EEA document cited. Indeed the EEA report supports use of higher RPE factors than 1.4. (EEA p. 2-5)

Further, the EEA report lays out in detail its cost methodology, which makes clear that the RPE factors it presents are intended to be applied to a cost basis that already includes detailed assessments of major categories of cost such as engineering expense, tooling, and facilities expenses. The EEA report also describes the tiers of costs going from suppliers to automobile manufacturers through the auto dealers (p. 2-5). NESCCAF and ARB's analyses omit major categories of costs by taking an RPE that was developed to be applied on top of a broad cost basis, and then applying it to a narrow cost basis that omits many of the major cost categories. Also, NESCCAF and ARB apply the RPE to supplier costs (Tier 1 of EEA p. 2-5), and ignore the automobile manufacturer's costs laid out in EEA Tier 2. The cost numbers supplied by Martec to the NESCCAF study clearly are not prepared on an accounting basis that would justify use of an RPE so low as 1.4.

In order to ensure that it is making correct policy decisions and to discharge its obligations under Pennsylvania law, the Board needs to make an independent assessment of the ARB and NESCCAF analyses, and cannot simply "rubber stamp" those analyses. To the extent that the Board concludes that those analyses have any merit, the Board must fully explain why it is choosing to rely on the ARB and NESCCAF analyses, and any reasons it may have for not accepting the points outlined above demonstrating why those analyses are not entitled to support or use by the Board.

**Cost Omissions**

The cost estimates used in the NESCCAF report were given with numerous caveats, as noted in Attachment B of the NESCCAF interim report. For example, an upgrade to a 42-volt electrical system is noted as needed for electric power steering for large trucks and electromagnetic camless valve actuation. Upgraded batteries are needed for the motor assist and start-stop hybrid systems. Increases in transmission torque capacity are noted as potentially needed but not specifically modeled for diesels and turbocharged engines. Modifications to base engine components are excluded for direct injection systems and noise vibration and handling (NVH) modifications are excluded for cylinder deactivation.

Automated manual transmissions are noted to have no North American capacity. This is an important caveat in view of the major investment and other costs associated with changing over capital-intensive transmission factories. The ARB report states a belief that "transmission suppliers would absorb the bulk of investment costs, not the vehicle manufacturers" (ISOR, p. 85), but this overlooks the reality that all expenditures are ultimately borne by consumers. It is noted that continuously variable transmission (CVT) costs are based on a competitive component sourcing environment without major licensing cost additions and high volumes -- none of which are realistic assumptions given the status of this technology. In addition, there are numerous instances of additional costs for vehicle integration that would be expected for these new technologies that are not specifically noted by NESCCAF.

The presentation of this list of cost omissions and simplistic assumptions in Attachment B of the NESCCAF report reveals that the authors were aware that important cost issues were being excluded from the analysis. Yet not only did ARB not compensate for these omissions, ARB added the unrealistic assumption that the NESCCAF costs for several "emerging technologies" would be reduced another 30%. The NESCCAF report states that "Martec assumed that at least three high-volume automakers would use each technology at volumes of at least 500,000 units per year and at least three competing suppliers were available to supply each automaker for each technology. This would create a highly competitive purchasing environment that would drive prices and costs to competitive levels" (NESCCAF p. II-18). The Martec estimates reflect "fully learned, high volume production of current technology designs" (NESCCAF p. II-18). Thus, learning curve effects are already incorporated in the NESCCAF costs. The NESCCAF report only allows that "to the extent that basic scientific advances in design or manufacturing do occur, future costs may be lower than estimated" (NESCCAF p. II-18). Yet costs in the relevant time frame would not be "fully learned", they would be at much higher levels reflecting introductory conditions for new technologies. Costs would reflect transitional investment and cost issues that have been omitted from the ARB analysis.

It is likewise unrealistic to factor in a 30% reduction beyond the fully learned, high volume levels based on a possibility of "basic scientific advances in design or manufacturing" (NESCCAF, II-18). Basic scientific advances are by nature not predictable and usually develop and progress toward implementation over long time frames. Reliance on basic scientific advances is in conflict with the technologies being available in the near or mid terms. Furthermore, given the pace of new technology introductions and replacement laid out by ARB in its technical justification, it is questionable whether maturation of technologies to "fully learned" levels might ever occur. The expected rate of change is simply too fast and disruptive, and expected product lifetimes too short, with new technology packages forced across the fleet in four year waves moving from the near term technologies in 2009-2012, to mid term technologies in 2013-2016 to, presumably, long term technologies described in the ARB technical analysis in 2017. Indeed, the shortened product lifecycles implied by this progression are not consistent with normal cost levels or rates of return, where powertrain technologies such as new engines or transmissions need useful economic lives of 10-20 years to be economically justifiable. Such premature obsolescence is a major cost of government regulations for a capital intensive industry such as automobile production; it is often overlooked in the financial analyses of proposed government regulations, to the detriment of the industry, its consumers, suppliers and employees.

**Incorrect 2009 Baseline Forecast**

NESCCAF shows a 2009 forecast that continues with OHV engines as the "dominant" technology for large trucks and minivans, among the five segments analyzed (Table II-4, p. II-7). While this representation is a simplification, it accurately reflects that OHV engines will continue to exist in large penetrations in 2009, especially among trucks. However, ARB's technology packages require conversion of all engines to overhead camshafts. ARB's cost adjustment for this change is far too low.

Further, ARB incorrectly applies anticipated fuel economy improvement factors to vehicles that either already have the technologies in the 2002 baseline, or which are not applicable for the technology. An example is to apply a fuel economy improvement factor for improved automatic transmissions to all vehicles, even though significant numbers of vehicles have manual transmissions that cannot be improved in this fashion or to this degree.

**Mobile Air Conditioning**

ARB inappropriately incorporated possible mobile air conditioning (MAC) improvements to increase the stringency of the GHG standard based on a mistaken view of the applicability of the flammable alternative refrigerant R-152a. General Motors has been a leader in exploring alternative refrigerants through the Society of Automotive Engineers Alternative Refrigerant Cooperative Research Program as well as independent research with our suppliers. This experience differs from ARB's characterization of R-152a. It is not yet clear if R-152a will be judged acceptable, and it certainly is not a simple drop-in replacement for R-134a (contradicting the NESCCAF analysis Appendix D-20). R-152a faces significant development issues, especially regarding its safety. If implemented, it would add costs for the required safety modifications.

ARB's assumption that manufacturers "will be converting to HFC 152a systems in the mid term" (ISOR, p. 107) is unwarranted and unduly speculative for a technology that is still at R-152a's stage of development. ARB should not have relied on a technology that has not even been demonstrated to any significant degree in test fleets as the basis for setting regulatory standards.

**Fuel Economy Technology**

ARB substantially overestimated the fuel economy improvements that would be expected to result from many of the technologies included in its technical justification. In order to better understand the results, we conferred with the analysts from the AVL engineering consulting group that performed the technology simulations for NESCCAF that ARB, in turn, used as the basis of much of its analysis. Following are some perspectives resulting from those discussions.

Vehicle Integration

Integrating fuel economy technologies into a vehicle involves a balance of all the performance attributes (tailpipe emissions, acceleration drive quality, noise and vibration, steering feel and response, ride and handling). In many cases, simultaneously meeting all vehicle performance requirements results in deteriorated fuel economy benefits and higher costs for a fuel economy technology. Benefits of a technology described in the public literature, by component suppliers, or produced by sub-systems simulations typically do not consider the integration and balancing issues required to completely integrate a technology into the vehicle. A major reason for ARB's overestimation of vehicle fuel economy potential is a disregard for this critical issue. Some examples include: the acceptable range of operation for cylinder deactivation to meet noise and vibration requirements, the additional exhaust and other noise canceling treatments needed to offset higher engine noise of a deactivated engine operating under high load or a downsized turbocharged GDI engine running at higher engine speeds.

Automated Manual Transmissions

The use of automated manual transmissions with dual wet clutches (AMTs) is nearly universal in the configurations that were used by ARB to set the standards. So the standards are highly dependent on the results projected for these types of transmissions. There are some significant issues with both the benefits analysis and the applicability of these types of transmissions:

- All of the AMT benefits are miscalculated due to the omission of important transmission losses. The June 2004 draft of the ARB report briefly described AMT technology, but did not go into any detail regarding clutch design. The analysis done by AVL assumed manual transmission efficiency values and only an added 15 Watt electrical load meant to represent gear-shifting-actuator loads. Neither transmission spin losses nor clutch actuator losses were accounted for in the AVL analysis. AVL has indicated that their analysis was specifically for dry-clutch AMTs. However, in the August 2004 ISOR, the AMT description (but not the analysis) was revised to include dual wet clutch designs in the AMT technology. Such a clutch design includes a hydraulic actuator pump that consumes significant energy, and according to LuK (AVL's source for AMT information) would result in a 4-6% lower drive cycle efficiency (ref. LuK presentation at SAE's Emerging Transmission Technologies TOPTEC in August 2003) than the dry clutch configuration analyzed by AVL. This loss is not included anywhere in the analysis, and its omission contributes significantly to the benefit claimed for transmission technology used to determine the standards.
- Some vehicle segments have seamless transmission operation as an important marketable requirement. These types of transmissions are simply not smooth enough for those market segments. Yet they are assumed to be applied in every vehicle segment.
- Single-clutch AMT's are not an acceptable alternative in the U.S. market. With an additional dry clutch to increase acceptability, dry dual clutch transmissions can only handle maximum torque of approximately 400 N-m. This torque level is approximately that of a V6 midsize car. At higher torque levels, a hydraulic system is required, accompanied by additional pump losses, mass, and increased electrical loads. Even hydraulic systems might not work on heavier trucks given extreme loads and durability concerns.
- The actual implementation of AMT transmissions into nearly all of the vehicle fleet (which is what the standard assumes) would require retirement of almost every North American investment in light-duty transmission manufacturing capacity and the addition of an equal amount of new AMT capacity somewhere in the world.

Turbocharged Engines

The use of aggressively downsized (41-52% smaller), highly turbocharged, intercooled, direct-injected engines with dual cam phasing is used to set the standard in all but one of the vehicle segments. So the standards are very dependent on the results projected for these types of engines. There are some significant issues with both the benefits analysis and the applicability of these types of engines:

- The projected benefit for the turbocharged, downsized, direct-injected, cam-phasing engines is based on very aggressive assumptions about the specific output that is possible for these types of engines. The most unlikely of these assumptions is that the engines will use premium fuel instead of regular fuel (as discussed in more detail below). All of the AVL analysis for these engines appears to be based on premium fuel. Without premium fuel, the specific output possible from these engines will be significantly reduced and the engine sizes will be overly optimistic due to selection of very low engine displacements driven by unrealistic BMEP (Brake Mean Effective Pressure) curve assumptions that depended on high boost levels and premium fuel usage.
- Typical turbocharger installations require an intercooler, which increases vehicle drag.
- There are significant discrepancies between the benefits projected by AVL for downsized turbocharged MPFI engines and downsized turbocharged GDI-S engines. AVL has indicated through a direct comparison of turbocharged MPFI versus turbocharged GDI-S DCP engine maps that engine fuel consumption differences between these two technologies are as much as 12% at typical Federal Test Procedure engine operation conditions. Such large differences in fuel consumption are unexplained by the relatively minor physical differences between the engine technologies. This discrepancy affects a technology package used to justify the emission standard in four of the five vehicle classes.
- AVL has confirmed that the application of aggressively downsized turbocharged engines did not include consideration of vehicle launch, drive quality, and transient engine/transmission/ turbo response. The simulation results provided by AVL indicate that the vehicles configured with these engines will have serious drive quality problems. General Motors believes such deteriorations in performance are not acceptable, and they demonstrate that not enough verification of "equal performance" was done. Demonstration of sufficient vehicle launch, drive quality, and transient performance should be required prior to consideration of this and other "torque-modifying" new powertrain technologies.

<u>Premium Fuel</u>

Portions of the analysis done by AVL appear to have included the assumption of premium fuel usage. AVL states that regular fuel was assumed for all of the engine configurations that used some form of variable valve actuation, but engine specific output levels taken directly from AVL output results match exactly with other premium fuel AVL work on variable valve actuation. Further investigation of this issue by AVL indicated that in most, but not all, cases their assumptions fell within very aggressive regular fuel specific output levels. Whether through an assumption of premium fuel usage or an overestimate of what is possible with regular fuel, the result is an over-estimate of the specific output possible with each of these technologies, which enables unrealistically aggressive engine downsizing – and fuel consumption reductions – to be simulated while maintaining equal performance. This discrepancy contributes to an over-assumption of the specific output capability (and thus the chosen engine size) of every DCP, DVVL, and CVVL engine in the AVL analysis.

Simulation Issues

The AVL study used a computer simulation tool and consistent methodology. However, *AVL has described their study as a generic study whose results can be used to compare relative differences between groupings of technologies, not for projecting specific consumption targets for specific vehicles.* As a generic study, the AVL work did not cover some important details and constraints that are a reality for vehicle manufacturers:

- All of the engine maps used in the simulation study were based on AVL's most optimistic, upper-limit projections of the full capability of the engine technologies, assuming full application of technology without sufficient constraints which reflect real-world combustion system dilution tolerance, airflow capacity, piston-to-valve clearances, oil system capacity at low speeds, idle speed control techniques, and Noise, Vibration and Harshness (NVH) concerns. The AVL engine maps assumed a best case for all of these aspects of engine design, and in several cases their "best-in-class" results were a smoothed composite of results from multiple engines – no individual engines represented the engine maps used for setting the standards. A study like this does not provide a quantitative target value that is suitable for setting fuel consumption regulations. The maps used by AVL to represent DCP, CCP, DVVL, and CVVL all had significant fuel consumption improvements at light loads where, in the real world, the improvements would be limited by combustion system dilution tolerance versus airflow capacity tradeoffs and by piston-to-valve clearance constraints.
- AVL has indicated that all of the vehicle/powertrain configurations chosen for the standard were chosen to maintain equal performance. However, seven of the ten configurations used for setting the near-term standard have worse 50-70 performance than their baseline cases; four of those cases (large truck 04, large truck 05, small truck 04, and minivan 04) are significantly worse and would be considered unacceptable when compared to the baselines.
- AVL did not consider any gradeability or drive quality metrics when choosing engine sizes. In nine of the ten configurations used for setting the near-term standard, the gradeability calculated by AVL was worse than the baseline gradeability; five of those cases (large truck 04, large truck 05, small truck 04, minivan 04, and minivan 05) showed significant degradation in gradeability to the point where they would likely be considered unacceptable. AVL made no explicit calculations concerning drive quality (the typical response to accelerator pedal inputs required by the driver) so it is impossible to quantify the impacts. Drive quality issues are frequently prevalent when the calculated gradeability is poor and when aggressive engine downsizing is attempted, so it is expected that there would be drive quality problems with several of the chosen configurations. Since the standards set by ARB were almost entirely based on configurations where drive quality problems are likely to occur, the standards should not be considered feasible unless more analysis validating acceptable drive quality is performed.
- The method used by AVL to input transmission shift patterns and torque converter lock patterns was explicit and well defined. However, the actual shift patterns and lock/unlock patterns were not chosen in a reproducible, consistent manner. There was no explicit test of the shift points to ensure that they were not too early (which would hurt drive quality, cause shift busyness problems, and

exaggerate fuel economy benefits) or not too late (which would help drive quality at the expense of fuel economy), and there was no consideration for the number of shifts per test cycle and the acceleration disturbance level during shifts (or any other indication of acceptable drive quality).

- The method used by AVL to adjust their baseline simulations to actual test vehicle performance and fuel economy results was to first "tweak" drivetrain efficiencies to dial-in vehicle 0-60 performance, and then "tweak" transmission shift and lock patterns to dial-in vehicle fuel economy. While a method such as this might produce a simulated fuel economy number that equals the test data, it does not result in a reliable baseline simulation. If, for example, the quoted engine power for the baseline engine was higher than actual (resulting in a "fast" 0-60 simulation result), the AVL method would artificially reduce the baseline drivetrain efficiency to match performance. Then, in order to match fuel economy numbers (assuming everything else about the simulation is in order), the AVL method would have to artificially make the shift/lock points too early. The result would be a baseline simulation result with unrealistic drivetrain efficiencies and shift/lock points.
- Given the observed degradations in gradeability and the well-defined but unvalidated transmission shift/lock methods used, it is inappropriate and overly optimistic for ARB to assume in Table 5.2-4 that all vehicles would benefit from additional aggressive shift logic and early torque converter lockup. The ARB report states that "driveability and acceleration concerns must be accounted for carefully in these alterations of shifting schedules." This is true, but it was not done by AVL or ARB. The ARB report states that "... care must be exercised to ensure smooth, responsive driveability and low noise, vibration, and harshness. AVL was conservative in its modeling of these features to ensure good driveability and minimum vibration." As described above, no systematic aggressiveness test was performed. The Table 5.2-4 adjustments are not justified. ARB had access to a full-featured simulation at AVL, but chose not to use simulation results, instead multiplying an unsimulated, unrealistic adjustment by the AVL results.

OHV Engines

Some of the vehicle configurations used to set the near-term standard were combinations of OHV engine technologies that are unlikely to be applied in the real world, applying DeAct plus DVVL plus CCP. The application of either CVVL or DVVL to OHV engines is not realistic as the mechanisms which might provide such function (especially in combination with DeAct and CCP) do not exist and are not being considered for development. Two major roadblocks preventing the combination of these technologies are (1) the fact that DeAct technology already uses a dedicated valve lifter and lifter housing that would preclude adding a new mechanism in the lifter valley and (2) the strict packaging requirements currently met by OHV engine designs would be violated if a large new CVVL or DVVL mechanism were added to the top of the cylinder head. Because these technology combinations have not been demonstrated in any realistic form, they violate the statement by ARB that "the technologies being explored are currently available on vehicles in various forms or have been demonstrated by auto companies and/or vehicle component suppliers in at least prototype form."

Hybrids

The AVL results for hybrid vehicles differed significantly from the estimates that ARB made. AVL's results for hybrids (which were based on analysis of simulation results) had significantly lower fuel consumption improvement than the ARB results (which were based on scaling of one production hybrid vehicle with performance significantly worse than that of any of the baseline vehicles).

Summary

Without actually examining system effects, it is very easy to double-count estimated fuel economy effects and to neglect important constraints. These sorts of problems are evident in many studies that use the "shopping-cart" approach. As a result, these studies tend to overestimate the possible benefits while underestimating the needed technology content and cost. AVL has identified some of the system interactions. But they have applied enormous technology content and cost.

For example, they have applied aggressively downsized, turbocharged, intercooled, premium-fuelled, direct-injected, variable valvetrain engines – a technology combination that has previously not been considered realistic, especially not for widespread application on the majority of the vehicle fleet. Another example is the application of AMT's on virtually the entire fleet. This is an all-new transmission of a type considered inappropriate for North American driving habits, where transmission smoothness is considered vital. (Subsequent assertions by ARB that conventional six-speed automatic transmissions could achieve results comparable to their calculations for AMTs are unsubstantiated and inaccurate.) Technologies such as camless valvetrains and HCCI combustion are emerging technologies that are at an early stage of development. It is premature to use them as the justification for setting regulatory standards.

In summary, ARB's analysis substantially overestimates benefits and underestimates costs by applying multiple new technologies that can have unexpected effects in combination, usually resulting in identification of additional constraints. This problem is compounded by the use of technologies that are still early in the development stage, which might not develop to fruition and which cannot be modeled with precision.

**Degraded Vehicle Performance**

As we examined the ARB analysis, it became very evident that the vehicle fuel economy computer simulations used to develop the standards did not maintain current or adequate levels of vehicle performance. Instead, they relied on technologies that would severely degrade vehicle performance, contradicting the claim by ARB that vehicle performance was maintained at current levels.

One prominent result of the analysis was that a large fuel consumption reduction was shown for downsized turbocharged engines. In fact, the downsized turbocharged powertrains served as a standard-setting configuration for all of the vehicle segments except one in the near-term calculations, as shown in Figure 1.

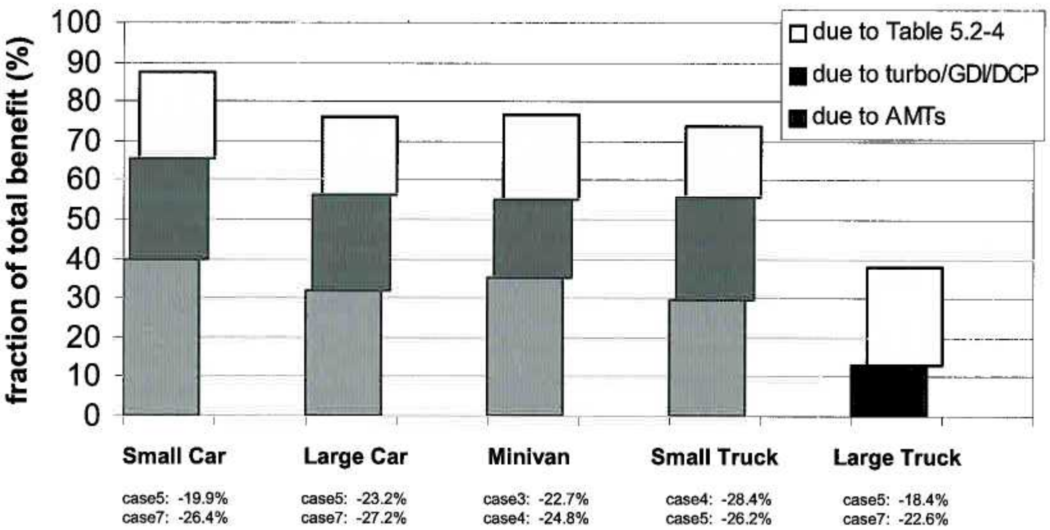


*Figure 1: Breakdown of CARB AB1493 fuel consumption improvements: indicates the contribution of AMTs, downsized turbocharged engines, and Table 5.2-4 vehicle assumptions to the total fuel consumption benefits projected by CARB for the near-term standard-setting.*

There are serious concerns with the methodology used to arrive at the chosen set of downsized turbocharged powertrains. These concerns are related to the real-world driveability performance of the proposed downsized turbocharged powertrains. Of specific concern is vehicle "launch" performance, which captures the initial acceleration characteristics of the vehicle from a stopped position. Also of concern are the transient response and driveability capabilities of the downsized turbocharged powertrains.

These concerns were not addressed in any way in the AVL analysis. If these concerns were sufficiently addressed, the result would be a reduction in the aggressiveness with which engines were downsized. The resulting fuel consumption benefits from downsizing/turbocharging would be reduced significantly because the vast majority of the claimed benefit comes from engine downsizing, ranging from a 41% to 52% displacement reduction. Since the California standards depend on very high production volumes of these downsized turbocharged powertrains, the feasibility has not been demonstrated.

In order to accurately address the launch and driveability concerns associated with downsizing/turbocharging, an analysis which includes other customer-driven vehicle attributes (launch, driveability, and transient response) would be needed. Nevertheless, the only performance criterion used to comprehend customer acceptance in the AVL simulation analysis was 0-60 mph acceleration time.

GM requested that AVL answer questions regarding their analysis and perform additional analyses on the vehicle configurations used for ARB standard-setting. The same AVL personnel and the same AVL methods were sought to perform these additional analyses. A portion of those results is summarized here.

The plot in Figure 2 shows the simulated acceleration response of the 2002 baseline minivan configuration compared with the simulated response of minivan case 4 (the downsized turbocharged case, which was one of the configurations used to set the California near-term standard). The simulation analysis was performed using AVL-CRUISE, and it exactly matches the analysis done for ARB.

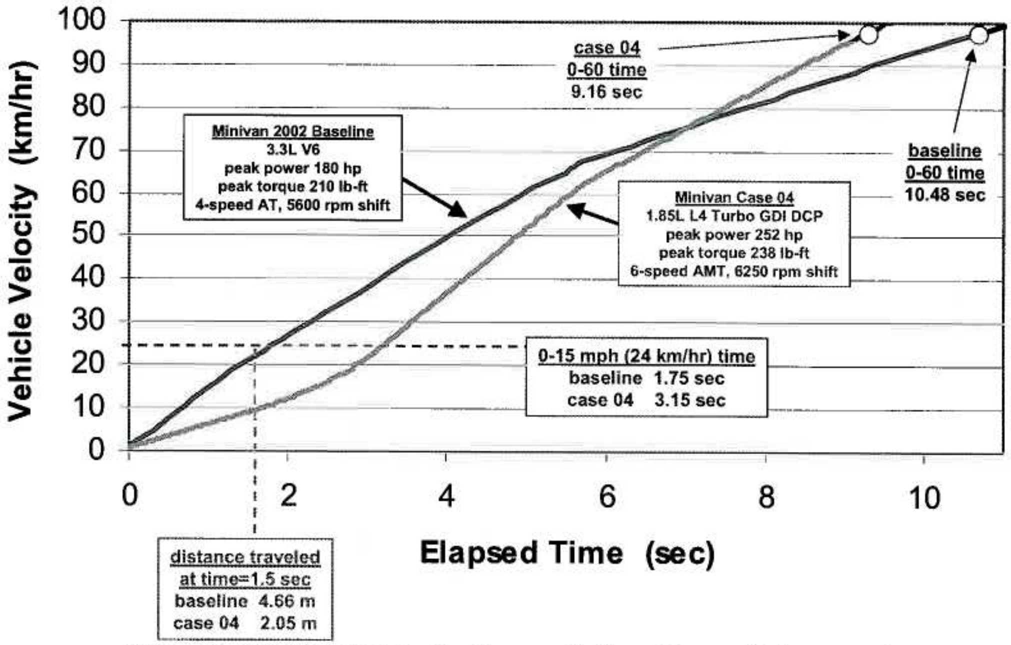


*Figure 2: AVL simulated acceleration results for minivan vehicle segment, showing baseline and case 4 (the downsized turbocharged case)*

It is evident from Figure 2 that the launch and early acceleration response of the downsized turbocharged powertrain for minivan case 4 is much worse than the baseline powertrain in terms of capability. Even though the 0-60 acceleration of case 4 is faster than that of the baseline, the performance lags when the vehicle is below 47 mph (75 km/hr). In case 4 it takes an engine with 252 horsepower to match the 0-60 time of the baseline 180 horsepower minivan engine! The unrealistically high horsepower value required for a baseline minivan engine is an indication that the balance of low-end torque and peak power for the powertrain is not realistic. Since the baseline case was chosen to be representative of the minivan class of vehicles, it is fair to state that the performance expectation for minivan customers for launch and early acceleration is not being met by minivan case 4.

Also highlighted in Figure 2 are some typical metrics regarding launch performance: 0-15 mph time and distance traveled at 1.5 seconds. Various manufacturers and powertrain developers use their own metrics, which may be slightly different, but those shown in Figure 2 are representative of launch. Clearly, minivan case 4 suffers from poor launch.

Launch is an important vehicle performance criterion because it is a positive indicator to the driver that the vehicle has sufficient capability to move from zero speed in a predictable manner. Turning on to a 2-lane highway, making a left turn in traffic, accelerating across an intersection, and starting up a hill are all very common examples of vehicle maneuvers where a certain level of "launch feel" is expected by customers. North American customers have become accustomed to a comfortable level of launch capability, enabled by engines with good low-end torque, properly ratioed transmissions, and torque converter-equipped automatic transmissions (this fact was observed in the AB1493 report). Some vehicle manufacturers have experienced significant negative customer reaction and lost sales as a result of inadequate vehicle launch capability. Sufficient launch capability is a requirement that must be met in the competitive marketplace.

Figure 3 shows launch and acceleration characteristics of the other downsized turbocharged powertrains used to set the California standards. These powertrains were applied to all vehicle segments except large trucks, so they make up a substantial volume (and represent huge production volumes) in the vehicle fleet envisioned in the ARB analysis. As can be seen in Figure 3, each vehicle with a downsized turbocharged powertrain travels significantly less distance during launch when compared to the baseline. In practical terms, when the baseline vehicle has made it through the intersection, the downsized turbocharged vehicle has only traveled halfway through the intersection. It is important to note that the baseline vehicles used here are exactly those chosen by AVL and ARB: vehicles representative of what is saleable in the competitive marketplace. *Any degradation from these baselines – let alone the huge degradations shown here – is a degradation in performance and contradicts the ARB assertion that vehicle performance was maintained.*

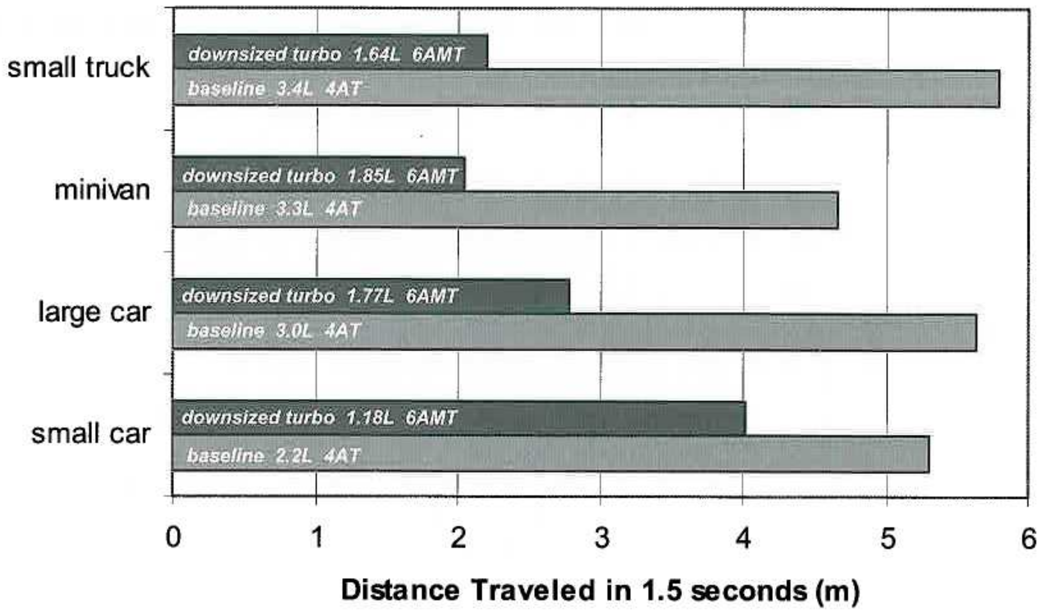


*Figure 3: AVL simulated launch results for baseline and downsized turbocharged vehicles; distance traveled in 1.5 seconds is used as basis for comparison.*

Another observation resulting from Figure 3 is that the heavier vehicles (trucks, minivans, large cars) suffer significantly more degradation in launch when the downsized turbocharged powertrains are applied. The simulation study performed by AVL, while sufficient for a generic comparison of various technology combinations, is not sufficient for standard-setting for vehicles which must meet customer requirements in order to be competitive. ARB states that the study projected baseline vehicle performance, and that their subsequent modeling "maintained those outcomes." This is simply not true.

**LaCrosse and Silverado Analysis**

The ARB staff subsequently disclosed an analysis in support of the California regulation that applied their maximum feasible fuel economy technology packages to two General Motors vehicles, the Buick LaCrosse passenger car and the Chevrolet Silverado pickup truck. This analysis repeated the mistakes that were made in the ISOR analysis.

In the case of the LaCrosse, a member of the ARB staff states that that GM could meet the large car near-term standard in a Buick LaCrosse by using a modified version of GM's 3.6L engine. The ARB staff member apparently included the benefits of dual cam phasers in his suggested near-term Buick LaCrosse, although the 3.6L engine already has dual cam phasers in production today. This results in the double-counting of the fuel consumption benefit of dual cam phasers, the very concern we have identified above.

It is possible to extract from the detailed simulations done by AVL in support of the ARB ISOR the approximate benefit of adding direct injection, cylinder deactivation, a 6-speed automatic transmission, electric power steering, and an improved alternator to the large car. That benefit, according to AVL, would be a 10.8% reduction in fuel consumption.

If the 2002 baseline large car (344.6 g/mi $CO_2$) were reduced by 10.8% (for the above changes) and also reduced by 15 g/mi $CO_2$ (for the unrealistic ARB R-152a MAC changes), the resulting $CO_2$ emissions would be 292 g/mi. This figure is significantly higher than the near-term standard for cars of 233 g/mi. In short, the analysis done for ARB does not support meeting the 2012 standard with this technology package.

GM simulated the same near term technologies with our own procedures to confirm that the California standards are not technically feasible. GM's simulation tool is our Unified Model. This is a dynamic simulation model that takes into account measured data of actual test vehicles and powertrains.

The 2005 Buick LaCrosse has the 3.6L LY7 DOHC V6 with dual cam phasing. This vehicle has an unadjusted combined fuel economy of 25.6 mpg, or 346 g/mi $CO_2$. We then added a Gasoline Direct Injection engine, and our 6-speed automatic transmission. We modified this transmission to simulate an automated manual transmission with a wet clutch system to handle this engine's torque capacity. We removed all power steering losses to simulate a rack power steering system and applied our RVC Gen IV advanced alternator control. Combining all these technologies together gives a vehicle fuel consumption and tailpipe $CO_2$ level that is far above the ARB greenhouse gas standard, even giving the vehicle credit for ARB's unrealistic R-152a MAC factor. In addition, the simulation predicts unacceptable transmission shift quality.

We also simulated the Silverado pickup with the 5.3L V8 and 4-speed automatic transmission. The 4WD version in 2005 has unadjusted combined fuel economy of 19.2 mpg, or 462 g/mi $CO_2$. We added displacement on demand, variable valve timing, improved power steering, the advanced alternator, and a six-speed automatic transmission. These yield a total fuel consumption that is far above of the ARB greenhouse gas standard, after accounting for the ARB R-152a MAC credit. None of these simulations adjusts for upcoming safety standards such as for braking, which will require higher rolling resistance tires.

Regarding the mid term standard, the ARB staff member states that: "there are numerous approaches that could be pursued in the leadtime remaining to 2016. General Motors could modify the engine to incorporate electrohydraulic camless valve actuation as the only other change needed to achieve the mid-term standard. Or General Motors could develop a homogeneous charge compression ignition combustion system for this engine coupled with an added integrated starter generator with launch assist." Both of the technologies cited by the ARB staff member are very far from ready for mass production, and may never be ready for mass production. Both technologies are research topics whose hardware concepts are not even well-defined -- hardware concepts have been proposed by many developers, but these have been research-grade types of systems. Both technologies have significant unresolved risk associated with their implementation (for example, in the case of EHVA camless, operation at low temperatures and control of valve closing velocity are major roadblocks; in the case of HCCI, the ability to extract a meaningful benefit while still controlling transient response capability over a speed-load range is a roadblock). Both technologies have significant noise and vibration characteristics which will require further measures to address. For a member of the ARB staff to assert that production of these technologies will significantly affect fleet fuel consumption in 2016 is unrealistic, and indicates an undue reliance on incomplete research systems.

## Comments on the LEV II Portion of Pennsylvania's Proposed Regulations

The LEV II regulations do not provide any meaningful benefits in ozone precursor emissions relative to the Federal Tier 2 regulations. Both LEV II and Tier 2 vehicles are far cleaner than the average vehicles on Pennsylvania's roads today, and emissions of the on-road fleet will come down dramatically as the fleet turns over as shown by the modeling previously submitted by the Alliance of Automobile Manufacturers. Note that this modeling does not account for the increases in ozone precursor emissions associated with the California greenhouse gas regulations. The following are comments on some specific parts of the proposed LEV II regulations.

### Fleet NMOG Average

GM believes Pennsylvania should not require compliance with the fleet NMOG average but instead require reporting. Fleet average NMOG is determined by sales mix. The sales mix in Pennsylvania is different than the sales mix in California because of differences in consumer demand. To comply with the fleet NMOG average, manufacturers may need to restrict sales of certain models in Pennsylvania that are not restricted in California. This would be detrimental to air quality because consumers would keep their older, higher emitting vehicles longer since they would be unable to purchase the new vehicles they wanted. By requiring reporting, the Environmental Quality Board could evaluate the differences between the California and Pennsylvania sales mix for each manufacturer and assess the problems that would be caused by requiring fleet NMOG compliance. The Department could also assess the fleet average emission levels at an industry-wide level since that is what matters from an air quality standpoint. If the industry-wide levels are below the fleet average standard, there would not be any need to require compliance. Requiring reporting instead of compliance will also alleviate the transitional issue identified in the Alliance comments.

## Conclusion

Based on a flawed analysis, California has created *de facto* fuel economy standards that far exceed technically feasible and economically practicable levels. In its recently released final rule regarding truck CAFE standards for 2008-2011, the National Highway Traffic Safety Administration of the U.S. Department of Transportation stated that the California greenhouse gas standards are both "expressly preempted" (p. 288) and "impliedly preempted" (p. 326) under federal law (NHTSA Docket No. 2006-24306). The California greenhouse gas rule as proposed for adoption by the Board will severely limit the product line that General Motors will be able to provide to its independent dealers in Pennsylvania, both in the initial years of the rule and in later years. Pennsylvania consumers will be met with reduced product choice and higher new vehicle prices that far surpass the value of fuel saved. In return, there will be no measurable environmental benefits, and the impacts on human health and the environment can even be expected to be negative. Likewise, adoption of the LEV II program will not provide any measurable air quality benefits compared to the federal Tier 2 program. In view of these considerations, Pennsylvania should not adopt the California motor vehicle emission standards, especially the greenhouse gas regulation.