July 12, 2017

MEMORANDUM

SUBJECT: Stakeholder Meeting with the Alliance of Automobile Manufacturers and Global Automakers on June 22, 2017

FROM: Robin Moran, Senior Policy Advisor
Assessment and Standards Division, Office of Transportation and Air Quality


This memo documents a meeting held on June 22, 2017 between representatives of the Alliance of Automobile Manufacturers (Alliance), Global Automakers and EPA, as well as the National Highway Traffic Safety Administration (NHTSA) and California Air Resources Board (CARB), to discuss the reconsideration of the Midterm Evaluation Final Determination.

The meeting attendees are included in an attachment to this memo.

The Alliance and Global Automakers requested this meeting with the purpose of understanding EPA’s ongoing efforts regarding the Midterm Evaluation since January 2017.

The following attachments include information presented during the meeting:

- EPA Presentation: Technical Update on the Midterm Evaluation

  In this presentation, EPA provided information on updated work it is undertaking in a variety of areas to gather and assess the latest data and information, including participating in numerous technical conferences, commissioning new technology cost studies, evaluation of advanced powertrains, benchmarking testing programs, publication of SAE papers, and consumer/economic issues.

- Auto Industry Presentation: Midterm Evaluation Discussion

  The Alliance and Global Automakers jointly presented information on recent compliance trends, technical modeling, customer acceptance, economic considerations, and technical and process questions. In addition, the two trade associations reviewed some of the key
comments they had previously submitted on the Draft Technical Assessment Report and the EPA Proposed Determination.

Attachments:
Meeting Participants List
EPA Presentation: Technical Update on the Midterm Evaluation
Auto Industry Presentation: Midterm Evaluation Discussion
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<thead>
<tr>
<th>Name</th>
<th>Organization</th>
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<tr>
<td>Robin Moran</td>
<td>EPA</td>
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<td>Norma Homeyer</td>
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<td>Jim Kliesch</td>
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<td>Fred Scione</td>
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<td>Yasumi Nakamura</td>
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<td>Mike Hartrick</td>
<td>Auto Alliance</td>
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<td>Steve Sinkez</td>
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<td>Susan Conti</td>
<td>Auto Alliance (phone)</td>
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<td>Catherine Wilmeth</td>
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<td>Amandine Munkus</td>
<td>Global Automakers</td>
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<td>Julia Rege</td>
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<td>Alexandria Reed</td>
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<td>Ted Wyssor</td>
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<td>Jo'ny Kargul</td>
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<td>Jack Lyman</td>
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<td>Hannah Fish</td>
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<td>Mike McCarthy</td>
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<td>Pippin Madder</td>
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Meeting with the Alliance of Automobile Manufacturers and Global Automakers

TECHNICAL UPDATE ON THE MIDTERM EVALUATION

June 22, 2017
Office of Transportation and Air Quality
National Vehicle and Fuel Emissions Laboratory
The Alliance of Automobile Manufacturers and Global Automakers requested a meeting with the purpose of “understanding EPA’s ongoing efforts and developments since January.”

The trade associations indicated they would plan to present slides on the topics below, and would like to hear updates from EPA on any ongoing work in these areas.

**Suggested Agenda:**

1. Welcome and Introductions / Antitrust & Confidentiality Reminder
2. Discussion Items
   2.1 2016 Vehicle Performance
   2.2 Technology Assessment
   2.3 ALPHA Model Discussion
   2.4 LPM Model Discussion
   2.5 OMEGA Model Discussion
   2.6 Evaluation of Costs
   2.7 Consumer Acceptance
   2.8 Economic Impacts
3. Close
March 15, 2017 - EPA Administrator Pruitt and DOT Secretary Chao announced a Federal Register Notice stating that EPA will reconsider the Final Determination published in January 2017:

“… EPA has concluded that it is appropriate to reconsider its Final Determination in order to allow additional consultation and coordination with NHTSA in support of a national harmonized program.”

“In accord with the schedule set forth in EPA’s regulations, the EPA intends to make a new Final Determination regarding the appropriateness of the MY 2022-2025 GHG standards no later than April 1, 2018.”
EPA’s On-going Work

• In following with the Administrator’s decision to reconsider the Final Determination, EPA is continuing to assess the most up-to-date information.

• The technical staff’s goal is to provide the Administrator with updated technical information that can be used in the reconsideration of the Final Determination.

• Updated technical information is being obtained from multiple sources, including:
  - *Stakeholder outreach*
  - *EPA-sponsored research*
  - *Technical conference participation*
  - *Reviews of the literature and other published reports*
  - *Monitoring current light-duty compliance, technology trends, and market developments*
Technical Conferences from which EPA has Gathered Data/Information
(since January 2017)

- Advanced Automotive Battery Conference
- Vienna Motor Symposium
- CAR Powertrain Roundtable
- Great Designs in Steel
- 2017 Low Voltage Vehicle Electrification Summit
- Society of Plastic Engineers AUTO EPCON
- Advanced Thermal Management Systems conference - ITB Group
- Detroit Advisory Panel of the Automotive/Petroleum Industry Forum
- Clemson University Global Tire Conference
- ICCT/Bipartisan Policy Center: International Competitiveness and the Auto Industry: What’s the Role of Motor Vehicle Emission Standards?
- CTI Symposium - Transmissions
- Association of Environmental & Resource Economists Summer Conference
- Society for Benefit Cost Analysis
- SAE Hybrid and Electric Vehicle Technologies
- SAE Government/Industry
- SAE World Congress
- SAE High Efficiency IC Engine
- SAE Light-duty Forum
- Automotive World Fuel Economy Detroit (Megatrends)
- Global Automotive Lightweight Materials (GALM)
- University of Wisconsin Engine Research Center Symposium - Impact of Future Regulations on Engine Technology

EPA has collected numerous technical papers/presentations from these conferences which we continue to review for new information
FEV tear-down cost studies in process:

- Diesel
  - 8 Cylinder Gas to 6 Cylinder Diesel
  - 6 Cylinder Gas to 4 Cylinder Diesel
  - 4 Cylinder Gas to 4 Cylinder Diesel
- Turbo Downsize
  - 8 Cylinder NA to 6 Cylinder Turbo
  - 6 Cylinder NA to 4 Cylinder Turbo
  - 4 Cylinder NA to 4 Cylinder Turbo
- CVT
- High Efficiency Gearbox (HEG)
- Update of databases used to inform previous cost studies
  - e.g., material costs, labor rates, adjust to 2016$, etc.
In-depth Work Underway to Evaluate Advanced Powertrains

**Vehicle benchmarking:**
- 2016 Chevy Malibu w/1.5 liter GDI-turbo-charged w/6-speed AT
- 2016 Acura ILX w/dual-clutch transmission with torque converter
- 2017 Ford F150 w/10 speed AT

**Engine benchmarking:**
- 2016 Honda Civic 1.5 liter GDI-turbo-charged 10.6:1 w/ CVT
- 2016 Mazda CX-9 2.5 liter GDI-turbo-charged w/ 6-speed AT
- 2018 Toyota Camry with 2.5 liter Toyota New Global Architecture (TNGA) engine

**Demonstration and modeling:**
- Demonstration of cooled EGR on a modified European Mazda 2.0 liter GDI naturally-aspirated 14:1 CR engine
- GTPower modeling of a 2012 PSA 1.6 liter GDI-turbo-charged engine with cooled EGR and an advanced turbo
- GTPower modeling of a 2016 Honda Civic 1.5 liter GDI-turbo-charged 10.6:1 CR engine
- ALPHA model comparison of several CVTs

*ALPHA modeling of all vehicles included in above component and vehicle benchmarking.*
1. 2016 Chevy Malibu w/1.5 liter GDI-turbo-charged w/ 6-speed AT
   • Vehicle has been procured, instrumented and testing is complete

2. 2016 Acura ILX w/dual-clutch transmission with torque converter
   • Vehicle has been procured, instrumented and initial testing is complete

3. 2017 Ford F150 w/10 speed AT
   • Vehicle has been procured and is being prepped for testing
   • Plan to evaluate transmission shift strategy and efficiency
1. **2016 Honda Civic 1.5 liter GDI-turbo-charged 10.6:1 CR w/ CVT**
   - Goal of benchmarking: Confirm Honda’s publically shared efficiency map and understand the engine’s technology and combustion strategy
   - Chassis testing is completed, and engine dyno mapping is nearly complete
   - Data review and engine benchmarking report are underway
   - Initial ALPHA vehicle validation of the Honda Civic is complete
   - Currently investigating various methods to conduct CVT powertrain testing

2. **2016 Mazda CX-9 2.5 liter GDI-turbo-charged w/ 6-speed AT**
   - Goal of benchmarking: Obtain engine efficiency and operational maps
   - Chassis testing completed
   - Engine installed in test cell and initial testing has begun

3. **2018 Toyota Camry with 2.5 liter Toyota New Global Architecture (TNGA) engine**
   - Goal of benchmarking: Confirm Toyota’s publically shared efficiency map (for non-HEV applications) and understand the engine’s technology and combustion strategy
   - Plan to procure vehicle within the next month
1. **Demonstration of cooled EGR on a modified European Mazda 2.0 liter GDI naturally-aspirated 14:1 CR engine**
   - Follows up on validation work described in SAE 2017-01-1016 and GT-Power modeling done in SAE 2016-01-0565
   - Currently investigating effects of cooling system improvements and in-cylinder motion

2. **GT-Power modeling of a 2012 PSA 1.6 liter GDI-turbo-charged engine with cooled EGR and an advanced turbo**
   - Benchmarking work completed on base engine with Tier-2 and Tier-3 fuels, and a GT-Power model constructed (Tier-2 fuel only)
   - Cool EGR and VNT turbo modeled in GT-Power
   - Currently drafting benchmarking report and reviewing GT-Power model

3. **GT-Power modeling of a 2016 Honda Civic 1.5 liter GDI-turbo-charged 10.6:1 CR engine**
   - Benchmarking almost complete (see earlier benchmarking slide)
   - GT-Power model created based on benchmarking data
   - Plan to examine the effect of adding cooled EGR, improved cooling, and improved turbos

4. **ALPHA model comparison of several CVTs**
   - Initial ALPHA vehicle validation completed on the Honda Civic equipped with a CVT
   - Benchmarking completed on Nissan Jatco CVT8 and currently drafting report
   - Comparison of available CVT data is underway
Four New EPA SAE Papers Published in 2017

Available at: https://www.epa.gov/regulations-emissions-vehicles-and-engines/midterm-evaluation-light-duty-vehicle-greenhouse-gas-ghg

ALPHA Related SAE Journal papers:

1. “Characterizing Factors Influencing SI Engine Transient Fuel Consumption for Vehicle Simulation in ALPHA,”
   • This paper addresses some of the transient engine operating conditions that must be considered to address shortfalls that can occur when simulating vehicle fuel consumption. It examines fuel adjustments for:
     a) Powertrain Torque Management
     b) Changes in Engine Power
     c) Deceleration Fuel Cutoff (DFCO)
     d) Cylinder Deactivation (CDA) Transition

   • The 1st part of the paper reviews the 3 steps EPA used to prepare for fleet modeling (benchmarking, validating ALPHA, and characterizing a core set of future powertrains)
   • The 2nd part of the paper shows how the above test data was generalized for use in modeling future fleets. Aspects of this generalization include engine scaling, transmission scaling, roadloads, cost-start adjustment for future vehicles, and performance neutrality.
Component Related:

   - This paper presents testing results from implementation of cEGR and CDA hardware on an Atkinson cycle capable engine
     - Open ECU and cEGR hardware was installed on base engine, a production 2.0L SKYACTIV-G engine with 75 degrees of intake cam phase authority and a 14:1 geometric compression ratio, and CO2 reduction effectiveness is evaluated.
     - Additionally, two cylinders were deactivated to determine what CO2 benefits could be achieved.
   - This test cell validation follows up on benchmarking and GT-Power modeling work described in two 2016 SAE papers (SAE 2016-01-1007 and SAE 2016-01-0565).

   - This paper presents the development and validation of the lead-acid battery model.
   - Resistances and capacitances were calculated using test data from a Duracell 92Ah lead-acid battery which is aftermarket equipment for the Chevrolet Malibu.
   - The lead-acid battery library in the ALPHA model was validated with data obtained from Argonne National Laboratory (ANL) from their chassis dynamometer testing of the 2010 Mazda 3 Hatchback i-Stop and 2010 VW Golf TDI Diesel Bluemotion.
   - The simulated battery voltages, currents, and state of charge (SOC) are in excellent agreement with the vehicle test data on a number of drive schedules.
Consumer/Economic Issues

- Consumer Acceptance
- Affordability
- Willingness to pay for vehicle attributes
- Vehicle sales
- Employment and economy-wide impacts
Consumer Acceptance: How do consumers respond to vehicles subject to the standards?

• Prior EPA studies indicate that consumers seem to be accepting of the technologies currently being used to meet the standards

• Industry comments have expressed concerns over acceptance of the future fleet related to vehicle cost increases as well as the degree of electrification required
  • More electrification means increases in vehicle cost, in addition to questions of consumer willingness to change technologies

• EPA continues to pursue access to a consumer satisfaction database to further assess consumer satisfaction, as some commenters suggested

• EPA is open to any new data/information on this issue
Affordability

- In comments and recent research, some key questions have arisen:
  - Are the standards regressive (i.e., putting disproportionate burden on low-income households)?
  - How will potential vehicle price increases affect consumer access to the vehicle market?

- Regressivity: 3 recent studies
  - 2 studies (Davis & Knittel; Levinson) found regressivity without accounting for fuel savings from the new technologies
  - 1 study (Greene & Welch) that accounts for fuel savings found that fuel economy improvements are progressive

- Vehicle price increases
  - Average vehicle transactions prices have increased in recent years
  - Seeking information to help identify contributors to price increases in addition to the standards (e.g. buying larger vehicles, or technologies such as safety features and connectivity that add to costs)
  - How might higher vehicle prices affect access to credit?
A factor in understanding demand for vehicles includes the role of vehicle attributes in the buying decision.

EPA has been developing estimates of consumers’ willingness to pay for vehicle attributes.

- See, e.g., presentation at the Society for Benefit-Cost Analysis annual meeting: [link](https://benefitcostanalysis.org/sites/default/files/public/C3.1%20Helfand%20et%20al%20WTP%20for%20veh%20char%2020170323.pdf)
- To date, estimates for attributes show very wide ranges
- We are trying to understand why there is so much variation
• Some auto industry comments encouraged EPA to quantify effects of the standards on vehicle sales
• The key variable appears to be the role of fuel economy in consumers’ vehicle purchase decisions
  • Estimates in published literature range from significant undervaluation to overvaluation, with no clear central value
• Sales estimates are very sensitive to this assumption
  • e.g., “A Macroeconomic Study of Federal and State Automotive Regulations,” Carley et al.
• How can the effects of the standards be separated from the effects of broader macroeconomic changes?
Employment and Economy-wide impacts

• Several recent studies addressed employment and economy-wide impacts:
  • Indiana University: “A Macroeconomic Study of Federal and State Automotive Regulations”
  
• Auto industry comments on employment analysis suggested fuller quantification

• EPA’s work on employment impacts to date has focused on the auto sector
  • Broader employment effects depend on the state of the macroeconomy

• EPA is exploring the use of economy-wide models to estimate broader macroeconomic effects
  • EPA has convened a panel of experts through the Science Advisory Board on economy-wide modeling to review these models, and expects a final report later this year
  
• See https://yosemite.epa.gov/sab/sabproduct.nsf/0/07E67CF77B54734285257BB0004F87ED?OpenDocument
Questions/Discussion
Midterm Evaluation Discussion

Industry - EPA

June 22, 2017
Agenda

- Introduction
- Recent Compliance Trends
- Technical Modeling
- Customer Acceptance
- Economic Considerations
- Technical and Process Questions
Background

• Automakers support reducing fuel consumption and greenhouse gas emissions

• A robust, technically accurate NHTSA rulemaking and EPA midterm evaluation is critical

• Automakers have significant concerns with technical outputs from EPA thus far

• We support a transparent and technically accurate modeling process
Process Moving Forward?

• Interagency communication

• Staff engagement with auto manufacturers to understand and adequately respond to concerns
  • Most efficient to have joint communications to resolve differences

• Transparency in processes and assumptions

• Adequate time to assess technical inputs and outputs as specifically applied for the MTE
Recent Manufacturer Efforts

- **Focused on NHTSA modeling**
  - Iterative meetings to more fully inform a 2016 model year technology baseline assessment
  - In-depth technical meetings with industry experts
  - Briefing from Novation Analytics regarding displacement-based transforms of full vehicle simulation data to compliance models

- **Evaluation of 2016+ compliance and technology trends**
  - Recent compliance trends as standards continue to ramp up
  - Continuing gap between non-electrified vehicles and future compliance targets

- **Assessment of EPA modeling work which informed the proposed and final determinations**
  - Continued efforts to understand the source of significant differences
  - Additional study by Novation Analytics subject of July 13 briefing to EPA
Significant challenges lie ahead

Sources
GHG Compliance Trend

Industry Compliance Values versus Standards in 2012-2015 Model Years, 2016 Projection

<table>
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<th>Year</th>
<th>EPA Greenhouse Gas Over / Under Compliance [g/mi]</th>
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<td>2012</td>
<td>11 Performance better than standard</td>
</tr>
<tr>
<td>2013</td>
<td>12 Performance better than standard</td>
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<tr>
<td>2014</td>
<td>13 Performance better than standard</td>
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<tr>
<td>2015</td>
<td>7 Performance better than standard</td>
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<td>2016</td>
<td>8 Performance worse than standard Estimate</td>
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<td>2017</td>
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Industry is no longer “meeting the standards more quickly than required” and is falling behind

Sources:
Improvement Needed to Meet 2025MY Standards

Current data on best non-electrified vehicles highlights manufacturer concerns on EPA technical outputs

Vehicle Categories and 2017MY Best-In-Category Unadjusted Combined CO2 with Maximum A/C and 3.0 g/mi Off-Cycle Credit

Sources: [www.fueleconomy.gov](http://www.fueleconomy.gov); strong hybrid range from U.S. EPA Technical Support Document to the Nov. 2016 Proposed Determination
Many inputs to LPM, not just ALPHA model?
Unclear “calibration process”
LPM “machine” requires special knowledge to operate
Many concerns with all three models used to inform previous determination
ALPHA Model

- **Recent EPA SAE papers describe improvements in ALPHA not used for the January determination**
  - Development of transient operation correction factors (increase in modeled fuel consumption)
  - Additional work on Atkinson engine modeling

- **Additional work could improve ALPHA model accuracy further**
  - Inclusion of hybrid systems including 48V mild hybrids
  - Validation of transient operation estimates across vehicle technologies and classes
  - Cold start penalties: Advanced emission system changes to bag 3; less exhaust heat availability
  - Regulation-driven requirements: Regular grade octane fuel, emission test weight bins
  - Performance neutrality metrics
  - Refinement of cylinder deactivation assessments
  - Validation of GT Power model using recently introduced Atkinson engines
  - Modeling of emissions and emission control system impacts
Lumped Parameter Model

• Documentation of step through from ALPHA to Lumped Parameter Modeling
  • Has this been updated?
  • If no, is there a timeline for updating?

• Is there additional information beyond the 18% of 2025 technology packages in control case were traceable back to ALPHA simulations?

• Unclear if change to road load and power to weight ratio fully addresses concerns regarding lack of displacement basis to modeling results

Manufacturers are seeking greater clarity on data and processes used for calibration of the lumped parameter model
OMEGA Model Discussion Points

- Model generally optimizes technology package selection in a manner not executable by manufacturers
  - Explosion of single vehicle / powertrain variants into multiple new variants
  - Implicit assumption of infinite engine displacement availability
  - “Improved” models at zero or negative cost

- No consideration of product timing implications to cost

- Cost traceability
  - FEV teardown analysis costs based on specific assumptions of volume and time in market – OMEGA outputs may violate these constraints without subsequent impact on cost

OMEGA generally yields results that are over-optimized in comparison to an executable plan
Need model outputs to be reviewed for feasibility and practicability before use in policy analysis
Consideration of Customer Acceptance

• Draft TAR, Proposed / Final Determinations:
  • Minimal consideration of gap between regulatory mandates and consumer desires
  • Affordability issues minimized by only looking at pieces of the regulatory burden over limited time
  • Favored 3rd party analysis over that provided by manufacturers

• Need more than “customers like fuel economy”
  • How do customers prioritize and value fuel economy in the actual purchase decision?
  • How much are customers willing to pay for additional fuel economy technologies?

• Need to evaluate overall impact on vehicle affordability
  • Total cost increases expected from baseline year associated with GHG regulations
  • Additional costs imposed by related regulations approved by EPA
  • In the context of changing credit markets
Considerations of Economic Impacts

- Previous EPA analysis provided generic estimates and argued that long-term fuel savings would generate positive economic outcomes
  - What are the next steps in expanding these estimates based on new data?

- How are economic impacts of stranded capital and changes to supply of parts demands being accounted for in the model?
  - Sharing of technology is not freely open from one manufacturer to another, how is this accounted for in the modeling?

- 3rd party studies of employment gains from efficiency technologies are limited
  - Fail to consider job creation associated with increasing sales absent efficiency regulation
  - Fail to consider whether similar investments in other types of technology would have created equivalent jobs

Economics of development cycles have not been fully accounted for/document in the modeling
Process Going Forward?

- How does EPA plan on coordinating MTE analysis with the NHTSA CAFE rulemaking modeling?

- Does EPA plan on making any wholesale changes to the modeling approach or will it be similar to the previously used approach?

- What adjustments does EPA plan on making based on recent meetings with manufacturers?

- What additional input is needed to understand our concerns?

- What other ongoing work is EPA engaged in?

- What does EPA see as next steps?

- How is the EPA planning on working to keep California at the table to continue One National Program?