EPA/NHTSA UPDATE ON PHASE II GHG AND FUEL EFFICIENCY RULES FOR MEDIUM AND HEAVY DUTY VEHICLES

Houshun Zhang
U.S. Environmental Protection Agency
• Significance of MD/HD Emissions

• Phase 1
  Program Overview

• Phase 2
  Scope & Current Status

• Federal Research

• California Regulatory Landscape

Phase 1

• Model Years 2014-2018/19

Phase 2

• Beyond Model Year 2018
World-Wide Transportation Energy Use: HD Vehicle Grows Faster than any Other Transportation Sub-sector

- World-wide, HD vehicle energy demand estimated to grow by 65% over next 30 years.
- In 2040, HD Vehicles projected to be largest transportation sub-sector use of energy.
- 40% of all transportation energy

ExxonMobil 2013 Energy Outlook Report
MD/HD Phase 1 – Implementation Highlights

- First ever Medium- & Heavy-Duty Standards Implemented in 2014
- Reducing fuel consumption, CO2 emissions, and operating costs for thousands of businesses
- Allows manufacturers to produce a single fleet of vehicles to meet requirement
- EPA & NHTSA conducted significant stakeholder outreach as part of this rulemaking development
- Phase 1 focused on off-the-shelf technologies
- No 2014 pre-buy: 2014 tractor sales up 33%, trailers up 42%, vocational up 10.5% vs 2013 (ACT Research Aug 26, 2014)

- 530 million barrels less oil
- 270 MMT lower GHGs
- $50 billion in fuel savings
- $49 billion in net benefits
Phase 1 – Divides diverse MD/HD vehicle sector into 4 distinct categories

- Semi tractors (not trailers)
- Vocational vehicles
- Full-size pickup trucks & work vans
- Heavy Duty Engines
Phase 1 – Pollutants addressed and flexibilities

- EPA regulates CO$_2$, N$_2$O, CH$_4$ and HFCs.
- NHTSA regulates fuel consumption.
- Both agencies offer manufacturers flexibilities including credit Averaging, Banking and Trading (ABT), among other provisions.

Greenhouse Gas Emissions Model (GEM)
From Climate Action Plan: “During the President’s second term, the Administration will once again partner with industry leaders and other key stakeholders to develop post-2018 fuel economy standards for heavy-duty vehicles ….”

From WH Fact Sheet: “This second round of fuel efficiency standards will build on the first-ever standards for medium- and heavy-duty vehicles (model years 2014 through 2018), and will reach well into the next decade.”
Heavy-duty Phase 2 Rulemaking – objectives discussed in Phase 1 rule

- **Joint NHTSA/EPA rulemaking process** with notice and opportunity for public review and comment.

- **Heavy-duty Phase 2 May Include:**
  - Looking beyond off-the-shelf technology
  - Potential inclusion of trailers
  - Additional and new technologies beyond Phase 1
  - Refined test procedures and updates to the GEM vehicle simulation compliance model—a full vehicle approach that includes engines
  - Full SBREFA panel process to develop solutions for small businesses
  - Updated technology, economic and environmental assessments
Phase 2 – NHTSA/EPA Research

➢ Technology Evaluations
  ▪ In-house and contractor modeling and testing of fuel-efficiency technologies for medium-
and heavy-duty vehicles in the years prior to and in the Phase 2 timeframe
  ▪ Evaluating the effectiveness and the costs

➢ Test procedure development, refinement and validation studies
  ▪ Evaluating improvements to Phase 1 drive cycles, and additional idle cycle
  ▪ Validating new aerodynamic and powertrain test procedure approaches
  ▪ Validating a wide range of improvements to Greenhouse Gas Emissions compliance
    model (GEM) to fully recognize new technologies

➢ SwRI hosted a technical research workshop supporting EPA and
NHTSA Phase 2 Standards for MD/HD Greenhouse Gas and Fuel
Efficiency — December 10 and 11, 2014
Phase 2 – Engine Technology

- Phase II GEM is being developed to account for all engine technologies that are tested in an engine dyno.

<table>
<thead>
<tr>
<th>Heat Rejection</th>
<th>Exhaust Gas</th>
<th>Friction</th>
<th>Paritic Loss</th>
<th>Pumping Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Engine Loss</td>
<td>Inertial / Braking</td>
<td>Aerodynamic Loss</td>
<td>Vehicle Auxiliary Loads</td>
<td>Transmission</td>
</tr>
<tr>
<td></td>
<td>Axles and Shaft</td>
<td>Rolling Resistance</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Advanced Bottoming Cycle
- Air Handling Improvement
- Coolant Pump
- Cylinder Deactivation
- Down-sizing & Boosted vs. NA
- Electric Turbo-compounding
- Engine Down-sizing
- Engine Down-speeding (reduced cruise RPM, combined with transmission technology)
- Engine Friction Reduction
- Engine Oil Pump Improvement
- GDI + Cooled EGR

- Improved Selective Catalytic Reduction
- Lean Burn GDI w/ SCR
- Lower Friction Engine Oil
- Mechanical Turbo-compounding
- Natural Gas
- Reduced After-treatment Backpressure
- Stoichiometric Gasoline Direct Injection (GDI)
- Stop / Start
- Turbo Efficiency Improvement
- Variable Valve Timing
Research on Vehicle & Trailer Technologies

A/C Reduced Reheat
Air Compressor Improvements
Automated Manual Transmission
Automatic Engine Shutdown
Automatic Tire Pressure Control
Battery Auxiliary Power Unit
Cab Insulation to Reduce A/C
Chassis Friction Reduction & Improved Lube
Diesel Auxiliary Power Unit
Driver Coaching Features
Driver Management Features
Dual Clutch Transmission
Fan Power Demand Reduction

Fuel Fired Heater
Full EV
Hybrid Technologies
Improved Aerodynamics
Improved Transmissions (more gears, higher ratio spread, shift points)
Low Rolling Resistance Tires
Manual Transmission
Shore Power
Single Wide Tires
Tractor Axle 6X2 or Clutched 6X4
Speed limiters
Weight Reduction

Technology application will vary by vehicle class, vocation, and engine fuel type
Phase 2 – Vehicle Technology

- OEM supplied aero drag and rolling resistance coefficients could be used to model the associated losses and
  - Promote advanced aerodynamic technologies
  - Encourage low rolling resistance tires
Phase 2 – Transmission Technology

- Transmissions, such as manual (MT), automated manual (AMT) and automatic (AT), can be modeled within GEM
  - Phase I GEM only models MT
- GEM will allow OEM to enter transmission information, such as gear ratio vs. gear number
- GEM includes a shift strategy for each type of transmission
Phase 2 – Driveline Technology

- Axle modeling parameters, such as axle ratio, could be input by OEM
- A technology improvement input methodology is developed to recognize other axle technologies, such as 6x2 axle configurations, and lubrication

Meritor ECSA Smar 6x2

Dana’s dual range axle
Technology Improvement Inputs

- Technology improvement inputs can be specifically designed to account for those technologies that are deemed inappropriate to model
  - Axle technologies, such as Meritor ECSA Smar 6x2 and Dana’s dual range axle
  - Transmission technologies, such as dual clutch transmissions or continuously variable transmissions
  - Lightweight material, such as high strength steel, aluminum, thermoplastic
  - Predictive cruise control (look ahead/smart coast …)
  - Idle reduction
  - Automated tire inflation systems
  - Start-Stop
GEM Validations – Absolute Comparisons

- GEM has been validated against chassis dyno tests covering 130 vehicle variants. Good agreements between GEM and tests have been obtained.
GEM Validations – Relative Comparisons

- Phase II GHG rule uses GEM to set up stringency standards
- To-be-certified vehicles will compare the simulation results with the baseline GEM results
- Only relative comparisons are important
- Most relative comparisons are under 2-3% difference except a few outliers
2010
- Issued, “Technologies and Approaches to Reducing the Fuel Consumption of Medium- and Heavy-Duty Vehicles”
- EPA and NHTSA considered this study in support of Phase 1; similar for Phase 2

2014
- As required by 2007 Energy Independence and Security Act, NHTSA sponsored a second NAS study for heavy-duty
- Published an interim report in April 2014 to help inform Phase 2 considerations; focused on recommendations that were nearly 100% in-line with EPA and NHTSA staff-level thinking
- Final report expected in 2016 to inform considerations beyond Phase 2
What’s Happening in California?

- **2008:** ARB adopted mandatory fleet-level requirements for tractors and trailers
  - Based on EPA SmartWay performance
- **2012:** ARB Released 2050 Vision for Clean Air document
  - Calls for significant additional NO\textsubscript{x} and CO\textsubscript{2} reductions from heavy-duty sector
- **2013:** Adopted EPA GHG Phase 1 Standards
  - Board hearing in December 2013
  - Similar to ARB’s adoption of HD criteria emissions standards
  - Also adopting new voluntary Low NO\textsubscript{x} standards for heavy-duty
  - Signaled intent to move beyond Federal Phase 1
  - Sunsetted CA fleet-level program for tractors, but not for trailers
- **2014:** ARB is significantly engaged on Phase 2
Wrap-up

• The fastest growing transportation sub-sector is heavy-duty. Reducing GHGs and fuel consumption from this sector will be vital toward addressing climate change and energy security.

• EPA and NHTSA are successfully implementing the first-ever national program for medium- and heavy-duty GHG and fuel efficiency.

• EPA and NHTSA are committed to fulfilling the President’s Climate Action Plan by proposing and finalizing “Phase 2” of this national program.

• Significant technical and analytical work is underway to develop Phase 2.

• For Phase 2 EPA and NHTSA are continuing our significant stakeholder outreach, which helped make Phase 1 a success.