Update on Phase 2 Greenhouse Gas Emission Standards for Medium- and Heavy-Duty Engines and Vehicles, and Related Research Studies

October 20, 2016
Fresno, California
Today’s Presentation

- **Background**
  - Summary of Federal Phase 2 GHG Standards
  - California Phase 2 to Create Nationally Harmonized Program
  - California Heavy-Duty Vehicle Research Updates
  - Next Steps
Medium- and Heavy-Duty Vehicles are a Significant Source of GHG Emissions

- **Nationwide:**
  - Medium and Heavy-duty trucks account for 1/5 of transportation sector GHG emissions
  - Fastest growing transportation sector in the US and globally

- **California:**
  - 21% of Transportation GHG
  - 8% of Statewide GHG Emissions

- Lower-emitting trucks needed to meet ambitious GHG targets:
  - 40% below 1990 levels by 2030
  - 80% below by 2050

California Phase 1 GHG Regulations Adopted

- ARB harmonized with the federal Phase 1 Program in December 2013
- Gave manufacturers ability to certify in California and ARB ability to enforce
- Will reduce CO₂ emissions in California by 12% in 2030
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U.S. EPA / NHTSA Phase 2 GHG Standards Adopted

- Final Rulemaking (FRM) published October 2016 (prepublication version released 8/16/16)
- Technology forcing
- Reduce fuel consumption by 82 billion gallons
- Lower GHG emissions by 1,100 MMT nationally
- Save vehicle owners $170 billion in fuel costs
- Tractor-trailer fuel economy expected to increase from ~6 mpg to ~9 mpg
Phase 2 Engine Standards

- Up to 5% reduction in GHG emissions from Phase 1 for combination tractor engines
- Up to 4% reduction in GHG emissions from Phase 1 for vocational engines
Phase 2 Vehicle Standards

Combination Tractors
25% reduction
Trailers Pulled by Combination Tractors
9% reduction

Vocational Vehicles
24% reduction

Large Pickups and Vans
16% reduction

Implementation: 2018-2027 for trailers
2021-2027 for all other segments
# Phase 2 Projected Vehicle Costs and Payback for 2027 MY Standards

<table>
<thead>
<tr>
<th></th>
<th>Phase 2 Projected Average Cost Increase per Vehicle</th>
<th>Payback in Years</th>
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<tbody>
<tr>
<td>Tractors</td>
<td>~$12,300</td>
<td>2</td>
</tr>
<tr>
<td>Trailers</td>
<td>~$1,085</td>
<td></td>
</tr>
<tr>
<td>Vocational Vehicles</td>
<td>~$2,680</td>
<td>4</td>
</tr>
<tr>
<td>Pick-ups/Vans</td>
<td>~$1,350</td>
<td>3</td>
</tr>
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</table>
Phase 2 Final Rule Achieves greater GHG Emission Reductions than Proposed Rule

- Changes to Notice of Proposed Rulemaking (NPRM) based on comments from stakeholders, including CARB, and newest data
- Nationally, Final Rulemaking (FRM) achieves 10% more GHG emission reductions than earlier alternatives considered
Phase 2 FRM Addressed Majority of ARB’s Concerns

- Tractor engine standards made more stringent
- Combination tractor, vocational vehicle, and trailer standards made more stringent
- Particulate matter emissions from diesel-powered auxiliary power units (APUs) controlled
- Aggressive advanced technology credit multipliers included that provide incentive for zero emission technologies
- Plans for low NOx standard discussed in preamble
Projected California GHG Benefits from FRM greater than NPRM

Reduction from Baseline (2017-2050, cumulative)

Baseline = 176.6 MMT
NPRM = 196.1 MMT

Source: ARB EMFAC 2014
Phase 2 Will Get Us Closer To Our Goals

Well-to-Wheel Emissions from California On-Road Sources

Current Control Programs  Phase 2  Equal Share Targets

Source: ARB (AQPSD) 2016
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California Phase 2: Expect to Propose Harmonization with the National Program

- One national strategy
- Harmonize with U.S. EPA’s Phase 2 standards
  - Same structure, timing, and stringency levels
  - Critical/key element of scoping plan
  - Would allow ARB to certify engines/vehicles and enforce Phase 2 in California
- Some modifications to credit, labeling, and rule flexibility provisions
- Concurrently, amend of TT GHG Rule to remove redundant requirements on trailers
Areas Where California Phase 2 May Differ from Federal Program – Possible Differences

- **Flexibility provisions**
  - Optional transition flexibility provisions for meeting the heavy- and medium-heavy duty engine standard
  - Vocational custom chassis

- **Improvements to vehicle and trailer labeling**

- **Minor differences in how natural gas engines are treated**

- **Encourage use of low-global warming potential refrigerants**

- **Minor differences in credits**

- **Other minor differences**
Possible Future California Fleet Regulatory Development: TT GHG 2 Rule

- **Description**
  - Develop aerodynamic requirements for non-box trailer types that travel significant time at high speeds

- **Timeline**
  - Complete trailer activity study: 2017
  - Workshops: October 2017, March 2018
  - ARB rulemaking process: 2018-2019
Possible Future California Fleet Regulatory Development: Vocational Vehicle Aerodynamics

Description
- Develop aerodynamic requirements for the vocational vehicles that travel most at high speeds

Timeline
- Workshop Schedule: November 2017, April 2018
- ARB rulemaking process: 2018-2019
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Vocational Truck Studies

- Vocational Aerodynamics (U.S. Department of Energy’s National Renewable Energy Laboratory (NREL)):
  - Cost: $390,000
  - Tested box trucks with and without aerodynamic devices
  - GHG emission benefits up to 8% depending on duty cycle
  - Draft report completed March 2016

- Follow-up Study (NREL and UC Irvine):
  - Characterize vocational truck fleets and driving patterns for Class 4-6 trucks in California
  - Cost: $400,000
  - Scheduled completion date: 2018
Collection of Tractor-Trailer Activity Data

- ARB contracted with University of California Riverside Center for Environmental Research and Technology, College of Engineering (UCR)

- Cost: $489,000

- UCR gathering activity and engine data from non-box type tractor-trailers (e.g., tankers, flatbeds)

- Determine whether additional trailer types will benefit from using aerodynamic devices

- Scheduled completion date: June 2017
Additional Research Studies

- **Collection of Activity Data from On-Road Heavy-Duty Diesel Vehicles (UCR)**
  - Cost: $324,000; Scheduled completion date: December 2016

- **In-Use Emissions Testing and Fuel Usage Profile of On-Road Heavy-Duty Vehicles (UCR and WVU)**
  - Co-funded by SCAQMD, CEC, SoCal Gas, and ARB
  - ARB Cost: $150,000 of $3,000,000;
    - Scheduled completion date: December 2018

- **Identify Pathways to Near Zero Heavy-Duty Sector (not yet awarded)**
  - Cost: $500,000; Scheduled completion date: December 2019

- **In-House Vehicle Speed Limiter Study (ARB)**
  - Scheduled completion date: Spring 2017
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Next Steps

- February 2017: Workshop on California Phase 2

- October 2017: Board consideration of California Phase 2 proposal

- Potential rulemakings for vocational aerodynamics and TT GHG 2 planned for Board consideration in 2019

- ARB staff will begin to monitor technology and conduct research for potential Phase 3 GHG planning

- ARB staff also focusing on NOx control
  - First low-NOx workshop scheduled for November 3, 2016
EXTRA SLIDES
FRM Tractor Engine, Tractor, Trailer, and Vocational Vehicle Standards More Stringent than NPRM

- Emission standards versus baseline standards

<table>
<thead>
<tr>
<th></th>
<th>FRM 2027 GHG/Fuel Consumption Reductions (per new vehicle)</th>
<th>NPRM 2027 GHG/Fuel Consumption Reductions (per new vehicle)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Separate Engine Standards</td>
<td>5% Tractor, 4% Vocational</td>
<td>4% Tractor, 4% Vocational</td>
</tr>
<tr>
<td>Combination Tractors</td>
<td>25%</td>
<td>24%</td>
</tr>
<tr>
<td>(including Engine Improvements)</td>
<td></td>
<td></td>
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<tr>
<td>Trailers</td>
<td>9%</td>
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<td>Pickups and Vans</td>
<td>16%</td>
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## Proposed California Phase 2 Carbon Dioxide (CO2) Benefits

### CO2 Emissions from Affected Vehicles
(in million metric tons per year)

<table>
<thead>
<tr>
<th>Calendar Year</th>
<th>Baseline CO2 Emissions</th>
<th>CO2 Emissions with Phase 2</th>
<th>CO2 Reductions</th>
</tr>
</thead>
<tbody>
<tr>
<td>2030</td>
<td>39.2</td>
<td>34.5</td>
<td>12%</td>
</tr>
<tr>
<td>2050</td>
<td>47.9</td>
<td>37.0</td>
<td>23%</td>
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</tbody>
</table>
PM Emissions from APUs Regulated in FRM

- FRM requires diesel APUs to meet diesel PM emission standards
  - Model Year 2018 through 2023 must meet 0.15 g (PM)/kW-hr standard
  - Model Year 2023+ must meet 0.02 g(PM)/kW-hr standard
Plans to Develop Low NOx Standards Included in Preamble

- Section I.F.(1), “Opportunities for Further Oxides of Nitrogen (NOx) Reductions from Heavy-Duty On-Highway Engines and Vehicles”

  - “EPA believes the opportunity exists to develop, in close coordination with CARB and other stakeholders, a new, harmonized national NOX reduction strategy for heavy-duty on-highway engines which could include the following:
    - Substantially lower NOX emission standards;
    - Improvements to emissions warranties;
    - Consideration of longer useful life, reflecting actual in-use activity;
    - Consideration of rebuilding/remanufacturing practices;
    - Updated certification and in-use testing protocols;
    - Incentives to encourage the transition to next-generation cleaner technologies as soon as possible;
    - Improvements to test procedures and test cycles to ensure emission reductions occur in the real-world, not only over the applicable certification test cycles”
Vehicle standards based on use of engines cleaner than standard

<table>
<thead>
<tr>
<th>Diesel Engines</th>
<th>NPRM Engine Standard CO₂ g/bhp-hr (% reduction from NPRM baseline)</th>
<th>FRM Engine Standard CO₂ g/bhp-hr (% reduction from FRM baseline)</th>
<th>Estimated FRM Engine emission rate used to establish vehicle standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>HHD Tractor</td>
<td>441 (-4.1%)</td>
<td>432 (-5.1%)</td>
<td>426 (sleeper cab) (-6.4%) 428 (day cab) (-5.4%)</td>
</tr>
<tr>
<td>HHD Vocational</td>
<td>533 (-4.0%)</td>
<td>503 (-4.2%)</td>
<td>500 (-4.8%)</td>
</tr>
<tr>
<td>MHD Tractor</td>
<td>466 (-4.3%)</td>
<td>457 (-5.0%)</td>
<td>455 (-5.4%)</td>
</tr>
<tr>
<td>MHD Vocational</td>
<td>553 (-4.0%)</td>
<td>535 (-4.1%)</td>
<td>531 (-4.8%)</td>
</tr>
<tr>
<td>LHD Vocational</td>
<td>553 (-4.0%)</td>
<td>552 (-4.2%)</td>
<td>548 (-4.8%)</td>
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ARB’s Submitted Extensive Comments on NPRM to Docket

- October 13, 2015: 176 page comment letter on all aspects of NPRM
- Additional submittals:
  - December 3, 2014: Solar reflective paint credit
  - December 29, 2014: Excess NOx emissions from hybrid vehicles
  - August 28, 2015: PM emission increase from diesel Auxiliary Power Unit (APU) use
  - June 16, 2016: Recommendation and basis for Advanced Technology Multipliers