HD Truck Fuel Economy Task Group
HTUF National Meeting
SEPT. 23, 2014
Summary with Discussion Notes
Bill Van Amburg, CALSTART
Agenda

» Task Group Goals

» Review of Discussions/Consensus to Date

» Segmentation/Duty Cycle Issues
  » Discussion

» Regulatory Flexibility Discussion

» Next Steps
Goals:
» In advance of rule development, discuss key issues for industry and users
» Make sure beneficial fuel saving technology included in rule design
» Seek areas of agreement; identify key areas of concern
» Work collaboratively to develop recommendations
» Provide feedback to agencies
Consensus to Date

» 3-4 Vocational segments based on CalHEAT findings are acceptable and outline way trucks generally used

» Duty cycles are critical to successful Phase 2

» However: want to recommend fewest number of meaningful “cycles” that “bound” how a truck generally used (cannot specifically match how EVERY truck is specifically used) – 80% solution

  » Accepted by industry and fleets as adequate
### 6 Truck Categories – Based on How Trucks Operate

<table>
<thead>
<tr>
<th>Class 7/8 Tractors</th>
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| **Over the Road** | • Younger Trucks; High Annual VMT  
• Mostly higher average speed, highway driving |
| **Short Haul/Regional** | • Between cities; Drayage; Day Cabs  
• Includes second use trucks; trucks w/ smaller engines |

<table>
<thead>
<tr>
<th>Class 3-8 Vocational Work Trucks</th>
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| **Urban** | • Cargo, freight, delivery, collection  
• Lower VMT; Lower Average speed; Stop-start |
| **Rural/Intracity** | • Cargo, freight, delivery, collection  
• Higher VMT; Higher Avg speed; Both urban/ highway |
| **Work site support** | • Utility trucks, construction, etc.  
• Lots of idle time; Lots of PTO use |

<table>
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<th>Class 2B/3</th>
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<td><strong>Pickups/Vans</strong></td>
<td>• Commercial use; Automotive OEMs &amp; volumes</td>
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Key Issues

» Assignment of vehicles to these categories hard to do in advance (at purchase) – OEMs concerned about certainty.

» Broadest category (bin) likely combines urban/suburban/rural – with a blended duty cycle/drive cycle

» Specific applications can be called out (refuse; regional Class 7/8)
Possible Duty Cycles

» Urban/suburban driving
  » CILCC; Pick-up and Delivery (PDDS); transit cycles; other (HHDDT creep weighting?)
    » Issues: # stops; extreme cycles?

» Intra-city/Rural driving
  » CILCC with high speed component; regional class 8 variant; UDDS? HHDDT

» Work site support cycles
  » CILCC for driving; utility work cycle or variant for idle component

» Refuse stands out as a potentially unique/intense duty cycle
Evidence for Off-Cycle Emissions

NOx Emissions (g/bhp-hr) by Average Speed
Over Test Cycle or PEMS Session
0.2 g/bhp-hr Certified Engines

23 Trucks Tested by ARB, WVU, UCR CE-CERT
14 Driving Cycles
5 PEMS Routes

Potential off-cycle emissions

0.2 g/bhp-hr

From: California Air Resources Board; 9/4/14 WCC Briefing
Duty Cycles

» HHDDT Transient could be a “proxy” for vocational.

» Challenges – fewer stops, higher speed than many applications – but close to the broad bulk of vehicles

» Alternatively, HHDDT’s three components could be “weighted” to provide more slow speed operations to better show real running range of vocational

» Refuse/extreme duty needs own cycle
Discussion Questions

» Would additional flexibility in the engine certification/testing process help encourage additional high-efficiency technologies?

» If so, what flexibility? In Phase 1, regulators allowed things like “powerpack” testing as an alternative. Was that helpful; sufficient? What more would be needed?

» Part of the flexibility for new technology in Phase 1 was a “credit” structure that allowed engine a truck OEMs to earn credits with advanced technology. To date, it appears no one has used that. Is that still a good structure; are more credits needed; or is something else needed?
Group Discussion (Page 1)

Matching the Appropriate Technology and Duty Cycle

» Miles per gallon becomes the key differentiator to determine whether the customer has an urban or rural application (Crosspoint Kinetics).

» Important that OEMs with vocational technologies are used in the best application. Sometimes an OEM may not use a tech in the best application.

» We may be able to define 3 – 4 duty cycles, but there may be 3 – 4 that cannot be defined and are uniquely different. Can we find a combination for urban/rural?

» Every truck has a duty cycle, there are generalized cycles that can apply to that truck for regulatory purposes.

» Refuse trucks can have various duty cycles (high vs. low density). With one refuse truck, it can have various cycles.
Group Discussion (Page 2)

*How to regulate 2\textsuperscript{nd} and 3\textsuperscript{rd} tier systems?*

- How will defined duty cycles affect an intermediary technology supplier (Odyne)?
- Need to pay attention to where the market is going with advanced vehicle technologies. How will second and third tier systems be regulated in Phase 2?
- Results of PTO (Hydraulic Hybrid Refuse Truck) in a dynamometer chassis test showed that fuel economy changed based on PTO involvement and use.
- Can second and third tier systems (like PTO) be given extra credit under new standards? However, vehicle OEMs receive the credits, how would this work?
Group Discussion (Page 3)

*Using Test Cycles that Show Real World Fuel Economy Benefits*

» The duty cycle needs to show the fuel economy benefits of the technology (EPA).

» Current test cycles do not reflect real world use that would show better reflection of fuel economy benefits.

» Is there a way to create a better feedback loop that would allow end-users to communicate fuel economy benefits to the OEM to ensure that the test cycle used accurately reflects the results used in the real world?

» It is important that we come up with model to better validate and show progress.
The push should be to create test cycles that are better reflective of duty cycle and best capturing fuel economy benefits.

2 things – engine certification and vehicle certification – test cell vs. chassis dyno.

Engine test has to better reflect real world application. Truck OEs would like full vehicle certification, look at a combination of those two things in play. So that it matches a real world condition.
Group Discussion (Page 5)

Re-Weighting Test Cycles – Closer to Real World Use

» Acceleration and kinetic intensity fall more in the middle with vocational duty cycles.

» A more simple way to determine the appropriate duty cycle is for EPA is to reweight the cycles. For ex. model a strong hybrid vs. conventional – vocational vs. highway, each scenario will have a different fuel efficiency percentage.

» EPA saw HHDDT falls within range of vocational cycles. So that whatever test cycle you choose – close to real world scenario to be a 1 to 1. HHDDT would represent a strong hybrid case oppose to low speed – high intensity.

» It is noted that HHDDT has low speed and idle components, but not many stop (accelerate/decelerate) events.
Group Discussion (Page 6)

Re-Weighting Test Cycles – Closer to Real World Use

continued...

» Possibly add additional test cycles to EPA’s existing list of cycles that may be better reflective of real world scenario.

» Consider keeping idling as a separate test cycle to determine GEM score? EPA may consider putting higher weighting with idling.

» Is it important to signal to EPA what test cycle is better reflective of fleet/technology?

» HHDDDT cruise may not always be reflective of certain duty cycles.
» Concerns by ARB that EPA engine certification tests not reflecting real world emissions. Testing program may need to be revised to present real world results.

» Real-world engines running often at lower speed, and lower torque/temperature, than is in certification test. In-use and off-cycle emissions looking higher than certification testing shows.

» There were concerns with hybrids producing higher NOx emissions when the issue may be the diesel engine.
Would flexibility with Engine Cert Test – Advance Vehicle Technologies?

- Chicken or the Egg Scenario – EPA needs to understand the technology to provide the right test, but it could also be the other way around: if the test reflects real world conditions and evaluates all factors impacting that condition (such as powertrain +?), it could be agnostic to tech.

- Could one new test cycle be structured out of components of multiple cycles – so only one test could derive the results for multiple certification pathways?
Group Discussion (Page 9)

Innovative Credits for Advanced Techs

» Could idle reduction technologies be given extra credit if it helps with GEM scoring? How would it be supported in the accreditation process?

» How would technologies that add more weight to the vehicle (like hydraulic hybrids) be impacted by the credit scoring?

» Credits can be a composite of events – how can we mitigate a specific event and give an end-user a better idea of what they want. Can the cycle itself provide guidance to the end-user.
Key Takeaways

» It is important that vocational technologies are used in the right application to get the best fuel economy benefits.

» One vocational vehicle (ex. refuse truck) can have multiple duty cycles. Difficult to assign test cycles that do not reflect real world use. May need a combination of urban/rural.

» Need to understand how 2nd and 3rd tier strategies will be regulated by Phase 2 standards (ex. PTO chassis dynamometer test results showed fuel economy changed with PTO involvement and use). Is it possible to receive extra credits? How would this work? Could credits be fungible and offered by component suppliers to OEMs?

» Create better feedback loop to OEMs from end-users on fuel economy gains to ensure that test cycles used accurately reflect real world use.
Key Takeaways continued...

» To show real world use, create test cycles that are more reflective of duty cycle (consider adding different data points to demonstrate benefits of advanced technology).

» Truck OEMs would like full vehicle certification to demonstrate fuel economy gains in real world use. Consider combining engine + vehicle cert tests.

» EPA sees that HHDDT falls across a number of vocational duty cycles but does not capture all.

» EPA may place higher weighting on idling. How do idle reduction strategies factor in with credits and GEM?
Next Steps

» Other issues?

» Provide additional thoughts, comments and feedback to CALSTART

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  » Alycia Gilde: agilde@calstart.org
CALSTART
Clean Transportation Technologies and Solutions
## Additional Segmentation Needed for FE Goals?

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<tr>
<th>Class 3-4</th>
<th>Class 5-6</th>
<th>Class 7-8</th>
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<tbody>
<tr>
<td>Urban Light</td>
<td>Urban Medium</td>
<td>Urban Heavy</td>
</tr>
<tr>
<td>Rural Light</td>
<td>Rural Medium</td>
<td>Rural Heavy</td>
</tr>
<tr>
<td>Worksite Light</td>
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One option: Creating “bins” similar to Class 8 – correlate the bins to weight class groupings.
Other options: could be tied to more specific applications – but that can add significant complexity
Possible Consolidation

**Class 8 Tractors**
- Highway line haul – ARB HHDDT; NESCAUM
- Regional haul – modified ARB HHDDT; HTUF Class 8b Regional
- Intermodal Class 8 Drayage Truck – Univ. of Texas/Port of Houston; TIAX/POLA/POLB

**Urban Voc**
- Pick Up and Delivery – HTUF Class 4 and HTUF Class 6 Parcel Delivery; CILCC
- Beverage - CILCC variant?
- Neighborhood Refuse Truck – NREL/Ohio State University/Oshkosh

**Work Voc**
- Utility Service Truck – CILCC with work-site operation
- Refrigeration - Handled within the Utility segment due to combination of driving cycle and work-site cycle
- Shuttle Bus – (Airport, Rental, Municipal) – truck cycle or bus cycle?
- Transit Bus – Manhattan; Orange County: CBD