

Workgroup Formation

ARB staff is currently in the process of evaluating existing regulations affecting new and in-use heavy-duty engines and vehicles to determine potential revisions to these regulations to better control NOx emissions. To facilitate this process and come up with informed revisions, ARB staff is forming workgroups to answer key questions and to share data and ideas with stakeholders. For this purpose, ARB staff has identified six broad areas of workgroups as follows:

1. HD Certification Standards and Test Procedures Workgroup
2. HD In-Use Compliance/Testing/Not-to-Exceed Workgroup
3. Warranty Workgroup
4. Durability/Useful Life Workgroup
5. HD OBD Workgroup
6. Emissions Inventory Workgroup

This document describes the objectives, key questions and data needs for each workgroup. To participate in any of the workgroups listed above, please email to lownox@arb.ca.gov identifying the workgroup(s) you would like to join, your full name, your company or affiliation, and your contact information.

Level of Commitment: We anticipate each workgroup will meet approximately monthly for the next several years, and that workgroup members would be asked to provide relevant data and insights from their organization to facilitate workgroup progress.

HD CERTIFICATION STANDARDS AND TEST PROCEDURES WORKGROUP

Objective:

Develop certification requirements to deliver the necessary real-world NO_x reductions

Considerations:

- Test cycle
- Low load cycle test procedure
- Numeric standard determination
- NTE demonstration at certification
- OBD implications
- Technologies
- Develop durability demonstration procedure to useful life
- New useful life
- Other outside the box ideas: e.g., geofencing, intelligent vehicles, vehicle NO_x standard, etc.

Key Questions and Data Needs:

Test cycle

1. What portion of real world duty cycles with high NO_x emissions are not represented by current test cycles?
2. Are there engine activity data of vocational vehicle operations that can be shared with ARB staff for use in low-load cycle development?
3. What are stakeholders' thoughts re idea of ARB developing a new low-load cycle that would be part of new engine certification? If ARB proceeds with developing such a cycle, how do you recommend it be constructed?
4. Is there a lab test cycle that could represent low load/temperature duty cycle operation?
5. Could Low Load Cycle replace Cold FTP for HD?
6. Should we align GHG and criteria pollutant test cycles?

Standard level

7. Are there alternative metrics to cycle work based standard levels that are more robust at low NO_x values?
8. What is the system variation at Low NO_x certification cycles?
9. Are there new test technologies required for the robust enforcement of Low NO_x regulations?
10. How much impact will IRAF and DF have for Low NO_x certification?
11. How do we develop design targets for Low NO_x certification?

Technologies

12. What technologies improve sustained low temperature NO_x reduction?
13. Can existing engine /aftertreatment control strategies used to meet the FTP NO_x standard be used to maintain control of NO_x emissions under sustained light load

and stop-and-go operations prevalent in urban areas and congested highways? If not, please describe calibration strategies needed to be developed?

14. What technologies improve catalyst warm-up for FTP cycle NO_x reduction?
15. What technologies can robustly achieve low NO_x emissions at high load/temperatures?
16. What sensing technology is required for robust feedback control of a Low NO_x system?
17. What technologies/strategies would you use to significantly reduce NO_x emissions from current diesel engines while also meeting the Phase 2 GHG standards?
18. What are the impacts of technology/calibration strategies for Low NO_x to other system requirements? GHG? N₂O? Customer fuel economy? Cost? Reliability? Maintenance and diagnostic requirements?
19. Any thoughts regarding how to best include incentives or requirements for advanced technology development as part of the upcoming NO_x standards? Development of such technologies is crucial for meeting ARB's long-term GHG goals.
20. Can you think of other "outside the box" alternatives to a heavy-duty engine NO_x standard? For example, a vehicle NO_x standard, geofencing, intelligent vehicles, etc.

HD IN-USE COMPLIANCE/TESTING/NOT TO EXCEED WORKGROUP

Objective:

Develop in-use requirements to ensure the certified NO_x reductions are enforced in real-world operation

Considerations:

- Analysis/comparison of NTE and European MAW method
- Determine method
- Updated HDIUT program
- New agency In-use Compliance method
- NTE event duration
- NTE control area/definition of region
- Temperature exclusions
- PEMS measurement accuracy
- NTE limits
- Pass/Fail protocol

Key Questions and Data Needs:

1. For most engines, how accurate is the ECM broadcast torque below the 30 percent maximum torque?
2. How to better include vocational operation in in-use assessments? What in the NTE requirements need to change?
3. ARB is considering revising the current manufacturers run in-use compliance program to make it more effective in ensuring emissions are controlled in-use at all engine operating conditions including light load operations. To accomplish this, ARB staff plan to revise the existing program by either,
 - a. expanding the NTE control area, eliminating/revising the various temperature exclusions and the NTE event minimum duration criteria (30 seconds), or
 - b. developing a new in-use compliance program similar to the “moving average window” (MAW) of the European Union.Can stakeholders comment or provide recommendations on the above ideas?
4. What are the requirements of an expanded NTE region?
5. What is the capability of PEMS measurements for in-use test compliance?
6. What should the measurement allowances be for PEMS relative to future lower NO_x standards?

WARRANTY WORKGROUP

Objective:

Ensure the development of robust products that are maintained and repaired as necessary

Considerations:

- Inducements
- Warranty
- DF testing
- Useful life
- New warranty period
- Warranty reporting requirements
- New recall requirements based on warranty reporting threshold

Key Questions and Data Needs:

Maintenance

1. ARB is considering including more specificity in the owners' manuals for basic maintenance so that end users are aware of any extra maintenance beyond what is currently done for newer technologies that are needed to meet the standards. Have you put any effort towards including such additional guidance in your owners' manuals?

Warranty

2. Do you currently provide a base warranty for your heavy-duty vehicles that differs in period and coverage from the warranty required by the emissions regulations (i.e., 50K/100K miles)? If so, what does that warranty cover and for how long?
3. Heavy-duty vehicles currently are typically operated for many more miles than which their current required emission control system warranties specify coverage (e.g., 100K miles for heavy-duty diesel vehicles). If ARB and US EPA were to lengthen the required emission control warranty periods, what periods would you recommend?
4. In general, heavy-duty vehicle warranty failure rates are very high for certain components.
 - a. What are your current emission control system warranty failure rates for each emission-related part, and how have these fail rates changed since 2007?
 - b. ARB is considering revising the emission control system warranty requirements to have the ability to enact corrective action more easily when warranty failure rates are high. What is the process that you currently utilize to address warranty failure rate concerns?
5. What would the cost implications to you be if the warranty periods were increased by 2 to 3 fold?
6. Do you know how much it costs to maintain a heavy-duty vehicle throughout its useful life, and if so can you tell us?

7. What are the different types of extended warranty packages that you are aware of being offered to the end-users of your products (either directly by you, as applicable, or by your dealers, or by third-party vendors)? What is the coverage for each of these packages, the periods of coverage, and the costs?
8. What rationale do you, as applicable, or your dealers/third-party vendors employ when deciding to offer an extended warranty (e.g., types of usage, owner, vehicle specifics, etc.)?
9. How often and how much do you typically spend honoring emission control system warranties annually? Do you have cost and component data that you would be willing to share with ARB?

DURABILITY/USEFUL LIFE WORKGROUP

Objective:

Amend durability testing and useful life requirements to ensure more durable, lower-emitting on-road heavy-duty engines throughout their extended useful lives

Considerations:

- Basis for extending useful life Streamlining durability testing requirements
- Validating accelerated aging protocols

Key Questions and Data Needs:

1. On average how many miles do your heavy-duty vehicle engines operate in-use before a major engine overhaul is required?
2. How well do accelerated durability procedures represent actual over-the-road engine aging?
 - a. Do you use any accelerated durability procedures? If so, how well do your procedures correlate with engine durability observed in use at higher mileage?
 - b. Do you have any thoughts on incorporating some amount of actual on-road aging using a prescribed cycle (i.e., similar to the method used by light-duty diesel vehicle manufacturers to age their vehicles out to useful life period under the Standard Road Cycle [i.e., 150K miles])?
3. What are the most common in-use engine-related malfunctions that you see (e.g., EGRs, turbochargers, fuel injectors, head gaskets, water pumps, sensors, emissions aftertreatment, etc.?) Which of these components fail first and at what mileage? What is the average mileage between failures for these components?
4. How would an increase in the current useful life definitions impact the durability demonstration at certification?
5. What would the cost implications to you be if the useful life period were increased by 2 to 3 fold?
6. Can you suggest any other protocol for better streamlining certification durability testing to make it more efficient and cost effective?

HD OBD WORKGROUP

Objective:

Explore OBD implications of proposed standard and test cycle changes.

Considerations:

- Evaluate sensor capabilities
- New thresholds
- Monitoring criteria for new LLC

Key Questions and Data Needs:

1. What is the impact of lower standard to OBD capability? Assuming current OBDEL.
2. What sensor technology will be required for robust OBD detection?
3. Can extended detection windows allow for more robust diagnostic detection?
4. What controls strategies would reduce variation and improve detection capability at lower emissions standards?
5. How do we ensure that new technologies are not restricted by current OBD regulations?

EMISSIONS INVENTORY WORKGROUP

Objective:

Improve emissions modeling in EMFAC2017 to support determining the needed regulatory changes

Considerations:

- Exhaust emission rates
 - Zero mile rates
 - Deterioration rates
 - Speed correction factors
- Idle emissions rates
- Start emissions rates
- Data requirements to improve model to account for low-load emissions control
- Method to account for changed durability, warranty and useful life requirements
- Overall emission reduction from the Low NOx rulemaking (standards, LLC, warranty/UL, In-use compliance)

Key Questions and Data Needs:

1. Where are the biggest uncertainties in the model where additional data would be most helpful?
2. What contribution is cold start to real world MD/HD truck NOx emissions?
3. What industry data are available on component deterioration, tampering, and mal-maintenance, such as emission impact rate and prevalence data (e.g., repair records) from various dealerships?
4. Mobile source emission inventories are based on the DMV vehicle registration database. This database only provides information on truck chassis and no information is available regarding the engine. What industry data are available that can tie VIN, engine serial number, and engine family. This information, if available, can be used to better reflect emission benefits associated with advanced technologies at the regional level.
5. Does industry collect telematics data from medium and heavy duty trucks?
Telematics data will be very useful to better characterize truck activity in California.

Data Needs:

1. Data that can help improve characterization of the emission increase (i.e., EIRs) associated with engine and after-treatment failures by manufacturer and engine model year. In general, we would like to have engine/vehicle emission data before and after a failure occurs. An example of such data are the test records collected through durability demonstration testing procedures commonly referred to as “DDV” testing where engine-manufacturers damage or remove engine parts to determine if the OBD MIL light comes on at the correct time or not. However, DDV data typically lack data on frequency of occurrence of different component failures. Also, in most cases emission data are not available for the empty can (i.e., the substrate/filter completely removed from the catalyst/filter container) demonstrations.
2. Data that can be used to determine the frequency of occurrence (i.e., FREQ) of Tampering, malfunction, mal-maintenance instances by manufacturer and engine

model year. For example: longitudinal warranty and repair data from Cummins' dealerships. With such data, the failure rate of a specific engine/after-treatment component over its useful life might be determined.

3. Longitudinal data that can shed some light on any natural degradation of after-treatment systems that might affect NOx and PM emissions from heavy duty diesel engines.
4. Data that can help better characterize SCR performance under different operating conditions. Test data implies that SCR loses NOx conversion efficiency under low speed driving cycles such as "Creep" and "Transient". Chassis dynamometer as well as on-road PEMS data are of interest.