Crediting Real World Fuel Efficiency in GHG Phase 2: Daimler Trucks North America’s Suggested Approach

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Overview of Test Methods in Place/Planned by Region

Complete vehicle simulation with tested inputs is suggested for GHG Phase 2. It is the most cost effective method, is repeatable, and can generate real-world FE values on a comparable basis.
Capturing Engine/Powertrain Interaction Over More Realistic Drive Cycles Requires Vehicle Simulation

- Issue: current engine regulatory test cycles do not match real-world driving, do not reflect achievable CO₂ reductions.
- Options for testing powertrains:
  - Chassis dyno testing: very costly and resource-intensive
  - Engine powertrain testing: resource intensive in that it requires a lot of testing and costly new facilities
  - Complete Vehicle Simulation: Max. flexibility for efficient, repeatable and accurate assessment of multiple configurations. Minimizes testing (required for inputs e.g. fuel maps)

Data collected from ECM downloads of customer vehicles

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Future Technology Evaluation Through Simulation

- Industry already uses tools like Autonomie extensively to assess technology potential
- Allows for easy integration of various powertrain architectures without extensive physical testing

- Looks at the vehicle as a complete system
- Uses a Forward-Looking Vehicle Model
  - Driver Model (PI Controller) generates commands sent to different components (throttle to the engine, gear number to the transmission,...) in order to follow a desired speed profile
  - Components will realistically react to the commands
  - Possible to develop control strategies
OEMs have all evolved to applying a complete vehicle approach using simulation to develop and validate new products. A regulation should mirror this approach to ensure that the regulation accurately reflects the CO₂ reductions our customers see in the real world.
US GHG Phase 1 to Phase 2 High Level Comparison

Key changes:
- No separate engine certification
- Engine fuel mapping
- Component efficiencies
- Distanced based cycles with road grade
- Additional cycles by vocation
- Trailer aero improvements

Suggestions for Phase 2/3 enhancements to Phase 1:
- Full vehicle certification.
- Simulation-based approach with detailed engine fuel maps.
- For certain data: lookup tables with the possibility to override data if manufacturer has better data or is near a regulatory threshold.
- Robust route profiles complemented by advanced/innovative technology corrections.
- Continued alt/innov tech certifications.
Complete Vehicle Approach: Flexibility without CO₂ Backsliding

- Provides manufacturers with flexibility needed to design the most cost effective solutions optimized for the application – without limiting innovation and competition
  - CO₂ backstops can be designed to prevent backsliding

![Graph showing vehicle and engine CO₂ emissions with backstop strategies to prevent backsliding.](image-url)
Advanced and Innovative Technologies

- Many Phase 1 Innovative Technologies will likely be quantified by Phase 2 and should be incorporated into GEM 2.0 via a pull-down menu. These menu options should be based on realistic fuel economy improvements.
  - If an OEM wishes to show a greater benefit, they can override default values with test data generated following innovative technology certification procedures (below).
- Continue the Phase 1 approach of allowing advanced technology credits to be generated as “Super Credits.”
Trailer regulations: Without Trailers, Phase 2 is Incomplete

- Further improvements to the tractor cannot be optimized independent from trailer aero improvements
- **System optimization** is the key to full-vehicle fuel economy improvements
- Test procedure is exactly like Phase 1 aero for tractors but translated to trailers:
  - EPA-defined reference tractor
  - Trailers put in bins or subject to max $C_dA$ requirement

Trailers are clearly on the table for Phase 2. At a minimum, the reference trailer must be updated to reflect more aerodynamic designs
Summary and High Level Principles for Phase 2

- **Regulation must accurately reflect real world reductions.** The only way to accurately reflect real-world consumption is through a complete vehicle standard that includes trailers.

- **Phase 2 must not force technology that doesn't reduce total cost of ownership** for the first customer (payback within 18 months) otherwise new technology won’t be purchased and environmental benefits will be delayed.

- **Phase 2 should be consistent with Phase 1 relative to current OBD requirements** providing adequate protection for criteria and GHG emissions. This also prevents OBD from becoming a barrier to new GHG technologies entering the market.

- **EPA, NHTSA and ARB must have one single program for GHG in the U.S.** Should ARB request a waiver for HD GHG standards that are more stringent, it should be denied on the basis that such standards are not needed to meet compelling or extraordinary conditions.

- **Trade-off of NOx and CO2 reduction targets.** Additional NOx stringency has negative impacts on GHG emissions and compromises our joint goal of FE improvement.

- **Complex clean diesel technology requires long design cycles.** It is not feasible to work to EPA/ARB 3-year mandated cycles. Consequently, at least one manufacturer has already left the market and another is struggling to meet requirements.
THANK YOU!

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