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10/23/2020

MEMORANDUM

SUBJECT: Development version of GEM and adjustment factors

FROM: Brian Nelson

TO: Improvements for Heavy-Duty Engine and Vehicle Test Procedures, and Other Technical Amendments - Docket EPA-HQ-OAR-2019-0307

This memo documents the release of a development version of GEM which incorporates some fixes/improvements relative to the unofficial version (GEM-P2V3.5) that was released at the time of the proposed rule. This additional unofficial version of GEM (GEM-P2V3.7) that is now available includes the following changes relative the GEM-P2V3.5:

- Fixes bugs/errors:
    - Corrects duty cycle weighting factors for HHD_M vehicles
    - Allows k-factor input w/o transmission power loss input
    - Changes limits on engine input to allow small negative torque inputs
    - Fixes error that was preventing clutched upshifts for automated manual transmissions and manual transmissions for HHD vehicles
- Includes features to accommodate proposed test procedure improvements:
    - Allows engine hybrid powertrain inputs
- Includes new technology input:
    - Adds option for vocational vehicles to receive credits for neutral coast

GEM-P2V3.0 was used to set standards in the Phase 2 final rule and is the version currently incorporated by reference into the regulations. At the time of the proposal, we noted that our preliminary evaluation of GEM-P2V3.5 indicated that there was little difference between GEM-P2V3.0 and GEM-P2V3.5 for cruise cycle operation but that it was possible that some minor differences between the two versions may be observed for specific categories and operations. In our proposed technical amendments, we requested comment on whether these differences in using GEM-P2V3.5 compared to GEM-P2V3.0 would impact the effective stringency of the standards and whether either GEM or the regulations needed to be revised to address them. In our efforts to understand any potential differences (in the positive or negative direction) between the GEM versions, we have developed a table of adjustment factors that could potentially be

applied to the GEM-P2V3.7 result to reduce such differences. The potential adjustment factors outlined below are a function of regulatory subcategory and model year (i.e. 2021-to-2023; 2024-to-2026; and 2027-and-later). The adjustment factors in Table 1 could potentially be applied to the composite GEM result using the equation below.

$$e_{CO2_{Corrected}} = \frac{e_{CO2}}{1 + AF}$$

Where:
e_{CO2} = unrounded composite CO2 emissions from GEM
AF = the applicable adjustment factor from Table 1

Table 1 GEM P2V3.7 Adjustment Factors

Regulatory Subcategory	Adjustment Factor		
	MY 2021-2023	MY 2024-2026	MY 2027-and-later
Class 7 Day Cab Low Roof	-0.0104	-0.0090	-0.0094
Class 7 Day Cab Mid Roof	-0.0106	-0.0084	-0.0097
Class 7 Day Cab High Roof	-0.0088	-0.0084	-0.0090
Class 8 Day Cab Low Roof	-0.0062	-0.0079	-0.0068
Class 8 Sleeper Cab Low Roof	-0.0014	-0.0015	-0.0016
Class 8 Day Cab Mid Roof	-0.0059	-0.0062	-0.0064
Class 8 Sleeper Cab Mid Roof	-0.0013	0.0000	0.0000
Class 8 Day Cab High Roof	-0.0058	-0.0062	-0.0066
Class 8 Sleeper Cab High Roof	-0.0013	-0.0014	-0.0016
Class 8 Heavy Haul	-0.0076	-0.0080	-0.0062
Multi-Purpose Light HDV Compression-ignition	0.0000	-0.0029	0.0000
Regional Light HDV Compression-ignition	0.0000	0.0000	0.0000
Urban Light HDV Compression-ignition	0.0000	0.0000	0.0000
Multi-Purpose Medium HDV Compression-ignition	-0.0038	0.0000	0.0000
Regional Medium HDV Compression-ignition	0.0000	0.0000	0.0000
Urban Medium HDV Compression-ignition	-0.0034	-0.0037	0.0000
Multi-Purpose Heavy HDV Compression-ignition	0.0038	0.0041	0.0043
Regional Heavy HDV Compression-ignition	0.0000	0.0000	0.0000
Urban Heavy HDV Compression-ignition	0.0065	0.0071	0.0037
Multi-Purpose Light HDV Spark-ignition	0.0000	0.0000	-0.0027
Regional Light HDV Spark-ignition	0.0000	0.0000	0.0000
Urban Light HDV Spark-ignition	0.0000	0.0000	0.0000
Multi-Purpose Medium HDV Spark-ignition	0.0000	0.0000	0.0000
Regional Medium HDV Spark-ignition	0.0000	0.0000	0.0040
Urban Medium HDV Spark-ignition	0.0030	0.0032	0.0034
School bus	-0.0034		0.0000
Motor home	0.0000		0.0000
Coach bus	0.0000		0.0049

Other bus	0.0067	0.0000
Refuse hauler	0.0096	0.0034
Concrete mixer	0.0125	0.0127
Mixed-use vehicle	0.0125	0.0127
Emergency vehicle	0.0123	0.0125

EPA is not requesting comment on, or reopening the comment period regarding, any of the information documented as being made available or made available in this memo. Links to a Windows executable file and the source code for GEM-P2V3.7 can be found at the following website:

https://www.epa.gov/regulations-emissions-vehicles-and-engines/greenhouse-gas-emissions-model-gem-medium-and-heavy-duty