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MEMORANDUM

SUBJECT: Adoption of GRPE Heavy-Duty Hybrid new annex to Global Technical Regulation n°4

FROM: United States Environmental Protection Agency

TO: GRPE HDH IWG

The United States has been an active participant in the Heavy-Duty Hybrid (HDH) Informal Working Group since its inception in 2010. We have been pleased by the progress that the group has made in drafting the Annex to GTR n°4 and we compliment the leadership and the participants in the work that has been done so far. We believe that when completed, the work of the HDH group will be an important means of determining criteria pollutant emissions from hybridized heavy-duty vehicles.

There are, however, currently a number of open issues that are causing concern for the United States and require resolution prior to considering the Annex for adoption. The United States summarized most of these issues at the June, 2013 GRPE meeting in informal document HDH-14-06e. To date, all of our issues remain unresolved. This document provides a review of the unresolved issues that need to be thoroughly addressed before the US can consider adopting this Annex to GTR n°4. In addition, we feel that the final resolution of these issues must include some amount of time for review and validation. These issues include: management of new systems models, allowable validation procedures, World Heavy Duty Hybrid Cycle (WHDHC) version applicability, validation test programs, and hybrid controller requirements. Each of these issues is discussed in more detail below.

1. Management of New Systems Models

A defined process for introducing new system models into the test procedure is required because the working group is not able to anticipate all the systems models that will be needed for future hybrid powertrains. A procedure for manufacturers to introduce these models is required so that there is a consistent process for all manufactures to follow.

2. Allowable Validation Procedures

A key part of the Annex to GTR n°4 is to define the procedures that can be used to validate a manufactures hardware-in-the-loop-simulation (HILS) system. So far the group has agreed that chassis dynamometer testing and powertrain testing will be allowed methods, but now the group is also considering the option of over the road testing as a validation procedure. Of the 3 options currently being considered, the United States supports both chassis and powertrain procedures. This support is based on the data generated from testing performed by this working group and other test programs lead by the United States to demonstrate that the two test procedures are repeatable and far enough along in development to give consistent results from laboratory to laboratory. For any method to be considered a validation method in the GTR, the test procedure needs to be defined in detail to ensure that there is consistent use of the procedure across manufactures applying for certification. If over the road testing is allowed as a validation procedure, the procedure needs to be designed in a way that the test will adequately challenge the vehicle over the same type of cycle as the WHDHC.

3. Applicability of WHDHC Version

For a robust certification process, the drive cycle is one of the most critical components. At this time, the version of the WHDHC that will be required under this Annex procedure is still unresolved. There have been a number a proposed drive cycles that are intended to match up with the world-harmonized-transient-cycle (WHTC) in terms of power vs. time, but each one is different. For the working group to be able to judge how well a new drive cycle matches up with the WHTC, a comparison between the two should be done. This comparison should compare not just the power of the drive cycle, but also the emission results. One way that this could be done is to use HILS to create the engine cycles for a conventional vehicle over the proposed versions of the WHDHC and compare the emission results from these cycles to the WHTC emission results.

4. Validation Test Programs

Two validation test programs where initiated by the working group in March of 2012 as a means to inform the working group's decision making process. The first validation test program has been completed; however the second validation test program is still in under way. It was agreed for the second test program that chassis testing, HILS, and engine testing would be performed on three hybrid vehicles. As of the 15th working group session held in San Francisco, only the chassis testing had been completed and the vehicle manufactures were still working on validating their HILS, software-in-the-loop-simulation (SILS), and model-in-the-loop-simulation (MILS). Since the test results of chassis testing and simulation portions of the validation test program are needed to make a number of key decisions, the United States would like access to the test files for all of the validation results (not just summary data) once they are available and a description of how the models were modified to meet the validation criteria. As discussed in the 13th session of the working group, the United States requested that the emission results (CO₂ [g/km] and NO_x [g/km]) and fuel consumption be compared between the chassis dynamometer and engine test results. Further, another critical portion of the validation test program that has not been completed is evaluation of how well HILS predicts engine operation during cold start. This is an

area where the GTR mandate goes beyond what is in the Japanese legislation, so through review and analysis of these results is also needed for the United States to be confident that the final procedure is robust.

5. Hybrid Hardware Controller Requirements

The last critical open issue is the required hybrid control functions and strategies that need to be included in the hardware controller. The working group has had many discussions on whether one or multiple controllers should be used in the HILS certification procedure. The United States' position is that the procedure should define the control functions that need to be in the hardware controller(s) and not the number of hardware controllers.

The United States is committed to continue working through the GTR process to assist in the creation of a robust heavy-duty hybrid certification procedure and we look forward to participating in future drafting and working groups to accomplish this goal. In addition, we offer the technical resources at our disposal to assist in efforts to resolve these very important issues.