Transmitted by the expert from OICA

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PROPOSAL FOR AN EMISSIONS TEST PROCEDURE FOR HEAVY DUTY HYBRID ELECTRIC VEHICLES (HEV'S)

The text reproduced below was prepared by the expert from OICA in order to propose harmonized test procedures for the determination of the levels of pollutant emissions from heavy duty hybrid electric vehicles (HEV) of categories 1-2 and 2, having a design speed exceeding 25 km/h and having a maximum mass exceeding 3.5 tonnes.

A. BACKGROUND

Greater fuel efficiency and the reduction of CO_2 emissions are becoming an increasingly urgent issue in view of global warming and surging petroleum prices. Hybrid electric vehicles (HEV's) are recognized as one solution for achieving lower emissions and increased fuel efficiency. Consequently, a widespread introduction of HEV's has taken place during the last years, primarily for passenger cars. But also commercial vehicle manufacturers have introduced, or announced the introduction of several hybrid concepts for urban, delivery and extra-urban operation.

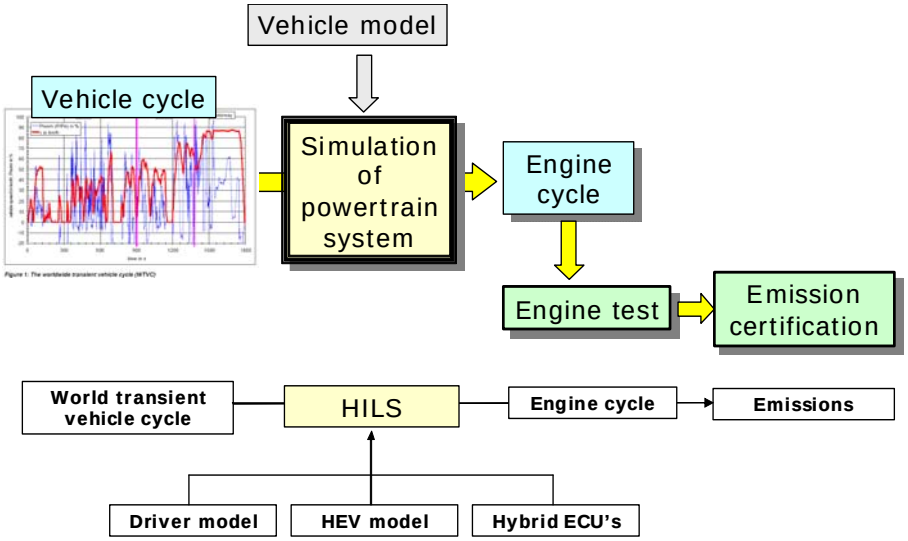
While emission test procedures for light duty HEV's are laid down in ECE R 83, such provisions do not exist today for heavy duty commercial vehicles in the context of the UN ECE.

Japan introduced a bench test method in 2004, but this method requires a larger, more expensive and technically demanding test area compared to conventional test cells. Moreover, in different types of hybrid powertrain systems (wheel-in-motor, etc.), it is difficult to measure regenerative braking energy and electric-motor power performance on the engine dynamometer. Therefore, a new test method for HEV engine certification was developed, which is based on the HILS (Hardware-in-the-Loop Simulation) principle. HILS uses real-time virtual simulation of engine and hybrid components performance during the test driving cycles of a hybrid vehicle. HILS is described in Kokujikan No.281 of 16 March 2007 “Measurement Procedure for Fuel Consumption Rate and Exhaust emissions of Heavy-Duty hybrid Electric Vehicles using Hardware-In-he-Loop-Simulator System”.

B. PROPOSAL

OICA proposes to develop a global technical regulation for certification of HEV's under the 1998 agreement. The proposal aims to provide a test procedure and harmonized technical requirements for emissions

certification of HEV's. The proposal is focused on emissions certification rather than on fuel consumption or CO_2 certification. OICA further proposes that the regulation should be based on the HILS approach, which starts from a vehicle cycle and simulates powertrain and vehicle components to come up with an engine cycle for emissions testing and measurement. The principle of HILS is shown in the diagram below:



Since vehicle and powertrain operation depend on the layout of the individual HEV, they need to be an integral part of the emissions test procedure. Looking at the engine only, is not sufficient for HEV's. OICA therefore proposes to use the World Harmonized Vehicle Cycle (WHVC) developed under the WHDC mandate as base cycle for the HILS method. Similar to the original WHDC approach, where a standard gearbox model was used for converting the WHVC into the engine cycle WHTC, HILS uses the individual powertrain components (engine, transmission, electric motor, battery), some vehicle parameters (mass, inertia) and a driver model for creating the final HEV engine cycle. This HEV engine cycle would then be used for emissions testing. However, certain HEV vehicle standardization is necessary to accommodate a powertrain system in a range of similar vehicles.

HILS includes the following models:

- The vehicle model covers running and acceleration resistance, taking into account rolling and air resistance coefficients, vehicle mass, rotating equivalent mass, speed and acceleration, etc.;
- The MG (motor-generator) model represents the electric motor and generator, whose input data are generated from component testing;
- The transmission model represents clutch and gearbox, the gear ratios and efficiencies;
- The battery and capacitor models express the conditions of the battery/capacitor, state of charge SOC, capacity, resistance, charge and discharge power, etc.

OICA also proposes to consider the overall vehicle mission by applying subsets, or combinations of subsets, of the WHVC (urban, rural, motorway) in combination with appropriate weighting factors for the emissions test. Testing requirements such as engine preconditioning, test fuels and general emissions testing and measurement provisions are proposed to be based on gtr n°4 (WHDC).

OICA is asking GRPE to establish a working group to develop the proposed regulation, and integrate the provisions as a new annex into gtr n°4 (WHDC). OICA is prepared to support the process with budget and manpower, and suggests the following ambitious timetable:

Item	**Time**
OICA proposal to GRPE	01/2010
Official GRPE document & mandate	06/2010
1st WG meeting (timing & cost)	09/2010
Report to GRPE	01/2011
2 years work program	
WG final report to GRPE	01/2013
GRPE adoption	01/2014
WP29 adoption	06/2014

C. JUSTIFICATION

As with gtr n°4 (WHDC) for conventional commercial vehicles, a globally harmonized emissions testing procedure will greatly facilitate the development and marketing of HEV's around the globe. Contrary to conventional vehicles and engines, emissions testing and certification of HEV's independent of the vehicle application is not the optimal technical solution. Since engine speed and load cycles of HEV's are in fact different from those of conventional powertrains, it is necessary to incorporate vehicle and mission related elements into the certification procedure.

OICA believes that HILS is the right approach for emissions testing of heavy duty HEV's by avoiding complete vehicle testing on a chassis dynamometer and at the same time allowing to use engine technology optimized for HEV operation. If the HILS approach is used, engine technologies and engine calibrations can be tailored to the hybrid applications, keeping the overall emissions performance equal to conventional engines and fully optimizing fuel consumption, CO_2 emissions and product costs.

Considering the extremely high investment for chassis dynamometers and the progress made over the last years on test cell equipment and computer technology, introduction of a simulation based certification procedure into the regulatory world is a cost-effective yet accurate method.

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