

## **ELEVENTH MEETING OF THE GRPE INFORMAL GROUP ON HEAVY DUTY HYBRIDS (HDH)**

**Ottawa, 10 to 12 October 2012**

### **MINUTES OF THE MEETING**

Venue: Ottawa Convention Center, Ottawa

Chairman: Petter Åsman (Sweden)

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#### **1.- WELCOME AND INTRODUCTION**

The Chairman welcomed the participants.

#### **2.- ADOPTION OF THE DRAFT AGENDA**

(Working paper HDH-11-02e)

The draft agenda was adopted. Working papers HDH-10-05 and HDH-10-06 will be discussed under agenda item 4. The order of agenda items 5 and 6 will be reversed.

#### **3.- DRAFT MINUTES OF THE TENTH MEETING**

(Working paper HDH-10-08)

The draft minutes of the 10<sup>th</sup> meeting were approved.

#### **4.- CONTRIBUTIONS FROM CONTRACTING PARTIES ON HD HYBRID AND GHG ACTIVITIES**

##### **4.1 Japan**

(Working paper HDH-11-05e)

Mr. Osaki presented JASIC's comments on the WHDHC approach proposed by TU Graz. The comments are related to the Excel tool provided by TU Graz to elaborate their proposal. The comments focus on five items: negative work, gear shifting, vehicle mass (for post-transmission simulation – option B), power patterns (option B) and option B HILS simulation. The negative work, which is essential for energy recuperation, is considered being underestimated when only taking the engine cycle as basis (see page 7). Therefore, it should be vehicle based. Gear shifting needs some smoothing procedure for option B. In general, engine speeds will be different with options A and B resulting in different emission results. As regards power patterns, the introduction of road gradients is considered necessary for option B. In a second evaluation, JASIC examined the possibility of using HILS for the WHDHC approach. In summary, only post-transmission approach is considered to be applicable for the HILS method, but in order to match with the WHVC approach, it is necessary to set gradients on the WHVC approach. The gradients turned out to be so big as to cause a hybrid ECU error in the simulation.

Mr. Silberholz responded that some of the issues raised by JASIC are on the to-do-list for the next weeks. The negative work proposed by TU Graz is based on European vehicle classes and might need to be adapted for vehicles outside Europe. Work on how to deal with gear shifting is also underway.

In general, it was agreed that the option B approach is closer to the original HILS approach than option A. It was agreed that the gradients with the WHVC approach would need to be limited to realistic values. The secretary reminded the group that the ToR are based on the WHVC (whole vehicle) approach. So, any alternative such as the WHDHC approach (options A and B) would need to be validated against the WHVC approach during the validation test program.

#### **4.2 OICA**

(Working paper HDH-11-06e)

Mr. Berg presented OICA's input. He indicated that the OICA members continue to support the validation test program 1 with the required inputs for the signal list and the component list. In addition, at least two vehicles will be made available for validation test program 2.

In OICA's opinion, both WHVC and WHTC curves need signal filtering in order to remove artifacts due to gear shifting events that are neither representative for a HV nor suitable for simulation. For the WHVC motorway phase, introduction of road gradients is proposed. As regards the WHDHC approach, the vehicle speed signal will likely be needed by the ECU (either from WHVC or backwards calculation).

### **5.- PRESENTATIONS BY RESEARCH INSTITUTES**

(Working paper HDH-11-04-Rev1e)

#### **5.1 TU Vienna/Graz/Chalmers**

Mr. Six started with the presentation of working paper HDH-11-04-Rev1. First, he indicated that the paper is a joint presentation of the three institutes involved. The institutes have a regular exchange of information.

The basis for the development of the serial hybrid simulator is the Japanese open source model for a serial hybrid provided by JARI. As a first step, an ECU control strategy with different ICE operation points was added to the model. Further, a driver model for the WHVC approach was developed. Details of task 1.1 are shown on pages 5 to 10.

Task 1.2 covers the development of a driver model appropriate for the WHDHC approach. Rationale for the WHDHC approach is to be in closer agreement to the test procedure for conventional ICEs. It is therefore essential that the driver model allows running the simulator with test cycles consisting of power and rpm at the wheel hub and at the power pack shaft. This requires two PID controllers, cycle reference tables and a watchdog system that prevents too aggressive control parameters, such as gradients. Task 1.3 covers the extension of the simulator with a library of non-electric components. Details of tasks 1.2 and 1.3 are shown on pages 13 to 18.

In order to develop the software ECU in a manner as realistic as possible, input of the OEMs is needed. An interface list and a component list were submitted to the OEMs for review and have been uploaded to the HDH webpage. Meetings with OEMs are planned to start in November 2012. The OEM input is specifically needed for task 1.5 (additional powerpack components) and task 1.6 (thermal models).

Mr. Silberholz continued the presentation with an overview of the thermal models. Thermal models are considered for the aftertreatment system (ATS), for the coolant and lube oil circuit, and for battery and electric motor. The ATS thermal models have been implemented in Simulink and are currently being validated with existing measurement data. Measurements for the parameterization of the thermal model for coolant and lube oil are currently conducted on an engine test bed. The thermal models for battery and electric motor are under preparation in cooperation with the Institute Electrical Measurement and Measurement Signal Processing at TU Graz. OEM input and validation is needed after the implementation. Details of task 1.6 are shown on pages 22 to 34.

After implementation of the models, simulation runs and validation of basic functions will be conducted. While relatively simple control strategies will be used for the model validation, the simulation runs are suggested to be based on largely realistic control strategies. Generic values, measurement data of the institutes and measurement data from OEMs (if available) will be used as input data. Task 1 is planned to be completed by the end of January 2013.

Task 2 (adaptation of the HILS simulator for parallel hybrids) will start in October 2012. The institutes propose that the model validation and simulation should be done with vehicles intended for validation test program 2. Task 3 includes the description of the test procedure and the user manual for the software. It was indicated that the Task 3 can only be on schedule, if the HILS structure is retained. Establishment of a component library, as favored by the HDH IWG, does not fit into the current HILS model.

## 5.2 Discussion

Mr. Berg considered thermal models as very complicated. Simulation should be as simple as possible. The cold start/ hot start influence might be better optimized through engine testing. Mr. Andrae confirmed that hardware testing might be a more straightforward solution than simulation in that case. OICA proposed that thermal models should only be used, if requested by the OEM. The HDH IWG will review the proposal and decide at the end of the validation test programs.

The institutes confirmed that establishment of a component library is principally possible, but would require additional time. They were then asked to present the issue in more detail at the next HDH meeting. The institutes further confirmed that after the SILS evaluation of the models, they can be used for a HILS simulation during validation test program 2.

It was agreed that a more intensive exchange of information between the institutes and JASIC would be needed to successfully complete the validation test program. EPA asked if a preliminary documentation of the models could be made available by the end of November in order to allow IWG members working with the simulation tool. The information on the model structure should be presented by the institutes at the next HDH meeting.

## 6.- ROAD MAP AND PROJECT PLANNING

(Working paper HDH-11-07e)

The secretary presented working paper HDH-10-07. On page 5, he referred to the Terms of Reference and the timing of the work program. According to the original timing, HDH IWG should submit the final report incl. the assessment of chassis dyno and powerpack testing at the 65<sup>th</sup> GRPE in January 2013. In addition, WP.29 should review the target completion date in June 2013. Taking the current timetable into account, it will not be possible to meet these deadlines. The secretary therefore proposed to submit the final report at the 67<sup>th</sup> GRPE in

January 2014, which consequently would delay GRPE adoption to June 2014. The updated roadmap, which is shown on page 6, was agreed by the IWG.

In order to start drafting the gtr, it was agreed to establish a drafting group. The chairman volunteered to chair this group, but to cope with the expected high workload a technical secretary needs to be installed. The EU Com was asked to provide the necessary budget. Nomination of experts to the drafting group should be communicated to the secretary by the next HDH meeting. It was also agreed that beyond a couple of face-to-face meetings, web meetings will be held. The IWG considered it important that EPA and JASIC will nominate drafting group members. Basis for the gtr is the Japanese procedure in Kokujikan n° 281. JASIC will check if it can be uploaded to the HDH webpage. The first meeting of the drafting group will take place in conjunction with the 13<sup>th</sup> HDH meeting on 19 and 20 March 2013 in Borlänge.

As regards the component library, Sweden announced the availability of budget for Chalmers University to start working in parallel to validation test program 1. The main work would be done during spring 2013. The IWG members welcomed the Swedish offer and agreed to the proposal.

As regards PTO operation, EPA agreed to exclude it for the time being. Inclusion of PTO operation would be left to the Contracting Parties.

EPA agreed to send their procedure for full load powerpack mapping (pre-TM only) to the secretary for being uploaded to the HDH webpage.

Validation test program 2 can be conducted by JRC in the second half of 2013. Mr. Perujo was asked to confirm the test slot by the next meeting. He asked if engine testing would be necessary in addition to vehicle testing on the chassis dyno. TNO indicated that they have a powertrain test bench, but would need budget for running the tests. EC will test a Freightliner M2E and asked what kind of data would be useful for the HDH group. EPA asked which acceptance criteria would be applied. The secretary responded that this would be determined at the 13<sup>th</sup> HDH meeting, but any proposals would be welcome.

## **7.- ASSESSMENT OF POWERPACK TESTING**

### **7.1 Joint EC/EPA presentation** (Working paper HDH-11-08e)

Mr. Giallonardo presented working paper HDH-11-08. He indicated that the program was focused on Post-TM testing. Several months of trials and high hybrid manufacturer involvement were needed for being able to run the tests. The complete set-up basically represents a chassis dyno test operated a powerpack test. It was only used for a relative comparison between hybrid and non-hybrid vehicles. It was concluded and confirmed by EPA that chassis dyno testing and powerpack testing compare pretty well for CO<sub>2</sub>, but differences were observed for criteria pollutants, especially NO<sub>x</sub>.

## **8.- ASSESSMENT OF CHASSIS DYNO TESTING**

No discussion took place.

## 9.- NEXT MEETINGS

The next HDH meetings will take place, as follows

- 12<sup>th</sup> HDH meeting: 15 January 2013, Geneva
- 13<sup>th</sup> HDH meeting: 21 and 22 March 2013, Borlänge, Sweden
- 14<sup>th</sup> HDH meeting: 04 June 2013, Geneva (date to be confirmed)
- 15<sup>th</sup> HDH meeting: October 2013, San Francisco (exact date to be confirmed)

## 10.- SUMMARY AND CONCLUSIONS

Chairman and secretary summarized the meeting as follows:

- Validation test program 1 has been started by the universities with the development of driver models and a first proposal of thermal models
- The budget for validation test program is shared between OICA and EU COM
- Sweden will provide budget for the development of the component library
- Concerns have been raised that the thermal models might complicate the simulation process; simple solutions are preferable over very accurate modelling
- OICA announced the availability of at least 2 vehicles for validation test program 2
- The universities were asked to establish regular exchange of information with JASIC
- The revised roadmap and project planning were agreed; the secretary will prepare an informal document for the 65<sup>th</sup> GRPE
- A drafting group will be established at the beginning of 2013; nomination of experts should be communicated at the 65<sup>th</sup> GRPE
- The Japanese regulation Kokujikan 281 will be the basis for the gtr
- PTO operation will be excluded from the current work program
- Acceptance criteria for validation test program 2 need to be agreed upon
- Discussion on chassis dyno and powerpack testing will continue on the basis of input from ongoing programs at the Contracting Parties
- The chairman acknowledged the good work progress and thanked to participants for their contributions and EC for hosting the IWG meeting

## 11.- OTHER BUSINESS

None.

## 12.- VISIT TO ENVIRONMENT CANADA



(Working paper HDH-11-03e)













A visit to EC's engine testing facility and to NRC's wind tunnel was organized on 12 October 2012. The hospitality of EC and the excellent organization of the IWG meeting by Ms. Julie Deschatelets were highly appreciated by the participants.

# 11<sup>th</sup> MEETING OF THE GRPE INFORMAL GROUP ON HEAVY DUTY HYBRIDS (HDH)

October 10 to 12, 2012, Ottawa, Canada

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