

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

**Ann Arbor, 16 to 18 March 2011**

### **MINUTES OF THE MEETING**

Venue: EPA NVFEL Office, Ann Arbor, USA

Chairman: Petter Åsman (European Commission)

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

On behalf of EPA, Mr. Jackson welcomed the participants. The Chairman expressed his deep sympathy with the people of Japan who suffered from a heavy earthquake. A minute of silence was held in memory of the victims.

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

(Working paper HDH-05-02)

The draft agenda was adopted.

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

(Working paper HDH-04-06)

The draft minutes of the 4<sup>th</sup> meeting were approved.

#### **4.- PRINCIPLES OF HYBRID CERTIFICATION**

##### **4.1 Summary of 4<sup>th</sup> meeting**

(Working paper HDH-05-08)

The Secretary reiterated the relationship between WHDC and HILS. He then gave an overview of the results from the 4<sup>th</sup> meeting. The roadmap and project planning had been agreed with minor modifications. Roadmap, project planning and extension of the mandate to powerpack testing were approved by GRPE at its 61<sup>st</sup> session.

##### **4.2 EPA's view on hybrid certification**

(Working paper HDH-05-10)

Mr. Jackson informed the meeting that EPA is currently in the middle of their Greenhouse Gas (GHG) rulemaking. This means that the strategy presented at the meeting might change during the course of the rulemaking. Also, all documents presented at the meeting would have to be submitted to the Public Docket. The final rule is expected to be signed at the end of July 2011. He indicated that the HILS procedure is not advanced enough to go into the final rule for now, but EPA is very interested in the progress of the HDH group.

As regards hybrid certification, EPA's focus is on CO<sub>2</sub> certification. Testing includes pre-and post-transmission powertrain options and PTO evaluation for quantifying hybrid benefits as well as hardware-in-the loop that includes actual system components. The proposed certification strategies are conventional vs. hybrid testing on chassis dyno, conventional vs. hybrid testing for powertrains on powertrain test cell or powerpack testing on engine test cell. The PTO test method is fully resolved for powertrain or powerpack testing.

Mr. Ryan presented EPA's lab installation for hybrid testing. Currently, it is possible to conduct powerpack testing with a pre-transmission hybrid. A layout is shown on page 5 of working paper HDH-05-10.

Mr. Sanchez gave an overview of post-transmission powerpack test procedures. This includes a driver model and a simple vehicle model (vehicle mass, mechanical drag, final drive ratio, tire radius) for the simulation procedure. Net energy change (NEC) calculation is based on SAE J 1711 and SAE J 2711, but EPA is looking into a modified version of SAE J 2711 to account for energy stored in the battery. The metrics are g/tonmile for post-transmission hybrids and g/kWh for pre-transmission hybrids.

An overview of the test cycles used is given on pages 20 to 27 of working paper HDH-05-10.

As regards PTO testing, EPA only found significant PTO operation in refuse and utility trucks. The two PTO subcycles were combined into one cycle (see page 30 of working paper HDH-05-10). The cycle is programmed into a hydraulic PTO test rig that is connected to the vehicle. The difference between conventional and hybrid vehicle will be used to calculate emission credits.

#### **4.3 Presentation by Environment Canada**

(Working paper HDH-05-11)

Mr. Couroux who is responsible for GHG regulations in Canada gave an overview of the GHG situation in Canada. 6% of total GHG emissions are emitted by HD vehicles. As with other emissions related regulations, Canada will align the GHG rule with the USA. The proposed rule will be published by mid 2011. He also emphasized Canada's commitment towards global harmonization of technical vehicle regulations. Canada-US collaboration has been established on emissions testing of HD vehicles at Environment Canada's (EC) Ottawa lab (test cycles, chassis dyno testing, powerpack testing for hybrids).

Ms. Christenson presented EC's testing experience and test results. Two chassis dyno based test series on the comparison between conventional and hybrid utility and delivery vehicles over various duty cycles have been conducted. Depending on the duty cycle, fuel efficiency improvement varied between 0 % and 54 % (17 % on WHVC) for the delivery truck and between 10 % and 75 % for the utility truck. Powerpack testing is planned for March/April 2011.

#### **4.4 Presentation by Cummins**

(Working paper HDH-05-12)

Mr. Andreae presented an overview of potential hybrid evaluation methods. He emphasized that simulation should be an essential part of hybrid certification, since simulation provides for highly repeatable evaluation. The accuracy of the simulation depends on the validation of the model. Cummins worked closely with EPA to define hybrid evaluation procedures including providing hardware to EPA for testing. Hybrid evaluation should build on existing

engine certification, since industry has significant experience with engine test procedures and protocols. A pre-transmission powerpack test would only require minimal changes to engine test procedures and protocols. Post-transmission powerpack testing requires more modifications, but is necessary for hybrid architectures that do not allow for pre-transmission testing.

#### **4.5 Presentation by Japan** (Working paper HDH-05-07)

The group very much appreciated that Mr. Osaki was able to attend the meeting despite the critical situation in Japan. Mr. Osaki presented the open source model proposed by Japan for the HDH activities. The open source model was developed by JAMA/JARI, since the current HILS certification model used in Japan can not be disclosed due to intellectual property rights. The model presented today is a rigid model for a parallel hybrid vehicle. The model is not the same as the model currently used in Japan, but its accuracy verification is nearly completed. In addition, a fluid coupling and torque converter model is under development, and the verification underway. The concept of the open source model is developed in a way so as to apply to various HEV's. It includes a standard I/O interface, parameter switches for various HEV's, a manufacturers' ECU interface model, a DSP free model and prevention against tampering. HILS requires two verification methods, a short trip verification (first 120 sec of JE05 cycle) and a long trip verification over the complete JE05 cycle to confirm the consistency of the HILS approach.

#### **4.6 Discussion**

The participants appreciated the very informative presentations.

Japan confirmed that the open source models will be available in 2012 and their verification will be completed by March 2013. The secretary recommended a close cooperation between JARI and the European research institutes.

The Japanese models run on Matlab/Simulink. Other software might be possible, but is not recommended.

Component testing is an important part of HILS as basis for the simulation. The participants agreed that this issue is essential for the research program.

Tough the EPA approach includes chassis dyno testing as one option, US manufacturers are in favor of powerpack testing. HILS is considered as an option for the future.

### **5.- ROAD MAP AND PROJECT PLANNING**

#### **5.1 Work program and timing** (Working papers HDH-05-03, HDH-05-08)

Based on the decision taken at the 4<sup>th</sup> meeting, the secretary had sent a request for quote to the institutes that had expressed interest in the research program. The research program should cover the following five tasks:

- Task 1: HILS model verification
- Task 2: HILS component testing verification
- Task 3: extension to non-electrical hybrids
- Task 4: PTO operation
- Task 5: WHVC weighting and scaling factors

The offer should also include an indication if the timeline proposed by the HDH group is feasible.

## **5.2 Feedback from research institutes**

(Working papers HDH-05-04, HDH-05-05, HDH-05-06, HDH-05-09)

On the basis of the request for quote, two offers were received.

TU Vienna and TU Graz submitted a joint proposal (working paper HDH-05-04). Whereas TU Vienna would mainly cover tasks 1 and 2, TU Graz would work on tasks 4 and 5. Due to manpower restraints, task 3 was not offered. Tasks 1 and 2 would be completed by November 2011, tasks 4 and 5 by January 2012. Total cost is 194 k€.

Chalmers University Gothenburg submitted a first offer w/o price (working paper HDH-05-05) and a report of the evaluation of the Japanese HILS method (working paper HDH-05-06) they had done under contract of the Swedish Hybrid Center (SHC). On request of the secretary, a second offer was submitted prior to the meeting (working paper HDH-05-09). This offer covers all 5 tasks at a total cost of 145 k€ and meets the HDH timeline.

INSIA (University Institute of Automobile Research) Madrid (Spain) did not respond.

The Chairman indicated that the link to TU Graz is essential, since they work as contractors in the EU CO<sub>2</sub> evaluation study. While some participants were in favor of Chalmers due to the lower total cost, other participants considered the TUV/TUG offer as more substantial. The secretary suggested that Chalmers could focus on task 3.

It was therefore agreed that all three institutes should work closely together and submit a joint proposal. Under this structure, one of the institutes could take the lead and subcontract the others. The secretary was asked to contact TUV/TUG about a possible cooperation with Chalmers. Due to the tight timing, the joint proposal must be available within three weeks.

## **5.3 Budget**

OICA re-confirmed availability of a budget of 200 k€. The Chairman indicated that the EU Commission will contribute under their framework contract. Details should be clarified by April 2011. Sweden is considering to fund part of the Chalmers work program.

## **6.- NEXT MEETINGS**

It was agreed that the location of the 7<sup>th</sup> HDH meeting, originally planned to take place in Japan, would be decided at the 6<sup>th</sup> HDH meeting. JASIC will inform the secretary about Japan's final decision.

The next HDH meetings will take place, as follows

- 6<sup>th</sup> HDH meeting: 06 June 2011 at 14:30 in Geneva
- 7<sup>th</sup> HDH meeting: October 2011 date and place to be confirmed

## **7.- SUMMARY AND CONCLUSIONS**

The Chairman summarized the meeting as follows:

- The meeting was very useful with interesting presentations and fruitful discussions

- Insight into EPA's GHG activities was helpful for the further work program of the HDH group
- The powerpack test method used in the USA seems to be a good alternative for further consideration
- The open source model presented by Japan is an important contribution to the success of the HDH mandate
- The work program is slightly behind schedule w/o jeopardizing the agreed timeline
- Budget for the research program is available so that the program can start in April/May
- It is agreed that all three institutes that are interested in the research program should work closely together in a joint study
- The meeting objectives have been achieved

#### **8.- OTHER BUSINESS**

None.

#### **9.- EPA LAB TOUR**

EPA kindly offered a tour of their emission labs. This included LD and HD test cells and a demonstration on the PTO test rig. The participants were very grateful for this opportunity.

The Chairman thanked EPA for hosting the meeting and sharing their expertise with the HDH group. This is a good basis for further cooperation in this matter.

Mr. Jackson extended EPA's appreciation to the HDH group for having their meeting in Ann Arbor.

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