

**SEVENTEENTH MEETING OF THE GRPE INFORMAL WORKING GROUP
ON HEAVY DUTY HYBRIDS (HDH)**

Madrid, 08 to 09 April 2014

MINUTES OF THE MEETING

Venue: Ministry of Industry, Energy and Tourism, Paseo de la Castellana 160, Madrid

Chairman: Petter Åsman (Sweden)

1.- WELCOME AND INTRODUCTION

The Chairman welcomed the participants and thanked INSIA and MINETUR for hosting the meeting.

2.- ADOPTION OF THE DRAFT AGENDA

(Working paper HDH-17-02e)

The draft agenda was adopted.

3.- DRAFT MINUTES OF THE SIXTEENTH MEETING

(Working paper HDH-16-08e)

The draft minutes of the 16th meeting were approved.

4.- CONTRIBUTIONS FROM STAKEHOLDERS

4.1 Korea

(Working paper HDH-17-03e)

Mr. Lee presented working paper HDH-17-03. Objective was to test a Korean manufactured hybrid bus on a chassis dyno over the WHVC. The vehicle was not able to follow the cycle during 12.4 % of the WHVC test points. Especially, WHVC acceleration rates proved to be too demanding for the vehicle. As a conclusion, the WHVC is not considered representative for typical Korean driving conditions.

During the discussion, Mr. Lee confirmed that a vehicle speed deviation of ± 2 km/h was selected as evaluation criterion, and that full load points the vehicle could not follow were not excluded. Dr. Perujo added that the WHVC was difficult to follow for some vehicles, but this could not be generalized for all vehicles.

5.- HDH WORK PROGRAM (Working paper HDH-17-08e)

The secretary presented a summary of the 16th meeting and an overview of the topics for this meeting including the open issues.

5.1 Model structure & component library (Working paper HDH-17-07e)

Mr. Six reported that the final version v1.0 of the MATLAB simulation model was released and uploaded to the HDH website.

The secretary proposed to make the MATLAB model available on the website of gtr n° 4. This was welcomed by the IWG members. The secretary will check with GRPE secretariat, if the proposal is acceptable to WP.29.

5.2 Status of validation test program 2 (Working paper HDH-17-07e)

The institutes presented the results of validation test program 2. The validation was performed on the basis of the Japanese validation procedure, including chassis dyno testing, application of the HDH drive cycle (WHVC with road gradients), application of generic vehicle parameters (where available), and HILS/SILS model verification.

Successful validation could be achieved for the two parallel hybrids, but not for the series hybrid. This was attributed to the increased system complexity, which makes validation criteria harder to be achieved and the reproducibility of reference measurements on the chassis dyno more difficult. A summary of the validation results is shown on page 31.

The results of the Iveco parallel hybrid truck are shown on pages 32 to 53. A high variability between two chassis dyno tests with the same vehicle configuration was reported. In general, good validation results were achieved with gear shift points excluded.

The results of the Volvo parallel hybrid bus are shown on pages 54 to 60. It was concluded that the model very well represented the vehicle, but validation would have failed w/o gear shift exclusions. Different gear shifting behavior between the model and the chassis dyno test was considered one of the major problems for parallel hybrids.

The results of the MAN series hybrid bus are shown on pages 61 to 70. There was a good overall comparison between simulation and measurement, but the Japanese validation criteria were not met. Differences in time behavior can influence the SOC level and lead to accumulation of errors.

The institutes concluded that the validation procedure needed further discussion. The topics for discussion are shown on pages 71 to 82. They proposed that the WHVC chassis dyno criterion could be relaxed to ± 4 km/h, but the ± 2 km/h would need to be retained for the HEC emission test. For correctly determining emissions, the chronological sequence of engine load points is relevant, and thus the R^2 criterion is considered to be reasonable, but less stringent R^2 are not recommended. Variation of chassis dyno results is a critical item for further investigation. Accumulation of errors could be reduced by application of a mini cycle based validation.

6.- Open issues

6.1 WHVC road gradients

(Working paper HDH-17-07e)

Mr. Six explained the approach for the developing the WHVC road gradients on pages 4 to 17. Introducing generic vehicle parameter enables vehicle independent certification (like WHTC). Alignment of cycle work and power could be achieved by an enhanced Minicycle approach. Easy handling of WHVC test schedule in the gtr is possible by a polynomial approach.

The proposal was agreed. Mr. Sanchez asked the institutes to compare the slopes to the WHTC with the original gearbox model with respect to engine speed and load.

6.2 Cold start

(Working paper HDH-17-05e)

Dr. Kawai presented working paper HDH-17-05. He reported about a good correlation of the HILS generic temperature model proposed by Japan between measured and predicted SCR temperatures. For HILS certification, he proposed that the measured and predicted temperatures should be verified only on the hot start cycle for the generic HILS model, but on both cold and hot start cycles for an OEM specific temperature model.

The proposal was agreed.

6.3 HILS validation criteria

It became clear from the presentation of the TUs that the problem of the HILS validation criteria could not be fully resolved. Mr. Tober proposed a 2-step approach of this gtr similar to the WLTP approach. He also proposed to optionally allow use of the WHTC until validation criteria are finally fixed in a second step.

The Chairman considered the proposal a viable solution, but confirmed that the current version of the gtr should be presented to GRPE for adoption. He added that a clear commitment from stakeholders would be necessary to justify a second step to GRPE and WP.29. He confirmed his earlier position that the selection of HILS or WHTC should be made on a regional level.

Mr. Sanchez was satisfied that 2 vehicles passed the validation criteria, and noted that appropriate time would be needed for a proper review of the validation criteria in a second step. He also noted that the powertrain test in Annex 10 is an option available for validation of hybrid systems that have difficulties of meeting the vehicle based validation criteria.

Mr. Martínez raised the question, if only parallel hybrids could be covered in step 1, and series hybrids added in step 2. He supported the Chairman's position that the optional use of the WHTC could not be left to the discretion of the vehicle manufacturer, but would need to be decided by the CP.

Dr. Kawai rejected the proposal to cover only parallel hybrids in step 1, since Japan would need both types of hybrids in their regional transposition. He supported to include the current Japanese validation criteria in the gtr.

On the basis of the discussion, the Chairman suggested to adopt the Japanese criteria for the gtr, but to consider a modification in a potential step 2. The secretary proposed to add language to the gtr that “CPs may decide in their regional transposition to make the HDH procedures mandatory”. Both proposals were agreed.

6.4 HILS testing

Iveco offered to EPA a HILS demonstration either in Europe or in the USA. Mr. Sanchez will clarify, which approach is acceptable to EPA.

6.5 Hybrid system family

(Working paper HDH-17-07e)

(Working paper HDH-17-09e)

Mr. Silberholz presented possible options for a hybrid family concept on pages 27 to 29. He suggested that the HILS cycles used for comparing parent and candidate powertrains should be normalized.

Mr. Dekker proposed to exclude a hybrid family concept due to its complexity in the first step. Dr. Kawai indicated that the engine family criteria had to be met also within the hybrid powertrain family, and no exceptions would be acceptable to Japan. He suggested that an additional criterion of “powertrain topology (or architecture)” would need to be added as a differentiating item. This was supported by Mr. Sanchez.

As a result of the discussion, Dr. Kawai presented a flowchart for defining the hybrid powertrain family (working paper HDH-17-09). The concept was agreed.

6.6 Cycle work

(Working paper HDH-17-07e)

The Chairman reported that the EU COM and EU stakeholders accepted the total system work for calculating specific emissions. Mr. Six presented the details of the cycle work concept on pages 19 to 21. The goal was to define system work at the wheel, which is valid for all vehicle topologies and the HILS and powertrain test methods.

The proposal was agreed. Modifications of the equations will be done by the drafting group.

6.7 Rated power

(Working paper HDH-17-07e)

Mr. Six presented the proposal of the institutes on pages 22 to 26. The provision is important, since it defines system load of the hybrid system during the test. The concept is based on a simulated full load acceleration from standstill to vehicle maximum speed. It offers the benefit that it can be used for HILS and powertrain testing.

The proposal was agreed in principle, but further technical details would need to be solved by the drafting group.

6.8 Approval of OEM specific models

This issue has been solved with the appropriate language in the formal document ECE/TRANS/WP.29/GRPE/2014/11. No further discussion took place.

6.9 Hardware control functions (Working paper HDH-17-06e)

Mr. Danczyk presented the OICA proposal. He recalled that discussion regarding HILS hardware configuration was started at the 15th HDH meeting, and that it was concluded that hybrid key functions should be requested as real ECU to be tested with HILS. He proposed that “torque split” should be defined as hybrid key function of parallel hybrids, and “energy management” for series hybrids. This proposal is in principal agreement with the Japanese approach.

Mr. Dekker indicated principal acceptance, but would like to prefer the same language “energy management” for both parallel and series hybrids. This was acceptable to OICA, and the proposal was finally agreed.

In addition, OICA proposed to exclude micro hybrids, whose engine operates very close to a conventional engine, and to permit use of the WHTC, instead. As criterion for exclusion, the ratio of positive electrical power to total system power should be defined. A value of less than 5 to 10 % is considered appropriate by OICA.

The proposal was agreed in principle, but with a power ratio of electrical power to engine power. Mr. Dekker and Dr. Kawai requested further discussion on suitable values for the ratio. The drafting group was asked to clarify the issue.

7.- DEVELOPMENT OF THE GTR

7.1 Report from the drafting group

The drafting group held three web meetings between January and March 2014 and had a face-to-face meeting on 18/19 February 2014 in Tokyo. As an outcome of these meetings, formal document ECE/TRANS/WP.29/GRPE/2014/11 was developed. It includes text finalized by March 2014, and was submitted to GRPE for consideration and adoption at the 69th session.

7.2 Annex 9 (HILS)

Most of the HILS procedure has been completed, and is included in formal document ECE/TRANS/WP.29/GRPE/2014/11. The remaining open sections will be finalized during the next drafting group meeting.

7.3 Annex 10 (powertrain method)

The major issue is alignment with Annex 9. This will be discussed at the next drafting group meeting.

8.- ROAD MAP AND PROJECT PLANNING (Working paper HDH-17-08e)

It was finally agreed that the HDH work program resulted in a procedure that can be submitted to GRPE for approval at the 69th session.

An extension of the mandate for a second step will only be proposed, if test program and budget for step 2 are available in June. If this is not the case, extension could also be submitted to WP.29 in November 2014.

An informal document to complement formal document ECE/TRANS/WP.29/GRPE/2014/11 will be submitted to GRPE 69 by 23/05/2014, which will include the drafting progress after March 2014. The secretary informed that WP.29/AC.3 agreed to align gtr n° 4 with gtr n° 11. The secretary will introduce the necessary language to the informal document. After adoption of both documents by GRPE 69, a consolidated document will be provided to WP.29 for approval. The technical report will be submitted as an informal document to GRPE 69, since the work program could not be completed by March 2014.

9.- NEXT MEETINGS

The next HDH meetings will take place, as follows

- 18th HDH meeting: 03 June 2014, Geneva

The next meetings of the drafting group will take place, as follows

- 12th HDH-DG meeting: 10 and 11 April 2014, Madrid
- 13th HDH-DG meeting: 24 April 2014 (web meeting)
- 14th HDH-DG meeting: 08 May 2014 (web meeting)

10.- SUMMARY AND CONCLUSIONS

Chairman and secretary summarized the meeting as follows:

- HILS library version 1.0 was released and agreed
- WHVC slopes based on mini cycle approach with polynomial correction were agreed; TUs will validate slopes with original WHTC gearbox model
- System work as basis for emissions calculation was agreed; equation proposed by the TUs was agreed in principal, but slight modification still needed
- Rated power proposal by TUs was agreed; some additional data needed for final solution
- Hybrid system family was agreed on the basis of the flowchart provided by Japan
- Validation criteria were met for parallel hybrids, but not for series hybrid bus
- General agreement that HILS method was very well developed
- Gear shifting is one of the major problems for model validation
- ± 2 km/h deviation can be relaxed for chassis dyno validation, but must be retained for HILS emissions test.
- Less stringent R^2 values for chassis dyno validation are not recommended
- Japanese validation criteria were agreed for both parallel and series hybrids, but further work is needed in a potential second step
- CPs may decide to make HDH mandatory
- Japanese cold start evaluation proposal was agreed
- Micro hybrids will be excluded from HDH approach, but clear provisions are to be developed by the drafting group
- Energy management ECU was agreed as key hybrid functionality for hardware tests; drafting group is asked to provide details
- The test procedure developed by HDH IWG was agreed to be submitted to GRPE for approval as amendment 3 to gtr n° 4
- HDH IWG will consider to propose a second step based on input being available at the 18th HDH meeting

11.- OTHER BUSINESS

The participants thanked INSIA and MINETUR for the excellent arrangements made for the meeting and José Maria Lopez for the interesting INSIA lab tour and the tapas reception.
