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HDH Validation Program 2 (HILS)

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JRC

Content

- ***Goals of the VP2***
- ***Status of VP2***

Goals

Provide methodology to verify the HILS model in the GTR

- Verification of HILS simulation model according to
  - Japanese method
  - test alternative methods
- Analyse relevant accuracy between HILS model and measurement for each measured magnitude
- Elaborate tolerable margins for the relevant magnitudes

Elaborate new draft verification procedure for GTR (if necessary)

- on-road / dyno / both
- simulation rules for gear box and gear shift needed
- description of interface model and hybrid ECU needed

Status

Three vehicles participates in the VTP2:

- Two parallel hybrids (VOLVO bus and IVECO truck)

- A serial hybrid (MAN bus).

The state of validation and the level of achieved agreement between the model and the experimental values are very different among the three vehicles.

VOLVO bus

- *High level of agreement between model and experimental values in terms of r^2*

WHVC 0s-140s	Vehicle	Electric motor		Engine		Battery
	Speed	Torque	Power	Torque	Power	Power
Kokujikan desired R^2	0.97	0.88	0.88	0.88	0.88	0.88
Volvo TEST 1	1.00	0.88	0.82	0.73	0.67	0.81
Volvo TEST 2	0.99	0.92	0.86	0.80	0.78	0.86

WHVC full	Vehicle speed	Engine Torque	Positive engine work	Fuel economy value
	R^2	R^2	$W_{eng\_HILS}/W_{eng\_vehicle}$	$FE_{SILS}/FE_{vehicle}$
Kokujikan	0.97	0.88	>0.97	<1.03
Volvo TEST 1	0.99	0.87	1.07	N/A
Volvo TEST 2	0.99	0.86	1.06	N/A

Test 1 corresponds to a flat WHVC
Test 2 corresponds to a WHVC with mini-cycle slopes

VOLVO validation results. Euro V parallel hybrid bus. Short cycle in open loop (pedal position used)

VOLVO bus

- *Missing requirements can be achieved if the gear position is forced on the model rather than using the gear-shift model provided*
- *Although this would be some kind of SILS it will be aligned with the Japanese regulation*
  - Japanese colleagues only tested vehicles that either have a manual transmission or if having an automatic transmission they can be run in manual (semi-automatic) mode
- *VOLVO is running the models with this feature to test the validity of this assumption.*

IVECO truck

- *The experimental program was run at JRC before summer 2013*
- *Delays due:*
  - lack of a NDA between IVECO and the provider of the hybrid power train
  - delays in setting up a HILS system at IVECO/FPT
- *New experimental program at the JRC's chassis dyno is foreseen for first half of February 2014*
- *Completion of programme at the end of March 2014*
- *Includes:*
  - Vehicle instrumented with strain gauges (for torque measurements)
  - Engine tests

MAN bus

- *Agreement between model and experimental values in terms of r2 is not quite there yet although quite close*

Verification

WHVC 0s-140s	Vehicle	Electric motor		Engine		Battery
	Speed	Torque	Power	Torque	Power	Power
Kokujikan	0.97	0.88	0.88	0.88	0.88	0.88
WHVC flat	0.997	0.871	0.849	0.862	0.875	0.695

WHVC full	Vehicle speed	Engine Torque	Positive engine work	Fuel economy value
	R^2	R^2	$W_{eng\_HILS}/W_{eng\_vehicle}$	$FE_{SILS}/FE_{vehicle}$
Kokujikan	0.97	0.88	>0.97	<1.03
WHVC flat	0.998	0.699	1.07	N/A

MAN validation results. Serial hybrid bus.

MAN bus

- *Detected difficulties:*
  - a serial hybrid that it is a more advanced/complicated that the vehicles that our Japanese colleagues have tested in the past
  - It mounts as ESS a bank of super-capacitor
  - The control strategy is such that any small deviation from the expected behaviour in the model with the real situation accumulates and amplified in time
  - Quite difficult to get matching between the model and the experimental data as the on-board ECU will take decisions that are not similar/comparable with that of the model.

MAN is planning to run other tests in house to try to meet the verification requirements of the Kokujikan 281.

Conclusions

- **Data processing and comparison between experimentally measured parameters and parameters obtained by the HILS model is still going-on.**
- **Some difficulties need yet to be resolved concerning discrepancies.**
- **The deadline for June 2014 (GRPE) can be met !!**

Thank you for your attention

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