Transmitted by Chairman and Secretary of the GRPE working group on WHDC

Informal document No. **GRPE-54-03** (54th GRPE, 04-08 June 2007, agenda item 12.1.)

GLOBAL TECHNICAL REGULATION (GTR) N° 4 (WHDC)

General information

Gtr N° 4 was adopted by WP.29/AC.3 at its 140th session from 14-17 November 2006 with the following options, whose selection is left to the discretion of the Contracting Parties:

- engine power determination
- reference fuel
- hot soak period (5 or 20 minutes)
- cold start weighting (10% or 14%)
- PM filter material (PTFE coated glass fiber or PTFE membrane) and size (47 or 70 mm)

The United States of America, Canada and the European Community representatives although giving full support to the establishment of the gtr, expressed their concerns for the presence of options in the gtr. Therefore, the Chairman of GRPE stated that the informal group on WHDC should resume its work in order to find a solution for the elimination of these options.

Furthermore, the representative of the United States of America added that the WHDC preamble specifically calls for review and possible revision of gtr N° 4 in the light of the completed procedures that result from the elaboration of the NRMM gtr.

In addition, India and China submitted some comments before the WP.29 meeting that could not be discussed at the WP.29 due to the short notice. The expert from India introduced the comment as GRPE-53-08 proposing to amend in gtr No. 4 the definition of "high speed n_{hi}" in order to avoid difficulties in applying the test cycle for gas engines.

GRPE referred this issue to the WHDC informal group. GRPE also agreed at its 53rd session on the need to re-establish the informal group on WHDC in order to find a solution for the elimination of the remaining options. Therefore, the GRPE Chairman suggested that the WHDC group should meet again in Geneva prior to the GRPE session in June 2007. The following pages list the options and the additional comments by India, China and the USA, give a short description of their relevance and present proposals for possible solutions.

Proposed timetable for the amendment of gtr N° 4

Action	Date	Duration	Location	Purpose
20th WHDC meeting	06.06.07	0.5 days	Geneva	Agreement of principles
21st WHDC meeting	October 2007	2 days	USA	Definition of work program
22nd WHDC meeting	January 2008	0.5 days	Geneva	Agreement of work program
Engine test program(s)	2007/08			
23rd WHDC meeting	April 2008	2 days	Japan	Review of work progress
24th WHDC meeting	June 2008	0.5 days	Geneva	Review of work progress
25th WHDC meeting	October 2008	2 days	India/China	Drafting of gtr
26th WHDC meeting	January 2009	0.5 days	Geneva	Submission of draft gtr
27th WHDC meeting	June 2009	0.5 days	Geneva	GRPE approval
-	Nov. 2009	-	Geneva	Adoption by WP.29

Engine Power Determination (§ 6.3.)

Options

No specific options are given in gtr N°4, but the contracting parties can use their respective power standards/regulations. In principle, net power or gross power may be used.

- Net power (e.g. ECE R 85)
- Gross power (e.g. USA w/o specifying the method)

Description of the problem

Brake specific emissions, as generally used for engine tests in the heavy duty testing environment, are expressed in grams per engine work delivered (g/kWh). This means that the emission level depends on the engine work (power) in the denominator. Since net power takes more engine auxiliaries into account, and is therefore lower than gross power, the emission level will be higher. However, the difference between gross and net power in the respective regulations is usually small.

Proposal by chair and secretariat

It is suggested to base emission levels and emission limits on a well defined engine power regulation. In the absence of other power regulations within the WP.29 framework, ECE R 85 should be used as basis, if other contracting parties agree.

Reference Fuel (§ 6.9.)

Options

No specific options are given in gtr N°4, but the contracting parties can use their respective reference fuels. It is strongly recommended to use one of the three reference fuels listed in Annex 2:

- EU reference fuel
- USA reference fuel
- Japanese reference fuel

Description of the problem

Fuel parameters have a significant influence on emissions. The most important source is fuel sulfur, but there are a couple of other fuel parameters that influence emissions and fuel consumption of an engine. Contrary to the sulfur influence, their magnitude is less predictable and unambiguous, but there is always a general trend that is valid for all engines. The most important of these parameters are cetane number, density, poly-aromatic content, total aromatics content and distillation characteristics. The following table shows the characteristics of the three recommended reference fuels and an average (artificial) reference fuel that complies with the specifications of the three reference fuels and that might be used for single engine testing, or by other contracting parties.

Fuel Specification	**USA**	**EU**	**Japan**	**Compromise**
Cetane number [-]	40 - 50	52 - 54	53 - 57	45 - 55
Density [kg/m³]	840 - 865	833 - 837	824 - 840	835 - 845
50 % BP [°C]	243 - 282	min 245	225 - 295	243 - 295
FBP [°C]	321 - 366	max 370	max 370	321 - 366
Viscosity [mm²/s]	2.0 – 3.2	2.3 - 3.3	3.0 - 4.5	2.0 - 4.0
Sulfur [ppm]	7 - 15	max 10	max 50 (10)	max 15
Aromatics [%]	min. 10	-	max 25	10 - 25
PAH [%]	-	2.0 - 6.0	max 5.0	2.0 - 6.0
Lubricity [µm]	-	max 400	-	-

Proposal by chair and secretariat

Members of the WHDC working group are asked to express their general opinion on the use of reference fuels in this gtr. We would also like to discuss the use of a single (average) reference fuel and how this reference fuel would cover other contracting parties' national reference fuels. In the absence of emissions limit values in this gtr, the issue is considered second priority.

Hot Soak Period (§ 7.8.3.2.)

Options

The gtr contains two options for the hot soak period to be selected by the contracting parties:

- 5 ± 1 minutes
- 20 ± 1 minutes

Description of the problem

The hot soak period is defined as the time between the end of the cold start cycle (engine shut-off) and the beginning of the hot start cycle (engine re-start). First introduced in the USA during the 1980's, the 20 minutes hot soak period was needed for analysis of the cold start results, recalibration of the analyzers and preparation of the sampling systems for the hot start test. Today, a time period of 20 minutes is not required anymore with modern test benches.

Real world operation of heavy duty vehicles does not justify a 20 minutes hot soak period, as outlined by OICA during previous WHDC meetings. Engine operation under cold start, warm-up and re-start should be covered by the cold start weighting factor rather than by the hot soak period.

Whereas in the past the hot soak period did not have a significant influence on engines w/o aftertreatment devices, the behavior of exhaust aftertreatment systems, increasingly used due to more stringent emissions limit values, might be influenced by the length of the hot soak period. Therefore, the USA did not agree to another soak time than the 20 minutes currently applied in their regulation. The EU opted for the 5 minutes soak time in the amendment to ECE R 49 (document ECE/TRANS/WP.29/2006/124) adopted by WP.29.

Proposal by chair and secretariat

As already proposed earlier, a soak time of 10 minutes seems to be a reasonable approach that takes both test cell requirements and real world engine operation into account. However, such a compromise should be based on sound science. It is therefore suggested that a test program is carried out that will investigate the influence of the hot soak period on engine and aftertreatment technologies. Since the gtr will mainly apply to future engine system technology, industry is asked to supply test results from prototype engines. In addition, tests are recommended to be conducted by certified type approval or certification laboratories.

Cold Start Weighting Factor (§ 8.5.2.1.)

Options

The gtr contains two options for the cold start weighting factor to be selected by the contracting parties:

- 14 % (equation 57a)
- 10 % (equation 57b)

Description of the problem

USA regulations require a cold start weighting factor of 14 % based on US in-use data. The EU opted for the 10 % weighting factor in the amendment to ECE R 49 (document ECE/TRANS/WP.29/2006/124) adopted by WP.29. Proportion of cold start data from other contracting parties have not yet been reported.

Proposal by chair and secretariat

WHDC members are asked to submit data on cold start proportion under real world driving conditions, if available. Contracting Parties are asked to investigate into the HD driving conditions and their relevance to cold start conditions. The data will be used to analyze, which of the options better represents global cold start proportion.

PM Filter Material and Size (§ 9.4.2.)

Options

The gtr contains two options for the filter material to be selected by the contracting parties:

- PTFE coated glass fiber filter
- PTFE membrane filter

and two options for the filter size to be selected by the contracting parties:

- 47 mm
- 70 mm

Description of the problem

These options are especially critical, since different combinations are possible. For the time being, USA and Japan have selected the combination PTFE membrane/47 mm in their regulations, while the EU opted for the combination PTFE coated glass fiber/70 mm in the amendment to ECE R 49 (document ECE/TRANS/WP.29/2006/124) adopted by WP.29. In general, the PTFE membrane filter is less sensitive to artifact formation on the filter surface, but more difficult to handle. The filter size itself is not considered having an influence on PM mass, but for the 47 mm filter a more accurate balance is commercially available.

Proposal by chair and secretariat

For higher PM measurement accuracy it is recommended to delete the options PTFE coated glass fiber filter and 70 mm so that the combination PTFE membrane/47 mm would be the only choice.

Definition of High Speed (n_{hi}, § 3.1.12. and 7.6.1.)

Comment from India

Informal document GRPE-53-08 submitted at the 53rd GRPE (January 2007)

Description of the problem

It may not be possible to determine n_{hi} for gas engines because, after the max. power point, there is often a sudden power drop to zero due to immediate fuel cut-off and ignition cut-off. Currently India is using rated speed as n_{hi} for gas engines.

India proposes to amend the definition of n_{hi} as follows:

"high speed (n_{hi})" means the highest engine speed where 70 per cent of the declared maximum power occurs. *In case of gas engines where determination of n_{hi} is not possible due a sudden drop of power, n_{hi} will be replaced with rated speed*."

Proposal by chair and secretariat

It is recommended to accept the Indian proposal.

Comments from China

Comments from China

The following comments were submitted by China to WP.29 secretariat ahead of the 140th WP.29 session, but not raised during the session:

- scope of gtr N°4 should be extended to gasoline engines
- 30% margin for engine unit cylinder displacement within the engine family concept provisions is considered too large (§ 5.2.3.4.2.)

Description of the problem

Extension of the gtr to gasoline engines was proposed, since gasoline engines are used in some countries (e.g. China, USA) for heavy duty vehicles. While in the USA the test cycle for gasoline engines is different from the test cycle for diesel engines, this gtr does not contain a different test cycle for the positive-ignition engines covered by the gtr (CNG, LPG engines). During the proposed timeframe for amendment of this gtr shown on page 1, it will not be possible to develop a new test cycle for gasoline engines. Therefore, the only solution will be to investigate whether the in-use behavior of gasoline engines is similar to that of other positive-ignition engines. If this can be proven, extension of the gtr to gasoline engines is principally possible. Minor revisions to the emissions measurement procedures might additionally be necessary.

As regards the 30% margin for the engine unit cylinder displacement (§ 5.2.3.4.2.) family designator, one of the principal concepts of the engine family concept is that every member of the family must meet the respective emissions limit values. This can be checked by e.g. COP (conformity of production) testing of any member of the family. For engine type approval or certification, § 5.2.4.3. allows the type approval authority to test additional engines of the family beyond the parent engine, if there is uncertainty about the worst case engine (highest emitter). Therefore, tightening of the 30 % margin is not considered necessary.

Proposal by chair and secretariat

China is asked to submit the comments raised at the November 2006 WP.29 meeting as informal document to GRPE and WHDC working group.

Extension of the scope to gasoline engines and potential problems associated with this proposal (e.g. application of the test cycles) should be discussed with the other WHDC members. If there is general agreement, an official proposal for changing the scope could be submitted to GRPE for consideration.

Contracting Parties are asked to investigate into the driving conditions of gasoline engines and their relationship to the existing WHDC cycles.

The proposed change to tighten the 30 % margin in § 5.2.3.4.2. is not recommended.

Alignment with NRMM gtr

Comment from the USA

At the 140th WP.29 session, the delegate from the USA asked to revise gtr N° 4 in light of the provisions of the future NRMM gtr.

Description of the problem

Parallel to the development of this gtr, US EPA developed a new emissions measurement regulation covering all internal combustion engines. This regulation is referred to as Part 1065. Part 1065 does not include limit values nor test cycles, but focuses solely on the emissions measurement procedures. On the other hand, the scope of a gtr is usually limited to a certain category of engines. Therefore, the general structure of this gtr is different from that of Part 1065.

The future NRMM gtr will likely include some new requirements from EPA's Part 1065 that partly deviate from the requirements in gtr N° 4. In addition, the structure of the NRMM gtr is somehow similar to the structure of Part 1065. For the sake of harmonization, it is desirable that the technical requirements for on-highway and nonroad engines are largely identical. Alignment seems to be possible due to the parallel process of the amendment of this gtr and the further development of the NRMM gtr. Change of the structure of this gtr would require a high drafting workload w/o improving the technical requirements or the use of the gtr. Therefore, the focus of the alignment should rather concentrate on the technical requirements than on the different structures.

Proposal by chair and secretariat

Alignment of the technical requirements between this gtr and the future NRMM gtr is clearly supported. A general change of the structure of this gtr is not recommended.

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