

15 November 2005

UNECE GRPE Informal WG NRMM Meeting
Minutes of the meeting at US-EPA, NVFEL, Ann Arbor, USA,
29th to 30th September 2005

Objective of the meeting:

During the Ann Arbor meeting in September 2004 and the January 2005 San Antonio meeting the discussion of the comparison document was successfully completed. Only some issues remain for further discussion. The Ispra April 2005 meeting served to start the elaboration of the future structure of the GTR document. Main target of the September 2005 meeting was to reach agreement on the future structure of the NRMM GTR. Furthermore the remaining open issues were to be discussed and resolved where possible.

Structure of meeting:

1. Presentation by the different experts in order to update on current developments
2. Presentation of proposed GTR structures
3. Discussion of remaining open issues

Minutes of Ispra Meeting April 2005 approved.
Agenda (Appendix 1) of Meeting adopted.
List of participants (enclosure 1).

NRMM related meetings since April 2005 (enclosure 2):

- Ispra Meeting April 2005 (8th NRMM)
- GRPE NRMM meeting 1st June 2005 (9th NRMM)
- 50th GRPE Meeting 2nd 3rd June 2005
- 136th WP.29 AC.3 Meeting June 05

Updates on current developments

1. The progress of work in the last half year was acknowledged by all experts present. Especially, it was emphasized by the involved legislative bodies that the development of a simple and harmonised test protocol leading indeed to a global harmonisation of the NRMM technical regulation is of very high priority to their respective organisation. This view was also supported in an official letter by EUROMOT. DG Enterprise and Industry was represented by Maria Spiliopoulou.

2. Confirming the importance of the comparison report and its function as reference it was agreed to try to resolve all open issues in 2005 and plan the drafting of the GTR in 2006.
3. Experts were informed that a list of Frequently Asked Questions (FAQ) related to the activities of the World Forum for Harmonization of Vehicle Regulations (WP.29), its subsidiary bodies and the Agreements under its administration is now found on UNECE WP.29 Website.
4. The formal proposal for the development of a NRMM GTR by EC to AC.3 was presented as official document to the June 2005 AC.3 meeting. It was adopted and is now in the list for development of candidate gtrs; TRANS/WP.29/AC.3/14.
5. A file with the relevant PMP documents has been prepared and distributed to inform all NRMM experts of the work completed in PMP¹.
6. Cleophas Jackson updated the experts on the development of the US non road legislation (enclosure 3). The final version of Part 1065 was published on 13th of July, 2005. He stated that for PM under 19 kW and NOx under 56 kW a technical review is foreseen in 2007. Over 560 kW is not part of the technical review, but considered nevertheless. A further issue is the evaluation of cold starting.
7. Kent Helmer (enclosure 4) reported that within the 2005 clean air non road rule the data driven development of a new constant speed cycle supported by EMA is pursued. In-use engine performance and temperature data are measured for 6 types of equipment.
8. Matt Spears presented (enclosure 5) the test procedure 1065, that deals with all the tests carried out on the test bench dynamometer. Due to the introduction of other machinery (locomotives, marine engines, ...) an updating of the test procedure becomes necessary and a new version will be prepared in 2006. This will also take into account errors and misprints. He informed that there is an US-EPA Website for 1065 info, which is regularly updated, and contains also the outcome of alternative procedures;
www.epa.gov/otaq/testingregs.htm)
9. Mitsuo Shikata (enclosure 6) presents the latest status of Japanese legislation.
10. Maria Spiliopoulou explained the role of DG-ENTR, the European legislative process and the status of the non road directive and its technical review in 2007 (enclosure 7). An organisational chart can be found at
http://europe.eu.int/comm/dgs/enterprise/pdf/org_en.htm
11. Shirish Shimpi reported on the ongoing CRC E-66 research activity (enclosure 8). Phase 1 of the E-66 program is completed and a report can be found on the CRC website; www.crcao.com . Phase 2 is almost completed.
12. Juergen Stein: On ISO update: Part 1 completed. It is now at FDIS stage and at Geneva secretary for publication. The next ISO meeting in Japan will be mainly on part 4 steady state cycle part 5 on fuels and part 11, which is more or less completed. On Euromot: They are engaged to contribute to the technical review 2007 with a report on the available technology developed with an independent consultant. He reported that Euromot will submit at the next GRPE meeting an official document requesting ECE R 96 to be amended to include the limit values corresponding to the European stage IIIA (enclosure 9).

¹ File also available on request from secretary NRMM

Presentation of structure proposals for NRMM GTR :

In the April 2005 NRMM meeting a first draft was presented to start the discussion on the NRMM GTR structure. By September 2005 a number of proposals were received in the secretariat of NRMM WG. The September meeting offered the opportunity for all experts for their in-depth presentation of their point of view and to propose a structure.

Giorgio Cornetti presented and explained proposal #2 (update of #1 according to the UNECE WP.29 GTR format document 883) (enclosure 10).

Shirish Shimpi acknowledged the importance of the new 1065 procedure and stated that according to EMA the GTR structure should follow the outline of 1065 (enclosure 11). Josephine O'Carroll supports the use of the structure of 1065.

Juergen Stein presented proposal #3 which he explained (enclosure 12). Hans-Walter Knuth made an in-depth presentation of this structure document (enclosure 13) and in particular to the calculation approach.

In view of the decision taken in San Antonio in January 2005 to keep the GTR clearly separated from the recommendations, Giorgio Billi explained the approach used in the EU for "product market access directives" with the practical example of the European Noise directive (2000/14/EC) with a compulsory legal text and a separate supporting guidance document. In order to facilitate reading, the guidance document alternates the legal text with the relevant recommendations. In the EU the Directive text remains the only one legally binding, while the guidelines are "useful literature". This scheme is very valid for the GTR and the supporting guidelines too. Maria Spiliopoulou confirmed that this approach represents common practice for all directives in DG ENTR.

Discussion of structure proposals for NRMM GTR :

At the end of the detailed presentations NRMM Chairman Giovanni De Santi opened the discussion on the different proposals. He stressed the importance to compromise in order to find an agreeable structure for all involved stakeholders given the conditions as laid out in the '98 agreement.

Matt Spears (enclosure 5) explained the way US-EPA has organized the regulation and thus the structure of Part 1065. He pointed out that too many changes will weaken its structure and content, but that US-EPA is flexible for shifting sections to other areas. Matt Spears explained why taking recommendations out is dangerous and might destroy the value of the document. He insists that explanatory paragraphs make sense. Rewording and reordering is fine. 1065 has been written by US EPA not only for experts but also for new users, which require new facilities, e.g. small volume manufacturers with lack of experience. Especially in view of gtr for countries with emerging emissions legislation or for previously unregulated countries, recommendations help to understand the procedure. Experienced users (for certification or type approval) in US and Europe easily can ignore the explanatory parts.

Juergen Stein states that the gtr should be limited to engines from 37 to 560 kW, which would be in line with the original mandate of this group, i.e. to focus on the NRTC. Since the scope of GRPE in the 1998 agreement does not cover marine engines and

locomotives, ECE R 96 should be the base for the scope of the gtr and thus determine engines and test cycles to be included. Furthermore, he considers 1065 to be a cookbook to set up test cell rather than a type approval procedure like in ISO 8178. For type approval, the procedure should be clear and the operator should not have to make decisions, which he needs to justify to the auditor. Matt Spears explained that it is only about selecting one option and that the auditor does not ask justifications. Bill Charmley indicated that the ISO approach could be true for emission related work if audience are limited to some manufacturers from US and EU, but surely not for a wider global audience. US-EPA insisted that the gtr's for NRMM and WHDC should align along 1065 in the future. US-EPA sees NRMM as the opportunity to create consensus on 1065 and anticipates amendments to the WHDC gtr at a later stage.

Bill Charmley emphasised that the approach taken in NRMM is very sound as all differences in the procedure were analysed. The development of 1065 involved foreign manufacturers, and the process took a comprehensive review to improve the test procedure. US-EPA believes that this is a good way to describe the test procedure. Juergen Stein indicated that also ISO 8178 has recently undergone thorough review.

After having submitted all alternative GTR structure proposals, Giovanni De Santi asked to understand which of the proposals offers the better version for the future. He recommended going back to the scientific aspects and making the choice accordingly. He suggested to look at the technical details and to make a confrontation to get a discussion which helps to understand the real implications chapter per chapter.

The working group started a long discussion on the structure by fully assessing the implications of the proposals. In order to complete the work a new structure was elaborated.

The final agreed structure is shown in the Appendix 2.

Conclusions for GTR structure:

This work was very constructive and the proposals were compared and a final structure was derived with the overall approval. A first draft of the NRMM gtr will be prepared by Giorgio Cornetti based on the structure of the Appendix 2. This draft will consist of two parts (as is common practice in directives by DG-ENTR): one is the mandatory text of the gtr, while the second is the guidance document with the explanatory text. The NRMM gtr draft will be presented at the April meeting in Ispra. This is a very important step for the NRMM WG.

Calculation comparison:

In Ann Arbor in September 2004 the NRMM WG decided to allow molar and mass based emission calculations in the GTR. To this end a calculation comparison was to be derived. Giorgio Cornetti presented this calculation comparison (enclosure 14) which is a 200 page document including numerical examples for the two parallel, molar and mass based calculations. He indicated that he needs still some specific information on the derivation of a limited number of equations from Matt Spears and Dr. Hans-Walter Knuth (Appendix 3) before mid November 2005. Preliminary information will be discussed at the January meeting in Geneva. The final document will be presented in the April 2006 meeting.

Open issues following the updated open issue list:

An open issue document had been prepared and was used for a topic by topic discussion. The open issue document summarised the items that had remained open from the previous discussions, but excluded the solved issues to increase readability.

Many of the topics where differences were found were resolved identifying the approach to be taken for the drafting of the GTR document. All the agreed results are documented in the above document which was updated during the discussion by the secretary and with complete approval (enclosure 15).

It was agreed that the NRMM secretary/chairman will clarify questions about the NRMM applicability with the secretary of GRPE (Romain Hubert).

Next meetings:

The future time table for the working group is scheduled as follows:

- 1) The NRMM WG meeting in the frame of the 51st GRPE meeting will be held in Geneva on the 17th of January 2006 (14H30 to 17H30). All experts are asked to participate in order to guaranty a productive meeting. An invitation with the priority work items will be circulated shortly.
- 2) The meeting afterwards is foreseen for 2 days on the 26th and 27th of April 2006 in Ispra, followed by an ISO meeting on 8178 on the 28th of April 2006 in Ispra in the same meeting room.

ENCLOSURES LIST:

- 1: List of participants
- 2: Rudolf Hummel: NRMM related meetings since April 2005 and work progress
- 3: Cleophas Jackson: US non road legislation
- 4: Kent Helmer: new constant speed cycle
- 5: Matt Spears: test procedure 1065
- 6: Mitsuo Shikata: status of Japanese legislation
- 7: Maria Spiliopoulou: European legislative process
- 8: Shirish Shimpi: CRC E-66 research activity
- 9: EUROMOT proposal
- 10: Giorgio Cornetti: structure proposal #2
- 11: Shirish Shimpi: position of EMA
- 12: Juergen Stein: structure proposal #3
- 13: Hans-Walter Knuth: in-depth description of #3 document
- 14: Giorgio Cornetti: Calculation Comparison
- 15: Open issue list

Appendix 1

WG NRMM informal meeting, 29th to 30th of September, 2005

NVFEL Ann Arbor, USA

(Chairman: Giovanni De Santi. Secretary: Giorgio Billi)

Proposed Agenda for Meeting of the contributing experts

- 1) Welcome to Ann Arbor / NVFEL
Organizational details
- 2) Roll call of delegates
- 3) Adoption of proposed agenda
- 4) Information from WP.29 on GTR development²
- 5) Summary of Geneva meetings
50th GRPE, 30 May to 3 June 2005
136th WP.29, 21 June to 24 June 2005
- 6) Information on new developments regarding NRMM engine standards
USA on cold start and constant speed data collection update
USA on recent release of CFR 40 part 1065
Japan on Status of Japanese NRMM legislation
Any other Country
ISO
EUROMOT
PMP
E-66
- 7) Presentation of proposals for structure of GTR draft
As discussed and decided during the April and June 2005 WG NRMM meetings, the September meeting will give the opening to the contributing experts of WG NRMM to present their proposals for the structure.

² <http://www.unece.org/trans/main/wp29/WP29-FAQ-2005.pdf>

- 8) Discussion of open issues:
Contributions by the different experts according to task list; target will be to find solutions to almost all of the open items and most time will be dedicated to this effort. (Including PMP comments in Geneva)
- 9) Conclusions and future actions:
 - a) General discussion of the above actions and decisions on tasks and responsibility
 - b) Update of Planning
 - c) Discussion on editorial committee for NRMM GTR drafting
- 10) Other topics and next meetings

Appendix 2 – Structure / contents decided on 29/09/2005

A. Technical rationale and justification

0. Summary with flow chart
1. Technical and economic feasibility
2. Anticipated benefits
3. Potential cost effectiveness

B. Text of regulation

1. Scope and purpose
2. Application
3. Definitions, symbols, abbreviations and references
4. General Requirements

Engines must meet the requirements of paragraph 5., when tested in accordance with the conditions in paragraph 6. and the procedures of paragraph 7.

5. Performance requirements

Performance requirements to be met by engines defined in paragraph 4. are emission limits. The emission limits values will be determined later according to the Gauvin's proposal accepted by AC.3.

The emission limits are related to the parent engine representing the engine family. The parent engine will be selected according to sub-paragraph 7.4. Description of engine family follows:

...

Engine family

Durability

Equivalency

6. Test conditions

Engine fluids such as the test fuel, lubricants and coolants are defined in paragraph 7.7.

Laboratory test conditions

Engines with charge air cooling

Engine power

Engine air intake system

Engine exhaust system

Engine with aftertreatment system

7. Test procedures

7.1 EQUIPMENT SPECIFICATIONS

Overview

Dynamometers and operator demand

Fuel properties and fuel temperature and pressure
Engine fluids, heat rejection, and engine accessories
Engine intake air
Engine exhaust
Raw exhaust sampling of gaseous emissions
Dilution for gaseous and PM constituents
Gas & PM probes, transfer lines, sampling components
Partial flow PM sampling
Continuous sampling
Batch sampling for gaseous and PM constituents
PM-stabil. & weighing environments for gravimetric

7.2 MEASUREMENT INSTRUMENTS

Overview
Data recording and control
Performance specs for measurement instruments
Measurement. of engine parameters & ambient conditions
Flow-related measurements
CO and CO₂ measurements
Hydrocarbon measurements
NO_x measurements
O₂ measurements
PM measurements

7.3 CALIBRATION AND PERFORMANCE CHECKS

Overview
Summary of required calibration/performance checks
Performance checks for accuracy, repeatability, noise
Linearity check
Continuous gas analyser system response check
Measurement of engine parameters & ambient conditions
Flow-related measurements
CO and CO₂ measurements
Hydrocarbon measurements
NO_x measurements
PM measurements

7.4 ENGINE SELECTION, PREPARATION AND MAINTENANCE

Test engine selection

Test engine preparation and maintenance

Maintenance limits for stabilized test engines

Durability demonstration (only deterioration procedure)

7.5 RUNNING AN EMISSION TEST IN THE LABORATORY

Moved to the beginning of Part 7

Overview

Engine mapping

Duty cycle generation

Cycle validation criteria

Pre-test verification procedure and pre-test data collection

Engine starting, restarting, and shutdown

Emission test sequence

Validation of proportional flow control for batch sampling

Constituent analyzer range validation, drift validation and drift correction

PM sample preconditioning and tare weighing

PM sample post-conditioning and total weighing

7.6 CALCULATION AND DATA REQUIREMENTS

Overview

Statistics

Test cycle generation

1980 international gravity formula

PDP & venturi (SSV & CFV) calibration calculations

SSV, CFV, and PDP flow rate calculations

Amount of water in an ideal gas

Emission calculations

Chemical balances of fuel, intake air, and exhaust

Removed water correction

THC and NMHC determination

Dilution air background emission correction

NO_x intake-air humidity correction

CLD quench check calculations

PM sample media buoyancy correction

Data requirements

7.7 ENGINE FLUIDS, TEST FUELS, ANALYTICAL GASES

General requirements for test fuels

Distillate diesel fuel

Residual fuel [Reserved]

Gasoline [Reserved]

Natural gas

Liquefied petroleum gas

Biodiesel

Lubricants

Coolants

Analytical Gases

Mass standards

Annex 1 – Test cycles

1.1 Steady-state test cycles (including G1 & G2 cycles for CI engines < 19 kW)

1.2 Ramped modal cycles

1.3 Transient test cycle

1.4 Constant speed variable load cycle

Annex 2 – Subject index

Appendix 3 – Formulas to be clarified

1A) Why p_A (p_{in}) is the pressure at the PDP inlet in one (eq. 25) of the two formulas, while in the other formula (eq. 26) is the pressure at the PDP outlet?

| | |
|--|----------|
| $K_S = \frac{60}{RPM_{PDP}} \cdot \sqrt{\frac{p_{in} - p_{out}}{p_{in}}}$ | (IV.321) |
| $K_S \left[\frac{s}{rev} \right] \quad p_{in}, p_{out} [Pa] \quad RPM_{PDP} \left[\frac{rev}{min} \right]$ | |

ISO 8178-1 [2004-02-18] eq. 25 and 26, p.36

1B) Why in the denominator of the two EPA formulas once there is the outlet pressure, while in the other formula there the inlet pressure?

| | |
|--|--------|
| $K_S = \frac{1}{RPM_{PDP}} \sqrt{\frac{p_{out} - p_{in}}{p_{out}}}$ | (V.60) |
| $K_S \left[\frac{s}{rev} \right] \quad RPM_{PDP} \left[\frac{rev}{min} \right] \quad \bar{p}_{in}, \bar{p}_{out} [Pa]$ | |

Formulas 1065-640-3 page 40577 and 1065-642-2 page 40581 [EPA 13/07/2005].

2) The following formulas refer to the EPA carbon balance. Demonstration is requested.

| | |
|---|---------|
| $x_{CO_2, dry} = \frac{x_{CO_2, meas}}{1 - x_{H_2O, CO_2, meas}} - \frac{x_{CO_2, airdry}}{1 - 0.5 \cdot \left(x_{COdry} - \frac{\alpha}{2} \cdot x_{Cproddry} - x_{NO_2, dry} \right)}$ | (V.179) |
| $x_{CO_2, dry}, x_{CO_2, meas}, x_{H_2O, CO_2, meas}, x_{CO_2, airdry}, x_{COdry}, x_{Cproddry}, x_{NO_2, dry} [vol\ fraction] \quad \alpha [-]$ | |

Formula 1065.655-7 page 40586 [EPA 13/07/2005].

| | |
|--|---------|
| $x_{O_2, proddry} = x_{CO_2, dry} + \frac{1}{2} \left(x_{COdry} + \frac{\alpha}{2} \cdot x_{Cproddry} + x_{NOdry} \right) + x_{NO_2, dry} - \beta \cdot x_{Cproddry}$ | (V.184) |
| $x_{O_2, proddry}, x_{CO_2, dry}, x_{COdry}, x_{Cproddry}, x_{NOdry}, x_{NO_2, dry} [vol\ fraction] \quad \alpha, \beta [-]$ | |

Formula 1065.655-6 page 40586 [EPA 13/07/2005].

| | |
|---|---------|
| $x_{dil} = 1 - \frac{x_{O_2, proddry} \cdot x_{prod / indry}}{x_{O_2, airdry}} (1 + x_{H_2O, indry})$ | (V.186) |
| $x_{O_2, proddry}, x_{prod / indry}, x_{O_2, airdry}, x_{H_2O, indry}, x_{dil} [vol\ fraction]$ | |

Formula 1065.655-4 page 40586 [EPA 13/07/2005].

| | |
|--|---------|
| $x_{prod / indry} = \frac{1}{1 - \frac{1}{2(1 - x_{dil})} \left(x_{COdry} - \frac{\alpha}{2} \cdot x_{Cproddry} - x_{NO_2, dry} \right)}$ | (V.187) |
| $x_{prod / indry}, x_{COdry}, x_{Cproddry}, x_{NO_2, dry}, x_{dil} [vol\ fraction]$ | |

Formula 1065.655-5 page 40586 [EPA 13/07/2005].

| | |
|--|---------|
| $x_{H_2Odry} = \frac{\alpha}{2} \cdot x_{Cproddry} + (1 - DF) \frac{x_{H_2Oindry}}{x_{prod / indry}} + x_{dil} \cdot x_{H_2Odildry}$ | (V.185) |
| $x_{H_2Odry}, x_{Cproddry}, x_{H_2Oindry}, x_{prod / indry}, x_{H_2Odildry}, x_{dil}$ [vol fraction] α [-] | |

Formula 1065.655-2 page 40586 [EPA 13/07/2005].
