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| Submitted by the experts of IWG MU, IWG ASEP and ISO | Informal document GRBP-77-05(77th GRBP, 7-10 February 2023, agenda item 3) |

 **Consolidated version of Supplement 8 to the 03 series of amendments to UN Regulation No. 51**

The text reproduced below has been prepared by the experts of the Informal Working Group on Measurement Uncertainties (IWG MU), the experts of the Informal Working on Additional Sound Emission Provisions (ASEP) and by the experts from the International Organization for Standardization (ISO). In this text, documents GRBP/2022/13, GRBP/2022/16 and GRBP-76-09 all presented and adopted at the 76th session of GRBP have been consolidated. The documents have been prepared to utilize the latest ISO 10844 standard test surface and also to improve measures to reduce variability in the Regulation.

 In addition to that some corrections to the 03 Series of amendments to UN Regulation No.51 (see working document GRBP/2023/12) have been added by the experts of the Informal Working Group on Measurement Uncertainties, Informal Working Group on ASEP and ISO. The proposed changes are based on the 03 series of amendment to UN Regulation No. 51 up to Supplement 7. The modifications are marked in bold for new or strikethrough for deleted characters and the corrections are highlighted in green.

**I. Proposal**

*Paragraph 2.24.,* amend to read:

“2.24 Table of symbols

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| … | … | … | … | … |
| Lcrs **(**i**)** | dB(A) | Annex 3 | 3.1.3.**4.**1.**2.** | vehicle sound pressure level at constant speed test for gear i; value to be reported and used for calculations to the first decimal place |
| Lcrs (i + 1) | dB(A) | Annex 3 | 3.1.3.**4.**1.**2.** | vehicle sound pressure level at constant speed test for gear (i + 1); value to be reported and used for calculations to the first decimal place |
| Lcrs rep | dB(A) | Annex 3 | 3.1.3.**4.**1.**2.** | reported vehicle sound pressure level at constant speed test; value to be reported and used for calculations to the first decimal place |
| Lwot **(**i**)** | dB(A) | Annex 3 | 3.1.3.**4.**1.**2.** | vehicle sound pressure level at wide-open-throttle test for gear i; value to be reported and used for calculations to the first decimal place |
| Lwot (i + 1) | dB(A) | Annex 3 | 3.1.3.**4.**1.**2.** | vehicle sound pressure level at wide-open-throttle test for gear (i + 1); value to be reported and used for calculations to the first decimal place |
| Lwot rep | dB(A) | Annex 3 | 3.1.3.**4.**1.**2.** | reported vehicle sound pressure level at wide-open-throttle; value to be reported and used for calculations to the first decimal place |
| Lurban | dB(A) | Annex 3 | 3.1.3.**4.**1.**2.** | reported vehicle sound pressure level representing urban operation; value to be reported mathematically rounded to the nearest integer |
| … | … | … | … | … |

*Paragraph 11,* add new subparagraphs 11.13. and 11.14., to read:

“**11.14. Supplement 8 does not apply to existing type approvals, originally granted prior to the date of entry into force of Supplement 7.**

**11.15. From the entry into force of Supplement 8, ISO 10844:2021 shall be accepted for all approvals granted under this Regulation. Until five years from the entry into force of Supplement 8, ISO 10844:2014 shall be accepted for all approvals granted under this Regulation.**”

*Annex 3, paragraph 2.1.1.,* amend to read:

“2.1.1. Test Site Outdoor

 The surface of the test track and the dimensions of the test site shall be in accordance with ISO 10844:~~2014~~**2021**.”

*Annex 3, Paragraph 3.1.2.1.1.,* amend to read:

“3.1.2.1.1. Power to mass ratio index (PMR)

 PMR is defined as follows:

 PMR = (Pn / mro) \* 1000 kg/kW, where Pn is measured in kW **and defined according to paragraph 2.8. of the main body** and mro is measured in kg and defined according to paragraph 2.4. of the main body.

 ~~If two or more sources of propulsive power operate at the conditions of test specified in paragraph 3.1.2.1 of Annex 3 to this Regulation, the total engine net power, P~~~~n~~~~, shall be~~~~the arithmetic sum of parallel propulsive engines on the vehicle.~~

 ~~Applicable parallel propulsive engines are those power sources which provide forward motion to the vehicle in combination at the conditions of test specified in paragraph 3.1.2.1. of Annex 3 to this Regulation.~~ ~~Specified power for non-combustion engines shall be the power stated by the manufacturer.~~

 The PMR with no dimension is used for the calculation of acceleration.”

*Annex 3, Paragraph 3.1.2.1.3.,* amend to read:

3.1.2.1.3. Partial power factor *kP*

 The partial power factor *kP* (see paragraph 3.1.3.**4.**1.**2.**) is used for the weighted combination of the test results of the acceleration test and the constant speed test for vehicles of category M1 and N1 and M2 < 3,500 kg technically permissible maximum laden mass

 In cases other than a single gear test, awot ref shall be used instead of awot test (see paragraph 3.1.3.**4.**1.**2.**).

 *Annex 3, Paragraph* *3.1.3.4.1.2.,* amend to read:

“3.1.3.4.1.2. […]

 The final result is calculated by combining Lwot rep and Lcrs rep. The equation is:

 Lurban = Lwot rep – kP \* (Lwot rep – Lcrs rep)

 The weighting factor *kP* gives the part power factor for urban driving. In cases other than a single gear test, *kP* is calculated by:

 kP = 1 – (aurban / awot ref)

 If only one gear was specified for the test, *kP* is given by:

 kP = 1 – (aurban / awot test)

 In cases where awot test is less than aurban:

 kP = 0

In cases where the PMR of the vehicle is lower than 25 the final result Lurban is the result of the acceleration test:

 Lurban = Lwot rep

 **In cases where Lwot,rep is less than Lcrs,rep:**

**kP=1**

**In cases where Lwot,rep is less than Lcrs,rep the final result Lurban is the result of the cruise test:**

**Lurban= Lcrs,rep**“

*Annex 3, Appendix 1, Figure 4a,* amend to read:

"Figure 4a

**Flowchart for vehicles tested according to paragraph 3.1.2.1. of Annex 3 to this Regulation – Lurban computation**

Determine PMR for test vehicle 3.1.2.1.1.

Determine target acceleration aurban (3.1.2.1.2.3.) and reference acceleration awot ref (3.1.2.1.2.4.)

Select test method (3.1.2.1.4.)

locked gears (3.1.2.1.4.1.) See Figures 4b, 4c and 4d

non-locked gears (3.1.2.1.4.2.) See Figure 4e

Acceleration test (3.1.2.1.5.)

Constant speed test (3.1.2.1.6.)

Calculation of gear weighting factor k if 2-gear test (3.1.2.1.4.1.)

Calculate *L* wot rep and *L* crs rep (3.1.3.**4.**1.**2.**)

Calculate *kP* (3.1.3.**4.**1.**2.)**

Calculate *L*urban (3.1.3.**4.**1.**2.)**

*Annex 3, Appendix 1, Figure 4b,* amend to read:

"Figure 4b

**Flowchart for vehicles tested according to paragraph 3.1.2.1. of Annex 3 to this Regulation -
Gear selection using locked gear PART 1**

Select Gear

Is acceleration stable according to 2.26.2.?

Calculate test acceleration according to 3.1.2.1.2.1.

Select Pre-acceleration and entry speed

Yess

No

Is acceleration within *awot\_ref* tolerance band?

Yess

No

Is acceleration less than or equal 2,0 m/s2? and engine speed less than *nMAX* prior to BB'?

Use gear and compute *k*P according to (3.1.3.**4.**1.**2.)**

Compute *Lwot\_rep*using results of valid runs

No

Select gears to obtain gear *i* with stable acceleration above

*awot\_ref* and gear *i*+1 with stable acceleration below *awot\_ref*

See Case 2 in Figure 4c

See Case 1 in Figure 4c

Yess

Testing locked gears according to 3.1.2.1.4.1.

*Annex 3 – Appendix 1, Figure 4c*, amend to read:

"Figure 4c

**Flowchart for vehicles tested according to paragraph 3.1.2.1. of Annex 3 to this Regulation –
Gear selection using locked gear PART 2**

Yess

No

Is acceleration of gear *i* less than or equal 2.0 m/s2? and engine speed less than *nMAX* prior to BB’?

Use both gears *i* and *i*+1, (*i*+2, *i*+3, or*…*) and compute *kP* according to 3.1.3.**4.**1.**2.** and *k* by 3.1.2.1.4.1.

Compute *Lwot\_rep*using results of valid runs

Case 1:

 Two gears, gear *i* with stable acceleration above *awot\_ref* and gear *i*+1 with stable acceleration below *awot\_ref*

Case 2:

 One gear with stable acceleration above 2.0 m/**s**2 or engine speed greater than *nMAX* prior to BB'

Determine first gear *i* + n (n=1, 2…) with stable acceleration less than or equal to 2.0 m/s2 and engine speed less than *nMAX* prior to BB'

Is acceleration of gear *i* +n more than *aurban*?

Yess

Use gear **i+n (n=1, 2, …)** and compute *kP* according to 3.1.3.**4.**1.**2.**

No

Use both gears *i* with acceleration higher than 2.0 m/s2 and *i*+1, (*i*+2, *i*+3, or*…*) with acceleration less than *aurban*

Is engine speed of gear *i* more than *nMAX* prior to BB’?

See Case 3 in Figure 4d

No

Yess

*Annex 3 – Appendix 1, Figure 4d*, amend to read:

"Figure 4d

**Flowchart for vehicles tested according to paragraph 3.1.2.1. of Annex 3 to this Regulation –
Gear selection using locked gear PART 3**

Yess

No

Yes

~~Determine first gear~~ *~~i~~* ~~+ n (n=1, 2, …) with stable acceleration less than or equal to 2.0 m/s² and engine speed less than~~ *~~S~~* ~~prior to BB’. Test with this gear at a speed,~~ *~~v~~~~test~~*~~, of 50 km/h~~

**Use gear i+n (n=1, 2, ...) with test speed 50km/h and compute *kP* according to 3.1.3.4.1.2.**

Reduce test speed *vtest* by 2.5 km/h with gear *i*

~~Test locked gears according to 3.1.2.1.4.1. with new test speed~~

**Use both gears i and i+n (n=1, 2, ...) with new test speed for gear i and 50km/h for gear i+n and compute *kP* according to 3.1.3.4.1.2.**

Is engine speed of gear *i* less than *nMAX* prior to BB’?

No

Case 3:

 No gear with acceleration more than *aurban* and engine speed less than *nMAX* prior to BB’

Is test speed *vtest* **=** 40 km/h?

*Annex 3 – Appendix 1, Figure 4e*, amend to read:

"Figure 4e

**Flowchart for vehicles tested according to paragraph 3.1.2.1. of Annex 3 to this Regulation Gear Selection using non-locked gears**

Yess

No

Compute *Lwot\_rep*using results of valid runs

Calculate test acceleration according to 3.1.2.1.2.2. Pre-acceleration is not allowed

Compute *kP*according to 3.1.3.**4.**1.**2.**

Can measures be taken to control downshifts?

Is acceleration stable? i.e. there is no delay.

Calculate test acceleration according to 3.1.2.1.2.2.

Select Pre-acceleration and entry speed

No

Yess

If possible, control downshift to obtain acceleration less than or equal to 2.0 m/s2 or *awot\_ref*, whichever is lower. If not possible, run higher than 2.0 m/s2 is valid.

Testing unlocked gears according to 3.1.2.1.4.2.

Select entry speed

No

See flowchart 4f.

engine speed greater than *nMAX* prior to BB'

Yes

*Annex 3 – Appendix 1, Figure 4f*, amend to read:

“Figure 4f

**Flowchart for vehicles tested according to paragraph 3.1.2.1.4.2. of Annex 3 to this Regulation – Gear Selection using non-locked gears**

**Possibility 2**

Test according to 3.1.2.1.4.2. with specified engine load

**Possibility 1**

Yess

No

Yes

Not valid test condition.

Reduce test speed *vtest* by 2.5 km/h

Test according to 3.1.2.1.4.2. with new test speed

Is engine speed less than *nMAX* prior to BB’?

No

Engine speed exceed *nMAX* prior to BB’

Is test speed *vtest* 40 **=** km/h?

Reduce engine load (by using partial load) such that *nBB’* is between 95 % *nMAX* and *nMAX*

Yess

*Annex 3, Appendix 2, paragraph 2.,* amend to read:

2. General (see the flowcharts in this Appendix 2, Figure 7a to Figure ~~7d~~ **7c**)

This Appendix provides correction for temperature and test track dependent on the tyre category and purpose.

For the correction, tyre rolling sound reference values are needed. Tyre rolling sound measurements shall be carried out according to the test procedure of Appendix 3 to Annex 3 of this regulation.

*Annex 3, Appendix 2, paragraph 3.3.4.,* amend to read:

 “3.3.4 For each gear, run and vehicle side extract the power train component LPT,wot,j from the reported acceleration test Lwot,j, by calculation.

In case that LTR,wot,j,ϑwot is greater than Lwot,j**:**

**(a)** the power train component LPT,wot,j is determined by

**(b) the tyre component LTR,wot,j,ϑ\_ref is determined by**

”

*Annex 3, Appendix 3, paragraph 5.1.4.1.,* amend to read:

“5.1.4.1. Date of track certification to ISO 10844: 2014/**2021\***: ………………………….”

***\* Delete what does not apply according to the transitional provisions in this Regulation.***

*Annex 9, Appendix 4, formula 3.2.4.4.2. No.2,* amend to read:

*Annex 9, Appendix 4, formula 3.4. No.2,* amend to read:

 **II. Justification**

*Measurement Uncertainties*

1. The temperature correction in Supplement 7 is based on the sound behavior of internal combustion engine (ICE) vehicles. Due to their powertrain noise, the sound emission in accelerating condition is always higher than in cruising condition.

For battery electric vehicles (BEVs) the dominant source is the tyre road noise. For this reason, the sound emission in cruising may be higher than during acceleration. In this case the current temperature correction will be inaccurate and cause an additional burden to the BEVs.

Since the standard ISO 362, which describes the basic measuring method of this Regulation, is based on the experience of ICE vehicles, now it must reflect the transformation to BEVs, including this specific case in its future work. The result of this work will probably lead to a new series of amendments to this Regulation.

In the meantime, the proposed Supplement 8 will reduce this additional burden to BEVs regarding the introduction of stage 3 limits, which will enter into force on 1 July 2024.

*Paragraph 2.24.*

1. The content of paragraph 3.1.3.1. was moved to paragraph 3.1.3.4.1.2. without any change when the measurement uncertainties and the real driving additional sound emission provisions (RD-ASEP) were introduced in Supplement 7. In the table of symbols, the references to this paragraph 3.1.3.1. need to be renumbered to 3.1.3.4.1.2., accordingly.

*Paragraph 11.14.*

3. Since the changes are referring to supplement 7 the timing of this corrections can be the same.

*Annex 3, paragraph 3.1.2.1.1.*

1. With Supplement 7, the definition of "Maximum net power, Pn" in paragraph 2.8. has been adjusted for better clarity. It is therefore proposed to amend the text in the definition of power to mass ratio index (PMR), to align it with the adjustment in Supplement 7.

*Annex 3, paragraph 3.1.2.1.3.*

1. The content of paragraph 3.1.3.1. was moved to paragraph 3.1.3.4.1.2. without any change when RD-ASEP was introduced in Supplement 7. In paragraph 3.1.2.1.3., the reference to this paragraph 3.1.3.1. needs to be renumbered to 3.1.3.4.1.2., accordingly.

*Annex 3, paragraph 3.1****.****3.4.1.2.*

1. To avoid confusion due to a reported value of Lurban, which may be smaller than Lcrs in this special case, Lurban is set to Lcrs , as shown in the diagram below.

Lcrs

Lwot, ICE

Lurb, ICE

Sound pressure level

acceleration

Lurb, BEV

Lwot, BEV

*Assumption:
BEV and ICE-vehicle have the same Lcrs,
same acceleration and the same kp-factor*

*Annex 3, Appendix 1, Figures 4a to 4f*

1. The content of paragraph 3.1.3.1. was moved to paragraph 3.1.3.4.1.2. without any change when RD-ASEP was introduced in Supplement 7. In the figures, references to this paragraph 3.1.3.1. need to be renumbered to 3.1.3.4.1.2., accordingly.

*Additional clarifications*

8. In Figure 4c, from the current wording in Annex 3, paragraph 3.1.2.1.4.1.(c), the addition of “i+n (n=1, 2, …)” in the box “Use gear and compute *kP* according to 3.1.3.4.1.2.” was made for better understanding and clarification.

9. In Figure 4d, to avoid misinterpretation, the following modifications were made from the current wording in Annex 3, paragraph 3.1.2.1.4.1.(d) for clarification and better understanding:

* + - * Adding “=” in the box “Is test speed vtest 40km/h”.
			* Replacing “*Determine first gear i + n (n=1, 2, …) with stable acceleration less than or equal to 2.0 m/s² and engine speed less than S prior to BB’. Test with this gear at a speed, vtest, of 50 km/h*” by “*Use gear i+n (n=1, 2, ...) with test speed 50km/h and compute kP according to 3.1.3.4.1.2*”.
			* Replacing “*Test locked gears according to 3.1.2.1.4.1. with new test speed*” by “*Use both gears i and i+n (n=1, 2, ...) with new test speed for gear i and 50km/h for gear i+n and compute kP according to 3.1.3.4.1*.2.”

10. In Figure 4f, from the current wording in Annex 3, paragraph 3.1.2.1.4.2., the addition of “=” in the box “Is test speed vtest 40km/h” was made for better understanding and clarification.

*Annex 3, Appendix 2, paragraph 2*

11. The reference numbers for the figures have to be corrected: ‘Figure 7a to Figure 7c’ instead of ‘Figure 7a to Figure 7d’.

*Annex 3, Appendix 2, paragraph 3.3.4*

12. Since the main burden in the temperature correction is caused by an incorrect speed correction of the tyre rolling sound LTR,wot,j,ϑ\_ref , the speed correction according to Annex 3, Appendix 2 paragraph 3.3.1 is not applied in this special case.

*ISO-Standard on test tracks*

*Annex 3, paragraph 2.1.1. and Annex 3, Appendix 3, paragraph 5.1.4.1.*

13. ISO has updated the 10844 standard to improve clarity. The primary objective is to reduce track-to-track variability caused by differing interpretations and implementations of the technical requirements. The following table includes other improvements that have been made.

| *3rd edition ISO 10844:2014 technical method* | *Improvements in ISO 10844:2021* | *Effect of improvements* |
| --- | --- | --- |
| Measurement of irregularity | Permit more modern and accurate methods of measurement (e.g. laser methods) in addition to straight­edge | Improved practicality and accuracy of irregularity measurement |
| Periodic check criteria for irregular­ity of tracks exclusively for testing heavy vehicles | Irregularity requirement changed to 10 mm in consideration of perma­nent deformation caused by heavy vehicles, and through acoustical analysis of potential shielding found negligible impact | Improved durability of tracks used exclusively for heavy vehicles with­out impacting acoustical measure­ment |
| Step requirement | Implement a step requirement that includes allowance for a step-up of maximum 5 mm to harmonize with irregularity requirement | Improved constructability while maintaining same surface geomet­ric tolerances |
| Sieving curve | Replace sieving curve figure with equivalent tabulation of sieve values defining an aggregate grading envelope | Reduced track-to-track variability caused by subjective interpretation of sieving curve figure |
| Expected Noise Due to Texture (ENDt) method | Replace optional calculation of ENDt with optional calculation of texture skewness, shape factor (g-factor), and texture spectrum | Skewness, shape factor (g-factor), and texture spectrum reported to correlate with measured pass-by noise, and are proposed for track correlation methods |
| Sampling for aggregate grading | Sampling of loose asphalt mixture as alternative to coring for evaluat­ing aggregate grading | Sampling of loose asphalt mixture is more practical and representa­tive compared to the small sample extracted from four cores |
| Examples of track construction | Examples have been removed | Avoided conflicts and confusion in interpretation of the technical requirements in the standard  |

*Annex 9, Appendix 4, formula 3.2.4.4.2 No.2*

14. Because of the wrong copy/paste of the formula, it has to be adjusted to the existing wording in Annex 9, Appendix 1 as approved through the adoption of Supplement 7.

*Annex 9, Appendix 4, Formula 3.4. No.2*

15. The subscript characters have to be corrected and put at the ‘right’ level, i.e. all at the same level.

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