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World Forum for Harmonization of Vehicle Regulations**Working Party on Noise and Tyres****Seventy-fifth session**

Geneva, 8–11 February 2022

Item 2 of the provisional agenda

UN Regulation No. 51 (Noise of M and N categories of vehicles)**Proposal for Supplement 10 to the 03 series of amendments
to UN Regulation No. 51****Submitted by the Informal Working Group on Additional Sound
Emission Provisions***

The text reproduced below was prepared by the experts from the Informal Working Group on Additional Sound Emission Provisions (IWG ASEP) in order to improve the current wording for better clarification. The proposed changes are based on the 03 series of amendment to UN Regulation No. 51 up to Supplement 6. The modifications are marked in bold for new or strikethrough for deleted characters.

* In accordance with the programme of work of the Inland Transport Committee for 2022 as outlined in proposed programme budget for 2022 (A/76/6 (Sect.20), para 20.76), the World Forum will develop, harmonize and update UN Regulations in order to enhance the performance of vehicles. The present document is submitted in conformity with that mandate.

I. Proposal

Paragraph 2.8., amend to read:

2.8. ~~"*Rated Maximum net power, P_n*" means the engine power available for propulsion expressed in kW and measured dependent on the drive train concepts pursuant to UN Regulation No. 85.~~

Applicable power sources are those, which provide drive power for forward motion to the vehicle.

2.8.1. ~~If two or more sources of propulsive power operate at the conditions of test specified in Annex 3 to this Regulation, the total engine 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 Annex 3 to this Regulation.~~

~~The specified power for non-combustion engines shall be the power stated by the vehicle manufacturer.~~

For vehicles with combustion engine(s) only (ICE)

The maximum engine power is the net power P_n of the combustion engine(s) measured at full engine load pursuant to UN Regulation No.85 paragraph 5.2.

2.8.2. **For battery electric vehicles (BEV) or fuel cell electric vehicle (FCEV) that have only one propulsion energy converter**

The net power P_n of the electric motor of the electric drive train is determined pursuant to UN Regulation No.85 paragraph 5.3.

2.8.3. **For hybrid electric vehicles (HEV) [where at least one electric machine contributes to propulsion], or pure electric vehicles that have more than one propulsion energy converter**

The maximum engine power is the "vehicle system power rating" according to the arithmetic sum of parallel propulsive engines on the vehicle or GTR 21, paragraph 6.9.1.(b) "sustained vehicle system power".

Paragraph 2.24., amend to read:

2.24. Table of symbols

...
k	—	Annex 3	3.1.2.1.4.1.	gear ratio weighting factor; value to be reported and used for calculations to the second decimal place
n _{MAX}	1/min	Annex 3	3.1.2.1.4.1.	Maximum engine rotational speed permitted for M₁, N₁, and M₂ less than 3500 kg; value to be reported and used for calculations to a precision of 10 min⁻¹ (xxx0)
S	1/min	Annex 3	3.1.2.1.4.1.	rated engine rotational speed in revs per minute, synonymous with the engine rotational speed at maximum power
n _{BB'}	1/min	Annex 3	3.1.2.2.	engine rotational speed of the vehicle, when the reference point passes BB'; value to be reported and used for calculations to a precision of 10 min ⁻¹

...
n _{BB'}	1/min	Annex 3	3.1.2.2.	engine rotational speed of the vehicle, when the reference point passes BB'; value to be reported and used for calculations to a precision of 10 min ⁻¹
S	1/min	Annex 3	3.1.2.2.	rated engine rotational speed in revs per minute, synonymous with the engine rotational speed at maximum power
n _{target BB'}	1/min	Annex 3	3.1.2.2.1.1.(a)	target engine rotational speed of the vehicle when the reference point has to pass line BB' (see 2.11.2. for definition of reference point)
...

Paragraph 6.1., amend to read:

"6.1. General specifications **for durability and against manipulation**

- 6.1.1. The vehicle, its engine and its sound reduction system shall be so designed, constructed and assembled as to enable the vehicle, in normal use, despite the vibration to which it may be subjected, to comply with the provisions of this Regulation.
- 6.1.2. The sound reduction system shall be so designed, constructed and assembled as to be able to reasonably resist the corrosive phenomena to which it is exposed having regard to the conditions of use of the vehicle, including regional climate differences, **and against manipulation.**"

Annex 3,

Paragraph 2.1.2., amend to read:

"2.1.2. Test Site Indoor

Test Site Indoor requirements shall be as specified below.

- (a) The test room dimensions are described in paragraph 7.2. of ISO 362-3:2016 **or later**. All room dimensions may be adjusted to meet the specific application for the products being tested according to Annex 8, paragraph 4.
- (b) The test facility shall meet the requirements of ISO 26101:2012 **or later** with the qualification criteria and measurement requirements appropriate to this test method as described in ISO 362-3:2016 **or later**, paragraph 7.3.
- (c) Condition of the floor is described in ISO 362-3:2016 **or later**, paragraph 7.4.
- (d) Cooling, ventilation, and exhaust gas management are described in ISO 362-3:2016 **or later**, paragraph 7.5.
- (e) Dynamometer requirements are described in ISO 362-3:2016 **or later**, paragraph 8.
- (f) Vehicle fixing system is described in ISO 362-3:2016 **or later**, paragraph 9.3."

Paragraph 3., amend to read:

"3. Methods of testing

Outdoor tests shall be performed according to paragraph 3.1.

Indoor tests shall be performed according to paragraph 3.1. using the specifications of ISO 362-3:2016 **or later**, variant A. For indoor application,

the manufacturer shall provide to the technical service, documentation according to Annex 8, paragraph 1. Variant A is a combination of indoor testing (power train sound) and outdoor testing (tyre/road sound)."

Paragraph 3.1.1., amend to read:

"3.1.1. General conditions of test

For outdoor testing, two lines, AA' and BB', parallel to line PP' and situated respectively $10\text{ m} \pm 0.05\text{ m}$ forward and $10\text{ m} \pm 0.05\text{ m}$ rearward of line PP' shall be marked out on the test runway.

For indoor testing, the virtual line AA' indicates the beginning of the test track, PP' indicates the virtual position of the two pass-by microphones, and BB' indicates the end of the test track. The simulated vehicle speed at AA', $v_{AA'}$, or vehicle speed at PP', $v_{PP'}$, is defined by the roller speed when the reference point of the vehicle passes the virtual line AA' or PP', respectively. The simulated vehicle speed at BB', $v_{BB'}$, is defined when the rear of the vehicle passes the virtual line BB'.

At least four measurements shall be made on each side of the vehicle and for each gear. Preliminary measurements may be made for adjustment purposes, but shall be disregarded.

The microphones shall be located **on both sides of the pathway** at a distance of $7.5\text{ m} \pm 0.05\text{ m}$ from the reference line CC' of the track and $1.2\text{ m} \pm 0.02\text{ m}$ above the ground.

The reference axis for free field conditions (see IEC 61672-1:2002) shall be horizontal and directed perpendicularly towards the path of the vehicle line CC'."

Paragraph 3.1.2.1.4.1., amend to read:

"3.1.2.1.4.1. Vehicles with manual transmission, automatic transmissions, adaptive transmissions or CVTs tested with locked gear ratios

The following conditions for selection of gear ratios are possible:

- (a) If one specific gear ratio gives an acceleration in a tolerance band of ± 5 per cent of the reference acceleration a_{wot_ref} , not exceeding 2.0 m/s^2 , test with that gear ratio.
- (b) If none of the gear ratios give the required acceleration, then choose a gear ratio i , with an acceleration higher and a gear ratio $i+1$, with an acceleration lower than the reference acceleration. If the acceleration value in gear ratio i does not exceed 2.0 m/s^2 , use both gear ratios for the test. The weighting ratio in relation to the reference acceleration a_{wot_ref} is calculated by:

$$k = (a_{wot_ref} - a_{wot_{(i+1)}}) / (a_{wot_{(i)}} - a_{wot_{(i+1)}})$$

- (c) If the acceleration value of gear ratio i exceeds 2.0 m/s^2 , the first gear ratio shall be used that gives an acceleration below 2.0 m/s^2 unless gear ratio $i+1$ (or $i+2$, or $i+3$ or ...) provides acceleration less than a_{urban} . In this case, two gears, i and $i+1$ (or $i+2$, or $i+3$ or ...) shall be used, including the gear i with acceleration exceeding 2.0 m/s^2 . In other cases, no other gear shall be used. The achieved acceleration a_{wot_test} during the test shall be used for the calculation of the part power factor k_P instead of a_{wot_ref} .
- (d) If **maximum rated** engine speed n_{MAX} is exceeded in a gear i before the vehicle passes BB' the next higher gear $i+1$ shall be used. If the next higher gear $i+1$ results in an acceleration below a_{urban} , the vehicle test speed, v_{test} , in the gear ratio i shall be reduced by 2.5 km/h and the gear ratio selection shall proceed as specified by the options given in this paragraph. In no case shall the vehicle test speed be reduced below 40 km/h .

If the ~~maximum rated~~ engine speed n_{MAX} is exceeded in gear ratio i before the vehicle passes BB' and the vehicle test speed is equal to 40 km/h, the higher gear ratio $i+1$ is allowed even if a_{wot_test} does not exceed a_{urban} .

The vehicle test speed in the higher gear ratio $i+1$ shall be 50 km/h.

The maximum engine speed n_{MAX} is given by the formula below:

$$n_{MAX} = 1.56 \times PMR^{-0.227} \times S, \text{ but not more than 80\% of } S.$$

- (e) If no gear ratio is available with an acceleration below 2.0 m/s², the manufacturer shall, if possible take measures to avoid an acceleration value a_{wot_test} greater than 2.0 m/s².

Table 1 in Appendix to Annex 3 provides examples for valid measures to control the downshift of gears or to avoid accelerations beyond 2.0 m/s². Any measure used by manufacturer for the above-mentioned purposes shall be documented in the test report."

Paragraph 3.1.2.1.4.2., amend to read:

- "3.1.2.1.4.2. Vehicles with automatic transmission, adaptive transmissions and CVTs tested with non-locked gear ratios:

Manufacturers may take measures to lock discrete gear ratios by electronic or mechanical measures and follow the gear selection provisions of paragraph 3.1.2.1.4.1. above. If so selected, this shall be stated in the test report.

Otherwise, the gear selector position for full automatic operation shall be used.

The acceleration value a_{wot_test} shall be calculated as defined in paragraph 3.1.2.1.2.2.

The test may then include a gear change to a lower range and a higher acceleration **or a higher engine speed**. A gear change to a higher range and a lower acceleration is not allowed. A gear shifting to a gear ratio which is not ~~used in~~ **representative for** urban traffic shall be avoided.

Therefore, it is permitted to establish and use electronic or mechanical devices, including alternate gear selector positions, to ~~prevent a downshift to a gear ratio which is typically not used for the specified test condition in urban traffic~~ **avoid:**

- (a) **accelerations beyond 2.0 m/s². Any measure used by manufacturer for the above-mentioned purposes shall be documented in the test report.** The achieved acceleration a_{wot_test} shall be greater or equal to a_{urban} .
- (b) **a test engine speed exceeding n_{MAX} (see Appendix 1, figure 4f).**
- (i) **Therefore, the vehicle test speed v_{test} may be reduced in steps by 2.5 km/h. In no case the vehicle test speed shall be reduced to a vehicle speed below 40 km/h, or**
- (ii) **The engine load is reduced to avoid a downshift to a gear ratio where n_{MAX} is exceeded.**

If possible, the manufacturer shall take measures to avoid an acceleration value a_{wot_test} greater than 2.0 m/s².

If possible, the manufacturer shall take measures to avoid an engine speed higher than n_{MAX} .

Table 1 in Appendix to Annex 3 provides examples for valid measures to ~~control the downshift of gears or to avoid accelerations beyond 2.0 m/s²~~ **enable a test condition within the above specified boundaries**. Any measure used

by manufacturer for the above-mentioned purposes shall be documented in the test report.

The achieved acceleration a_{wot_test} is then used for the calculation of the partial power factor k_P (see paragraph 3.1.2.1.3.) instead a_{wot_ref} ."

Paragraph 3.1.2.1.6., amend to read:

"3.1.2.1.6. Constant speed test

The constant speed test shall be carried out with the same gear(s) specified for the acceleration test and a constant speed of 50 km/h with a tolerance of ± 1 km/h between AA' and BB', or if applicable at the speed determined for the acceleration test according 3.1.2.1.4.1. (d) **or 3.1.2.1.4.2.** with a tolerance of ± 1 km/h between AA' and BB'.

During the constant speed test, the acceleration control shall be positioned to maintain a constant speed between AA' and BB' as specified. If the gear is locked for the acceleration test, the same gear shall be locked for the constant speed test.

The constant speed test is not required for vehicles with a PMR < 25."

Paragraph 3.1.3.1., amend to read:

"3.1.3.1. Vehicles of categories M₁, N₁ and M₂ ≤ 3,500 kg technically permissible maximum laden mass

The calculated values for the acceleration test and the constant speed test are given by:

$$L_{wot\ rep} = L_{wot\ (i+1)} + k * (L_{wot\ (i)} - L_{wot\ (i+1)})$$

$$L_{crs\ rep} = L_{crs\ (i+1)} + k * (L_{crs\ (i)} - L_{crs\ (i+1)})$$

$$\text{Where } k = (a_{wot\ ref} - a_{wot\ (i+1)}) / (a_{wot\ (i)} - a_{wot\ (i+1)})$$

In the case of a single gear ratio test the values are the test result of each test.

The final result is calculated by combining $L_{wot\ rep}$ and $L_{crs\ rep}$. The equation is:

$$L_{urban} = L_{wot\ rep} - k_P * (L_{wot\ rep} - L_{crs\ rep})$$

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

$$k_P = 1 - (a_{urban} / a_{wot\ ref})$$

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

$$k_P = 1 - (a_{urban} / a_{wot\ test})$$

In cases where $a_{wot\ test}$ is less than a_{urban} :

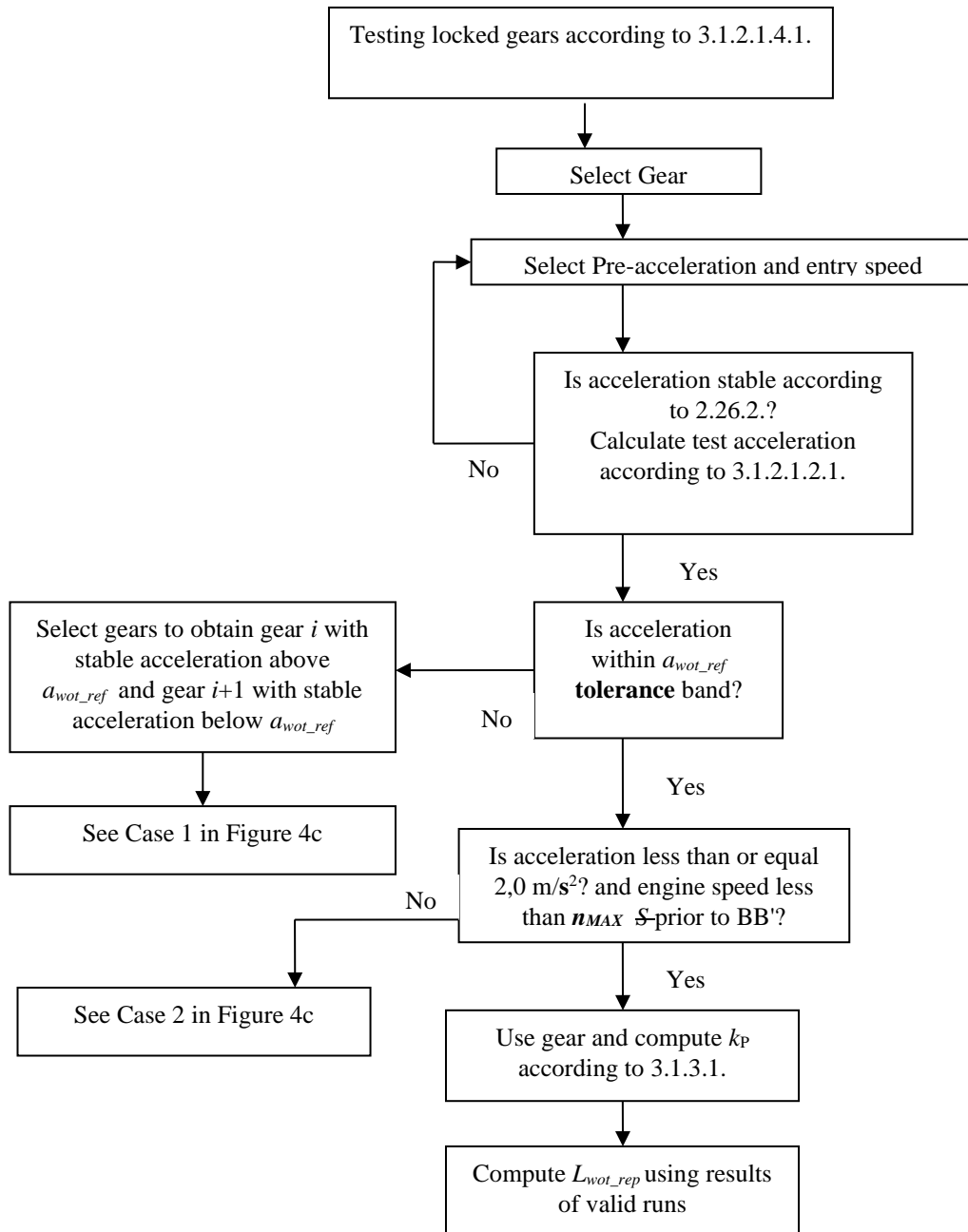
$$k_P = 0$$

In case of a vehicle with a PMR < 25, the final result L_{urban} is equal to $L_{wot\ rep}$."

Annex 3 - Appendix, Figure 4b, amend to read:

"Figure 4b

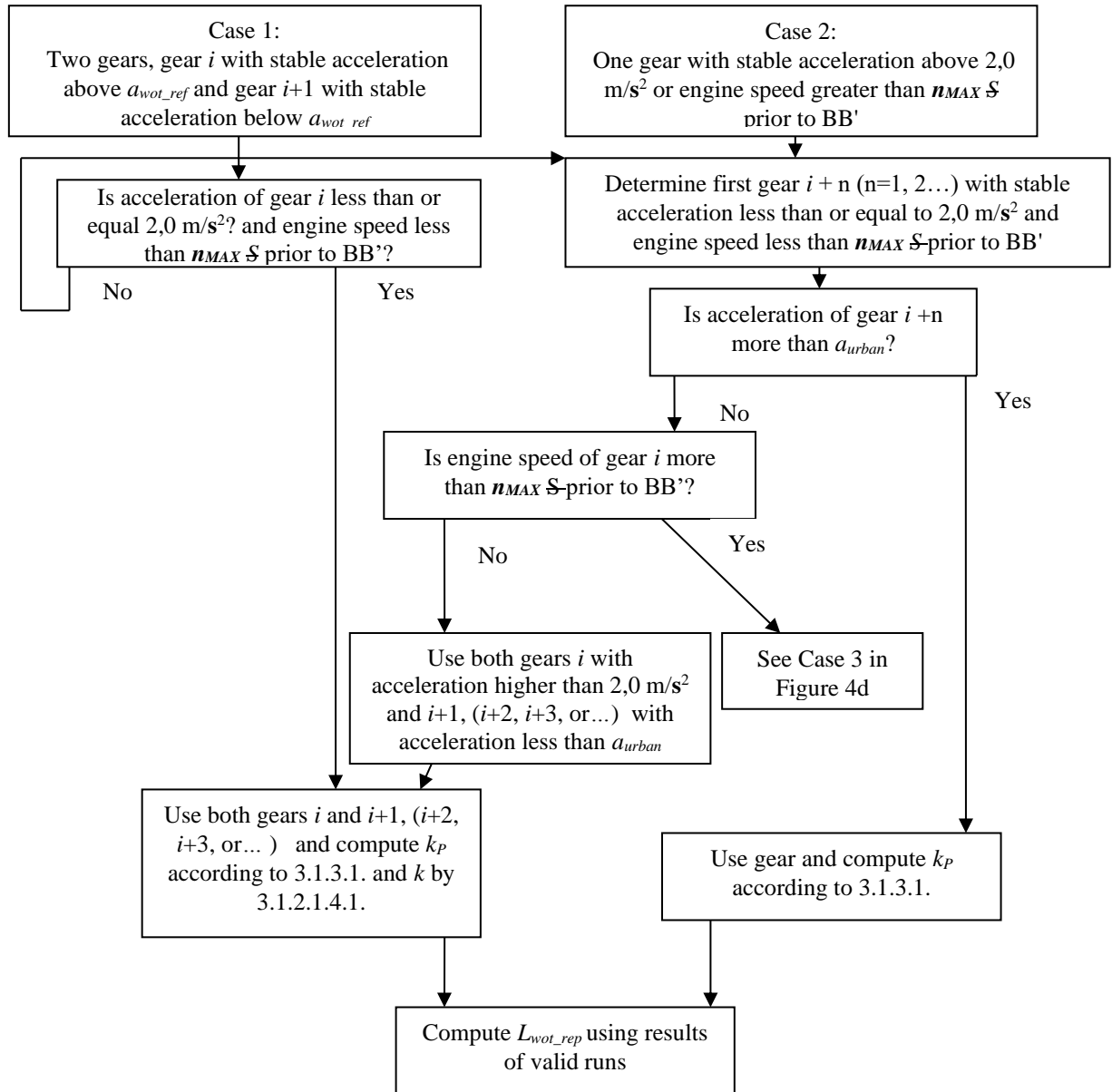
Flowchart for vehicles tested according to paragraph 3.1.2.1. of Annex 3 to this Regulation - Gear selection using locked gear PART 1



"

Annex 3 - Appendix, 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**

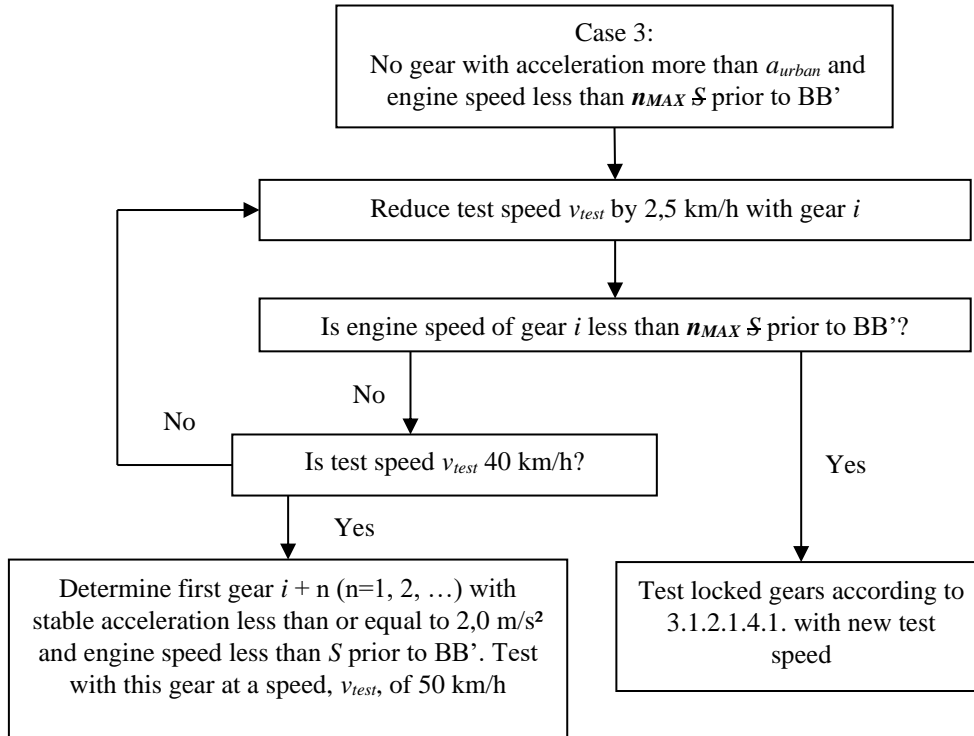


"

Annex 3 - Appendix, Figure 4d, amend to read:

"Figure 4d

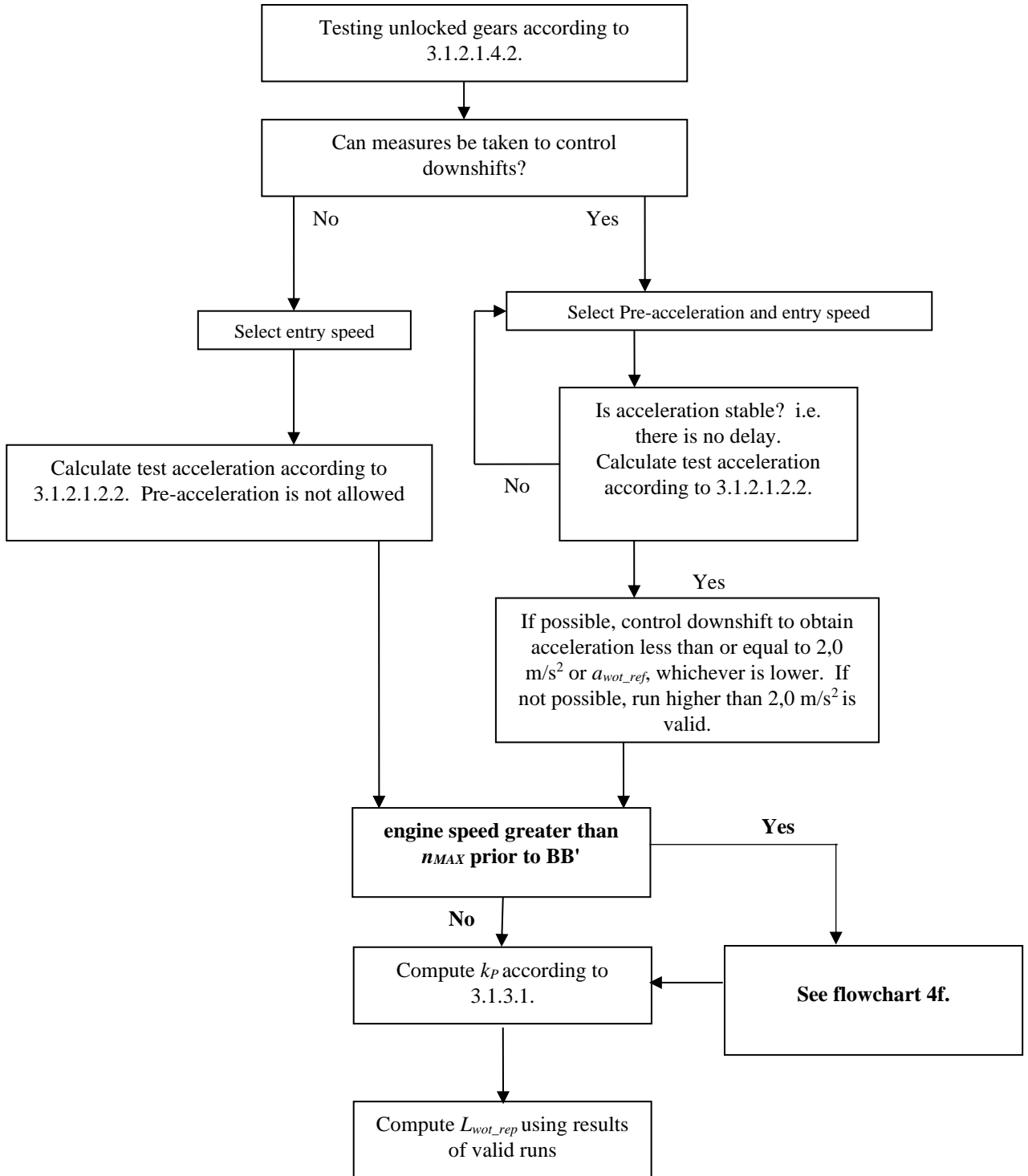
Flowchart for vehicles tested according to paragraph 3.1.2.1. of Annex 3 to this Regulation – Gear selection using locked gear PART 3



"

Annex 3 - Appendix, Figure 4e, amend to read:

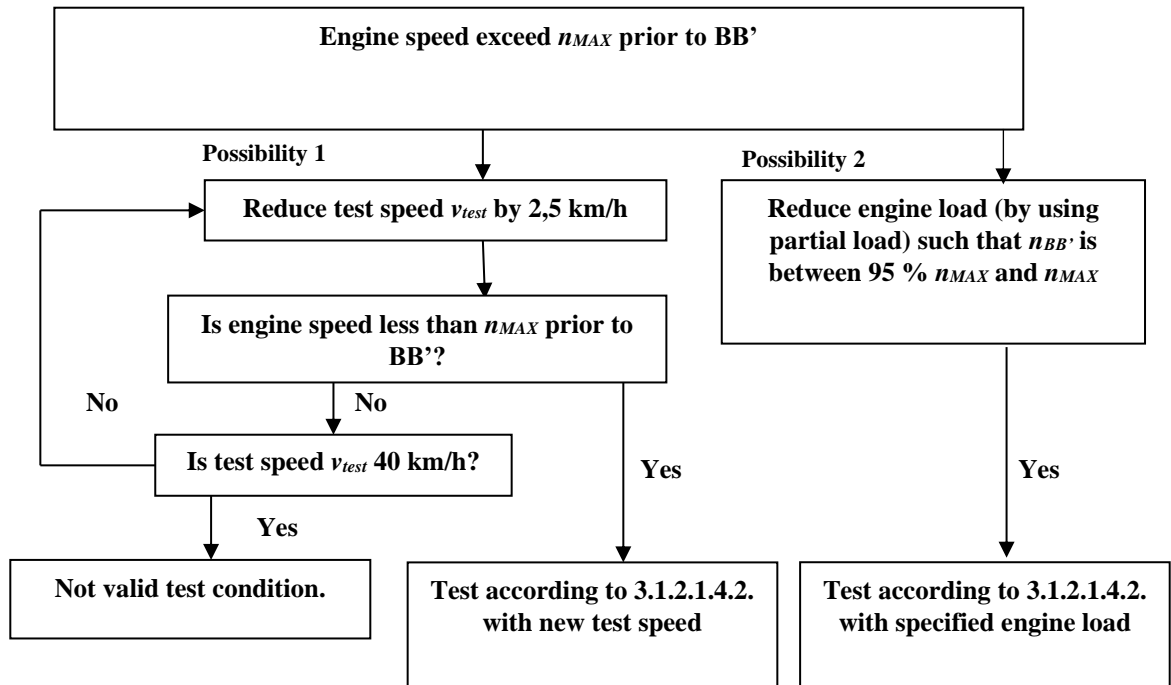
"Figure 4e
**Flowchart for vehicles tested according to paragraph 3.1.2.1. of Annex 3 to this Regulation –
 Gear Selection using non-locked gears**



Annex 3 - Appendix, add a new Figure 4f, 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



"

Annex 8,

Introduction, amend to read:

"Annex 8

Indoor testing

Indoor testing is only for Annex 3 and Annex 7 measurements.

1. Documentation for indoor application

..."

Paragraph 2.2., amend to read:

"2.2. Power train sound

It shall be ensured that there is no remaining tyre/road sound affecting the measurements. In any case it shall be ensured that the remaining tyre/road sound shall be at least 10 dB below the maximum A-weighted sound pressure level produced by the vehicle under test. If this condition cannot be fulfilled, a correction shall be carried out. This correction procedure is described in ISO 362-3:2016 **or later** Annex B, paragraph B.6.

The vehicle shall be measured according to the operating condition specified in paragraphs 3.1.2.1. or 3.1.2.2. of Annex 3 of this Regulation."

Paragraph 2.4., amend to read:

"2.4. Calculation of the total vehicle sound

The total vehicle sound is the energetical sum of tyre/road sound and power train sound. This calculation shall be carried out for each single run as describe in ISO 362-3:2016 **or later**, paragraph 10.2.4."

Paragraph 3., amend to read:

"3. Procedure for measurement, evaluation, and calculation of tyre/road sound when using variant A

All conditions for evaluation of tyre/road sound, free rolling sound, and torque influence are described in ISO 362-3:2016 **or later**, Annex B."

Paragraph 4., amend to read:

"4. Adjustment of room dimensions

To cater for the smaller size test rooms, the maximum levels shall be evaluated with caution though to avoid missing them according to ISO 362-3:2016 **or later**, Annex E."

II. Justification

1. In paragraph 2.8. "Maximum net power, P_n ", for better clarity, the definition has been adjusted to each propulsion technology (ICE, BEV, HEV, FCEV).
2. In paragraph 2.24. "Table of symbols", the symbol n_{MAX} for maximum engine rotational speed permitted for M_1 , N_1 , and M_2 less than 3500 kg used for simplification in Annex 3 as 80 per cent of S has been added.
3. Provisions for durability and against manipulation have been introduced through.
4. Paragraph 6. has been amended to clarify that the sound reduction system shall be designed also against manipulation.

5. The amendment of Supplement 6 to the 03 series of amendments to UN Regulation No. 51 introducing 20 m behind the line BB' is not yet taken into account in the current standard ISO 362-3:2016. It is proposed to amend the reference to this standard as "ISO362-3:2016 **or later**" to make possible using the standard as soon as it is updated.
6. Annex 3, paragraphs 2.1.2., 3., 3.1., 3.3.3., and Annex 8, paragraphs 2.2., 2.4., 3., 4. have been amended accordingly.
7. In Annex 3, paragraph 3.1., clarification has been added on the two microphones to be installed on the test track in line PP' instead of one microphone as allowed in the past, for measurements in one run of both sides left/right. This change will increase accuracy.
8. In Annex 3, paragraph 3.1.2.3.4.1. (d), n_{MAX} for simplification in Annex 3 as 80 per cent of S has been added.
9. Annex 3, paragraph 3.1.2.1.4.2., has been reworded for clarification of the non-locked gear ratio.
10. In Annex 3, paragraph 3.1.2.1.6., the numbering has been updated with addition of reference to paragraph 3.1.2.1.4.2. mentioned above.
11. In Annex 3, paragraph 3.1.3.1., clarification has been added for the result of vehicles with the power-to-mass ration (PMR) less of 25.
12. Annex 3, figures 4b to 4f have been updated according to the introduction of n_{MAX} mentioned above.
