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World Forum for Harmonization of Vehicle Regulations

Working Party on Noise

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Item 4 (a) of the provisional agenda

**Regulation No. 51 (Noise of M and N categories of vehicles):
Development****Proposal for Supplement 3 to the 03 series of amendments to
Regulation No. 51****Submitted by the experts of Germany and OICA***

The text reproduced below was prepared by a group of experts to update and revise the 03 series of amendments to Regulation No. 51. The proposed amendments to the current Regulation are marked in bold for new or strikethrough for deleted characters.

* In accordance with the programme of work of the Inland Transport Committee for 2016–2017 (ECE/TRANS/254, para. 159 and ECE/TRANS/2016/28/Add.1, cluster 3.2), the World Forum will develop, harmonize and update Regulations in order to enhance the performance of vehicles. The present document is submitted in conformity with that mandate.

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I. Proposal

Paragraph 1., amend to read:

"1. Scope

This Regulation contains provisions on the sound emitted by motor vehicles and applies to vehicles of categories M and N.¹

The specifications in this Regulation are intended to reproduce the sound levels which are generated by vehicles during normal driving in urban traffic.

This regulation provides as well additional sound emission provisions for vehicles of categories M₁ and N₁ referring to driving conditions with extreme accelerations in an extended speed range representative for urban and suburban traffic."

Paragraph 2.8.1., amend to read:

"2.8.1. ~~"Total engine power" means the sum of all power from available propulsion sources.~~

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."

Paragraph 2.24., table, amend to read:

"2.24. Table of symbols

Symbol	Unit	Annex	Paragraph	Explanation
...
BB'	—	Annex 3	3.1.1.	line perpendicular to vehicle travel which indicates end of zone in which to record sound pressure level during test is 10 m behind line PP'
v _{AA'}	km/h	Annex 3	3.1.2.1.2.	vehicle velocity when the reference point passes line AA' (see paragraph 2.11.5.1. for definition of reference point); value to be reported and used for calculations to the first decimal place
v _{BB'}	km/h	Annex 3	3.1.2.1.2.	vehicle velocity when the reference point or rear of the vehicle passes line BB' (see paragraph 2.11.5.1. for definition of reference point); value to be reported and used for calculations to the first decimal place
v _{PP'}	km/h	Annex 3	3.1.2.1.2.	vehicle velocity when the reference point

				passes line PP' (see paragraph 2.11. 5.1. for definition of reference point); value to be reported and used for calculations to the first decimal place
...
m_t (2 axles virtual)	kg	Annex 3	2.2.7.4.	test mass of a virtual vehicle with two axles (4x2 or 4x4)
V_{rf}	—	Annex 3	2.2.7.4.	vehicle with more than two axles representing the vehicle family
m_{unladen} (2 axles virtual)	kg	Annex 3	2.2.7.4.	unladen vehicle mass of the virtual vehicle with two axles
m_{xload} (2 axles virtual)	kg	Annex 3	2.2.7.4.	extra loading for the virtual vehicle with two axles
m_{ac ra max} (chosen)	kg	Annex 3	2.2.7.4.	Technically permissible maximum laden mass allowed for the chosen rear axle as defined in paragraph 2.2.7.4. in Annex 3

"

Add a new paragraph 2.27. to read:

"2.27. "Kickdown" means a driver initiated automated gear shift to a test condition outside the specific target conditions for the vehicle as defined in Annex 3."

Add a new paragraph 2.28. to read:

"2.28. "Prevention of downshift" means a measure by the vehicle manufacturer to ensure that the vehicle is tested within its specific target conditions as defined in Annex 3 and Annex 7."

Paragraph 3.3., amend to read:

"3.3. In the case of paragraph 2.2.2. the single vehicle, representative of the type in question, will be selected by the Technical Service conducting approval tests, in accordance with the vehicle manufacturer, ~~as that with the lowest mass in running order with the shortest length and~~ following the specification laid down in paragraph 3.1.2.2. in Annex 3."

Paragraph 6.2.3., amend to read:

"6.2.3. Additional sound emission provisions

The Additional Sound Emission Provisions (ASEP) apply only to vehicles of categories M₁ and N₁ equipped with an internal combustion engine, **which is operational within the control range of Annex 7.**

..."

Annex 1, Appendix 1, paragraph 2.3.3., amend to read:

"2.3.3. If applicable, ~~P~~pre-acceleration length IPA (Point of the ~~acceleration~~ accelerator depression in meter before line AA'). **If the pre-acceleration length differs per gear, reporting per gear is required."**

Annex 1,

Appendix 2,

Add a new paragraph 0.2.to read:

"0.2. Type:"

The existing paragraphs 0.2. to 0.6., renumber as 0.3. to 0.7. accordingly.

Add a new paragraph 3.2.6. and subparagraphs to read:

"3.2.6. Pressure charger(s)

3.2.6.1. Make(s):

3.2.6.2. Type(s):"

Annex 3,

Paragraph 2.1., amend to read:

2.1. ...
 The meteorological instrumentation should be positioned adjacent to the test area at a height of 1.2 m ± 0.02 m. The measurements shall be made when the ambient air temperature is within the range from 5 °C to 40 °C.

Tests carried out on request of the manufacturer at temperatures below 5° C shall be accepted as well.

...

Paragraph 2.2.1., table, amend to read:

"2.2.1. ...

Vehicle category	Vehicle test mass
M ₁	$m_t = m_{ro} \pm 5\%$ The test mass m_t of the vehicle shall be between $m_{ro} - 10\%$ and $m_{ro} + 20\%$
N ₁	$m_t = m_{ro} \pm 5\%$ The test mass m_t of the vehicle shall be between $m_{ro} - 10\%$ and $m_{ro} + 20\%$
N ₂ , N ₃	$m_{target} = 50 \text{ [kg/kW]} \times P_n \text{ [kW]}$ Extra loading, m_{load} , to reach the target mass, m_{target} , of the vehicle shall be placed above the rear axle(s). The target mass m_{target} shall be achieved with a tolerance of ±5 per cent. The sum of the extra loading and the rear axle load in an unladen condition, $m_{ra \text{ load unladen}}$, is limited to 75 per cent of the technically permissible maximum laden mass allowed for the rear axle, $m_{ac \text{ ra max}}$. The target mass shall be achieved with a tolerance of ±5 per cent. If the test mass m_t is lower than the target mass, the test mass shall be achieved with a tolerance of ±5 per cent. If the centre of gravity of the extra loading cannot be aligned with the centre of the rear axle, the test mass, m_t , of the vehicle shall not

	<p>exceed the sum of the front axle in an unladen condition, $m_{fa \text{ load unladen}}$, and the rear axle load in an unladen condition, $m_{ra \text{ load unladen}}$ plus the extra loading, m_{xload}, and the mass of the driver m_d.</p> <p>The test mass for vehicles with more than two axles shall be the same as for a two-axle vehicle.</p> <p>If the vehicle mass of a vehicle with more than two axles in an unladen condition, $m_{unladen}$, is greater than the test mass for the two-axle vehicle, then this vehicle shall be tested without extra loading.</p> <p>If the vehicle mass of a vehicle with two axles, $m_{unladen}$, is greater than the target mass, then this vehicle shall be tested without extra loading.</p>
M₂ (M ≤ 3,500 kg)	<p>$m_t = m_{ro}$</p> <p>The test mass m_t of the vehicle shall be between m_{ro} -10% and m_{ro} +20%</p>
Complete M ₂ (M > 3,500 kg), M ₃	<p>If the tests are carried out with a complete vehicle having a bodywork,</p> <p>$m_{target} = 50 \text{ [kg/kW]} \times P_n \text{ [kW]}$ is calculated in compliance with conditions above (see N₂, N₃ category)</p> <p>or</p> <p>$m_t = m_{ro}$</p> <p>The mass in running order shall be achieved with a tolerance of ±10%.</p> <p>The test mass m_t of the vehicle shall be achieved with a tolerance between - 10% and + 10% of m_{ro}.</p>
Incomplete M ₂ (M > 3,500 kg), M ₃	<p>If the tests are carried with an incomplete vehicle not having a bodywork,</p> <p>$m_{target} = 50 \text{ [kg/kW]} \times P_n \text{ [kW]}$ is calculated in compliance with conditions above (see N₂, N₃ category),</p> <p>or</p> <p>$m_t = m_{chassisM2M3} + m_{xloadM2M3} = m_{ro}$</p> <p>The mass in running order shall be achieved with a tolerance of ±10%.</p> <p>The test mass m_t of the vehicle shall be achieved with a tolerance between - 10% and + 10% of m_{ro}.</p>

"

Paragraph 2.2.7.1., amend to read:

"2.2.7.1. Calculation of extra loading

...

In this case, the test mass of the vehicle is lower than the target mass

$$m_t < m_{target} \quad (13)$$

The test mass, m_t , shall be achieved with a tolerance of ±5 per cent."

Add a new paragraph 2.2.7.4. to read:

2.2.7.4. Calculation of the test mass of a virtual vehicle with two axes

When a vehicle family is not represented by a two-axle vehicle because it is physically not available, the vehicle family can be represented by a vehicle with more than two axes (vrf). In that case the test mass of a virtual two-axle vehicle (m_t (2 axes virtual)) can be calculated in the following way:

Take from the vehicle with more than two axes (vrf), the measured unladen front axle load (m_{fa} (vrf) load unladen) and the measured unladen rear axle load (m_{ra} (vrf) load unladen) of that driven rear axle (m_{ra} (vrf) load unladen) which has the highest unladen load for the calculation of the unladen vehicle mass of the virtual two-axle vehicle ($m_{unladen}$ (2 axes virtual)).

If the vehicle (vrf) has more than one front axle, take the one with the highest unladen front axle load.

$$\rightarrow m_{unladen} (2 \text{ axes virtual}) = m_{fa} (vrf) \text{ load unladen} + m_{ra} (vrf) \text{ load unladen}$$

$$\rightarrow m_{xload} (2 \text{ axes virtual}) = m_{target} - (m_d + m_{unladen} (2 \text{ axes virtual}))$$

Due to the requirement that the sum of the extra loading (m_{xload} (2 axes virtual)) and the unladen rear axle load, m_{ra} (vrf) load unladen, is limited to 75 % of the technically permissible maximum laden mass allowed for the rear axle, $m_{ac\ ra\ max}$ (2 axes virtual), this value, $m_{ac\ ra\ max}$ (2 axes virtual), has to be chosen in such a way that it represents the rear axle of the forecasted highest production-volume in the manufacture's variation with a technically permissible maximum laden mass allowed for the rear axle ($m_{ac\ ra\ max}$ (chosen)) for the vehicle family as declared by the manufacturer.

$$\rightarrow m_{ac\ ra\ max} (4x2 \text{ virtual}) = m_{ac\ ra\ max} (chosen)$$

$$\text{If } m_{xload} (2 \text{ axes virtual}) \leq 0,75 m_{ac\ ra\ max} (chosen) - m_{ra} (vrf) \text{ load unladen}$$

then

$$m_t (2 \text{ axes virtual}) = m_{xload} (2 \text{ axes virtual}) + m_d + m_{fa} (vrf) \text{ load unladen} + m_{ra} (vrf) \text{ load unladen}$$

and

$$m_t (2 \text{ axes virtual}) = m_{target}$$

$$\text{If } m_{xload} (2 \text{ axes virtual}) > 0,75 m_{ac\ ra\ max} (chosen) - m_{ra} (vrf) \text{ load unladen}$$

then

$$m_t (2 \text{ axes virtual}) = 0,75 m_{ac\ ra\ max} (chosen) + m_d + m_{fa} (vrf) \text{ load unladen}$$

and

$$m_t (2 \text{ axes virtual}) < m_{target}$$

The test mass of the vehicle with more than two axes representing the vehicle family is defined as followed:

$$m_t (vrf) = m_t (2 \text{ axes virtual})$$

and the extra loading is calculated as

$$m_{xload} (vrf) = m_t (2 \text{ axes virtual}) - m_d - m_{unladen} (vrf)$$

Paragraph 3.1.2.1., amend to read:

"3.1.2.1. Vehicles of category M₁, N₁ and M₂ ≤ 3,500 kg technically permissible maximum laden mass:

The path of the centreline of the vehicle shall follow line CC' as closely as possible throughout the entire test, from the approach to line AA' until the rear of the vehicle passes line BB' +20 m. If the vehicle is fitted with more than two-wheel drive, test it in the drive selection which is intended for normal road use.

...

~~If the vehicle is fitted with an auxiliary manual transmission or a multi-gear axle, the position used for normal urban driving shall be used.~~ In all cases, the gear ratios for slow movements, parking or braking shall be excluded.

..."

Paragraph 3.1.2.1.4.1. (e), amend to read:

"3.1.2.1.4.1. ...

(c) If the acceleration value of gear ratio *i* exceeds 2.0 m/s², the first gear ratio shall be used that gives an acceleration below 2.0 m/s² 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/s². 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}.

...

(e) If rated engine speed is exceeded in a gear ratio (***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 rated engine speed is exceeded in gear ratio (*i*) before the vehicle passes BB' and the vehicle test speed is equal to 40km/h, in this case, 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."

Add a new paragraph 3.1.2.1.4.3. to read:

"3.1.2.1.4.3. **Vehicles with only one gear ratio, like but not limited to Battery Electric Vehicles (BEV) and Fuel Cell Vehicles**

The gear selector position for forward driving shall be used. The acceleration value a_{wot test} shall be calculated as defined in paragraph 3.1.2.1.2.1.

The achieved acceleration a_{wot test} shall be greater or equal to a_{urban}.

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

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 3.1.2.1.5., amend to read:

"3.1.2.1.5. Acceleration test

The manufacturer shall define the position of the reference point in front of line AA' of fully depressing the accelerator. The accelerator shall be fully depressed (as rapidly as is practicable) when the reference point of the vehicle reaches the defined point. The accelerator shall be kept in this depressed condition until the rear of the vehicle reaches line BB'. The accelerator shall then be released as rapidly as possible. **The measurement reading shall not end before the rear of the vehicle is 20 m behind the BB' line.** The point of fully depressing the accelerator shall be reported in Addendum to the Communication form (Annex 1, Appendix 1). The Technical Service shall have the possibility of pretesting.

If the vehicle length was set according to the provisions of 3.1.2.1.2. the accelerator shall be kept in the depressed condition until the reference point reaches BB' + 5 m for front engine vehicles, and BB' + 2.5 m for mid-engine vehicles.

..."

Paragraph 3.2.3., amend to read:

"3.2.3. Test site - local conditions (see Appendix of Annex 3, Figure **23a**)"

Paragraph 3.2.5.3., amend to read:

"3.2.5.3. Measuring of noise in proximity to the exhaust (see Appendix of Annex 3, Figure **23b to 3d**)"

Annex 4, paragraph 1., amend to read:

"1. General

...

Unless one of these conditions is fulfilled, the complete silencing system or components thereof shall be submitted to a conventional conditioning using one of three installations and procedures described below, **or - on request of the manufacturer - by removing the fibrous materials from the silencer."**

Annex 6, paragraph 2.1., amend to read:

"2.1. The vehicle(s) under test shall be subjected to the test for measurement of sound of vehicle in motion as described in paragraph 3.1. of Annex 3.

For vehicles of category M_1 , N_1 and $M_2 \leq 3,500$ kg technically permissible maximum laden mass,

- **the same mode, gear(s)/gear ratio(s), gear weighting factor k and partial power factor k_p as determined during the type approval process.**
- **the test mass m_t of the vehicle shall be between $m_{ro} -10\%$ and $m_{ro} +20\%$ "**

Annex 6, paragraph 3., amend to read:

"3. Sampling and evaluation of the results

One vehicle shall be chosen and subjected to the tests set out in point 2. If the sound level of the vehicle tested does not exceed by more than 1 dB(A) the limit value ~~prescribed in Annex 3~~ **specified in paragraph 6.2.2. of this Regulation**, and, where appropriate, paragraph 3. of Annex 5, the vehicle type shall be considered to conform to the requirements of this Regulation.

..."

II. Justification

Paragraph 1.

1. The scope was originally drafted for the Annex 3 test, which refers to normal urban driving. The proposed additional sentence covers the intention of Annex 7.

Paragraph 2.8.1.

2. We suggest adopting the wording from standard ISO 362-1:2015, because its specification is much clearer. If an electric motor is not operational during the type approval tests, then its power must not contribute to the calculation of the power to mass ratio (PMR).

Paragraph 2.24., table

3. The amendments regarding paragraph 2.2.7.4. of Annex 3 were made, because paragraph 2.2.7.4. is a new paragraph.

4. The amendments were also made for line BB' to reflect that the measurement will not end after line BB'. For the speeds $v_{AA'}$, $v_{BB'}$ and $v_{PP'}$, a wrong reference coming from ISO was corrected.

Paragraph 2.27.

5. A new definition of "kickdown" was introduced, because it is used in this Regulation. With a large variety of products, it is unclear what "kickdown" exactly means. This definition is a design neutral approach and reflects the intention of Annex 3 and Annex 7.

Paragraph 2.28.

6. Prevention of downshift is a legal measure to ensure that the vehicle can be tested within the test conditions as specified by this Regulation.

Paragraph 3.3.

7. Due to the requirement that the vehicles have to be loaded in order to be able to achieve the urban driving conditions as described in paragraph 3.1.2.2. of Annex 3, this sentence has no meaning. It was already deleted in Regulation (EU) No. 540/2014 for the same reason.

Paragraph 6.2.3.

8. The current specification requires a hybrid vehicle to be assessed according to the additional sound emission provisions (ASEP), although such a vehicle does not have the internal combustion engine (ICE) running within the control range of Annex 7. There will be no valid test result. Such vehicles should be exempted from ASEP.

Annex 1, Appendix 1

9. For the test method according to 3.1.2.1 the pre-acceleration length may differ per gear ratio. In this case, it is necessary to report the pre-acceleration length per gear ratio.

Annex 1, Appendix 2

10. Missing elements of the information document have been added, namely "0.2. type" and "3.2.6. pressure charger(s)".

Annex 3, paragraph 2.1.

11. Lower temperatures will lead to slightly higher test results due to an increased tyre rolling sound. Thus, testing at lower temperatures will be a disadvantage for the manufacturer. If for practical reasons the manufacturer wishes to carry out tests at lower temperatures, this shall be accepted by the type approval authority.

Annex 3, paragraph 2.2.1.

12. For M_1 and N_1 , the current provision has led to ambiguities about its meaning. The proposed new sentence clarifies the meaning. Further, the tolerances are broadened, as research shows, that the impact of the test mass can be neglected in a wide range.

13. For M_2 , M_3 , N_2 and N_3 , the current provision has led to ambiguities about its meaning. The proposed new sentence clarifies the meaning. If the test mass of the vehicle is equal to the target mass, the target mass shall be achieved with a tolerance of ± 5 per cent according to equation (2) in paragraph 2.2.7.1. of Annex 3. Consequently this has to be valid also for the test mass m_t . If the test mass of the vehicle is lower than the target mass according to equation (12) and (13) in paragraph 2.2.7.1. of Annex 3, the test mass shall be achieved with a tolerance of ± 5 per cent.

14. Concerning M_2 and M_3 , for clarification and to avoid misunderstanding, the loading conditions for complete vehicles of category M_2 ($M > 3,500$ kg) and M_3 were aligned with the requirements for incomplete vehicles of category M_2 ($M > 3,500$ kg) and M_3 . As a consequence, vehicles of category M_2 ($M \leq 3,500$ kg) have to be added to the table and their test mass requirement has to be aligned with those of vehicles of category M_1 and N_1 .

Annex 3, paragraph 2.2.7.1.

15. See the above justification for M_2 , M_3 , N_2 and N_3 in paragraph 2.2.1.

Annex 3, paragraph 2.2.7.4.

16. If a manufacturer does not produce vehicles with two axles only, he is not able to calculate the right test mass for his vehicles with more than two axles. For calculating the test mass, a vehicle with two axles has to be put on a scale to measure the unladen front axle load, $m_{fa \text{ load unladen}}$, and the unladen rear axle load, $m_{ra \text{ load unladen}}$, for being able to calculate m_{unladen} as given in formula (3) of paragraph 2.2.7.1. of Annex 3.

17. This new paragraph provides a procedure for calculating the test mass of a virtual vehicles with two axles, based on an existing vehicle with more than two axles, when a vehicle with two axles is physically not available to be put on a scale.

Annex 3, paragraph 3.1.2.1.

18. This proposed change will extend the measurement to a position where misfiring is detectable.

19. The deleted sentence is redundant, see 2.2.4.

Annex 3, paragraph 1.1.2.1.4.1. (d)

20. The introduced numbering was added for clarity and overcomes ambiguities in gear usage in case one gear ratio is above 2 m/s^2 and the other below a_{urban} .

Annex 3, paragraph 1.1.2.1.4.1. (e)

21. The suggested changes give more clarification about the proper setup for testing for vehicles with very short gear ratios.

Annex 3, paragraph 3.1.2.1.4.3.

22. This paragraph provides the proper specifications for vehicles with only one gear ratio.

Annex 3, paragraph 3.1.2.1.5.

23. This provision helps simplify the testing and has no impact on the test result. With a fixed vehicle length, it is not necessary to adjust the test equipment (light barriers, pylons) for each vehicle anew.

Annex 3, paragraph 3.2.3.

24. Correction of a wrong reference.

Annex 3, paragraph 3.2.5.3.

25. Correction of a wrong reference.

Annex 4, paragraph 1.

26. The performance of the fibrous material can be checked by complete removing of the fibrous material. This easy possibility was lost when revising Annex 5 of the 02 series of amendments to Regulation No. 51.

Annex 6, paragraph 2.1.

27. During the conformity of production procedures (CoP), neither vehicle nor tyres will have a proper pre-conditioning. In many cases, the vehicles are foiled and parts may be missing as theft protection. It is very unlikely that the vehicles will have already the same performance as the type approval vehicle. This will help simplify the CoP testing as well. This provision adopts the specifications from the revised ASEP provisions (Informal document GRB-65-26, Annex 7, para. 1).

28. In addition, the range of masses was broadened in the same way as proposed for type approval.

Annex 6, paragraph 3.

29. Correction of a wrong reference.
