Transmitted by the experts of OICA

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agenda item 3.

Proposal for a supplement 11 to the 03 series of amendments to UN Regulation No. 51

This proposal concerns to amendments to Annex 7 of UN Regulation No. 51. The proposed changes are based on the 03 series of amendment to UN Regulation No. 51 up to Supplement 09. The modifications are marked in bold for new or strikethrough for deleted characters.

I. Proposal

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 M_1 and N_1 ~~equipped with an internal combustion engine~~.

Vehicles are deemed to fulfil the requirements of Annex 7, if the vehicle manufacturer provides technical documents to the type approval authority showing, that the difference between maximum and minimum engine speed of the vehicles at BB' for any test condition inside the ASEP control range defined in paragraph 2.3. of Annex 7 to this Regulation (including Annex 3 conditions) does not exceed 0.15 x S. This article is intended especially for non-lockable transmissions with variable gear ratios (CVT).

Vehicles are exempted from ASEP if one of the following conditions is fulfilled:

(a)   For vehicles of category N_1, if the engine capacity does not exceed 660 cc and the power-to-mass ratio PMR calculated by using the technically permissible maximum laden mass does not exceed 35.

(b)   For vehicles of category N_1, if the payload is at least 850 kg and the power-to-mass ratio calculated by using the technically permissible maximum laden mass does not exceed 40.

(c)   For vehicles of category N_1 or M_1 derived from N_1, if the technically permissible maximum laden mass is greater than 2.5 tons and the R-point height is greater than 850 mm from the ground and the power- to-mass ratio calculated by using the technically permissible maximum laden mass does not exceed 40.

(d)   For vehicles of category M_1 or N_1 with propulsion technologies other than combustion engines and equipped with exterior sound enhancement systems, operating only as an Acoustic Vehicle Alerting System (AVAS)[1], if

-     **the maximum sound of the devices does not exceed the sound level of 75 dB(A)[2] in the speed range up to and equal 50 km/h and;**
-     **the exterior sound enhancement systems are switched off at any vehicle speed higher than 50 km/h.**

The sound emission of the vehicle under typical on-road driving conditions, which are different from those under which the type-approval test set out in

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[1] as defined in UN Regulation No. 138 paragraph 2.,
[2] measured according to Annex 3 of UN Regulation No. 138

Annex 3 and Annex 7 was carried out, shall not deviate from the test result in a significant manner.[3]

Any ~~electric~~ sound enhancement system for the purpose of the exterior sound emission shall be operational during the type-approval test."

Add new paragraph 11.17., to read:

"11.17. **Supplement 11 does not apply to existing type approvals and its extensions, granted prior to the date of entry into force of Supplement 11."**

Annex 7

Add new paragraph 1.1., to read:

"1.1. **Vehicles with propulsion technologies other than combustion engines, not exempted by item (d) of paragraph 6.2.3. of the main body, shall comply with Analysis method 1[4] only. The Analysis method 2[5] and the Reference sound assessment[6] are not applicable for these vehicles.**

Manufacturers of vehicles according to this paragraph shall provide a statement of compliance for ASEP based on the slope assessment only, confirming that the vehicle when tested with any acceleration up to 5m/s² does comply with the specifications described in paragraph 3.5. of this Annex."

Paragraph 2.3., amend to read:

"2.3.   Control range

The ASEP requirements apply to every gear ratio κ that leads to test results within the control range as defined below.

Vehicle speed V_{AA_ASEP}: $v_{AA} \geq 20$ km/h

Vehicle acceleration a_{WOT_ASEP}: $a_{WOT} \leq 5.0$ m/s^2

Engine speed n_{BB_ASEP}: $n_{BB} \leq 2.0 * PMR^{-0.222} * S$ or

$n_{BB} \leq 0.9 * S$, whichever is the lowest

For vehicles according to paragraph 1.1. of this annex,

-     **the engine speed specifications are not applicable and**
-     **the manufacturer may take measures to achieve an acceleration a_{WOT_ASEP} within the acceleration control range.**

Table 1 in Appendix 1 to Annex 3 provides examples for valid measures to enable a test condition within the above specified acceleration boundaries. Any measure used by manufacturer for the above-mentioned purposes shall be documented in the test report.

Vehicle speed V_{BB_ASEP}:

If the vehicle, in the lowest valid gear does not achieve the maximum engine speed n_{BB_ASEP} below 70 km/h, increase the vehicle speed in that gear to reach the maximum engine speed n_{BB_ASEP}, but not beyond 80 km/h.

For any other gear, the maximum vehicle speed is 70 km/h.

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[3] See document GRB-68-03 as guidance for technical interpretation. The document can be found in https://unece.org/documents-reference-only-0
[4] Slope assessment, described in paragraph 3. of this Annex
[5] L_{urban} assessment, described in paragraph 4. of this Annex
[6] described in paragraph 5. of this Annex.

For vehicles tested in non-locked transmission conditions, **and for vehicles according to paragraph 1.1. of this Annex,** the maximum vehicle speed is 80 km/h.

Gears $\kappa \leq$ gear i as determined in Annex 3

Transmission conditions:

Annex 3 gear selection	*Annex 7 gear selection*
Locked	Gear_i, $\text{gear}_{i-1},\ldots$
Non-locked	Non-locked

"

Paragraph 2.5.2., amend to read:

"2.5.2.   Measurements reading:

Per test point, one single run is carried out.

For every separate test run, the following parameters shall be determined and noted:

The maximum A-weighted sound pressure level of both sides of the vehicle, indicated during each passage of the vehicle according to paragraph 3.1.2.1.5. of Annex 3, shall be mathematically rounded to the first decimal place ($L_{wot,\kappa j}$). If a sound peak obviously out of character with the general sound pressure level is observed, the measurement shall be discarded. Left and right side may be measured simultaneously or separately. For further processing, the higher sound pressure level of both sides shall be used.

The vehicle speed readings at AA', PP' and BB' shall be rounded and reported with the first significant digit after the decimal place. ($v_{AA,\kappa j}$; $v_{PP,\kappa j}$; $v_{BB,\kappa j}$)

If applicable, the engine speed readings at BB' shall be reported as a full integer value ($n_{BB,\kappa j}$).

In case of vehicles according to paragraph 1.1. of this Annex:

The engine speeds for the calculation of the slope in the paragraphs 3.2. and 3.3. is calculated from the vehicle speeds $v_{BB,\kappa j}$ **by the formula**

$$n_{BB,\kappa j} = 1000 * v_{BB,\kappa j}/[xx]$$ **and mathematically rounded to the nearest integer."**

Paragraph 3.1., amend to read:

"3.1.   Determination of the anchor point

The anchor point is the same for each gear ratio κ falling under the control range according to paragraph 2.3. The parameters for the anchor point are taken from the acceleration test of Annex 3 as follows:

In the case the test has been carried out with two gear ratios:

L_{anchor} is the higher sound pressure level of $L_{wot,(i)}$ of left and right side of gear ratio i;

n_{anchor} is the average of $n_{BB,wot}$ of the 4 runs of gear ratio i reported from Annex 3;

In the case the test has been carried out in a single gear:

L_{anchor} is the higher sound pressure level of L_{wot} of left and right side of gear ratio selected for the test;

n_{anchor} is the average of $n_{BB,wot}$ of the 4 runs of gear ratio selected for the test reported from Annex 3;

In the case of vehicles according to paragraph 1.1. of this Annex:

L_{anchor} is the higher sound pressure level of L_{wot} of left and right side of gear ratio selected for the test;

n_{anchor} is calculated from the average vehicle speed $v_{BB,wot}$ of the 4 runs of gear ratio selected for the test reported from Annex 3 by the formula

$$n_{anchor} = 1000 * v_{BB,wot}/[xx]$$ **and mathematically rounded to the nearest integer."**

Paragraph 3.2.1., amend to read:

"3.2.1.   Calculation of the slope of the regression line for each gear ratio κ

The linear regression line is calculated using the anchor point and the four correlated additional measurements with the results for engine speeds and sound levels as reported under 2.5.2. of this annex.

$$Slope_k = \frac{\sum_{j=1}^{5}(n_j - \overline{n})(L_j - \overline{L})}{\sum_{j=1}^{5}(n_j - \overline{n})^2} \quad \text{(in dB(A)/1,000 min}^{-1})$$

With $\quad \overline{L} = \frac{1}{5}\sum_{j=1}^{5}L_j \quad$ and $\quad \overline{n} = \frac{1}{5}\sum_{j=1}^{5}n_j \quad$;

Where n_j = engine speed measured at line BB'

For vehicles according to paragraph 1.1 of this annex, a constant value of $Slope_κ = 5$ dB/1,000 min^{-1} shall be considered for further calculation."

II. Justification

1. Paragraph 6.2.3. Additional sound emission provisions

By introducing ASEP in Annex 7 in 2016 the scope was limited to vehicles with internal combustion engines (ICE) based on the experience of variabilities in the exhaust silencing systems. Electric driven vehicles have been exempted from ASEP.

For electric driven vehicles the new UN Regulation No. 138, dealing with the reduced audibility of these vehicles, was worked out until 2017. At that moment no one expected sound enhancement systems beyond the scope and aim of UN R138.

This proposal is an approach to address the concern that electric vehicles might be equipped with sound enhancement systems beyond the scope and aim of UN R138. This proposal does not require any changes to UN R138.01. This proposal is given as a supplement to enable the quickest entry into force, providing all manufacturers clear direction on the design of sound enhancement systems.

UN R138 should remain a safety regulation, this environmental concern is properly addressed by UN R51.03.

Therefore, OICA proposes to apply ASEP to any vehicle which has a sound enhancement system operating outside the scope of UN R138. As the border of operation is not clear in UN R138.01, this proposal has added a definition for a border to paragraph 6.2.3. (see item (d)) based on the state of discussion of the TF QRTV.

The definition given in 6.2.3 (d) requires limits for maximum sound pressure levels of the AVAS device only. Therefore, measuring methods with a complete vehicle in standstill (Method B and D in UN Regulation No. 138 Annex 3) might be needed, since tyre noise alone can exceed the maximum limits proposed and measured in R138.02 in the speed range up to and equal 50 km/h when measured as a full vehicle (Method A).

The aim of this proposal is to be effective and simple to enable the implementation as a supplement. OICA deems this feasible as it will affect only software and not hardware changes.

2. Paragraph 11.17. Transitional Provisions

The transitional period of 12 months is necessary to enable manufacturer – if applicable - to develop and implement software changes inclusive their validation and certification.

These changes will not be applied to existing type approvals and its extensions, granted prior to the date of entry into force of this Supplement, since the introduction of electric vehicles should not be hampered.

On the other hand, a fast implementation will support that all manufacturers will have clear direction on the design of sound enhancement systems.

Therefore, OICA proposes that manufacturers – if applicable – use the time between 80th GRBP in September 2024 and the estimated entry into force of this supplement in October 2025 as the needed transitional period of 12 months.

3. Annex 7, new paragraph 1.1.

The extension of ASEP to electric vehicles requires changes in the Annex 7 to enable the evaluation of such vehicles according to ASEP.

Due to the high acceleration potential of electric vehicles, the L_{urban} assessment (Analysis method 2) would bring unnecessary flexibility.

The Reference Sound Assessment is not necessary, as it is based on UN R51.02 with very high limits values compared to the current technology of electric vehicles.

Therefore, ASEP evaluation should be limited to the Analysis method 1 (Slope assessment) method only.

4. *Annex 7, paragraph 2.3. Control range.*

Since the used engine speeds for propelling electrical vehicles are different to the used engine speeds of ICE vehicles, the engine speed specifications are not applicable here.

While acceleration of ICE vehicles is limited by selecting the gear to be measured, in the case of electric vehicles, it might be necessary to limit acceleration to 5 m/s² to allow ASEP test.

Due to the lack of different gear ratios, it is possible to limit acceleration with alternative measures. These alternative measures have already been established in Annex 3.

5. *Annex 7, paragraph 2.5.2. Measurement readings*

A virtual engine speed is introduced based on the vehicle speed. With this virtual engine speed, the Analysis method 1 (Slope assessment) can be used without changes.

The value of this virtual gear ratio must be evaluated with the whole range of electric vehicles by manufacturer measurements in the speed range up to 80 km/h. Due to the weather conditions this evaluation will be performed in spring 2024.

6. *Annex 7, paragraph 3.1. Determination of the anchor point*

For the determination of the anchor point engine speed, the virtual engine speed introduced in paragraph 2.5.2 is also used.

7. *Annex 7, paragraph 3.2.1. Calculation of the slope of the regression line for each gear ratio κ*

AVAS Levels are regulated in UN-R138. To create a handshake between UN-R138 and UN-R51 Annex 7 at 20 km/h, OICA proposes to use a constant value of 5 dB/1,000 min^{-1} for Slope$_k$.

With Slope$_k$ set to the maximum value, most ambitious ASEP Limits are created between 20 to 50 km/h with 4 dB/1,000 min^{-1}.
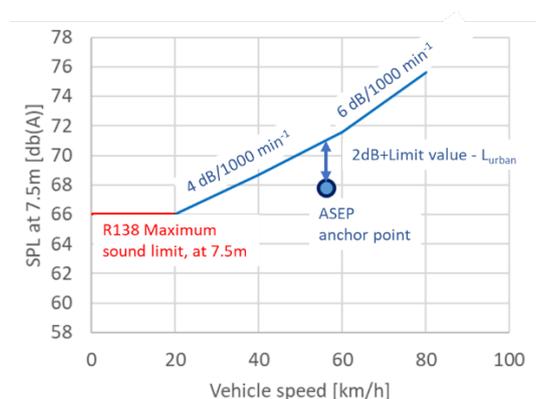
When set with a limit for L$_{urban}$ at 68 dB(A) for a vehicle with a non-locked transmission, this value of Slope$_k$ provides limit values that match the value of 66 dB(A) at 20 km/h, which is the equivalent of the 75 dB(A) limit for maximum sound level in UN Regulation 138. This handshake is illustrated in the figure above.