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World Forum for Harmonization of Vehicle Regulations

Working Party on Noise

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Item n° … of the provisional agenda

REGULATION No. 51

Proposal for amendments to Regulation No. 51

Submitted by the expert from the OICA */

This proposal was transmitted by the expert from OICA in order to incorporate the Additional Sound Emissions Provisions

The document is based on TRANS/WP.29/GRB/2005/2/Rev.1 from 4 April 2005

The modifications to the current text of the Regulation are marked in **blue bold** or ~~strikethrough~~ characters. Comments by OICA are marked in *red*

*/ In accordance with the programme of work of the Inland Transport Committee for 2006-2010 (ECE/TRANS/166/Add.1, programme activity 02.4), the World Forum will develop, harmonize and update Regulations in order to enhance performance of vehicles. The present document is submitted in conformity with that mandate.

A. *PROPOSAL*

The list of contents and annexes, amend to read:

[…]

6.2.3. Additional sound emission provisions

The additional sound emission provisions apply to vehicles of categories M1.

They are preventive requirements intended to also cover driving conditions of the vehicle in real traffic, which can be environmentally relevant concerning their sound emission and which differs from those during type approval, described in Annex 3.

6.2.3.1. The vehicle manufacturer shall not intentionally alter, adjust, or introduce any mechanical, electrical, thermal, or other device or procedure solely for the purpose of fulfilling the noise emission requirements as specified in this regulation and as determined by the test procedure of Annex 3 but which will not be operational during typical on-road operation. These measures are commonly referred to as "cycle detection".

6.2.3.2. Any control device, function, system or measure that could affect the noise output may be installed on a vehicle provided that:

- it is activated only for such purposes as engine protection, cold starting or warming up, or
- it is activated only for such purposes as operational security or safety and limp-home strategies, or
- it is required to fulfil this and/or other regulations

6.2.3.3. The sound emission of the vehicle under normal driving conditions different from the conditions of the type approval test in Annex 3 shall not differ considerably from what can be expected from the type approval test result for this specific vehicle with regard to technical practicability. This is fulfilled if the requirements of Annex 10 are met.

…

[…]

8. CONFORMITY OF PRODUCTION

The conformity of production procedures shall comply with those set out in the Agreement, Appendix 2 (E/ECE/324-E/ECE/TRANS/505/Rev.2) with the following requirements:

8.1. Vehicles approved to this Regulation shall be so manufactured as to conform to the type approved by meeting the requirements set forth in paragraph 6. above.
(Note: This paragraph formulates that any produced vehicle must comply to all requirements of paragraph 6 including ASEP)

8.2. The minimum requirements for conformity of production control procedures set forth in Annex 7 to this Regulation shall be complied with.
(Note: Annex 7 regulates, which measurements are part of a production control process. All produced vehicles have to comply with ASEP but need not be tested, unless a manufacturer decide to do so on a voluntary base.)

8.3. The authority which has granted type approval may at any time verify the conformity control methods applied in each production facility. The normal frequency of these verifications shall be one every two years.
(Note: In addition the 58 Agreement says:
"The approval authority may carry out any check or test prescribed... [] ... in the applicable Regulation (ECE R 51) annexed to this Agreement."

For more clarity the group may decide to incorporate this sentence into the regulation 51)

[…]

Annex 1

(Maximum format: A4 (210 x 297 mm))

COMMUNICATION

[OICA: The Annex 1 communication form need to be extended for ASEP]

[...]

x.x Additional Sound Emission Provisions

Cross mark which method of verification was applied.

[ ] The specifications of paragraph 6.2.3 of the main body have been verified by testing according to annex 10 of this regulation. Based approval is granted with respect to ASEP. The test results have been added to the test report.

[ ] Statement of compliance
The manufacturer confirms that the presented vehicle representative for the type of vehicle to be type approved complies with the Additional Sound Emission Provisions specified in 6.2.3 of ECE R 51.

Signature of the manufacturer:.....

Approval is granted on the basis of this statement.

Annex 10

ADDITIONAL SOUND EMISSION PROVISIONS
applicable for M1 and N1 only

~~During development of the provisions for off cycle emissions the technical provisions of UNECE Regulation No. 51.02 series of amendments shall be fulfilled.]~~

1. General

1.1. Measuring instruments and conditions of measurement.

The measuring instrumentation and the measurement conditions are those as specified in Annex 3 paragraph 1 and 2.

The location of the microphones are those as set forth in Annex 3 paragraph 3.1.1

The test track specifications are those set forth in Annex 8.

2. Measuring method

2.1. [ASEP test area - boundary conditions

Some vehicles may have different software programs or modes which affect the acceleration behavior of the vehicle. The vehicle shall be tested in that mode that delivers the highest acceleration performance without deactivating safety features.

The range of valid operation conditions is defined as follow:

Vehicle speed:	**t.b.d.**
Vehicle acceleration:	**t.b.d.**
Engine Speed nAA_ASEP:	**t.b.d.**
Engine speed n_{BB_ASEP}:	**t.b.d.]**

(OICA: Proposals for boundary conditions have been made, but there was no detailed discussion on this topic up to now. As a general goal OICA aims for making the requirements as design neutral as possible.)

2.2 Conditions of Testing

2.2.1 Vehicles with manual transmissions, automatic transmissions, adaptive transmissions or CVT's tested with locked gear ratios
(OICA: Some definition for hybrids needed)

The tests shall be run in every gear ratio within the boundaries as defined in paragraph 2.1 in this Annex.

2.2.1.1 Test Point Definitions

Four valid measurements shall be carried out in each valid gear ratio, equally distributed between the reported engine speed at line BB for the lowest tested gear i of the acceleration tests in Annex 3 and the maximum test engine speed n_{BB_ASEP} as specified in 2.1 or that engine speed that is given by the maximum vehicle speed at line BB', whichever is lower.

The target engine speeds are given by the following formula:

Test Point P_k : $N_k = N_{BB\_}woti + k/4 * (N_{BB\_ASEP} - N_{BB\_woti})$ **for k = 1 to 4**

Tolerence for N_k**: +/- [150] min-1**

2.2.2 Vehicles with automatic transmissions, adaptive transmissions and CVT's tested with non-locked gear ratios and technologies where no engine speed as a sensible evaluation parameter is available

The test may include a gear ratio change to a lower range and a higher acceleration. A gear change to a higher range and a lower acceleration is not allowed. A gear shifting which leads to a condition that is not in compliance with the boundary conditions shall be avoided. In that case, it is permitted to establish and use electronic or mechanical devices, including alternate gear selector positions.

2.2.2.1 Test Point Definitions

Four valid measurements shall be carried out at the test points as specified below.

The first test point P_1 is defined by using an entry speed v_{AA} of 20 km/h. If a stable acceleration condition cannot be achieved the speed shall be increased in steps of 5 km/h until a stable acceleration is reached.

The other three test points are defined by the following formula:

Test Point P_k : $v_{BB\_k} = v_{BB\_1} + k/4 * (v_{BB\_1} - v_{BB\_max})$ **for k = 2 to 4**

where v_{BB_1} **= vehicle speed at BB' of test point** P_1

v_{BB_max} **= maximum vehicle speed as specified in 2.1.1**

Tolerance for v_{BB_k}**: +/- [5] km/h**

For all test points the boundary conditions as specified in 2.1 shall be met.

2.3. Test of the vehicle in motion

The path of the centerline 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'. 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.

At line AA' the accelerator shall be fully depressed as rapidly as possible.

To achieve a more stable acceleration between line AA' and BB' pre-acceleration before line AA' may be used.

The accelerator shall be kept in depressed condition until the rear of the vehicle reaches line BB'.

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

- **The maximum A-weighted sound pressure level indicated during each passage of the vehicle between the two lines AA' and BB', mathematically rounded to the first decimal place.** (L_k)

  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. The results of each side shall be evaluated separately.

- **The vehicle speed readings at AA' and BB' shall be reported with the first significant digit after the decimal place.**

- **If applicable, the engine speed readings at AA' and BB' shall be reported as a full integer value.**

3. Analysis and Interpretation of results

3.1. Determination of the anchor point for each gear ratio.

(OICA: Definition for anchor point is needed)

For measurements in gear ratio i the anchor point is the reported engine speed n_{woti} at BB' and the maximum sound level L_{woti} of gear ratio i of the acceleration test in Annex 3.

For any gear ratio different from gear ratio i a tyre rolling sound correction is needed for the sound level L_{wot}. For this correction the manufacturer may chose as the representative rolling sound $L_{rollrep}$

- **the tyre rolling sound of the specific tyre measured at 50 km/h, or**
- **the result of a cruise-by measurement in gear ratio i, i+1, i+2, ... measured as described in annex 3, paragraph 3.1.2.1.6**

The sound level is calculated by:

$$L_{WOT\ i\ corrected} = 10 * LOG(10^{(Lwoti/10)} - 10^{(Lrollrep/10)} + 10^{((32*LOG(ik/ii)+Lrollrep)/10)})$$

where i_k **= gear ratio of the tested gear in km/1000rpm**
i_i **= v_{BBi}/n_{woti} using the reported values for gear ratio i in Annex 3**
$L_{rollrep}$ **= representative rolling sound**

3.2. Calculation of the slope of the regression line for each gear.

3.2.1 Vehicles having a propulsion system with a sensible engine speed to vehicle speed relationship

The linear regression line is calculated using the anchor point(s) and the correlated additional measurements.

Slope_regression = cov(N,L)/V(N)

With $\mathrm{cov}(N,L) = \frac{1}{5}\sum_{i=1}\left(Ni - \overline{N}\right)\left(Li - \overline{L}\right)$;

$\overline{L} = \frac{1}{5}\sum_{k} L_k$;

$\overline{N} = \frac{1}{5}\sum_{k} N_k$;

And $V(N) = \frac{1}{5}\sum_{i=1}^{5}\left(N_i - \overline{N}\right)^2$ **, where N_i = engine speed measured at line BB'**

3.2.2 Vehicles having a propulsion system with no sensible engine speed to vehicle speed relationship

The linear regression line is calculated using the anchor point and the correlated additional measurements.

Slope_regression = cov(v,L)/V(V)

With $\text{cov}(V, L) = \frac{1}{5}\sum_{i=1}\left(Vi - \overline{V}\right)\left(Li - \overline{L}\right)$ **;**

$\overline{L} = \frac{1}{5}\sum_{k} L_k$ **;**

$\overline{V} = \frac{1}{5}\sum_{k} V_k$ **;**

And $V(V) = \frac{1}{5}\sum_{i=1}^{5}\left(V_i - \overline{V}\right)^2$ **, where V_i = vehicle speed measured at line BB'**

3.2.3 Slope for further calculation

The slope for the further calculation is the derived result of the calculation formulas under 3.2.1 or 3.2.2 rounded to the first decimal place, unless the below given borders are exceeded.

For gear ratios with an acceleration > [1,2 * a_{wotref}]
If *Slope_regression* > 6 then *Slope* = 6 is chosen as a representative slope
If *Slope_regression* < [3] then *Slope* = [3] is chosen as a representative slope

For gear ratios with an acceleration < [1,2 * a_{wotref}]
If *Slope_regression* > 7 then *Slope* = 7 is chosen as a representative slope
If *Slope_regression* < [4] then *Slope* = [4] is chosen as a representative slope

(OICA: Acceleration value for separation to be investigated)

3.2.1. Calculation of the linear noise level increase expected for each measurement

The sound level L_{target} shall be calculated using the engine speeds - respective vehicle speeds - measured for each point, using the Slope determined in 3.2 starting from the specific anchor point for each gear ratio.

$L_{target\_k} = L_{anchor\_k} + Slope_k * (N_{BB\_Pk} - N_{BB\_woti})$, or

$L_{target\_k} = L_{anchor\_k} + Slope_k * (v_{BB\_Pk} - v_{BB\_woti})$

Evaluation of the validity of a measured point:

The Requirements of Annex 10 are fulfilled if the difference between the expected sound level and the measured sound level for every measured point is within a range of [3] dB.

If $| L_{target} - L_k | < [3]$ dB(A) then ➔ ASEP conformity is reached

If the difference in a point exceeds the given tolerance of [3] dB two additional measurements may be carried out to verify the measurement uncertainty. The vehicle is still in compliance with ASEP, if the average of the valid measurements at this specific point fulfill the above specification.

B. JUSTIFICATION

GRB asked OICA to prepare a working document for their ASEP proposal.