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**Economic Commission for Europe**

Inland Transport Committee

**World Forum for Harmonization of Vehicle Regulations**

Working Party on Noise and Tyres

**Eightieth session**

Geneva, 17–20 September 2024

Item 3 of the provisional agenda

**UN Regulation No. 51 (Noise of M and N Categories of Vehicles)****Proposal for corrections to the 03 series of amendments to  
UN Regulation No. 51****Submitted by the experts from the International Organization of Motor  
Vehicle Manufacturers\***

This proposal concerns primarily 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 10. The modifications are marked in bold for new or strikethrough for deleted characters.

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\* In accordance with the programme of work of the Inland Transport Committee for 2024 as outlined in proposed programme budget for 2024 (A/78/6 (Sect. 20), table 20.5), 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

Add a new paragraph 2.29. to read:

- "2.29. **“Exterior sound enhancement system (ESES)” means an active system that is installed to a vehicle for producing exterior sound, such as but not limited to AVAS according to the definition of UN Regulation No. 138, sound actuators, either integrated into an exhaust silencing system or mounted as an individual unit.”**

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<sub>1</sub> and N<sub>1</sub> ~~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<sub>1</sub>, 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<sub>1</sub>, 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<sub>1</sub> or M<sub>1</sub> derived from N<sub>1</sub>, 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<sub>1</sub> or N<sub>1</sub> with propulsion technologies other than combustion engines and equipped with an ESES:**

**if the sound levels of the ESES under any vehicle operating condition do not exceed the following maximum sound requirements:**

- **75 dB(A) at any vehicle speed below or equal to 50 km/h**
- **55 dB(A) at any vehicle speed above 50 km/h**

**measured (at 2 m microphone distance), under the test procedures pursuant to the 02 series of amendments of UN Regulation No. 138, Annex 3, paragraph 3.3.2.**

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 Annex 3 and Annex 7 was carried out, shall not deviate from the test result in a significant manner.<sup>1</sup>

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<sup>1</sup> See recommendations provided by informal document GRB-68-03 as guidance for technical interpretation. The document can be found in <https://unece.org/documents-reference-only-0>.

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

*Paragraph 11.6.*, amend to read:

"11.6. Until 30 June 2028, vehicles with a serial hybrid drive train which have a combustion engine with no mechanical coupling to the power train are excluded from the requirements of paragraph 6.2.3. above, **provided those vehicles comply with the exemptions of item (d) of paragraph 6.2.3.**"

*Add new paragraphs 11.17. and 11.18.*, to read:

**"11.17. Supplement 10 does not apply to existing type approvals and their extensions, granted prior to the date of entry into force of Supplement 10.**

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

*Annex 3,*

*Paragraph 1.2.*, amend to read:

"1.2. ~~Calibration~~ **Daily verification and adjustment** of the entire Acoustic Measurement System for a Measurement Session

At the beginning ~~and at the end~~ of every measurement session, the entire acoustic measurement system shall be checked by means of a sound calibrator of at least precision Class 1 according to IEC 60942:2003, **and - if necessary - adjusted to the reference values given by the calibrator.**

**At the end of the measurement session, the entire acoustic measurement system shall be re-checked by the same calibrator which has been used for the calibration in the beginning.** Without any further adjustment, the difference between the readings **at the beginning and at the end** shall be less than or equal to 0.5 dB.

If ~~this value the difference~~ **is exceeded-greater than 0.5 dB**, the results of the **whole** measurements ~~session obtained after the previous satisfactory check~~ shall be discarded."

*Paragraph 2.2.3.3.*, amend to read:

"2.2.3.3. ~~Active Sound Systems~~ **Exterior Sound Enhancement Systems (ESES)**

Any ~~active sound devices~~ **ESES**, either for noise control, or sound enhancement, shall operate as foreseen by the vehicle manufacturer and not be interfered with during the measurements."

*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  $L_{PT,wot,j}$  from the reported acceleration test  $L_{wot,j}$ , by calculation.

$$L_{PT,wot,j} = 10 \times \lg(10^{0.1 \times L_{wot,j}} - 10^{0.1 \times L_{TR,wot,j,9wot}})$$

In case that

$$10^{0.1 \times L_{TR,wot,j,9wot}} \geq 0.99 \times 10^{0.1 \times L_{wot,j}}$$

the power train component  $L_{PT,wot,j}$  is determined by

$$L_{PT,wot,j} = 10 \times \lg(0.01 \times 10^{0.1 \times L_{wot,j}})$$

with  $L_{TR,wot,j,9wot}$  redefined as

$$L_{TR,wot,j,9wot} = 10 \times \lg(0.99 \times 10^{0.1 \times L_{wot,j}})$$

The redefined  $L_{TR,wot,j,9wot}$  shall then be subjected to temperature correction in ~~3.2.3~~ **3.3.3.** to obtain the corresponding  $L_{TR,wot,j,9ref}$ ."

Annex 7,

Add a 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<sup>2</sup> (Slope assessment method) only.**

**This shall apply as well to hybrid electric vehicles tested without an operating combustion engine.**

**Manufacturers of vehicles according to this paragraph shall provide a statement of compliance for ASEP, confirming that the vehicle complies with the specifications described in paragraph 3.5. of this Annex, when tested with any acceleration within the control range in paragraph 2.3."**

Paragraph 2.3., amend to read:

"2.3. Control range

The ASEP requirements apply to every gear ratio  $\kappa$  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<sup>2</sup>

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 above are not applicable.**

**The manufacturer shall 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.

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:

<i>Annex 3 gear selection</i>	<i>Annex 7 gear selection</i>
Locked	Gear, gear <sub>i-1</sub> ,...
Non-locked	Non-locked

<sup>2</sup> The Analysis method 2 (Lurban assessment) and the reference sound assessment are not applicable for these vehicles.

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 ( $L_{wot,kj}$ ). 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. ( $v_{AA,kj}$ ;  $v_{PP,kj}$ ;  $v_{BB,kj}$ )

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

**For vehicles according to paragraph 1.1. of this Annex the engine speed per test run shall be calculated by the formula below**

$$n_{BB,kj} = v_{BB,kj} / \left( 20 - 8 \times \log_{10} \left( \frac{a_{test}}{a_{anchor}} \right) \right) \times 1000$$

**for achieved accelerations  $a_{test} > a_{anchor}$ ; and**

$$n_{BB,kj} = v_{BB,kj} / 20 \times 1000$$

**for achieved accelerations  $a_{test} \leq a_{anchor}$**

**with  $a_{anchor} = a_{wot,test}$  of Annex 3 (average of 4 runs)**

**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 reported for the acceleration test in Annex 3 by the formula**

$$n_{anchor} = v_{BB,wot} / 20 \times 1000$$

**and mathematically rounded to the nearest integer."**

Paragraph 3.5., amend to read:

"3.5. Specifications

Every individual sound measurement shall be evaluated.

The sound level of every specified measurement point shall not exceed the limits given below:

$$L_{kj} \leq L_{ASEP_{kj}} + X$$

With:

$$X = 3 \text{ dB(A)} + \text{limit value}^3 - L_{urban} \text{ for vehicles tested with}$$

- for vehicles tested with non-locked transmission conditions **given by multiple gear ratios, or**

<sup>3</sup> As applicable for the approved type of vehicle

- for vehicles according to paragraph 1.1. of this Annex, having an  $L_{\text{crs\_rep}}$  greater than  $L_{\text{wot\_rep}}$  of Annex 3, or
- for vehicles according to paragraph 1.1. of this Annex, having multiple electric propulsion sources

$$x = 2 \text{ dB(A)} + \text{limit value}^d - L_{\text{urban}} \text{ of Annex 3 for all other vehicles}$$

If the measured sound level at a point exceeds the limit, two additional measurements at the same point shall be carried out to verify the measurement uncertainty. The vehicle is still in compliance with ASEP, if the average of the three valid measurements at this specific point fulfils the specification."

*Annex 9,*

*Paragraph 1.,* amend to read:

"1. General

The Real Driving Additional Sound Emission Provisions (RD-ASEP) apply only to vehicles of categories M1 and N1 equipped with:

- an internal combustion engine (ICE) for propulsion of the vehicle, or
- any other propulsion technology fitted with an ~~exterior sound enhancement system~~ **ESES**."

*Paragraph 2.2.,* delete.

*Paragraph 2.3.,* renumber to 2.2.:

"2.32. "*Deceleration*" means the vehicle deceleration stipulated by the release of the acceleration control unit only, without any driver applied braking (service brake, retarder, parking brake, etc...)."

*Paragraph 2.4.,* renumber to 2.3.:

"2.43. "*Performance*" means the product of acceleration and vehicle speed as quantity of the achieved vehicle performance."

*Paragraph 2.5.,* renumber and amend to read:

"2.54. "~~Power trains~~ **Powertrain**" means a propulsion system as combination of the energy storage system, the energy supply system and the powertrain according to the UN Mutual Resolution No. 2 (for example PEV, HEV, FCHEV)."

## II. Justification

*New paragraph 2.29., definition for a sound enhancement system*

1. This definition was elaborated by the Informal Working Group on Real Driving - Additional Sound Emission Provisions (IWG RD - ASEP) to introduce a legal definition for devices, which are primarily introduced to modify and enhance the exterior sound of a vehicle. Of course, this definition aims at avoiding including components, such as but not limited to fans or pumps that emit as well sound, but such devices serve primarily other functions.

*Paragraph 6.2.3. "Additional sound emission provisions"*

2. 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 vehicles (EVs) have been exempted from ASEP.

3. For electric driven vehicles the new UN Regulation No. 138, dealing with the reduced audibility of these vehicles, was worked out until 2017. In lack of experience, the IWG on Quiet Road Transport Vehicles (QRTV) left the door open to allow development of devices

<sup>4</sup> As applicable for the approved type of vehicle

according to the need for safety, as at that time the discussion about the maximum needed operation range for AVAS was not agreed.

4. While the last amendment to UN Regulation No. 138 extended its specification range for AVAS systems to 50 km/h, and in parallel request was raised to enhance the ASEP control range to speeds lower than 20 km/h, the two Regulations provide parallel specification for the same operation range.

5. UN Regulation No. 138 should remain a safety Regulation, and the environmental concerns should be addressed by the 03 series of amendments to UN Regulation No. 51.

6. Therefore, OICA proposes to apply ASEP to any vehicle having a sound enhancement system operational outside the scope of 02 series of amendments to UN Regulation No. 138.

7. A difficult question occurred, how to define “turned-off”, as manufacturer report, that a complete shutdown of an AVAS is not possible, for quick re-start when needed. The proposal is made to require an attenuation by at least 20 dB, which would result in a maximum sound level not higher than 55 dB(A) in 2m distance.

8. The aim of this proposal is to be effective and simple and to change as little as possible in the current ASEP concept. In the vision of OICA, this could be implemented as a Supplement to 03 series of amendments to UN Regulation No. 51. OICA deems this feasible as it will affect only software and not hardware changes.

*Paragraph 11.6. “Transitional provisions”*

9. As serial hybrid vehicles can be equipped with an ESES, they should not be totally exempted. In this amendment, the exemption clause is restricted to serial hybrid vehicles equipped with a sound device working as an AVAS only, i.e. that are exempted by the clause added in paragraph 6.2.3. item (d).

*Paragraph 11.17. and paragraph 11.18. “Transitional provisions”*

10. Because of slight changes (corrections) in the evaluation of the results introduced in Supplement 10, Annex 3 and of the new requirements introduced in this Supplement 11 Annex 7, paragraph 1.1. in comparison with Supplements up to Supplement 9, transitional provisions are needed.

*Annex 3, paragraph 1.2. “Calibration”*

11. This topic is not related to the prime intention of this Supplement 11, which is to cover EVs with ESES under ASEP. However, ambiguity did raise on the way of calibration, as the calibration is specified as a check of the system. However, due to changes of ambient condition, the data acquisition system may naturally drift and lead to values moving out of the calibration tolerance.

12. Before a measurement session, a validation of the measuring system is always necessary including an eventual adjustment to the reference values given by the calibrator. After a measurement session, a potential drift of the microphone calibration is re-checked. Here, without any further adjustment the system shall be within the 0,5 dB range, to validate the measurements which have been performed.

13. The procedure can be compared to the necessary tare function for scales, e.g. in supermarkets. Before the weight of goods is determined, customers expect that the scale is balanced to zero.

*Annex 3, paragraph 2.2.3.3.: reference to the definition of ESES*

14. As the definition of “*Exterior Sound Enhancement Systems*” is introduced in paragraph 2.29. of the main body, it is relevant to refer to it in this paragraph of Annex 3.

*Annex 3, appendix 2, paragraph 3.3.4.: correction of a wrong reference*

15. Supplement 10 brought a clarification to the calculation process making the separation between the contribution of the tyres and the contribution of the powertrain, avoiding adding uncertainty in the temperature correction process. However, the text of Supplement 10 included a false reference to paragraph 3.2.3. The proposed change is a correction to the right reference to paragraph 3.3.3.

*Annex 7, new paragraph 1.1.*

16. The extension of ASEP to battery electric vehicles (BEV) and hybrid electric vehicles (HEV) requires changes in Annex 7 to enable the evaluation of such vehicles according to ASEP.

17. The Reference Sound Assessment is not necessary, as it is based on the 02 series of amendments to UN Regulation No. 51 with very high limit values compared to the current technology of electric vehicles. Therefore, ASEP evaluation shall be limited to Analysis method 1 only; i.e. the slope assessment.

18. The sound dynamic of electric vehicles is rather low, compared to ICE vehicles, and therefore the assessment for  $L_{urban}$  would lead to unnecessary higher tolerances.

19. Some specificities of electric vehicles must be taken into consideration.

- First, the circumstance that the acceleration performance could become much higher compared to ICE vehicle. Therefore, the tyre torque effect can play a greater role and may lead to sound levels that are significantly higher than the level of the anchor point.
- Secondly, Supplement 8 introduced the case where  $L_{urban} = L_{crs\_rep}$  when  $L_{crs\_rep}$  is greater than  $L_{wot\_rep}$ . This happens more frequently on electric vehicles. It results in a lower margin for ASEP, as the clearance to the limit value (i.e. the term limit value –  $L_{urban}$  in the equations of the margin  $x$  in Annex 7 paragraph 3.5.) is lowered and is not consistent to  $L_{anchor}$ , defined as  $L_{wot\_rep}$ .

20. It is proposed to solve this by

- covering the EVs under the extended tolerance of 3 dB, same as for continuously variable transmission (CVT) vehicles in the slope assessment. See paragraph 3.5. of Annex 7.
- Adjusting the engine speed based on the provisions of RD-ASEP (Annex 9) in case of accelerations (see paragraph 2.5.2.) greater than anchor.

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

21. Since the used engine speeds for propelling electrical vehicles are different to the used engine speeds of ICE vehicles, the engine speed specifications of electric motors are not applicable here. The points P1 to P4 shall be determined based on the vehicle speed.

22. 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  $5 \text{ m/s}^2$  to enable ASEP tests. Therefore, the same provisions as in Annex 3 Table 1 shall be used.

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

23. The border curve of ASEP is based on engine speed. EVs do not provide a meaningful engine speed for the purpose of ASEP. A virtual vehicle speed to engine speed ratio of 20 km/h per 1000 rpm is introduced for all test runs and for the anchor point for the borderline. With this virtual engine speed, the Analysis method 1 can be used without changes.

24. The value 20 km/h per 1000 rpm has been selected to match with the typical sound level increase of tyres at 50 km/h. Tyres follow a logarithmic curve with very high slope at low speed, which flatten out towards high speeds. The best fit is 20 km/h per 1000 rpm.

25. Electric vehicles can very often produce accelerations significantly higher than the acceleration achieved for the anchor point, which is limited to  $2 \text{ m/s}^2$ . Beyond  $2 \text{ m/s}^2$  the tyre torque effect can be dominant and may no longer fit to the fixed gear ratio of 20 km/h per 1000 rpm. Therefore, for accelerations higher than  $a_{wot, test}$  of Annex 3, a formula is proposed to introduce the performance based added sound – especially tyre torque, based on the Annex 9 term  $\Delta L_{va}$ .

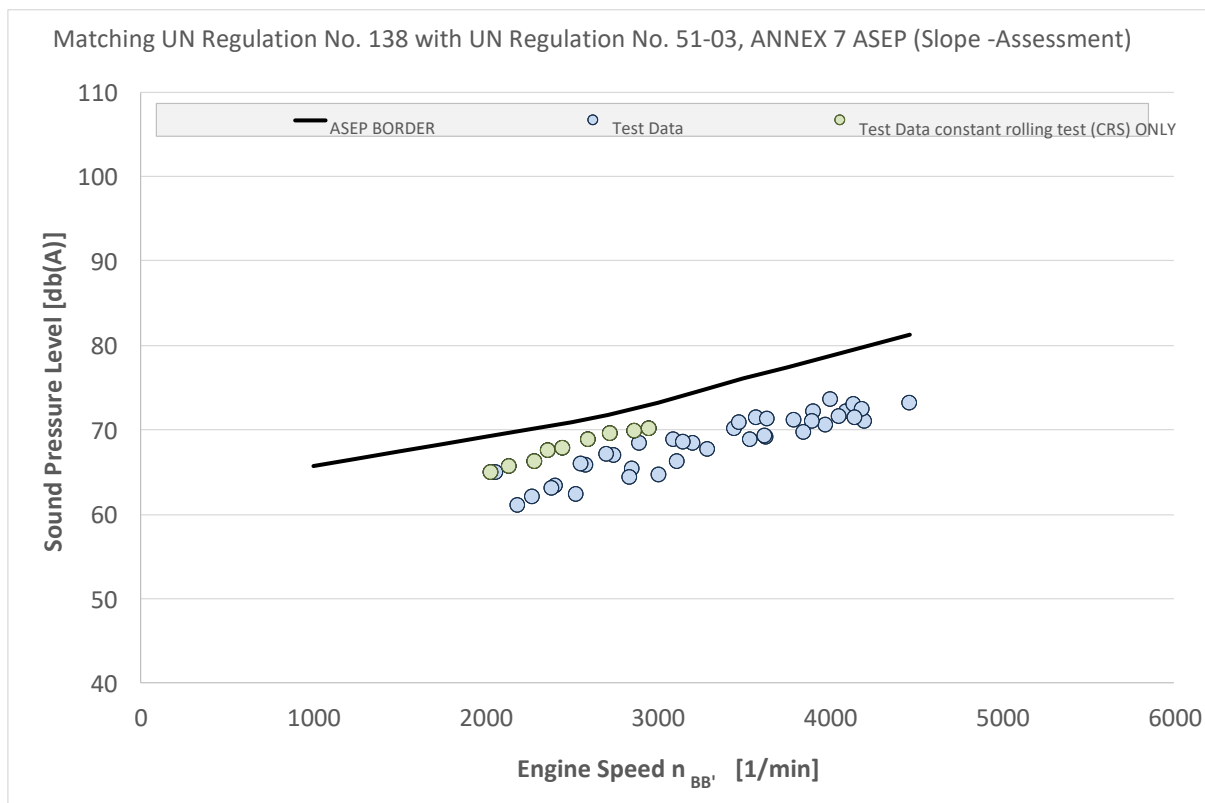
26. The term accounts for the circumstance, that EVs can have very high acceleration independent of the gear, while ICE always need lower gears and higher engine speeds to provide high acceleration performance.

*Annex 7, paragraph 3.5., tolerance for slope-assessment requirements*



27. All EVs are tested in “D” (drive mode), independent from the consideration how many effective gear ratios the vehicle has. In difference to ICE vehicles, EVs can have multiple engines and a dynamic shift of the propulsion source. This adds extended uncertainty to the sound emission of the vehicle. OICA considers the EVs falling under the same margin as vehicles tested in D with non-locked gears.

28. In addition, many EVs show that the cruise test result of Annex 3 is higher than the acceleration test result of Annex 3, which adds further uncertainty, as the anchor point based on the accelerated condition of Annex 3 is not the worst case from Annex 3, as shown in the diagram below:



29. Therefore, it is proposed to cover EVs with specified criteria under the provisions for non-locked automatic transmission.

*Annex 9, paragraph 1. “General”*

30. As the definition of “*Exterior Sound Enhancement System (ESES)*” is introduced in paragraph 2.29. of the main body, it is proposed to align the existing term with the acronym ESES.

*Annex 9, paragraph 2.2.*

31. This paragraph gives a definition of “*Exterior Sound Enhancement System*”. As this definition is moved to paragraph 2.29. of the main body, paragraph 2.2. of Annex 9 shall be deleted.

*Annex 9, paragraphs 2.3. to 2.5.*

32. As the previous paragraph 2.2. is deleted, the following paragraphs 2.3 to 2.5. shall be renumbered accordingly.