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Working Party on Noise and Tyres

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Item 2 of the provisional agenda
UN Regulation No. 51 (Noise of M and N categories of vehicles)

Amendment to Working Document GRBP/2022/4 proposed by the experts at the 17th Session.

Proposal for Supplement 9 to 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 introduce Real Driving Additional Sound Emission Provisions (RD-ASEP) as a preliminary test procedure for the purpose of collecting experience on the complete new test and evaluation concept. 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 1., add a new footnote 2 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 M_1 and N_1 referring to driving conditions with extreme accelerations in an extended speed range representative for urban and suburban traffic**.[2]"**

Paragraph 5. and its subparagraphs., amend to read:

"5. Approval

5.1. Type approval shall only be granted if the vehicle type meets the requirements of paragraphs 6. and 7. below.

5.1.1. **Starting from 1 July 2023 and for a period of twelve months, during type approval of a vehicle, measurements in accordance with Annex 9 (RD-ASEP) shall be performed. The test results shall be communicated to the Type Approval Authority in the format according to the test report sheet of Appendix 5 in Annex 9.**

For the purpose of type approval, it is not mandatory to comply with the provisions of Annex 9.

For vehicles with PMR not exceeding 60, the performance of RD-ASEP tests is not mandatory.

RD-ASEP tests are not applicable to any tests done for the purpose of extension of existing approvals according to UN Regulation No. 51.

In case the type approval tests of Annex 3 and Annex 7 were carried out in an indoor facility, the test and the delivery of data according to Annex 9 are not mandatory.

Insert a new Annex 9 to read:

"Annex 9

Measurement method to evaluate compliance with the Real Driving Additional Sound Emission Provisions (RD-ASEP)

1. General

[1] As defined in the Consolidated Resolution on the Construction of Vehicles (R.E.3.), ECE/TRANS/WP.29/78/Rev.6.

[2] **Additional Sound Emission Provisions refer to the specifications of paragraph 6.2.3. of the main body and Annex 7. A new Annex 9 was introduced for a sound evaluation of a vehicle under Real Driving Conditions (RD-ASEP) for evaluation purposes without impact on the type approval. RD-ASEP covers an extended control range with driving conditions outside of normal driving with higher accelerations and vehicle speeds up to 100 km/h. See also the provisions in paragraph 5.1.**

The Real Driving Additional Sound Emission Provisions (RD-ASEP) apply only to vehicles of categories M_1 and N_1 equipped with:

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

1.1. **Notwithstanding the provisions of Annex 7, paragraph 1., section 4 inclusive its footnote, tests according to Annex 9 done in the course of type approval shall be witnessed by the ~~Type Approval~~ Authority present during the tests.**

Tests shall be carried out on the same test track and under similar environmental conditions subject to the limitations in paragraph 3.3.

1.2. **Exemptions**

Notwithstanding the requirements above, vehicles which have no ICE for propulsion are exempted from RD-ASEP, if a sound enhancement system is fitted to the vehicle solely for the purpose of fulfilling the provisions of UN Regulation No. 138, and the sound emitting device (AVAS) does not emit a sound pressure level of more than 75 dB(A) [3] under any operation conditions exceeding the specification range of UN Regulation No.138.

1.3. **All symbols' abbreviations and acronyms used in this Annex are listed and defined in Appendix 3 to this Annex.**

1.4. **All formulas used in this Annex and Appendix 1 are listed in Appendix 4 to this Annex.**

2. **Definitions**

2.1. **"*Exhaust silencing system with variable geometry*" means a silencing system, not including pressure charging, containing one or more active, passive, or self-actuated moving parts or devices.**

These parts or devices will cause a change of the gas flow through the exhaust silencing system and result in a change of the sound reduction performance, by opening or closing one or more valves in the exhaust gas flow as a function of varying driving or engine conditions (engine speed, load, vehicle speed, etc.).

Active devices mean actuators, controlled by any means.

Passive or self-actuated devices mean units controlled by exhaust flow.

2.2. **"*Exterior sound enhancement system*" means a system that is installed to a vehicle for producing exterior sound, such as but not limited to sound actuators, either integrated into an exhaust silencing system or mounted as an individual unit.**

2.3. **"*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…).**

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

2.5. **"*Power trains*" 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).**

[3] **See footnote 3 in paragraph 6.2.7. of UN Regulation No. 138 "The maximum overall sound pressure level of 75 dB(A) measured at a distance of 2 m is corresponding to the overall sound pressure level of 66 dB(A) measured at a distance of 7,5 m."**

3. Facilities

3.1. Due to spatial limitations of test facilities[4] not every test condition may be performed on every test facility.

3.2. Notwithstanding such restrictions, the RD-ASEP tests shall be done on these test facilities.

3.3. Tests for Annex 9 may be carried out on different test facilities[5] in case of facility limitation(s). However, it is recommended to carry out all tests on one test facility and under similar environmental conditions to reduce measurement uncertainties.

4. Measurement method

4.1. Measurement instruments and condition of measurements

Unless otherwise specified, the measurement instruments, the conditions of the measurements and the condition of the vehicle are equivalent to those specified in Annex 3, paragraphs 1. and 2.

4.2. Method of testing

Unless otherwise specified, the conditions and procedures of Annex 3, paragraphs 3.1. to 3.1.2.1.2.2. shall be used. For the purpose of this Annex, single test runs are performed and evaluated.

4.3. Control range

A measurement for RD-ASEP is valid, if all parameters are within the specifications of the table below during the test run between lines AA' and BB'.

Parameter	*Minimum*	*Maximum*
Vehicle Speed	**> 0 km/h at line AA'**	**100 km/h at line BB'**
Acceleration	**0 m/s²**	**4 m/s²**
Performance	**0 m²/s³**	**35 m²/s³**
Gear	**ANY for forward driving**	
Mode	**ANY**	

In any operation condition, the engine speed of a vehicle, which can be propelled with an ICE operating, is limited to 80% of S.

4.4. Target operation conditions

The target operation condition for a single test run is randomly selected by the authority present during the tests carried out for type approval.

The operation condition during measurements per run is defined by

- **the gear selector position,**
- **the vehicle mode,**
- **the vehicle entry speed at line AA', and**
- **the percentage of accelerator depression, either for constant speed or in steps of 25 % acceleration depression.**

[4] Facilities may provide restriction for safety reasons, such as for vehicle speed.

[5] Tests for Annex 3, Annex 7, and Annex 9 may be carried out on different test facilities if documentation exists that demonstrates that the differences in sound performance are neglectable.

The manufacturer may establish a mechanical or electronic device to enable the requested percentage of accelerator depression.

The requested accelerator depression shall be achieved during the test with a tolerance of ± 10 % of full range.

The requested vehicle speed at AA' shall be achieved during the test with a tolerance of ± 3 km/h.

If under the chosen operation condition, a stable acceleration according to paragraph 2.26.1. of the main body cannot be enabled, the authority present during the test shall decide how to modify the operation condition (e.g. different gear selector position, speed, acceleration, driving mode).

The chosen operation condition shall result in a run within the control range. Each operation condition shall differ substantially from the test conditions of Annex 3 and all other operation conditions already chosen for this type approval already carried out under this Annex. For vehicles with a combustion engine for propulsion, the operating conditions shall be chosen to differ substantially in engine speed.

The number of operation conditions per vehicle in total is dependent on the vehicles technology and provided by the table below.

	D-Range	*M (locked)*
Automatic Transmissions (lockable)	**5**	**10**
Automatic Transmissions (non-lockable)	**15**	**n.a.(*)**
Vehicles with only one gear	**15**	**n.a.(*)**
Manual Transmissions	**n.a.(*)**	**15**

(*) Not applicable

The operation conditions and test results shall be entered into the test report sheet according to the table of the Appendix 3 to this Annex.

4.5. Test of the vehicle

4.5.1. The path of the centerline of the vehicle shall follow line CC' as closely as possible throughout the entire test, starting from the approach of the reference point according to definition in paragraph 2.11. of the main body to line AA' until the rear of the vehicle passes line BB' + 20 m.

The accelerator shall be positioned such to achieve the requested operation condition for this run latest when the reference point of the vehicle reaches line AA'. The accelerator shall be kept in its position until the rear of the vehicle passes line BB'. The accelerator shall then be fully released between BB' and BB'+ 5 m and kept in this released position until the rear of the vehicle passes the line BB'+20 m.

4.5.2. Non-locked transmissions

In case of non-locked transmission conditions, the test may include a gear change to a lower range and a higher acceleration under accelerated conditions.

A gear change to a higher range could occur under cruise and low load acceleration conditions. Such upshifts shall be avoided. The authority present during the test shall modify operation conditions so that these upshifts are avoided between AA' and BB'.

In the approach to line AA', the vehicle shall be driven in a way to allow the transmission to stabilize the gear.

4.5.3. Measurement readings

Per operation condition, one test run is carried out.

If a measurement within the control range is invalid due to background noise disturbances, wind gusts or other reasons, the measurement shall be discarded and repeated.

For every 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 between the two lines AA' and BB' + 20 m, shall be measured and shall be mathematically rounded to the first decimal place (L_{TEST}).**

  If a sound peak obviously out of character with the general sound pressure level is observed, the measurement shall be discarded.

  For further processing, the higher sound pressure level of both sides shall be used.

- **The vehicle speed reading at lines BB', when the rear end of the vehicle passes this line, shall be rounded and reported with the first significant digit after the decimal place ($v_{BB'\_TEST}$).**

- **If applicable, the engine speed readings at line AA' and BB' shall be rounded to 10 min^{-1} and reported ($n_{AA'\_TEST}$; $n_{BB'\_TEST}$).**

All measured values shall be entered into the test report sheet according to the table of Appendix 5 to this Annex.

4.5.4. Calculated values

All calculated values shall be entered into the test report sheet according to the table of Appendix 5 to this Annex.

4.5.4.1. Acceleration *a*

The accelerations shall be calculated between lines PP' to BB', in accordance with the formula provided in paragraph 3.1.2.1.2.2. of Annex 3 and be reported to the second digit after the decimal place (a_{TEST}) as results.

4.5.4.2. Performance $v_{\cdot}a$

The performance shall be calculated from the reported vehicle speed at line BB' and the acceleration result from paragraph 4.5.4.1. and rounded to the first digit after the decimal place.

4.5.4.3. Expected sound pressure level L_{TEST_EXP}

For the calculation of the expected sound pressure level per test run, the measured values according to paragraph 4.5.3. and calculated values according to paragraphs 4.5.4.1. and 4.5.4.2. shall be used. All calculations are done according to Appendix 1 to this Annex.

5. Compliance assessment

5.1. Case 1

The compliance of the vehicle is acceptable if the measured sound pressure levels of all valid test runs are lower than or equal to the expected sound pressure levels of paragraph 4.5.4.3.

$L_{TEST} \leq L_{TEST\_EXP}$

5.2. Case 2

If not more than two valid runs of the specified runs exceed the expected sound pressure level of paragraph 4.5.4.3. by not more than 2 dB the compliance of the vehicle is acceptable.

5.3. Case 3

If more than two valid runs of the specified runs exceed the expected sound pressure level of paragraph 4.5.4.3. then the vehicle is non-compliant with RD-ASEP.

5.4. Case 4

If one or more valid runs exceed the expected sound pressure level of paragraph 4.5.4.3. by more than 2 dB, the vehicle is non-compliant with RD-ASEP.

5.5 The case of compliance according to this paragraph 5 and the final result (compliance yes/no) have to be mentioned in the Test report of Appendix 5 to this Annex 9.

Annex 9 – Appendix 1

Sound Expectation Model

1. General

All the formulas and values coming from Annex 3 are identified with a suffix of '$_{ANCHOR}$' in the symbols.

For example, v_{TEST_ANCHOR} in Annex 9 is equal to v_{TEST} from Annex 3.

2. Extraction of parameters from measurements according to Annex 3

2.1. The procedure set out in this Annex requires the performance of tests in accordance with Annex 3.

2.2. Determination of reference data from Annex 3:

2.2.1. The necessary reference data to establish the sound expectation model are taken from the pass-by and from the cruise-by test of one gear of the Annex 3 tests.

2.2.1.1. In the case the test has been carried out with two gear ratios, the reported parameters for gear i shall be selected. In the case the test has been carried out in a single gear, the reported parameters for this single gear shall be selected.

2.2.1.2. The parameters taken from Annex 3 tests are in all cases the arithmetic average of the four valid runs as determined by the measurements in Annex 3. All values shall be taken over without any temperature or test track correction. The engine speed is not requested for Annex 3. However, for the purpose of Annex 9 it needs to be measured.

The parameters to be reported from the acceleration test are:

- **The sound pressure level L_{ACC_ANCHOR} which is the higher value of the measured sound pressure levels of the left and right side of the vehicle, rounded to the first decimal. If applicable, the value shall be corrected according to Table 1 of the Appendix to Annex 3, measures No. 3, sub Nos. 1 or 2.**
- **The vehicle speed $v_{BB'\_ACC\_ANCHOR}$ when the rear of the vehicle passes line BB', rounded to the first decimal.**
- **The engine speed $n_{BB'\_ACC\_ANCHOR}$ when the rear of the vehicle passes line BB', rounded to 10 min^{-1}. If applicable, the value shall be corrected according to Table 1 of the Appendix to Annex 3, measures No. 3, sub Nos. 1 or 2.**

The parameters to be reported from the constant speed test are:

- **The sound pressure level L_{CRS_ANCHOR} which is the higher value of the measured sound pressure levels of the left and right side of the vehicle, rounded to the first decimal.**
- **The reference vehicle speed v_{REF} is 50 km/h, unless the vehicle was tested in Annex 3 at a different vehicle speed. In this case use the reported vehicle speed $v_{BB'\_CRS\_ANCHOR}$, rounded to the first decimal.**
- **The engine speed $n_{BB'\_CRS\_ANCHOR}$ when the rear of the vehicle passes line BB', rounded to 10 min^{-1}.**

2.3. Selection of parameter coefficients

The necessary coefficients are dependent on the vehicle design and listed in the table in Appendix 2 to this Annex.

2.3.1. **Discrete Determination of the factor x**

On request of the manufacturer the factor x may be determined by discrete coast-down measurement to determine L_{REF_TR} directly, according to Appendix 2 of Annex 3 to this Regulation for the reference vehicle speed. Rounding and temperature correction shall not apply.

2.4. **Calculate the Reference Tyre/Rolling Sound Level L_{REF_TR}**

(Formula 2.4. of Appendix 4)

2.5. **Calculate the Reference Power Train Mechanics Sound Level L_{REF_PT}**

(Formula 2.5. of Appendix 4)

2.6. **Calculate the Reference Dynamic Sound Level L_{REF_DYN}**

(Formula 2.6. of Appendix 4)

2.7. **Determine the Vehicle Dynamic Delta Sound Level ΔL_{DYN}**

If the arithmetic sound level difference between the reported acceleration sound level L_{ACC_ANCHOR} and the reported constant speed sound level L_{CRS_ANCHOR} is at least 1.1 dB(A) or higher, the vehicle dynamic delta sound level ΔL_{DYN} is calculated by

(Formula 2.7. No.1 of Appendix 4, in junction with Formulas 2.7 Nos. 2 and 3 of Appendix 4)

If the arithmetic sound level difference between the reported acceleration sound level L_{ACC_ANCHOR} and the reported constant speed sound level L_{CRS_ANCHOR} is less than 1,1 dB, the vehicle dynamic delta sound level ΔL_{DYN} is set to 10 dB.

$$\Delta L_{DYN} = 10 \text{ dB}$$

In cases where the arithmetic sum of sound energy adjusted reference tyres rolling sound $L_{REF\_TR\_ADJ}$ and the adjusted reference power train $L_{REF\_PT\_ADJ}$ is equal or greater than the sound energy of the anchor point L_{ACC_ANCHOR}, the vehicle dynamic delta sound level ΔL_{DYN} is set to 10 dB:

If

$$10^{0.1 x L_{REF\_TR\_ADJ}} + 10^{0.1 x L_{REF\_PT\_ADJ}} \geq 10^{0.1 x L_{ACC\_ANCHOR}}$$

then $\Delta L_{DYN} = 10 \text{ dB}$

2.8. **Having established the sound expectation model for a given vehicle based on its particular pass-by test results according to Annex 3 of this Regulation, proceed to the single point evaluation for each test run performed according to paragraphs 4.4. and 4.5. of Annex 9.**

3. **Calculation of the expected sound level L_{TEST_EXP}**

3.1. **For each single test run, performed for the purpose of Annex 9, an expected sound level L_{TEST_EXP} shall be calculated.**

3.2. **Necessary input data for the sound model are taken from the pass-by measurement according to paragraph 4.5.1. of Annex 9.**

3.2.1. **For the calculation of the expected sound level the parameters listed in paragraphs 4.5.3. and 4.5.4.1. and 4.5.4.2. of Annex 9 are needed.**

In addition, the vehicle speed to engine speed ratio κ_{TEST} of the test run shall be determined, expressed in km/h per 1000 min^{-1} and calculated by the formula below, rounded to the second decimal

(Formula 3.2.1. of Appendix 4)

3.2.2. **Virtual engine speed for vehicles without internal combustion engine**

When testing vehicles without an internal combustion engine for direct forward propulsion, an engine speed information will not be available. In such cases the engine speed is simulated on the basis of the measured vehicle speed $v_{BB'\_TEST}$ by using a virtual uniform gear ratio of 30 km/h per 1000 min^{-1}.

(Formula 3.2.2. of Appendix 4)

3.2.3. Virtual engine speed for hybrid electric vehicles

In case that an internal combustion engine is mechanically coupled with drive axle whenever internal combustion engine is operating, this paragraph shall be applied.

In case of the other HEV systems, paragraph 3.2.4. shall be used.

Hybrid electric vehicle may have been tested in Annex 3 partly or fully in electric condition. For evaluation according RD-ASEP, engine speeds and, if applicable corrected sound pressure levels, will have to be assigned to the cruise and the acceleration test.

3.2.3.1. Case 1 – Internal combustion engine is operational during acceleration test and constant speed test:

3.2.3.1.1. Assignment of engine speed

For the acceleration test and the constant speed test, use the engine speed information from the test result of Annex 3.

3.2.3.1.2. Adjustment of sound pressure level

No adjustment is applied.

3.2.3.2. Case 2 – Internal combustion engine is operational during acceleration test but not during the constant speed test:

3.2.3.2.1. Assignment of engine speed

For the acceleration test, use the engine speed information from the test result of Annex 3.

For the constant speed test, determine the highest gear in which the vehicle can drive at the target speed of the vehicle v_{TEST} (usually 50 km/h) as selected for the constant speed test in Annex 3. Calculate the engine speed with the gear ratio of that gear.

3.2.3.2.2. Adjustment of sound pressure level

No adjustment is applied to the acceleration test result.

The adjusted cruise test result $L_{CRS\_ANCHOR'}$ is determined by

(Formula 3.2.3.2.2. of Appendix 4)

3.2.3.3. Case 3 – Internal combustion engine is operational during constant speed test but not during the acceleration test

3.2.3.3.1. Assignment of engine speed

For the constant speed, use the engine speed information from the test result of Annex 3.

For the acceleration test, determine the highest gear that provides an acceleration greater than the reference acceleration a_{ACC_REF} but not exceeding 2.0 m/s^2. Calculate the engine speed with the gear ratio of that gear.

3.2.3.3.2. Adjustment of sound pressure level

No adjustment is applied to the constant speed test result.

The adjusted sound pressure level for the acceleration test is determined by

(Formula 3.2.3.3.2. of Appendix 4)

where *Limit* is the applicable limit value for this vehicle type according to paragraph 6.2.2. of the main body and k_P is the determined k_P-factor from the Annex 3 test.

3.2.3.4. Case 4 – Internal combustion engine does neither operate during the acceleration test nor the constant speed test

3.2.3.4.1. Assignment of engine speed

For the constant speed test, determine the highest gear in which the vehicle can drive at the target speed of the vehicle v_{TEST} (usually 50 km/h) as selected for the constant speed test in Annex 3. Calculate the engine speed with the gear ratio of that gear.

For the acceleration test, determine the highest gear that provides an acceleration greater than the reference acceleration a_{ACC_REF} but not exceeding 2.0 m/s². Calculate the engine speed with the gear ratio of that gear.

3.2.3.4.2. Adjustment of sound pressure level

The adjusted sound pressure level for the constant speed test is

(Formula 3.2.3.4.2. No.1 of Appendix 4)

The adjusted sound pressure level for the acceleration test is

(Formula 3.2.3.4.2. No.2 of Appendix 4)

where *Limit* is the applicable limit for this vehicle type according to paragraph 6.2.2. of the main body and k_P is the determined k_P-factor from the Annex 3 test.

3.2.4. Virtual engine speed for hybrid electric vehicle the other system than paragraph 3.2.3.

3.2.4.1. Case 1 – Internal combustion engine is operational during acceleration test and constant speed test

3.2.4.1.1. Assignment of engine speed

For the acceleration test and the constant speed test, use the engine speed information from the test result of Annex 3.

3.2.4.1.2. Adjustment of sound pressure level

No adjustment is applied

3.2.4.2. Case 2 – Internal combustion engine is operational during acceleration test but not during the constant speed test

3.2.4.2.1. Assignment of engine speed

For the acceleration test, use the engine speed information from the test result of Annex 3.

For the constant speed test, determine a virtual uniform gear ratio of 30 km/h per 1000 min^{-1} at the target speed of the vehicle v_{TEST} as selected for the constant speed test in Annex 3. Calculate the engine speed with the gear ratio of that gear.

3.2.4.2.2. Adjustment of sound pressure level

No adjustment is applied to the acceleration test result.

The adjusted cruise test result $L_{CRS\_ANCHOR'}$ is determined by

(Formula 3.2.4.2.2. of Appendix 4)

3.2.4.3. Case 3 – Internal combustion engine is operational during constant speed test but not during the acceleration test

3.2.4.3.1. Assignment of engine speed

For the constant speed, use the engine speed information from the test result of Annex 3.

For the acceleration test, determine a virtual uniform vehicle speed to engine speed ratio of 20 km/h per 1000 min^{-1}. Calculate the engine speed with the vehicle speed $v_{BB'\_ACC\_ANCHOR}$.

(Formula 3.2.4.3.1. of Appendix 4)

3.2.4.3.2. Adjustment of sound pressure level
No adjustment is applied to the constant speed test result.

The sound pressure level for the acceleration test is determined by

(Formula 3.2.4.3.2. of Appendix 4)

where *Limit* is the applicable limit for this vehicle type according to paragraph 6.2.2. of the main body and k_P is the determined k_P-factor from the Annex 3 test.

3.2.4.4. Case 4 – Internal combustion engine is neither operational during the acceleration test nor during the constant speed test

3.2.4.4.2. Assignment of engine speed

For the constant speed test, determine a virtual uniform vehicle speed to engine speed ratio of 30 km/h per 1000 min^{-1} at the target speed of the vehicle v_{TEST} as selected for the constant speed test in Annex 3. Calculate the engine speed with the vehicle speed.

(Formula 3.2.4.4.2. No. 1 of Appendix 4)

For the acceleration test, determine a virtual uniform vehicle speed to engine speed ratio of 20 km/h per 1000 min^{-1}. Calculate the engine speed with the vehicle speed

(Formula 3.2.4.4.2. No. 2 of Appendix 4)

3.2.4.4.3. Adjustment of sound pressure level

The adjusted sound pressure level for the constant speed test is

(Formula 3.2.4.4.3. No. 1 of Appendix 4)

The adjusted sound pressure level for the acceleration test is

(Formula 3.2.4.4.3. No. 2 of Appendix 4)

where *Limit* is the applicable limit for this vehicle type and k_P is the determined k_P-factor from the Annex 3 test.

3.2.5. Virtual constant speed test for PMR < 25

A vehicle having a PMR lower than 25 is tested in Annex 3 without constant speed test. For the purpose of RD-ASEP a constant speed test result has to be assigned in Annex 9.

3.2.5.1. The virtual constant speed test result $L_{CRS\_ANCHOR'}$ is determined by

(Formula 3.2.5.1. of Appendix 4)

3.2.5.2 Assignment of engine speed

3.2.5.2.1. Annex 3 acceleration test done in locked gear

For the acceleration test, use the engine speed information from the test result of Annex 3.

If an engine speed information is not available for the acceleration test result (e.g. EV or HEV), the engine speed for the acceleration test is calculated by the formula below:

(Formula 3.2.5.2.1. No.1 of Appendix 4)

For the constant speed test, the engine speed is calculated with the parameters determined above for the acceleration test with the formula below:

(Formula 3.2.5.2.1. No.2 of Appendix 4)

For constant speed test, depending on the situation different cases using internal combustion engine and/or electric engine, use the formulas of paragraph 3.2.4.

3.2.5.2.2. Annex 3 acceleration test done in non-locked gear or one gear

The engine speed for the constant speed test is calculated with a virtual uniform gear ratio of 30 km/h per 1000 min^{-1} at the target speed of the vehicle v_{TEST} as selected for the constant speed test in Annex 3.

(Formula 3.2.5.2.2. of Appendix 4)

3.3. Calculation of expected tyre rolling sound component L_{TR_EXP}

The expected tyre rolling sound component L_{TR_EXP} is calculated dependent on the achieved vehicle speed $v_{BB'\_TEST}$ during the test.

For vehicles speeds up to and inclusive v_{TEST}, L_{TR_EXP} is calculated by

(Formula 3.3. No.1 of Appendix 4)

For vehicle speeds $v_{BB'\,TEST}$ exceeding v_{TEST}, $L_{TR\,EXP}$ is calculated by

(Formula 3.3. No.2 of Appendix 4)

The parameters θ_{TR_LO} and θ_{TR_HI} are taken from the parameter table as applicable for the vehicle.

3.4. Calculation of expected power train mechanical sound component L_{PT_EXP}

The expected power train base mechanical sound component L_{PT_EXP} is calculated dependent on the achieved engine speed $n_{BB'\_TEST}$ during the test.

For engine speeds up to and inclusive $n_{BB'\_CRS\_ANCHOR}$, L_{PT_EXP} is calculated by

(Formula 3.4. No.1 of Appendix 4)

For engine speeds exceeding $n_{BB'\_CRS\_ANCHOR}$, L_{PT_EXP} is calculated by

(Formula 3.4. No.2 of Appendix 4)

The parameters θ_{PT_LO},θ_{PT_HI} and n_{SHIFT_PT} are taken from the parameter table as applicable for the vehicle.

3.5. Calculation of expected base dynamic sound component L_{DYN_EXP}

The expected base dynamic sound component L_{DYN_EXP} is calculated dependent on the achieved engine speed $n_{BB'\_TEST}$ during the test.

For engine speeds up to and inclusive $n_{BB'\_ACC\_ANCHOR}$, L_{DYN_EXP} is calculated by

(Formula 3.5. No.1 of Appendix 4)

For engine speeds exceeding $n_{BB'\,ACC\,ANCHOR}$, L_{DYN_EXP} is calculated by

(Formula 3.5. No.2 of Appendix 4)

The parameters θ_{DYN_LO}, θ_{DYN_HI} and n_{SHIFT_DYN} are taken from the parameter table as applicable for the vehicle.

3.6. Calculation of expected dynamic delta sound component ΔL_{DYN_EXP}

3.6.1. Determination of the maximum reference acceleration a_{MAX_REF}

3.6.1.1. The maximum reference acceleration a_{MAX_REF} is the maximum acceleration performance determined in a low gear under full load condition.

A test run not part of the RD-ASEP assessment shall be performed to determine the maximum acceleration performance a_{MAX_REF} of the vehicle. This value will be used in the model to determine the load achieved during a RD-ASEP test run.

This test run is recommended to be carried out in a gear ratio and at a vehicle entry speed such, that the vehicle engine speed $n_{BB'\_TEST}$ is between the 50% of S and 80% of S. The acceleration a_{TEST} and the performance $v \cdot a_{TEST}$ may exceed the control range during this test.

This operation condition is determined by the vehicle manufacturer in agreement with the authority present during the test.

The acceleration a_{MAX_REF} is calculated according to the provisions of paragraph 4.5.4.1. of Annex 9.

The vehicle speed to engine speed ratio κ_{TEST} of this operation condition is defined as the reference vehicle speed to the engine speed ratio κ_{REF}. For calculation, see paragraph 3.2.1. of this Appendix.

3.6.2. Calculation of the partial load $LOAD_{TEST}$ achieved during the test run

The partial load normalized with the maximum load is calculated based on the achieved acceleration a_{TEST}, relative to the reference acceleration a_{MAX_i} with the formula below

(Formula 3.6.2. of Appendix 4)

3.6.3. Performance related calculations

3.6.3.1. Calculation of the performance $v \cdot a_{TEST}$

The performance achieved during the test is calculated from the achieved acceleration expressed in m/s² and the vehicle speed expressed in km/h by

(*Formula 3.6.3.1. of Appendix 4)*

3.6.3.2. Calculation of the dynamic performance component $\Delta L_{DYN\_v \cdot a}$

The dynamic performance component of the vehicle dynamic sound is calculated based on the achieved performance $v \cdot a_{TEST}$ relative to the achieved performances from Annex 3 Type-approval acceleration test.

(Formula 3.6.3.2. No.1 of Appendix 4)

If the achieved performance does not exceed the reference performance $v \cdot a_{ANCHOR}$, the dynamic performance component $\Delta L_{DYN\_v \cdot a}$ is equal zero.

If the achieved performance exceeds the reference performance, the dynamic performance component $\Delta L_{DYN\_v \cdot a}$ is calculated by

(Formula 3.6.3.2. No.2 of Appendix 4)

The parameter β is taken from the parameter table as applicable for the vehicle.

The maximum dynamic performance component $\Delta L_{DYN\_v \cdot a}$ is limited to 10 dB.

3.6.3.3. Aggregation of dynamic sound components

The final dynamic delta sound component ΔL_{DYN_EXP} dynamic is calculated by

(Formula 3.6.3.3. of Appendix 4)

The parameters α_1 and α_2 are taken from the parameter table as applicable for the vehicle.

3.7. For vehicles falling under the scope of UN Regulation No. 138 equipped with a sound system covering the specification range of UN Regulation No. 138 a tolerance ΔL_{AVAS} on the RD-ASEP model is applied to ensure compatibility with the maximum permissible sound level emitted by the AVAS according to UN Regulation No.138.

For the vehicle speed range up to v_{REF} of Annex 3 of this UN Regulation, the additional tolerance is dependent on the achieved vehicle speed v_{TEST} during the RD-ASEP test.

(Formula 3.7. of Appendix 4)

For vehicle speeds $v_{BB'\_TEST}$ exceeding v_{TEST}, no additional tolerance is applied, ΔL_{AVAS} is set to zero in that case.

***3.8.* Calculation of the expected sound level L_{TEST_EXP}**

The calculation results of the paragraphs 3.3. to 3.7. are used to calculate the expected sound level for an individual run to be compared with the measured maximum sound pressure level, by the following formula

(Formula 3.8. of Appendix 4)

3.9. Proceed with the compliance assessment according to paragraph 5. of Annex 9.

Annex 9 – Appendix 2

Parameter Table for the Sound Expectation Model

The table below provides the necessary parameters for establishing the sound expectation model of Annex 9 Appendix 1. The parameters to be selected depend on the propulsion technology.

- **Column A: ICE**
- **Column B: BEV, FCEV**
- **Column C: HEV**

				M1/N1		
Model Part	*Parameter*	*Symbol*	*Unit*	*A*	*B*	*C*
SOUND FROM TYRE ROLLING SOUND UNDER NO LOAD	Reference Vehicle Speed (as reported from Annex 3)	v_{TEST}	km/h	50 (min.40)	50 (min.40)	50 (min.40)
	Tyre Rolling Sound Energy Fraction of Annex 3 Cruise Test L_{CRS_ANCHOR}	x	%	90 or measure	95	90 or measure
	Tyre Rolling Sound Slope ≤ v_{TEST}	θ_{TR_LO}	dB	20	20	20
	Tyre Rolling Sound Slope > v_{TEST}	θ_{TR_HI}	dB	40	40	40
SOUND FROM THE MECHANICAL SYSTEM UNDER NO LOAD	Power Train Sound Slope ≤ $n_{BB'\_CRS'\_ANCHOR}$	θ_{PT_LO}	dB	60	60	60
	Power Train Sound Slope > $n_{BB'\_CRS'\_ANCHOR}$	θ_{PT_HI}	dB	115	85	115
	Form Factor for the logarithm function of the mechanical sound model	n_{SHIFT_PT}	1/min	5000	5000	5000
SOUND FROM DYNAMICS SYSTEM UNDER LOAD	Dynamic Sound Slope ≤ $n_{BB'\_ACC\_ANCHOR}$	θ_{DYN_LO}	dB	50	50	50
	Dynamic Sound Slope > $n_{BB'\_ACC\_ANCHOR}$	θ_{DYN_HI}	dB	105	75	105
	Form Factor for the logarithm function of the dynamic sound model	n_{SHIFT_DYN}	1/min	5000	5000	5000
SOUND FROM DYNAMICS SYSTEM UNDER EXTENDED PERFORMANCE v·a	Dynamic v·a Factor β	β	dB(A)	8	8	8
	Partial Load Form Factor α_1	α_1	---	0,17	0,17	0,17
	Partial Load Form Factor α_2	α_2	---	0,40	0,40	0,40

Annex 9 – Appendix 3

Symbols, Abbreviations and Acronyms

Annex 9			
Symbol	***Unit***	***Paragraph***	***Explanation***
a_{MAX_REF}	m/s^2	3.4.	maximum reference acceleration as determined in a low gear under full load condition.
L_{TEST}	dB(A)	3.5.3.	sound pressure level measured for any target operation condition; value to be reported and used for calculations to the first decimal place
$v_{AA'\_TEST}$	km/h	3.5.3.	vehicle speed measured for target operation condition when the reference point passes line AA'; value to be reported and used for calculations to the first decimal place
$v_{PP'\_TEST}$	km/h	3.5.3.	vehicle speed measured for target operation condition when the reference point passes line PP; value to be reported and used for calculations to the first decimal place
$v_{BB'\_TEST}$	km/h	3.5.3.	vehicle speed measured for target operation condition when the rear end of the vehicle passes line BB'; value to be reported and used for calculations to the first decimal place
$n_{AA'\_TEST}$	1/min	3.5.3.	engine speed measured for target operation condition when the reference point of the vehicle passes line AA'; value to be reported and used for calculations to a precision of 10 min^{-1}
$n_{BB'\_TEST}$	1/min	3.5.3.	engine speed measured for target operation condition when the rear end of the vehicle passes line BB'; value to be reported and used for calculations to a precision of 10 min^{-1}
a_{TEST}	m/s^2	3.5.4.1.	acceleration from PP' to BB'; value to be reported and used for calculations to the second decimal place
$v \bullet a_{TEST}$	m^2/s^3	3.5.4.2.	performance calculated from the reported vehicle speed at line BB' in meters per second and the acceleration result from paragraph 3.5.4.1. and rounded to the first digit after the decimal place.
L_{EXP}	dB(A)	3.5.4.3.	the expected sound pressure level for a discrete test run
Annex 9 - Appendix 1			
L_{ACC_ANCHOR}	dB(A)	2.2.1.2.	vehicle sound pressure level for the acceleration test to be reported from Annex3 with the tested gear in single-gear test or the lower tested gear in two-gear test and used for calculations to the first decimal place
$v_{BB'\_ACC\_ANCHOR}$	km/h	2.2.1.2.	vehicle speed value when the rear of the vehicle passes line BB' for the acceleration test to be reported from Annex3 with the tested gear in single-gear test or the lower tested gear in two-gear test and used for calculations to the first decimal place
$n_{BB'\_ACC\_ANCHOR}$	1/min	2.2.1.2.	engine speed value when the rear of the vehicle passes line BB' for the acceleration test to be reported from Annex3 with the tested gear in single-gear test or the lower tested gear in two-gear test and used for calculations to a precision of 10 min^{-1}
L_{CRS_ANCHOR}	dB(A)	2.2.1.2.	vehicle sound pressure level at constant speed test; value to be reported from Annex3 with the tested gear in single-gear test or the lower tested gear in two-gear test and used for calculations to the first decimal place

$v_{BB'\_CRS\_ANCHOR}$	km/h	2.2.1.2.	vehicle speed value when the rear of the vehicle passes line BB' for the constant speed test to be reported from Annex3 with the tested gear in single-gear test or the lower tested gear in two-gear test and used for calculations to the first decimal place
$n_{BB'\_CRS\_ANCHOR}$	1/min	2.2.1.2.	engine speed value when the rear of the vehicle passes line BB' for the constant speed test to be reported from Annex3 with the tested gear in single-gear test or the lower tested gear in two-gear test and used for calculations to a precision of 10 min^{-1}
x	-	2.3.1.	energy contribution ratio of tyre/rolling sound level at L_{CRS_ANCHOR}
L_{REF_TR}	dB(A)	2.3.1.	calculated Reference Tyre Rolling Sound Level
L_{REF_PT}	dB(A)	2.5.	calculated Reference Power Train Mechanics Sound Level
L_{REF_DYN}	dB(A)	2.6.	calculated Reference Dynamic Sound Level
ΔL_{DYN}	dB(A)	2.7.	Vehicle Dynamic Delta Sound Level
$L_{REF\_TR\_ADJ}$	dB(A)	2.7.	Tyre Rolling Sound Level with adjusted vehicle speed for ΔL_{DYN} calculation
$L_{REF\_PT\_ADJ}$	dB(A)	2.7.	Power Train Mechanical Sound Level with adjusted engine speed for ΔL_{DYN} calculation
θ_{TR_LO}	dB(A)	2.7.	sound slope for tyre rolling sound when vehicle speed is not greater than the reference speed
θ_{PT_LO}	dB(A)	2.7.	sound slope for Power Train Sound when vehicle engine speed is not greater than $n_{BB'\_CRS'\_ANCHOR}$
n_{SHIFT_PT}	1/min	2.7.	constant (shifting factor) for the regression curve of the mechanic sound model
k_{TEST}	km/h·min	3.2.1.	vehicle speed to engine speed ratio under "Real Driving Additional Sound Emission Provisions" (RD-ASEP) as expressed in km/h per 1000 min-1 during a test run, rounded to the second decimal
k_{REF}	km/h·min	3.2.1.	Reference vehicle speed to engine speed ratio defined in paragraph 3.6.1.
$L_{CRS\_ANCHOR'}$	dB(A)	3.2.3.2.2.	corrected cruise test result for HEV
$L_{ACC\_ANCHOR'}$	dB(A)	3.2.3.3.2.	corrected acceleration test result for HEV
Limit	dB(A)	3.2.3.3.2.	sound level limits in the table of paragraph 6.2.2. of main body to this Regulation for the valid phase
L_{TR_EXP}	dB(A)	3.3.	expected tyre rolling sound
q_{TR_HI}	dB(A)	3.3.	sound slope for tyre rolling sound when vehicle speed is greater than the reference speed
L_{PT_EXP}	dB(A)	3.4.	expected power train mechanics sound
θ_{PT_HI}	dB(A)	3.4.	sound slope for Power Train Mechanics Sound when vehicle engine speed is exceeding $n_{BB'\_CRS'\_ANCHOR}$
L_{DYN_EXP}	dB(A)	3.5.	expected base dynamic sound
θ_{DYN_LO}	dB(A)	3.5.	sound slope for Dynamic Sound when vehicle engine speed is not greater than $n_{BB'\_ACC'\_ANCHOR}$
θ_{DYN_HI}	dB(A)	3.5.	sound slope for Dynamic Sound when vehicle engine speed is exceeding $n_{BB'\_ACC'\_ANCHOR}$
ΔL_{DYN_EXP}	dB	3.6.	expected dynamic delta sound
$LOAD_{TEST}$		3.6.2.	load achieved during the test run

a_{MAX_κ}	m/s^2	3.6.2.	Maximum acceleration in gear κ
$\Delta L_{DYN\_v \times a}$	dB	3.6.3.2.	dynamic performance component calculated based on the achieved performance $v \bullet a_{TEST}$ relative to a reference performance.
β		3.6.3.2.	coefficient for calculating dynamic performance component
$v \bullet a_{ANCHOR}$	m^2/s^3	3.6.3.2.	performance value to be reported from Annex3 with the tested gear in single-gear test or the lower tested gear in two-gear test and used for calculations to the first decimal place
a_1		3.6.3.3.	coefficient for calculating dynamic sound components
a_2		3.6.3.3.	coefficient for calculating dynamic sound components

Annex 9 – Appendix 4

Formulas

Formula 2.4

$$L_{REF\_TR} = 10 \times lg(x \times 10^{0.1 \times L_{CRS\_ANCHOR}})$$

Formula 2.5

$$L_{REF\_PT} = 10 \times lg((1 - x) \times 10^{0.1 \times L_{CRS\_ANCHOR}})$$

Formula 2.6

$$L_{REF\_DYN} = L_{REF\_PT} - 15$$

Formula 2.7 No.1

$$\Delta L_{DYN} = 10 \times lg(10^{0.1 \times L_{ACC\_ANCHOR}} - 10^{0.1 \times L_{REF\_TR\_ADJ}} - 10^{0.1 \times L_{REF\_PT\_ADJ}}) - L_{REF\_DYN}$$

Formula 2.7 No.2

$$L_{REF\_TR\_ADJ} = \theta_{TR\_LO} \times lg(\frac{v_{BB'\_ACC\_ANCHOR}}{v_{REF}}) + L_{REF\_TR}$$

Formula 2.7 No.3

$$L_{REF\_PT\_ADJ} = \theta_{PT\_LO} \times lg\left(\frac{(n_{BB'\_ACC\_ANCHOR} + n_{SHIFT\_PT})}{(n_{BB'\_CRS\_ANCHOR} + n_{SHIFT\_PT})}\right) + L_{REF\_PT}$$

Formula 3.2.1

$$\kappa_{TEST} = v_{BB'\_TEST} / n_{BB'\_TEST} \times 1000$$

Formula 3.2.2.

$$n_{BB'\_TEST} = (v_{BB'\_TEST}/30) \times 1000$$

Formula 3.2.3.2.2.

$$L_{CRS\_ANCHOR'} = L_{CRS\_ANCHOR} + 0.5\ dB$$

Formula 3.2.3.3.2.

$$L_{ACC\_ANCHOR'} = (Limit - k_P \times L_{CRS\_ANCHOR})/(1 - k_P)$$

Formula 3.2.3.4.2 No.1

$$L_{CRS\_ANCHOR'} = L_{CRS\_ANCHOR} + 0.5\ dB$$

Formula 3.2.3.4.2 No.2

$$L_{ACC\_ANCHOR'} = (Limit - k_P \times L_{CRS\_ANCHOR'})/(1 - k_P)$$

Formula 3.2.4.2.2

$$L_{CRS\_ANCHOR'} = L_{CRS\_ANCHOR} + 0.5\ dB\text{(A)}$$

Formula 3.2.4.3.1.

$$n_{ACC\_ANCHOR} = (v_{BB'\_ANCHOR}/20) \times 1000$$

Formula 3.2.4.3.2

$$L_{ACC\_ANCHOR'} = \left(Limit - k_P \times L_{CRS\_ANCHOR}\right)/(1 - k_P)$$

Formula 3.2.4.4.2 No.1

$$n_{CRS\_ANCHOR} = (v_{TEST}/30) \times 1000$$

Formula 3.2.4.4.2 No.2

$$n_{ACC\_ANCHOR} = \left(v_{BB'\_ACC\_ANCHOR}/20\right) \times 1000$$

Formula 3.2.4.4.3 No.1

$$L_{CRS\_ANCHOR'} = L_{CRS\_ANCHOR} + 0.5\ dB(A)$$

Formula 3.2.4.4.3 No.2

$$L_{ACC\_ANCHOR'} = \left(Limit - k_P \times L_{CRS\_ANCHOR'}\right)/(1 - k_P)$$

Formula 3.2.5.1.

$$L_{CRS\_ANCHOR'} = L_{ACC\_ANCHOR} - 1{,}1\ \mathrm{dB(A)}$$

Formula 3.2.5.2.1 No.1

$$n_{BB'\_ACC\_ANCHOR} = \frac{v_{BB'\_ACC\_ANCHOR}}{20} \times 1000$$

Formula 3.2.5.2.1 No.2

$$n_{BB'\_CRS\_ANCHOR} = \frac{v_{TEST}}{v_{BB'\_ACC\_ANCHOR}} \times n_{BB'\_ACC\_ANCHOR}$$

Formula 3.2.5.2.2.

$$n_{BB'\_CRS\_ANCHOR} = \frac{v_{TEST}}{30} \times 1000$$

Formula 3.3. No.1

$$L_{TR\_EXP} = \theta_{TR\_LO} \times \lg\left(v_{BB'\_TEST}/v_{TEST}\right) + L_{REF\_TR}$$

Formula 3.3. No.2

$$L_{TR\_EXP} = \theta_{TR\_HI} \times \lg\left(v_{BB'\_TEST}/v_{TEST}\right) + L_{REF\_TR}$$

Formula 3.4. No.1

$$L_{PT\_EXP} = \theta_{PT\_LO} \times \lg\left(\left(n_{BB'\_TEST} + n_{SHIFT\_PT}\right)/\left(n_{BB'\_CRS\_ANCHOR} + n_{SHIFT\_PT}\right)\right) + L_{REF\_PT}$$

Formula 3.4. No.2

$$L_{PT_{EXP}} = \theta_{PT_{HI}} \times \lg\left(\left(n_{BB'_{TEST}} + n_{SHIFT_{PT}}\right)/\left(n_{BB'_{CRS_{ANCHOR}}} + n_{SHIFT_{PT}}\right)\right) + L_{REF_{PT}}$$

Formula 3.5. No.1

$$L_{DYN\_EXP} = \theta_{DYN\_LO} \times \lg\left(\left(n_{BB'\_TEST} + n_{SHIFT\_DYN}\right)/\left(n_{BB'\_ACC\_ANCHOR} + n_{SHIFT\_DYN}\right)\right) + L_{REF\_DYN}$$

Formula 3.5. No.2

$$L_{DYN\_EXP} = \theta_{DYN\_HI} \times \lg\left(\left(n_{BB'\_TEST} + n_{SHIFT\_DYN}\right)/\left(n_{BB'\_ACC\_ANCHOR} + n_{SHIFT\_DYN}\right)\right) + L_{REF\_DYN}$$

Formula 3.6.2.

$$LOAD_{TEST} = a_{TEST}/a_{MAX\,i} \quad \text{where} \quad a_{MAX\_i} = \frac{\kappa_{REF}}{\kappa_{TEST}} \times a_{MAX\_REF}$$

Formula 3.6.3.1.

$$v \cdot a_{TEST} = \frac{v_{BB'\_TEST}}{3{,}6} \times a_{TEST} \quad [m^2/s^3]$$

Formula 3.6.3.2. No.1

$$v \cdot a_{ANCHOR} = v_{BB'\_ACC\_ANCHOR} \times a_{ACC\_ANCHOR}$$

Formula 3.6.3.2. No. 2

$$\Delta L_{DYN\_v \bullet a} = \beta \times \lg\left(\frac{v \cdot a_{TEST}}{v \cdot a_{ANCHOR}}\right)$$

Formula 3.6.3.3.

$$\Delta L_{DYN\_EXP} = \left(\Delta L_{DYN} + \Delta L_{DYN\_v \cdot a}\right) \times (1 - \alpha_1/(LOAD_{TEST} + \alpha_2))/\left(1 - \alpha_1/(1 + \alpha_2)\right) + 0,3$$

Formula 3.7.

$$\Delta L_{AVAS} = \left(L_{ACC\_ANCHOR} - 58\right) \times \left(1 - \left(v_{BB'\_TEST}/v_{TEST}\right)^{0,75}\right)$$

Formula 3.8.

$$L_{TEST\_EXP} = 10 \times \lg\left(10^{0,1 \times L_{TR\_EXP}} + 10^{0,1 \times L_{PT\_EXP}} + 10^{0,1 \times \left(L_{DYN\_EXP} + \Delta L_{DYN\_EXP}\right)}\right) + \Delta L_{AVAS} + 2dB(A)$$

Annex 9 – Appendix 5

Test report sheet

Test Report for Pass-by Sound Measurements According to UN R51.03 Annex 9

Parameter from Annex 3 as specified by Paragraph 2.2. of Appendix 1 to Annex 9								
Refer gear (index)		L_{ACC_ANCHOR}	[dB(A)]		L_{CRS_ANCHOR}	[dB(A)]		
Refer gear (number)		$v_{BB'\_ACC\_ANCHOR}$	[km/h]		$v_{BB'\_CRS\_ANCHOR} = v_{REF}$	[km/h]		
		$n_{BB'\_ACC\_ANCHOR}$	[rpm]		$n_{BB'\_CRS\_ANCHOR}$	[rpm]		
		a_{ACC_ANCHOR}	[m/s²]					

Model Parameters	
Parameter Set	A/B/C
Ref gear ratio	
Ref acceleration	

	Target Condition				Measured Values												Conformity		
Run	Gear Selector Position	Selected Mode	Vehicle Speed $v_{AA'}$	Accelerator Position (%pedal depression)	Start Point Acceleration (pre-acceleration length)	Vehicle Speeds			Engine Speed at line BB'	Maximum Sound Pressure Level Left Side	Maximum Sound Pressure Level Right Side	Run Valid with Control Range	Comments	Acceleration between PP'-BB'	Vehicle Performance	Expected Sound Pressure Level	$L_{TEST} < L_{EXP}$	$L_{TEST} < L_{EXP}$ + tolerance	$L_{TEST} > L_{EXP}$ + tolerance
Nr	Gear/Nr.				l	$v_{AA'}$	$v_{PP'}$	$v_{BB'}$	$n_{BB'}$	L_{LEFT}	L_{RIGHT}	Yes/No		a_{TEST}	v·a	L_{EXP}	Cross X if applicable	Cross X if applicable	Cross X if applicable
			km/h	%	m	km/h	km/h	km/h	1/min	dB(A)	dB(A)			m/s²	m²/s³	dB(A)			
Test Runs																			
1																			
2																			
3																			
4																			
5																			
6																			
7																			
8																			
9																			
10																			
11																			
12																			
13																			
14																			
15																			
Additional Runs																			
1																			
2																			
3																			
4																			
5																			

Compliance of the test results to Annex 9: YES/NO **Number Case of compliance according to paragraph 4 of Annex 9:**

II. Justification

The technologies currently used in systems for noise reduction in motor vehicles of classes M_1 and N_1 (e.g. flap silencer systems, sound actuators) allow free shaping of the vehicle sound emissions. This is relatively free from the speed or load conditions of the combustion engine. The current test criteria of Annex 7 only test the sound emissions under the full load in some transmission ratios. With the introduction of RD-ASEP, the sound emissions of all load conditions shall be assessed in the future. In order to determine the practicability of a new requirement including its limit values, the requirements of RD-ASEP will be introduced in parallel with the requirements of Annex 7 for a period of twelve months by means of a new Annex 9. For granting type approval, only the requirements of Annex 3 and Annex 7 continue to be decisive. Annex 9 is only for data collection and data analysis and has no influence on granting type approval within the aforementioned period.