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**Proposal IN PROGRESS a 04 Series of amendment to UN-R51
from the Drafting group IWG-ASEP
Based on UN-R51-03.Supplement 6
(volunteers: Germany, Japan, China, OICA, ISO representatives)
This document updates the previous GRBP-73-05**

Agreement

**Concerning the Adoption of Uniform Technical Prescriptions for
Wheeled Vehicles, Equipment and Parts which can be Fitted and/or be
Used on Wheeled Vehicles and the Conditions for Reciprocal
Recognition of Approvals Granted on the Basis of these Prescriptions***

(Revision 3, including the amendments which entered into force on 20 January 2016)

Addendum **XX – Regulation No. 51**

Revision 5

Covering all series including the **04** series of amendments:

04 series to the original version of the Regulation – Date of entry into force: xxxxx

**Uniform provisions concerning the approval of motor vehicles having at
least four wheels with regard to their sound emissions**



* Former title of the Agreement: Agreement Concerning the Adoption of Uniform Conditions of Approval and Reciprocal Recognition of Approval for Motor Vehicle Equipment and Parts, done at Geneva on 20 March 1958.

UNITED NATIONS

UN Regulation No. 51

Uniform provisions concerning the approval of motor vehicles having at least four wheels with regard to their sound emissions

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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, **Real Driving** Additional Sound Emission Provisions (**RD-ASEP**) for vehicles of categories M₁ and N₁ **covering driving conditions outside of normal driving with higher accelerations and vehicle speeds up to 100 km/h** ~~referring to driving conditions with extreme accelerations in an extended speed range representative for urban and suburban traffic.~~

2. Definitions

For the purpose of this Regulation,

- 2.1. "Approval of a vehicle" means the approval of a vehicle type with regard to **exterior** sound;
- 2.2. "Vehicle type" means a category of motor vehicles which do not differ in such essential respects as:
 - 2.2.1. For vehicles tested according to Annex 3, paragraph 3.1.2.1.:
 - 2.2.1.1. The shape or materials of the engine compartment and its soundproofing;
 - 2.2.1.2. The type of engine (positive or compression ignition, two- or four-stroke, reciprocating or rotary piston), number and capacity of cylinders, number and type of carburettors or injection system, arrangement of valves, or the **number and the** type of electric motor(s);
 - 2.2.1.3. Rated maximum net power and corresponding rated engine speed(s); however if the rated maximum net power and the corresponding rated engine speed differs only due to different engine mappings, these vehicles may be regarded as from the same type;
 - 2.2.1.4. The silencing system.
 - 2.2.2. For vehicles tested according to Annex 3, paragraph 3.1.2.2.:
 - 2.2.2.1. The shape or materials of the engine compartment and its soundproofing;
 - 2.2.2.2. The type of engine (positive or compression ignition, two- or four-stroke, reciprocating or rotary piston), number and capacity of cylinders, type of injection system, arrangement of valves, rated engine speed (S), or the type of electric motor;
 - 2.2.2.3. Vehicles having the same type of engine and/or different overall gear ratios may be regarded as vehicles of the same type;

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

- 2.3. However, if the differences in paragraph 2.2.2. provide for different target conditions, as described in paragraph 3.1.2.2. of Annex 3, these differences are considered as a change of type;
- 2.4. "*Mass of a vehicle in running order (m_{RO})*" means
- (a) In the case of a motor vehicle:

The mass of the **unladen** vehicle, with its fuel tank(s) filled to at least 90 per cent of its or their capacity/ies, including the mass of the driver, of **100%** liquids, fitted with the standard equipment in accordance with the manufacturer's specifications and, when they are fitted, the mass of the bodywork, the cabin, the coupling and the spare wheel(s) as well as the tools;
 - (b) In the case of a **towing vehicle designed to be coupled to a trailer**:

The mass of the vehicle including the fuel and liquids, fitted with the standard equipment in accordance with the manufacturer's specifications, and, when they are fitted, the mass of the bodywork, additional coupling(s), the spare wheel(s) and the tools.
- 2.5. "*Technically permissible maximum laden mass (M)*" means the maximum mass allocated to a vehicle on the basis of its construction features and its design performances; the technically permissible laden mass of a trailer or of a semi-trailer includes the static **vertical** mass transferred to the towing vehicle when coupled;
- 2.6. "*Vehicle length*" means a dimension which is measured according to **paragraphs 6.1.1., 6.1.2, and 6.1.3. of ISO standard 612-1978**. In addition to the provisions of that standard, when measuring the vehicle structural length the following devices shall not be taken into account:
- (a) Wiper and washer devices;
 - (b) Front or rear marker-plates;
 - (c) Customs sealing devices and their protection;
 - (d) Devices for securing the tarpaulin and their protection;
 - (e) Lighting equipment;
 - (f) **Device for indirect vision**;
 - (g) Rear space watching aids;
 - (h) Air-intake pipes;
 - (i) Length stops for demountable bodies;
 - (j) Access steps;
 - (k) Ram rubbers;
 - (l) Lifting platforms, access ramps and similar equipment in running order, not exceeding **300 mm**, provided that the loading capacity of the vehicle is not increased;
 - (m) Coupling devices for motor vehicles.

- 2.7 "Vehicle width" means a dimension which is measured according to ISO standard 612-1978, term No. 6.2. In addition to the provisions of that standard, when measuring the vehicle structural width the following devices shall not be taken into account:
- (a) Customs sealing devices and their protection;
 - (b) Devices for securing the tarpaulin and their protection;
 - (c) Tyre failure tell-tale devices;
 - (d) Protruding flexible parts of a spray-suppression system;
 - (e) Lighting equipment.
- 2.8.
- "Maximum net power, P_n " means the engine power available for propulsion expressed in kW and measured dependent on the drive train concepts.**
- Applicable power sources are those, which provide drive power for forward motion to the vehicle.**
- 2.8.1. **For vehicles with combustion engine(s) only**
- The maximum engine power is the net power P_n of the combustion engine(s) measured at full engine load pursuant to UN Regulation No. 85 paragraph 5.2.**
- 2.8.2. **For pure electric vehicles that have only one propulsion energy converter**
- The net power P_n of the electric motor of the electric drive train is determined pursuant to UN Regulation No. 85 paragraph 5.3.**
- 2.8.3. **For hybrid electric vehicles [where at least one electric machine contributes to propulsion], or pure electric vehicles that have more than one propulsion energy converter**
- The maximum engine power is the "vehicle system power rating" according to GTR 21, paragraph 6.9.1 (b) "sustained vehicle system power".**
- 2.8.4. **For fuel cell electric vehicles**
- The maximum engine power is the net power P_n of the combustion engine(s) measured at full engine load pursuant to UN Regulation No. 85 paragraph 5.2.**
- 2.9. "Rated engine speed, S " means the declared engine speed in min^{-1} (rpm) at which the engine develops its rated maximum net power pursuant to UN Regulation No. 85 or, where the rated maximum net power is reached at several engine speeds, the highest one of those speeds.
- 2.10. "Power to Mass Ratio index (PMR)" means a numerical quantity (see Annex 3, paragraph 3.1.2.1.1.) with no dimension used for the calculation of acceleration.
- 2.11. "Reference point" means one of the following points:
- 2.11.1. In the case of vehicles of categories M_1 , N_1 and $M_2 \leq 3,500$ kg technically permissible maximum laden mass:

- (a) For front engine vehicles: the front end of the vehicle;
- (b) For mid-engine vehicles: the centre of the vehicle;
- (c) For rear engine vehicles: the rear end of the vehicle.

For vehicles having multiple propulsion sources, the reference point is determined by the position of the propulsion source having the highest power. If there are multiple propulsion sources of equivalent power, then the position of the most forward propulsion source shall prevail.

- 2.11.2. In the case of vehicles of categories $M_2 > 3,500\text{kg}$ technical permissible maximum laden mass, M_3 , N_2 , N_3 :
 - (a) For front-engine vehicles, the front end of the vehicle;
 - (b) For all other vehicles, the border of the engine closest to the front of the vehicle;
- 2.12. "*Engine*" means the power source without detachable accessories.

Power source includes in this context all sources of motive power; for example, electric or hydraulic power sources used alone or in combination with other power sources.
- 2.13. "*Target acceleration*" means acceleration at a partial throttle condition in urban traffic and is derived from statistical investigations.
- 2.14. "*Reference acceleration*" means the required acceleration during the acceleration test on the test track.
- 2.15. "*Gear ratio weighting factor k*" means a dimensionless numerical quantity used to combine the test results of two gear ratios for the acceleration test and the constant speed test.
- 2.16. "*Partial power factor k_P* " means a numerical quantity with no dimension used for the weighted combination of the test results of the acceleration test and the constant speed test for vehicles.
- 2.17. "*Pre-acceleration*" means application of acceleration control device prior to AA' for the purpose of achieving stable acceleration between AA' and BB' as referred to in Figure 1 of Appendix 1 to Annex 3.

- 2.18. Gear²
- 2.18.1. "Gear ratios"
- 2.18.1.1. "Internal gearbox ratio" means the ratios of engine to gearbox output shaft revolutions.
- 2.18.1.2. "Final drive ratio" means the ratio(s) of gearbox output shaft to driven wheel revolutions.
- 2.18.1.3. "Total gear ratio" means the ratios between vehicle speed and engine speed during the passage of the vehicle through the test track.
- 2.18.1.4. "Gear ratio" used in context with vehicles tested according to 3.1.2.1. of Annex 3 and Annex 7 is the total gear ratio as defined in 2.18.1.3. above **(especially in junction with CVTs³ where any gear ratio may be available)**.
- 2.18.2. "Locked gear ratio" means the control of the transmission such that the gear will not change during a test.
- 2.18.3. "Gear" means in the context of this Regulation a discrete gear ratio either selectable by the driver or by an external device.
- 2.18.4. For vehicles tested according to paragraph 3.1.2.1. of Annex 3 and Annex 7, "gear_i" and "gear_{i+1}" are defined as two gears in sequence, where gear_i either provides an acceleration within the 5 per cent tolerance according to paragraph 3.1.2.1.4.1. (a) of Annex 3 or an acceleration greater than the reference acceleration, and gear_{i+1} an acceleration lower than the reference acceleration according to paragraph 3.1.2.1.4.1. (b) or (c) of Annex 3.
- 2.19. "Silencing system" means a complete set of components necessary for limiting the sound produced by an engine, its intake and its exhaust (the exhaust manifold(s), the catalyst(s) and emission after-treatment device(s) are not considered part of the silencing system; these parts belong to the engine).
- 2.20. "Design family of exhaust silencing system or exhaust silencing system components" means a group of silencing systems or components thereof in which all of the following characteristics are the same:
- (a) The presence of net gas flow of the exhaust gases through the absorbing fibrous material when in contact with that material;
 - (b) The type of the fibres;
 - (c) Where applicable, binder material specifications;
 - (d) Average fibre dimensions;

² Note: The common understanding of a "low gear" or a "high gear" shall not apply to gear ratios. For example, the lowest gear for forward driving, the first gear, has the highest gear ratio of all forward driving gears. While manual transmission has discrete gears, many non-manual transmissions can have more gear ratios engaged by the control unit of the transmission.

- ³ A CVT might have predefined by soft- or hardware discrete gears, but could provide as well more gear ratios by external control measures.

- (e) Minimum bulk material packing density in kg/m³;
 - (f) Maximum contact surface between the gas flow and the absorbing material.
- 2.21. *"Exhaust silencing system of different types"* means silencing systems which significantly differ in respect of at least one of the following:
- (a) Trade names or trademarks of their components;
 - (b) The characteristics of the materials constituting their components, except for the coating of those components;
 - (c) The shape or size of their components;
 - (d) The operating principles of at least one of their components;
 - (e) The assembly of their components;
 - (f) The number of exhaust silencing systems or components.
- 2.22. *"Replacement silencing system"* means any part of the silencing system or its components intended for use on a vehicle, other than a part of the type fitted to this vehicle when submitted for type-approval pursuant to this Regulation.
- 2.23. *"R-point"* means R-point as defined in paragraph 2.4. of Annex 1 to the Consolidated Resolution on the Construction of Vehicles (R.E.3.).
- 2.24. Table of symbols
- 2.24.1. Table of symbols for Annex 3**
- Symbols listed under the paragraphs 2.2.1 up to 3.1.1 are general symbols used for both test methods described under paragraphs 3.1.2.1 and 3.1.2.2.**
- Symbols listed under the paragraphs 3.1.2.1 are used for the test method of vehicles of category M₁, N₁ and M₂ ≤ 3,500 kg technically permissible maximum laden mass.**
- Symbols listed under the paragraphs 3.1.2.2 are used for the test method of vehicles of category M₂ > 3,500 kg technically permissible maximum laden mass, M₃, N₂, N₃.**

<i>Symbol</i>	<i>Unit</i>	<i>Paragraph</i>	<i>Explanation</i>
m _{RO}	kg	2.2.1.	mass in running order; value to be reported and used for calculations to a precision of 10 kg
m _T	kg	2.2.1.	test mass of the vehicle; value to be reported and used for calculations to a precision of 10 kg
m _{TARGET}	kg	2.2.1.	target mass of the vehicle
m _{XLOAD}	kg	2.2.1.	extra loading
m _{FA LOAD UNLADEN}	kg	2.2.1.	front axle load in unladen condition
m _{RA LOAD UNLADEN}	kg	2.2.1.	rear axle load in unladen condition

<i>Symbol</i>	<i>Unit</i>	<i>Paragraph</i>	<i>Explanation</i>
m _{UNLADEN}	kg	2.2.1.	unladen vehicle mass
m _{AC RA MAX}	kg	2.2.1.	Technically permissible maximum laden mass allowed for the rear axle as declared by the manufacturer
m _D	kg	2.2.1.	mass of driver
m _{CHASSIS M2M3}	kg	2.2.1.	mass of the incomplete vehicle (M ₂ or M ₃)
m _{XLOAD M2M3}	kg	2.2.1.	extra load to be added to the incomplete vehicle (M ₂ or M ₃) to reach the mass of the vehicle in running order as chosen by the manufacturer
m _{FA LOAD LADEN}	kg	2.2.7.2.	front axle load in laden condition
m _{RA LOAD LADEN}	kg	2.2.7.2.	rear axle load in laden condition
m _{TT} (2 axles virtual)	kg	2.2.7.4.	test mass of a virtual vehicle with two axles (4x2 or 4x4)
veh _{RF}	—	2.2.7.4.	vehicle with more than two axles representing the vehicle family
m _{UNLADEN} (2 axles virtual)	kg	2.2.7.4.	unladen vehicle mass of the virtual vehicle with two axles
m _{XLOAD} (2 axles virtual)	kg	2.2.7.4.	extra loading for the virtual vehicle with two axles
m _{AC RA MAX} (chosen)	kg	2.2.7.4.	Technically permissible maximum laden mass allowed for the chosen rear axle as defined in paragraph 2.2.7.4. in Annex 3
AA'	—	3.1.1.	line perpendicular to vehicle travel which indicates beginning of zone in which to record sound pressure level during test
BB'	—	3.1.1.	line perpendicular to vehicle travel which is 10.00 m behind line PP'
CC'	—	3.1.1.	line of vehicle travel through test surface defined in ISO 10844
PP'	—	3.1.1.	line perpendicular to vehicle travel which indicates location of microphones
v _{TEST}	km/h	3.1.2.1.	vehicle test speed
PMR	—	3.1.2.1.1.	power-to-mass ratio index to be used for calculations; value to be reported and used for calculations to the first decimal place
P _N	kW	3.1.2.1.1.	rated total engine net power
l	m	3.1.2.1.2.	reference length; value to be reported and used for calculations to a precision of 0.01 m (1 cm)
l _{VEH}	m	3.1.2.1.2.	length of vehicle; value to be reported and used for calculations to a precision of 0.01 m (1 cm)

<i>Symbol</i>	<i>Unit</i>	<i>Paragraph</i>	<i>Explanation</i>
V _{AA'}	km/h	3.1.2.1.2.	vehicle velocity when the reference point passes line AA' (see paragraph 2.11. for definition of reference point); value to be reported and used for calculations to the first decimal place
V _{BB'}	km/h	3.1.2.1.2.	vehicle velocity when the reference point or rear of vehicle passes line BB' (see explicit definition under the discrete test procedures starting from 3.1.2.1. and 3.1.2.2. of Annex 3 for the various categories of paragraph 2.11. for definition of reference point); value to be reported and used for calculations to the first decimal place
V _{PP'}	km/h	3.1.2.1.2.	vehicle velocity when the reference point passes line PP' (see paragraph 2.11. for definition of reference point); value to be reported and used for calculations to the first decimal place
a _{ACC TEST}	m/s ²	3.1.2.1.2.1.	acceleration from AA' to BB'; value to be reported and used for calculations to the second decimal place
a _{ACC TEST i}	m/s ²	3.1.2.1.2.1.	acceleration achieved in a particular gear i; value to be reported and used for calculations to the second decimal place
l _{PA}	m	3.1.2.1.2.1.	point of depressing the accelerator before line AA'; value to be reported in full meter
a _{ACC TEST PP'-BB'}	m/s ²	3.1.2.1.2.2.	acceleration from PP' to BB'; value to be reported and used for calculations to the second decimal place
a _{URBAN}	m/s ²	3.1.2.1.2.3.	target acceleration representing urban traffic acceleration; value to be reported and used for calculations to the second decimal place
a _{ACC REF}	m/s ²	3.1.2.1.2.4.	reference acceleration for the acceleration test; value to be reported and used for calculations to the second decimal place
k _P	—	3.1.2.1.3.	partial power factor; value to be reported and used for calculations to the second decimal place
a _{ACC i}	m/s ²	3.1.2.1.4.1.	acceleration in gear ratio i; value to be reported and used for calculations to the second decimal place
a _{ACC (i + 1)}	m/s ²	3.1.2.1.4.1.	acceleration in gear ratio (i + 1); value to be reported and used for calculations to the second decimal place
gear ratio i	—	3.1.2.1.4.1.	gear ratio which provides an acceleration within the 5 per cent tolerance of the reference acceleration a _{ACC REF} or greater than the reference acceleration a _{ACC REF}
gear ratio i+1	—	3.1.2.1.4.1.	second of two gear ratios, with an acceleration lower than gear ratio i

<i>Symbol</i>	<i>Unit</i>	<i>Paragraph</i>	<i>Explanation</i>
gear ratio i+2, i+3, ...	—	3.1.2.1.4.1.	gear ratios selectable for the pass-by test of Annex 3, if gear ratio i and gear ratio i+1 exceed an acceleration of 2.0 m/s ²
k	—	3.1.2.1.4.1.	gear ratio weighting factor; value to be reported and used for calculations to the second decimal place
n_{MAX}	1/min	3.1.2.1.4.1	Maximum engine rotational speed permitted for M₁, N₁, and M₂ less than 3500 kg; value to be reported and used for calculations to a precision of 10 min⁻¹ (xxx0)
n _{BB'}	1/min	3.1.2.2.	engine rotational speed of the vehicle, when the reference point passes BB'; value to be reported and used for calculations to a precision of 10 min ⁻¹
S	1/min	3.1.2.2.	rated engine rotational speed in revs per minute, synonymous with the engine rotational speed at maximum power
n _{TARGET BB'}	1/min	3.1.2.2.1.1.(a)	target engine rotational speed of the vehicle when the reference point has to pass line BB' (see 2.11.2. for definition of reference point)
v _{TARGET BB'}	km/h	3.1.2.2.1.1.(a)	target vehicle velocity when it is necessary that the reference point has to pass line BB' (see 2.11.2. for definition of reference point)
v _{BB' GEAR i}	km/h	3.1.2.2.1.1.(b)	target vehicle velocity when certain conditions are met
v _{BB' GEAR i, i=1,2}	km/h	3.1.2.2.1.1. (c)	target vehicle velocity when certain conditions are met
gear _x	-	3.1.2.2.1.1. (d)	first of two gear ratios used for testing of M ₂ having a maximum authorized mass of more than 3 500 kg, M ₃ , N ₂ , and N ₃ where certain criteria on test conditions are met
gear _y	-	3.1.2.2.1.1. (d)	second of two gear ratios used for testing of M ₂ having a maximum authorized mass of more than 3,500 kg, M ₃ , N ₂ , and N ₃ where certain criteria on test conditions are met
v _{BB'X}	km/h	3.1.2.2.1.1. (d)	target vehicle velocity when certain conditions are met
v _{BB'Y}	km/h	3.1.2.2.1.1. (d)	target vehicle velocity when certain conditions are met
v _{BB'1}	km/h	3.1.2.2.1.2. (b)	target vehicle velocity when certain conditions are met
v _{BB'2}	km/h	3.1.2.2.1.2. (b)	target vehicle velocity when certain conditions are met
n _{BB'i, i=1,2}	1/min	3.1.2.2.1.2. (d)	engine rotational speed when the reference point passes BB' when certain conditions are met
L _{CRS i}	dB(A)	3.1.3.1.	vehicle sound pressure level at constant speed test for gear i; value to be reported and used for calculations to the first decimal place

<i>Symbol</i>	<i>Unit</i>	<i>Paragraph</i>	<i>Explanation</i>
L _{CRS (i + 1)}	dB(A)	3.1.3.1.	vehicle sound pressure level at constant speed test for gear (i + 1); value to be reported and used for calculations to the first decimal place
L _{CRS REP}	dB(A)	3.1.3.1.	reported vehicle sound pressure level at constant speed test; value to be reported and used for calculations to the first decimal place
L _{ACC (i)}	dB(A)	3.1.3.1.	vehicle sound pressure level for the acceleration test for gear i; value to be reported and used for calculations to the first decimal place
L _{ACC (i + 1)}	dB(A)	3.1.3.1.	vehicle sound pressure level for the acceleration test for gear (i + 1); value to be reported and used for calculations to the first decimal place
L _{ACC REP}	dB(A)	3.1.3.1.	reported vehicle sound pressure level for the acceleration ; value to be reported and used for calculations to the first decimal place
L _{URBAN}	dB(A)	3.1.3.1.	reported vehicle sound pressure level representing urban operation; value to be reported mathematically rounded to the nearest integer

2.24.2. Table of symbols for Annex 7

<i>Symbol</i>	<i>Unit</i>	<i>Paragraph</i>	<i>Explanation</i>
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

<i>Symbol</i>	<i>Unit</i>	<i>Paragraph</i>	<i>Explanation</i>
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·a	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
Annex 7-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

<i>Symbol</i>	<i>Unit</i>	<i>Paragraph</i>	<i>Explanation</i>
α	-	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
Δ L _{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 Δ L _{DYN} calculation
L _{REF PT ADJ}	dB(A)	2.7.	Power Train Mechanical Sound Level with adjusted engine speed for Δ L _{DYN} calculation
$\theta_{TR LO}$	dB(A)	2.7.	sound slope for tyre rolling sound when vehicle speed is not greater than the reference speed
$\theta_{PT LO}$	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
κ_{TEST}	Km/h/(1000 1/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
κ_{REF}	km/h/(1000 1/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
$\theta_{TR HI}$	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
$\theta_{PT HI}$	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
$\theta_{DYN LO}$	dB(A)	3.5.	sound slope for Dynamic Sound when vehicle engine speed is not greater than n _{BB} ' ACC' ANCHOR
$\theta_{DYN HI}$	dB(A)	3.5.	sound slope for Dynamic Sound when vehicle engine speed is exceeding n _{BB} ' ACC' ANCHOR

<i>Symbol</i>	<i>Unit</i>	<i>Paragraph</i>	<i>Explanation</i>
$\Delta L_{DYN\ EXP}$	dB(A)	3.6.	expected dynamic delta sound
$LOAD_{TEST}$		3.6.2.	load achieved during the test run
a_{TEST}	m/s ²	3.6.2.	acceleration achieved during the test run
$a_{MAX\ \kappa}$	m/s ²	3.6.2.	Maximum acceleration in gear κ
$v \cdot a_{TEST}$	m ² /s ³	3.6.3.1.	dynamic performance achieved during the test
$\Delta L_{DYN\ v \cdot a}$		3.6.3.2.	dynamic performance component calculated based on the achieved performance $v \cdot a_{TEST}$ relative to a reference performance.
β		3.6.3.2.	coefficient for calculating dynamic performance component
$v \cdot a_{REF}$	m ² /s ³	3.6.3.2.	reference performance
α		3.6.3.3.	coefficient for calculating dynamic sound components
$n_{MAX\ TORQUE}$	1/min	Appendix 4	engine speed when the engine is at the maximum torque

2.25. Modes

2.25.1. "Mode" means a distinct driver-selectable condition which affects the sound emission of the vehicle.

2.26. Stable acceleration

For the purpose of this Regulation, three conditions are **provided** for stable acceleration.

2.26.1. "Stable acceleration" applicable to all vehicles subject to this Regulation for low engine speed conditions, which eliminates power train reactions such as bumping and jerking.

2.26.2. "Stable acceleration" applicable to vehicles of category M₁, N₁ and M₂ < 3,500 kg technically permissible maximum laden mass avoids acceleration delays in acceleration due to engine control application, at the moment when the acceleration unit is depressed. This is typically ensured by using pre-acceleration.

2.26.3. "Stable acceleration" for the purpose of Annex 7 is based on the assumption of a constant acceleration over the complete measurement distance between AA' and BB' plus the vehicle length.

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

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

- 2.29. **"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.

- 2.30. **"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.

- 2.31. **"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...).

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

- 2.33. **"Electronic Control System"** means a combination of units, designed to co-operate in the production of the stated vehicle control function by electronic data processing. Such systems, often controlled by software, are built from discrete functional components such as sensors, electronic control units and actuators and connected by transmission links. They may include mechanical, electro-pneumatic or electro-hydraulic elements. "The System", referred to herein, is the one for which type approval is being sought.

- 2.34. **"Software"** means the part of an Electronic Control System that consists of digital data and instructions."

- 2.35. **"Rx Software Identification Number (RXSWIN)"** means a dedicated identifier, defined by the vehicle manufacturer, representing information about the type approval relevant software of the Electronic Control System contributing to the UN Regulation No. 51.04 type approval relevant characteristics of the vehicle.

- 2.36 **"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.2⁴ (for example PEV, HEV, FCHEV)

3. Application for approval

- 3.1. The application for approval of a vehicle type with regard to sound shall be submitted by its manufacturer or by his duly accredited representative.

⁴ As defined in the Mutual Resolution No.2 (M.R.2) ECE/TRANS/WP.29/1121

- 3.2. It shall be accompanied by the undermentioned documents and the following particulars in triplicate:
 - 3.2.1. A description of the vehicle type with regard to the items mentioned in paragraph 2.2. above. The numbers and/or symbols identifying the engine type and the vehicle type shall be specified;
 - 3.2.2. A list of the components, duly identified, constituting the sound reduction system;
 - 3.2.3. A drawing of the assembled sound reduction system and an indication of its position on the vehicle;
 - 3.2.4. Detailed drawings of each component to enable it to be easily located and identified, and a specification of the materials used.
 - 3.2.5. A technical information document including the information as outlined in Annex 1, Appendix 2.
- 3.3. In the case of paragraph 2.2.2. the single vehicle, representative of the type in question, will be selected by the Technical Service conducting approval tests, in accordance with the vehicle manufacturer, following the specification laid down in paragraph 3.1.2.2. in Annex 3.
- 3.4. At the request of the Technical Service conducting approval tests, the vehicle manufacturer shall, in addition, submit a sample of the sound reduction system and an engine of at least the same cylinder capacity and rated maximum net power as that fitted to the vehicle in respect of which type-approval is sought.
- 3.5. The Type Approval Authority shall verify the existence of satisfactory arrangements for ensuring effective control of the conformity of production before type approval is granted.

4. Markings

- 4.1. The **following** components **relevant for exterior sound emissions**, excluding fixing hardware and piping, shall bear **a marking consisting** the trade name or mark of the manufacturer of the **components, and the manufacturer's trade description**:
 - **exhaust silencer,**
 - **sound enhancement system.**
- 4.2. These markings shall be clearly legible and be indelible even after fitting.
- 4.3. A component may carry several approval numbers if it has been approved as component of several replacement silencing systems.

5. Approval

- 5.1. Type approval shall only be granted if the vehicle type meets the requirements of paragraphs 6. and 7. below.
- 5.2. An approval number shall be assigned to each type approved. Its first two digits (at present 04 corresponding to the 04 series of amendments) shall indicate the series of amendments incorporating the most recent major technical amendments made to the Regulation at the time of issue of the approval. The

same Contracting Party shall not assign the same number to another vehicle type.

- 5.3. Notice of approval or of extension or of refusal or withdrawal of approval or of production definitively discontinued of a vehicle type pursuant to this Regulation shall be communicated to the Parties to the Agreement applying this Regulation, by means of a form conforming to the model in Annex 1 to this Regulation.
- 5.4. There shall be affixed, conspicuously and in a readily accessible place specified on the approval form, to every vehicle conforming to a vehicle type approved under this Regulation an international approval mark consisting of:
 - 5.4.1. A circle surrounding the letter "E" followed by the distinguishing number of the country which has granted approval;⁵
 - 5.4.2. The number of this Regulation, followed by the letter "R", a dash and the approval number to the right of the circle prescribed in paragraph 5.4.1.
- 5.5. If the vehicle conforms to a vehicle type approved under one or more other Regulations annexed to the Agreement, in the country which has granted approval under this Regulation, the symbol prescribed in paragraph 5.4.1. need not be repeated; in such a case the regulation and approval numbers and the additional symbols of all the Regulations under which approval has been granted in the country which has granted approval under this Regulation shall be placed in vertical columns to the right of the symbol prescribed in paragraph 5.4.1.
- 5.6. The approval mark shall be clearly legible and be indelible.
- 5.7. The approval mark shall be placed close to or on the vehicle data plate affixed by the manufacturer.
- 5.8. Annex 2 to this Regulation gives examples of arrangements of the approval mark.

6. Specifications

- 6.1. General specifications **for durability and against manipulation**
 - 6.1.1. The vehicle, its engine and its sound reduction system shall be so designed, constructed and assembled as to enable the vehicle, in normal use, despite the vibration to which it may be subjected, to comply with the provisions of this Regulation.
 - 6.1.2. The sound reduction system shall be so designed, constructed and assembled as to be able to reasonably resist the corrosive phenomena to which it is exposed having regard to the conditions of use of the vehicle, including regional climate differences, **and against manipulation.**
- 6.2. Specifications regarding sound levels
 - 6.2.1. Methods of measurement

⁵ The distinguishing numbers of the Contracting Parties to the 1958 Agreement are reproduced in Annex 3 to the Consolidated Resolution on the Construction of Vehicles (R.E.3), document ECE/TRANS/WP.29/78/Rev.6

- 6.2.1.1. The sound made by the vehicle type submitted for approval shall be measured either indoors or outdoors by the methods described in Annex 3 **and Annex 7** to this Regulation. The specific conditions for indoor testing are provided in Annex 8 to this Regulation. The results of the outdoor and indoor tests are deemed equivalent.

For each specific test condition for vehicles, the manufacturer can select to test the vehicle either indoors or outdoors. The Type Approval Authority shall always have the option to mandate an outdoor test for verification. The option of the type approval authority to mandate an outdoor test shall apply to any test specified in this Regulation, including conformity of production testing.

In addition, the sound shall be measured on the stationary⁶ vehicle in the case of a vehicle where an internal combustion engine cannot operate when the vehicle is stationary, the emitted sound shall only be measured in motion. In the case of a hybrid electrical vehicle of category M1 where an internal combustion engine cannot operate when the vehicle is stationary, the emitted sound shall be measured according to Annex 3, paragraph 4.

Vehicles having a technically maximum permissible laden mass exceeding 2,800 kg shall be subjected to an additional measurement of the compressed air noise with the vehicle stationary in accordance with the specifications of Annex 5, if the corresponding brake equipment is part of the vehicle.

- 6.2.1.2. The values measured in accordance with the provisions of paragraph 6.2.1.1. above shall be entered in the test report and a certificate corresponding to the model shown in Annex 1.

- 6.2.2. Sound level limits

The sound level measured in accordance with the provisions of paragraph 3.1. of Annex 3 to this Regulation, mathematically rounded to the nearest integer value, shall not exceed the following limits:

⁶ A test is made on a stationary vehicle in order to provide a reference value for administrations which use this method to check vehicles in use.

Vehicle category	Vehicles used for the carriage of passengers	Limit Values (dB(A))		
		Phase 1	Phase 2	Phase 3
M ₁	PMR ≤ 120	72	70	68
	120 < PMR ≤ 160	73	71	69
	PMR > 160	75	73	71
	PMR > 200, no. of seats ≤ 4, R-point height < 450mm from the ground	75	74	72
M ₂	M ≤ 2.5 t	72	70	69
	2.5 t < M ≤ 3.5 t	74	72	71
	M > 3.5 t; P _N ≤ 135 kW	75	73	72
	M > 3.5 t; P _N > 135 kW	75	74	72
M ₃	P _N ≤ 150 kW	76	74	73
	150 kW < P _N ≤ 250 kW	78	77	76
	P _N > 250 kW	80	78	77
Vehicle category	Vehicles used for the carriage of goods	Phase 1	Phase 2	Phase 3
N ₁	M ≤ 2.5 t	72	71	69
	M > 2.5 t	74	73	71
N ₂	P _N ≤ 135 kW	77	75	74
	P _N > 135 kW	78	76	75
N ₃	P _N ≤ 150 kW	79	77	76
	150 kW < P _N ≤ 250 kW	81	79	77
	P _N > 250 kW	82	81	79

- 6.2.2.1. For vehicle types of category M₁ derived from N₁ vehicle types having a technically permissible maximum laden mass above 2.5 tons and a R-point height greater than 850 mm from the ground, the limits of vehicles types of category N₁ having a technically permissible maximum laden mass above 2.5 tons apply.
- 6.2.2.2. For vehicle types designed for off-road⁷ use, the limit values shall be increased by 2 dB(A) for M₃ and N₃ vehicles category and 1 dB(A) for any other vehicle category.
- For vehicle types of category M₁ the increased limit values for off-road vehicles are only valid if the technically permissible maximum laden mass > 2 tons.
- 6.2.2.3. Limit values shall be increased by 2 dB(A) for wheelchair accessible vehicles of category M₁ constructed or converted specifically so that they accommodate one or more persons seated in their wheelchairs when travelling on the road, and armoured vehicles, as defined in paragraph 2.5.2. of R.E.3.
- 6.2.2.4. For vehicle types of category M₃ having a gasoline only engine, the applicable limit value is increased by 2 dB(A).

⁷ As defined in the Consolidated Resolution on the Construction of Vehicles (R.E.3.), document ECE/TRANS/WP.29/78/Rev.6

6.2.2.5. For vehicle types of category N₁ having a technically permissible maximum laden mass of less than or equal to 2.5 tons, the engine capacity not exceeding 660 cc and the power-to-mass ratio (PMR) calculated by using the technically permissible maximum laden mass not exceeding 35 and a horizontal distance "d" between the front axle and the driver's seat R point of less than 1,100 mm, the limits of the vehicle types of category N₁ having a technically permissible maximum laden mass above 2.5 tons apply.

6.2.3. **Real Driving** Additional sound emission provisions

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.

6.2.3.1. **Exemptions**

Notwithstanding the requirements above, vehicles equipped with an ICE for propulsion, inclusive HEV are exempted from RD-ASEP, if their exhaust silencing systems have no variable geometries,

- and the vehicle has no sound enhancement systems, or
- 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 does not emit a sound pressure level of more than 75 dB(A)⁸ under any operation conditions exceeding the specification range of UN Regulation No. R138.

Manufacturer shall demonstrate compliance to the 75dB(A) by using the test set up according to UN Regulation No. R138 Annex 3 paragraph 3.3.2.2. by using the control range of RD-ASEP described in Annex 7 paragraph 3.3

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) under any operation conditions exceeding the specification range of UN Regulation No. R138.

Manufacturer shall demonstrate compliance to the 75dB(A) by using the test set up according to UN Regulation No. R138 Annex 3 paragraph 3.3.2.2. by using the control range of RD-ASEP described in Annex 7 paragraph 3.3.

6.2.3.2. **Specifications**

6.2.3.2.1. The vehicle shall meet the requirements of Annex 7 to this Regulation.

6.2.3.2.2. The vehicle manufacturer shall not intentionally alter, adjust, or introduce any mechanical, electrical, thermal, or other device or procedure solely for the

⁸ 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."

purpose of fulfilling the sound emission requirements as specified under this Regulation which is not operational during typical on-road operation.

- 6.2.3.2.3. **Regardless of the specifications above**, the sound emissions of the vehicle under **other** driving conditions **not subject to the measuring conditions of the Annex 3 and Annex 7**, shall not deviate from the **evaluation principles outlined by Annex 7** in a significant manner.

6.2.3.3. Provisions against manipulation

6.2.3.3.1. Software manipulation

6.2.3.3.1.1. Requirements for software identification

For the purpose of ensuring the software of the System can be identified, an RXSWIN may be implemented by the vehicle manufacturer.

6.2.3.3.1.2. If the manufacturer implements an RXSWIN the following shall apply:

6.2.3.3.1.2.1. The vehicle manufacturer shall have a valid approval according to UN Regulation No. 156.

6.2.3.3.1.2.2. The vehicle manufacturer shall provide the following information in the communication form of this Regulation:

- the RXSWIN
- how to read the RXSWIN or software version(s) in case the RXSWIN is not held on the vehicle

6.2.3.3.1.2.3. The vehicle manufacturer may provide in the communication form of this Regulation a list of the relevant parameters that will allow the identification of those vehicles that can be updated with the software represented by the RXSWIN. The information provided shall be declared by the vehicle manufacturer and may not be verified by an Approval Authority.

6.2.3.3.1.3. The vehicle manufacturer may obtain a new vehicle approval for the purpose of differentiating software versions intended to be used on vehicles already registered in the market from the software versions that are used on new vehicles. This may cover the situations where type approval regulations are updated, or hardware changes are made to vehicles in series production. In agreement with the testing agency duplication of tests shall be avoided where possible.

6.2.3.3.2. Hardware manipulation

All exhaust silencing systems shall be designed, constructed and assembled in a way that does not easily permit removal of baffles, exit-cones and other parts whose primary function is as part of the silencing/expansion chambers. It also applies to control units for active systems and to components like exhaust or intake flaps, or to vacuum tubes controlling the flaps, whose removal for purposes of maintenance, repair, or replacement is only possible by special tools and expertise.

6.3. Specifications regarding exhaust systems containing fibrous materials

6.3.1. Requirements of Annex 4 shall be applied.

7. Modification and extension of approval of a vehicle type

- 7.1. Every modification of the vehicle type shall be notified to the Type Approval Authority which approved the vehicle type. The Type Approval Authority may then either:
 - 7.1.1. Consider that the modifications made are unlikely to have an appreciable adverse effect and that in any case the vehicle still complies with the requirements, or
 - 7.1.2. Require a further test report from the Technical Service responsible for conducting the tests.
- 7.2. Confirmation or refusal of approval, specifying the alterations shall be communicated by the procedure specified in paragraph 5.3. above to the Parties to the Agreement applying this Regulation.
- 7.3. The Type Approval Authority issuing the extension of approval shall assign a series number for such an extension and inform thereof the other Parties to the 1958 Agreement applying this Regulation by means of a communication form conforming to the model in Annex 1 to this Regulation.

8. Conformity of production

- 8.1 The conformity of production procedures shall comply with those set out in the Agreement, **Schedule 1 (E/ECE/TRANS/505/Rev.3)**.
- 8.2 **Control procedures carried out by the manufacturer for conformity of production according to paragraph 2.3 of Schedule 1 of the Agreement (see 8.1 above) shall at least comply with the requirements of Annex 6 to this Regulation.**
- 8.3 **Whenever measurements on Conformity of Production according to paragraph 3. of Schedule 1 of the Agreement (see 8.1 above) or measurements other than type approval or conformity of production initiated by an authority to evaluate the conformity of the vehicle with regard to this Regulation are carried out, the setup of the vehicle and the assessment methods as established during type approval shall be taken as reference for the conformity assessment**

Notwithstanding this provision, the requirements of 6.2.1.1 remain valid.

9. Penalties for non-conformity of production

- 9.1. The approval granted in respect of a vehicle type pursuant to this Regulation may be withdrawn if the requirements set forth above are not met.
- 9.2. If a Contracting Party to the Agreement applying this Regulation withdraws an approval it has previously granted, it shall forthwith so notify the other Contracting Parties applying this Regulation, by means of a communication form conforming to the model in Annex 1 to this Regulation.

10. Production definitively discontinued

- 10.1. If the holder of the approval completely ceases to manufacture a vehicle type approved in accordance with this Regulation, he shall so inform the authority which granted the approval. Upon receiving the relevant communication that authority shall inform thereof the other Parties to the 1958 Agreement applying this Regulation by means of a communication form conforming to the model in Annex 1 to this Regulation.

11. Transitional provisions

- 11.1. **As from the official date of entry into force of the 04 series of amendments to this Regulation, no Contracting Party applying this Regulation shall refuse to grant or refuse to accept type-approvals under this Regulation as amended by the 04 series of amendments.**

[Further transitional provisions to be completed]

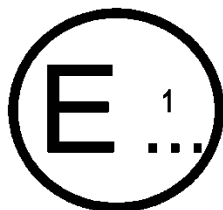
12. Names and addresses of Technical Services responsible for conducting approval tests and of Type Approval Authorities

The Contracting Parties to the 1958 Agreement applying this Regulation shall communicate to the United Nations Secretariat the names and addresses of the Technical Services responsible for conducting approval tests and of the Type Approval Authorities which grant approval and to which forms certifying approval or extension or refusal or withdrawal of approval, issued in other countries, are to be sent.

Annex 1

Communication

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



issued by: Name of administration:

.....
.....
.....

concerning:² Approval granted
 Approval extended
 Approval refused
 Approval withdrawn
 Production definitively discontinued

of a vehicle type with regard to its sound emission pursuant to UN Regulation No. 51

Approval No. Extension No.

Section I

- 0.1. Make (trade name of manufacturer):
- 0.2. Type:.....
- 0.3. Means of identification of type if marked on the vehicle: ³
- 0.3.1. Location of that marking:
- 0.4. Category of vehicle:⁴
- 0.4.1. Subcategory according to paragraph 6.2.2., the 2nd column of the table and the paragraphs 6.2.2.1. to 6.2.2.5.....
- 0.5. Company name and address of manufacturer:
- 0.6. Names and Address(es) of assembly plant(s):
- 0.7. Name and address of the manufacturer's representative (if any):

¹ Distinguishing number of the country which has granted/extended/refused/withdrawn approval (see approval provisions in the Regulation).

² Delete what does not apply.

³ If the means of identification of type contains characters not relevant to describe the vehicle types covered by the type-approval certificate such characters shall be represented in the documentation by the symbol: '?' (e.g. ABC??123??).

⁴ As defined in the Consolidated Resolution on the Construction of Vehicles (R.E.3.), document ECE/TRANS/WP.29/78/Rev.6

Section II

1. Additional information (where applicable): See Addendum (Appendix 1)
2. Technical Service responsible for carrying out the tests:.....
3. Date of test report:
4. Number of test report:.....
5. Remarks (if any): See Addendum (Appendix 1)
6. Place:
7. Date:
8. Signature:.....
9. Reasons for extensions:

Attachments:

Information package

Test report(s)

Annex 1 – Appendix 1

Addendum to the communication form No ...

1. Additional information
 - 1.1. Power plant
 - 1.1.1. Manufacturer of the engine:.....
 - 1.1.2. Manufacturer's engine code:
 - 1.1.3. Rated maximum net power: kW at min⁻¹
or maximum continuous rated power (electric motor) kW
 - 1.1.4. Pressure charger(s), Make and Type:.....
 - 1.1.5. Air filter, Make and Type:
 - 1.1.6. Intake silencer(s), Make and Type:.....
 - 1.1.7. Exhaust Silencer(s), Make and Type:
 - 1.1.8. Catalyst(s), Make and Type:.....
 - 1.1.9. Particulate Trap(s), Make and Type:
 - 1.2. Transmission
 - 1.2.1. Type (mechanical, hydraulic, electric, etc.):.....
 - 1.3. Non-engine devices designed to reduce noise:
 - [1.4.] Non-engine devices designed to produce noise:.....
 - [1.4.1] Within the specifications of the UN Regulation 138: yes/no¹
 - [1.4.1.1.] Make and Type or Approval number [1.4.2.] Outside the specifications of the UN regulation 138: yes/no²
 - [1.4.2.1.] Make and Type or Approval number
2. Test results
 - 2.1. Sound level of moving vehicle (Annex 3): dB(A)
Selected mode for tests of the vehicle in motion:
 - 2.2. Sound level of stationary vehicle: dB(A) at min⁻¹ in mode³
Sound level of stationary vehicle: dB(A) at min⁻¹ in mode⁴

¹ Delete what does not apply

² Delete what does not apply

³ If applicable

⁴ If applicable

- Sound level of stationary vehicle: dB(A) at min⁻¹ in mode⁵
- Sound level of stationary vehicle: dB(A) at min⁻¹ in mode⁶
- Sound level of stationary vehicle: dB(A) at min⁻¹ in mode⁷
- 2.2.1. Sound level of compressed air, service brake: dB(A)
- 2.2.2. Sound level of compressed air, parking brake: dB(A)
- 2.2.3. Sound level of compressed air, during the pressure regulator actuation: dB(A)
- 2.3. Data to facilitate in-use compliance test of hybrid vehicles, where an internal combustion engine cannot operate when the vehicle is stationary
- 2.3.1. Gear (i) or position of the gear selector chosen for the test:
- 2.3.2. Position of the operating switch during measurement L_{ACC} (i), (if switch is fitted)
- 2.3.3. If applicable, pre-acceleration length l_{PA} (Point of the accelerator depression in meter before line AA'). If the pre-acceleration length differs per gear, reporting per gear is required."
- 2.3.4. Sound pressure level L_{ACC} (i) dB(A)
- 2.4. Testing method information
- 2.4.1. Test method selected: Outdoor/Indoor⁸
3. Remarks:.....
.....

⁵ If applicable

⁶ If applicable

⁷ If applicable

⁸ Delete what does not apply.

Annex 1 – Appendix 2

Technical Information Document

- 0. General
 - 0.1. Make (trade name of manufacturer):
 - 0.2. Type:
 - 0.3. Means of identification of type, if marked on the vehicle:¹
 - 0.3.1. Location of that marking:
 - 0.4. Category of vehicle:²
 - 0.5. Company name and address of manufacturer:
 - 0.6. Name and address of the manufacturer's representative (if any):
 - 0.7. Name(s) and address(es) of assembly plant(s):
- 1. General construction characteristics of the vehicle
 - 1.1. Photographs and/or drawings of a representative vehicle:
 - 1.2. Number of axles and wheels:³
 - 1.2.1. Powered axles (number, position, interconnection):
 - 1.3. Position and arrangement of the engine:
- 2. Masses and dimensions⁴ (in kg and mm) (Refer to drawing where applicable):
- 2.1. Range of vehicle dimensions (overall):
- 2.1.1. For chassis without bodywork:
- 2.1.1.1. Length:
- 2.1.1.2. Width:
- 2.1.2. For chassis with bodywork
- 2.1.2.1. Length:
- 2.1.2.2. Width:

¹ If the means of identification of type contains characters not relevant to describe the vehicle types covered by the type-approval certificate such characters shall be represented in the documentation by the symbol: '?' (e.g. ABC??123??).

² As defined in the Consolidated Resolution on the Construction of Vehicles (R.E.3.), document ECE/TRANS/WP.29/78/Rev.6

³ Only for the purpose of defining "off-road vehicles".

⁴ Standard ISO 612: 1978 — Road vehicles — Dimensions of motor vehicles and towed vehicles - terms and definitions.

(a) Where there is one version with a normal cab and another with a sleeper cab, both sets of masses and dimensions are to be stated.

(b) Optional equipment that affects the dimensions of the vehicle shall be specified.

- 2.2. Mass in running order⁵
 - (a) Minimum and maximum for each variant:
 - (b) Mass of each version (a matrix shall be provided):
- 2.3. Technically permissible maximum laden mass stated by the manufacturer:^{6, 7}
- 3. Power plant⁸
 - 3.1. Manufacturer of the engine:.....
 - 3.1.1. Manufacturer's engine code (as marked on the engine, or other means of identification):
 - 3.2. Internal combustion engine
 - 3.2.1. Specific engine information
 - 3.2.1.1. Working principle: positive ignition/compression ignition, cycle four stroke/two stroke/rotary⁹
 - 3.2.1.2. Number and arrangement of cylinders:.....
 - 3.2.1.2.1. Firing order:.....
 - 3.2.1.3. Engine capacity:¹⁰ cm³
 - 3.2.1.4. Rated maximum net power: kW at min⁻¹ (manufacturer's declared value)
 - 3.2.2. Fuel feed
 - 3.2.2.1. By fuel injection (compression ignition only): yes/no⁹
 - 3.2.2.1.1. Working principle: Direct injection/pre-chamber/swirl chamber⁹
 - 3.2.2.1.2. Governor
 - 3.2.2.1.2.1. Type:.....
 - 3.2.2.1.2.2. Speed at which Cut-off starts under load: min⁻¹
 - 3.2.2.2. By fuel injection (positive ignition only): yes/no⁹
 - 3.2.2.2.1. Working principle: Intake manifold (single-/multi-point²)/direct injection/other (specify)⁹

⁵ The mass of the driver is assessed at 75 kg. The liquid containing systems (except those for used water that shall remain empty) are filled to 90 per cent of the capacity specified by the manufacturer. The information referred to in points 2.2. (b) do not need to be provided for vehicle categories N₂, N₃, M₂ and M₃.

⁶ For vehicles coupled with a trailer or a semi-trailer, which exert a significant vertical load on the coupling device or the fifth wheel, this load, divided by standard acceleration of gravity, is included in the maximum technically permissible mass. Please fill in here the upper and lower values for each variant.

⁷ Please fill in here the upper and lower values for each variant.

⁸ In the case of a vehicle that can run either on petrol, diesel, etc., or also in combination with another fuel, items shall be repeated. In the case of non-conventional engines and systems, particulars equivalent to those referred here shall be supplied by the manufacturer.

⁹ Delete what does not apply.

¹⁰ This value shall be calculated ($\pi = 3.1416$) and rounded off to the nearest cm³.

-
- 3.2.3. Intake system
 - 3.2.3.1. Air filter, drawings, or
 - 3.2.3.1.1. Make(s):.....
 - 3.2.3.1.2. Type(s):.....
 - 3.2.3.2. Intake silencer, drawings,
 - 3.2.3.2.1. Make(s):.....
 - 3.2.3.2.2. Type(s):.....
 - 3.2.4. Exhaust system
 - 3.2.4.1. Description and/or drawing of the exhaust system:
 - 3.2.4.2. Exhaust silencer(s):.....
 - Type, marking of exhaust silencer(s):.....
 - Where relevant for exterior noise, reducing measures in the engine compartment and on the engine:
 - 3.2.4.3. Location of the exhaust outlet:.....
 - 3.2.4.4. Exhaust silencer containing fibrous materials:
 - 3.2.5. Catalytic convertor: yes/no⁹
 - 3.2.5.1. Number of catalytic convertors and elements (provide the information below for each separate unit):.....
 - 3.2.6. Pressure charger(s)
 - 3.2.6.1. Make(s):
 - 3.2.6.2. Type(s):
 - 3.3. Electric motor
 - 3.3.1. Type (winding, excitation):.....
 - 3.3.1.1. Maximum hourly output: kW
 - 3.3.1.2. Operating voltage: V
 - 3.4. Engine or motor combination:
 - 3.4.1. Hybrid electric vehicle: yes/no⁹
 - 3.4.2. Category of hybrid electric vehicle: off-vehicle charging/not off-vehicle charging:⁹
 - 3.4.3. Operating mode switch: with/without⁹
 - 3.4.3.1. Selectable modes
 - 3.4.3.1.1. Pure electric: yes/no⁹
 - 3.4.3.1.2. Pure fuel consuming: yes/no⁹
 - 3.4.3.1.3. Hybrid modes: yes/no⁹ (if yes, short description):
 - 3.4.4. Electric motor (describe each type of electric motor separately)
 - 3.4.4.1. Make:.....
 - 3.4.4.2. Type:.....

3.4.4.3. Rated maximum net power: kW

4. Transmission¹¹

4.1. Type (mechanical, hydraulic, electric, etc.):

4.2. Gear ratios

<i>Gear</i>	<i>Internal gearbox ratios (ratios of engine to gearbox output shaft revolutions)</i>	<i>Final drive ratio(s) (ratio of gearbox output shaft to driven wheel revolutions)</i>	<i>Total gear ratios</i>
Maximum for CVT ¹²			
1			
2			
3			
...			
Minimum for CVT			
Reverse			

4.3. Maximum vehicle design speed (in km/h):¹³

5. Suspension

5.1. Tyres and wheels

5.1.1. Tyre/wheel combination(s)

(a) For tyres indicate size designation, load-capacity index and speed category symbol;

(b) For wheels indicate rim size(s) and off-set(s).

5.1.2. Upper and lower limits of rolling radii

5.1.2.1. Axle 1:

5.1.2.2. Axle 2:

5.1.2.3. Axle 3:

5.1.2.4. Axle 4:

etc.

6. Bodywork

6.1. Type of bodywork:

6.2. Materials used and methods of construction:.....

7. Miscellaneous

7.1. Details of any non-engine devices designed to reduce noise (if not covered by other items):

Signed:

Position in company:

Date:

¹¹ The specified particulars are to be given for any proposed variants.

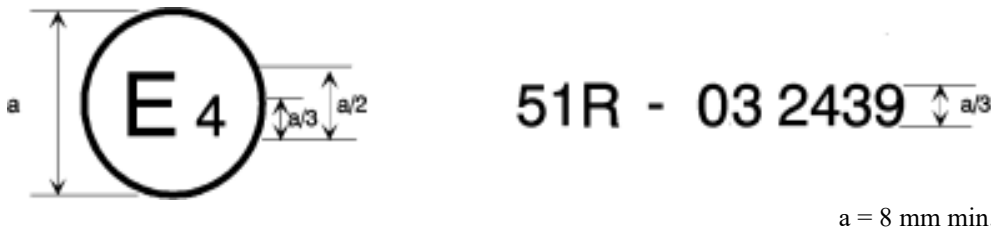
¹² Continuous Variable Transmission (CVT): transmission with variable gear ratios.

¹³ With respect to trailers, maximum speed permitted by the manufacturer.

Annex 2

Arrangements of the approval mark

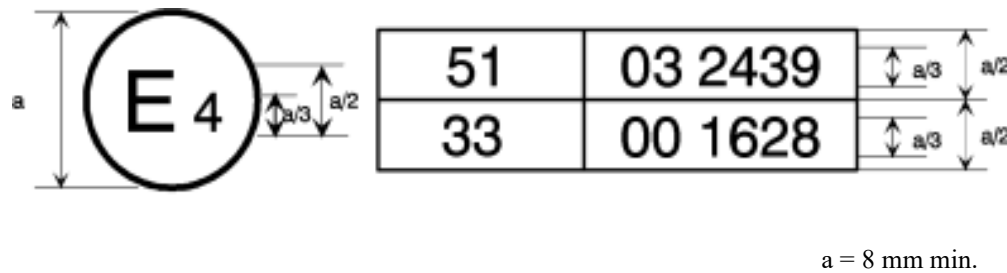
Model A
(See paragraph 5.4. of this Regulation)



The above approval mark affixed to a vehicle shows that the vehicle type concerned has, with regard to its noise emission, been approved in the Netherlands (E 4) pursuant to UN Regulation No. 51 under approval No. 032439.

The first two digits of the approval number indicate that UN Regulation No. 51 already included the **04** series of amendments when the approval was granted.

Model B
(See paragraph 5.5. of this Regulation)



The above approval mark affixed to a vehicle shows that the vehicle type concerned has been approved in the Netherlands (E 4) pursuant to UN Regulations Nos. 51 and 33.¹ The approval numbers indicate that, at the dates when the respective approvals were granted, UN Regulation No. 51 included the **04** series of amendments while UN Regulation No. 33 was in its original form.

¹ The latter number is given as an example only.

Annex 3

Methods and instruments for measuring the sound made by motor vehicles

1. Measuring instruments

1.1. Acoustic measurements

The apparatus used for measuring the sound level shall be a precision sound-level meter or equivalent measurement system meeting the requirements of Class 1 instruments (inclusive of the recommended windscreen, if used). These requirements are described in "IEC 61672-1:2002 **or later** - Precision sound level meters", second edition, of the International Electrotechnical Commission (IEC).

For indoor testing, when no general statement or conclusion can be made about conformance of the sound level meter by each channel of the array conformance (e.g. when pass-by sound level simulation algorithms do not compute the overall level but spectrum or temporal to recompose it), a simulated pass-by run shall be performed at a constant speed of 50 km/h while a constant tone signal is supplied to all channels of the arrays. The simulated A-weighted sound level is processed and the deviation from a reference tone signal shall be checked in accordance to IEC 61672-3:**2006 or later**.

Measurements shall be carried out using the "fast" response of the acoustic measurement instrument and the "A" weighting curve also described in "IEC 61672-1:2002 **or later**". When using a system that includes a periodic monitoring of the A-weighted sound pressure level, a reading should be made at a time interval not greater than 30 ms.

The instruments shall be maintained and calibrated in accordance to the instructions of the instrument manufacturer.

1.2. Calibration of the entire Acoustic Measurement System for a Measurement Session

At the beginning and at the end of every measurement session the entire measurement system shall be checked by means of a sound calibrator that fulfils the requirements for sound calibrators of at least precision Class 1 according to IEC 60942:2003 **or later**. Without any further adjustment the difference between the readings of two consecutive checks shall be less than or equal to 0.5 dB(A).

If this value is exceeded, the results of the measurements obtained after the previous satisfactory check shall be discarded.

For indoor testing, the entire measurement system shall be checked at the beginning and at the end of a series of sessions.

A qualified calibration method (i.e. electrical calibration) is recommended to be provided by the hardware supplier and, in that case, shall be implemented in the measurement software used. Simulation algorithms using sound source localization detection should deactivate that feature for these tests.

- 1.3. Compliance with requirements
- Compliance of the acoustic measurement instrumentation shall be verified by the existence of a valid certificate of compliance. These certificates shall be deemed to be valid if certification of compliance with the standards was conducted within the previous 12 months period for the sound calibration device and within the previous 24 months period for the instrumentation system. All compliance testing shall be conducted by a laboratory, which is authorized to perform calibrations traceable to the appropriate standards.
- 1.4. Instrumentation for speed measurements
- The engine speed shall be measured with instrumentation having an accuracy of ± 2 per cent or better at the engine speeds required for the measurements being performed.
- The road speed of the vehicle shall be measured with instrumentation having an accuracy of at least ± 0.5 km/h, when using continuous measurement devices.
- If testing uses independent measurements of speed, this instrumentation shall meet specification limits of at least ± 0.2 km/h.
- 1.5. Meteorological instrumentation
- The meteorological instrumentation used to monitor the environmental conditions during the test shall include the following devices, which meet at least the given accuracy:
- (a) Temperature measuring device, ± 1 °C;
 - (b) Wind speed-measuring device, ± 1.0 m/s;
 - (c) Barometric pressure measuring device, ± 5 hPa;
 - (d) A relative humidity measuring device, ± 5 per cent.
2. Conditions of measurement
- 2.1. Test Site and ambient conditions
- The specifications for the test site provide the necessary acoustic environment to carry out the vehicle tests documented in this Regulation. Outdoor and indoor test environments that meet the specifications of this Regulation provide equivalent acoustic environments and produce results that are equally valid.
- 2.1.1. Test Site Outdoor
- The surface of the test track and the dimensions of the test site shall be in accordance with ISO 10844:2014 **or later**.
- 2.1.2. Test Site Indoor
- Test Site Indoor requirements shall be as specified below.
- (a) The test room dimensions are described in paragraph 7.2. of ISO 362-3:2016 **or later**. All room dimensions may be adjusted to meet the specific application for the products being tested according to Annex 8, paragraph 4.
 - (b) The test facility shall meet the requirements of ISO 26101:2012 **or later** with the qualification criteria and measurement requirements

appropriate to this test method as described in ISO 362-3:2016 **or later**, paragraph 7.3.

- (c) Condition of the floor is described in ISO 362-3:2016 **or later**, paragraph 7.4.
- (d) Cooling, ventilation, and exhaust gas management are described in ISO 362-3:2016 **or later**, paragraph 7.5.
- (e) Dynamometer requirements are described in ISO 362-3:2016 **or later**, paragraph 8.
- (f) Vehicle fixing system is described in ISO 362-3:2016 **or later**, paragraph 9.3.

2.1.3. Ambient conditions

The surface of the site shall be free of powdery snow, tall grass, loose soil or cinders. There shall be no obstacle which could affect the sound field within the vicinity of the microphone and the sound source. The observer carrying out the measurements shall so position himself as not to affect the readings of the measuring instrument.

Measurements shall not be made under adverse weather conditions. It shall be ensured that the results are not affected by gusts of wind.

The meteorological instrumentation should be positioned adjacent to the test area at a height of $1.20 \text{ m} \pm 0.02 \text{ m}$. The measurements shall be made when the ambient air temperature is within the range from 5°C to 40°C .

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

The tests shall not be carried out if the wind speed, including gusts, at microphone height exceeds 5 m/s, during the sound measurement interval.

A value representative of temperature, wind speed and direction, relative humidity, and barometric pressure shall be recorded during the sound measurement interval.

Any sound peak which appears to be unrelated to the characteristics of the general sound level of the vehicle shall be ignored in taking the readings.

The background noise shall be measured for duration of 10 seconds immediately before and after a series of vehicle tests. The measurements shall be made with the same microphones and microphone locations used during the test. The A-weighted maximum sound pressure level shall be reported.

The background noise (including any wind noise) shall be at least 10 dB(A) below the A-weighted sound pressure level produced by the vehicle under test. If the difference between the ambient noise and the measured sound is between 10 and 15 dB(A), in order to calculate the test results the appropriate correction shall be subtracted from the readings on the sound-level meter, as in the following table:

<i>Difference between ambient noise and sound to be measured dB(A)</i>	<i>10</i>	<i>11</i>	<i>12</i>	<i>13</i>	<i>14</i>	<i>15</i>
Correction dB(A)	0.5	0.4	0.3	0.2	0.1	0.0

For indoor testing, background noise shall take into account noise emissions produced by the dynamometer rollers, ventilation systems, and facility exhaust gas systems.

2.2. Vehicle

2.2.1. The vehicle shall be representative of vehicles to be put on the market as specified by the manufacturer in agreement with the Technical Service to fulfil the requirements of this Regulation.

Measurements shall be made without any trailer, except in the case of non-separable vehicles. At the request of the manufacturer, measurements may be made on vehicles with lift axle(s) in a raised position.

Measurements shall be made on vehicles at the test mass m_T specified according to the following table.

When testing indoors, the test mass, m_T shall be utilized by the control system of the dyno roller. Actual mass of the vehicle has no effect on results and it is permitted to load the vehicle as necessary to prevent slip between the tyres and the dyno rolls. To detect excessive slip, it is recommended to control the ratio of engine rotational speed and vehicle speed between the acceleration phase and the constant-speed status. To avoid slip, it is possible to increase the axle load.

Target mass, m_{TARGET} , is used to denote the mass that N_2 and N_3 vehicles should be tested at. The actual test mass of the vehicle can be less due to limitations on vehicle and axle loading.

Vehicle category	Vehicle test mass
M ₁	The test mass m_T of the vehicle shall be between $0.9 m_{RO} \leq m_T \leq 1.2 m_{RO}$
N ₁	The test mass m_T of the vehicle shall be between $0.9 m_{RO} \leq m_T \leq 1.2 m_{RO}$
N ₂ , N ₃	$m_{TARGET} = 50 \text{ [kg/kW]} \times P_N \text{ [kW]}$ Extra loading, m_{XLOAD} , to reach the target mass, m_{TARGET} , of the vehicle shall be placed above the rear axle(s). If the test mass m_T is equal to the target mass m_{TARGET} , the test mass m_T shall be $0.95 m_{TARGET} \leq m_T \leq 1.05 m_{TARGET}$ The sum of the extra loading and the rear axle load in an unladen condition, $m_{RA \text{ LOAD UNLADEN}}$, is limited to 75 per cent of the technically permissible maximum laden mass allowed for the rear axle, $m_{AC \text{ RA MAX}}$. If the test mass m_T is lower than the target mass m_{TARGET} , the test mass m_T shall be achieved with a tolerance of ± 5 per cent. If the centre of gravity of the extra loading cannot be aligned with the centre of the rear axle, the test mass, m_T , of the vehicle shall not exceed the sum of the front axle in an unladen condition, $m_{FA \text{ LOAD UNLADEN}}$, and the rear axle

Vehicle category	Vehicle test mass
	load in an unladen condition, $m_{RA\ LOAD\ UNLADEN}$ plus the extra loading, m_{XLOAD}, and the mass of the driver m_D. The test mass for vehicles with more than two axles shall be the same as for a two-axle vehicle. If the vehicle mass of a vehicle with more than two axles in an unladen condition, $m_{UNLADEN}$, is greater than the test mass for the two-axle vehicle, then this vehicle shall be tested without extra loading. If the vehicle mass of a vehicle with two axles, $m_{UNLADEN}$, is greater than the target mass, then this vehicle shall be tested without extra loading.
$M_2 (M \leq 3,500\ kg)$	The test mass m_T of the vehicle shall be between $0.9\ m_{RO} \leq m_T \leq 1.2\ m_{RO}$
Complete $M_2 (M > 3,500\ kg)$, M_3	If the tests are carried out with a complete vehicle having a bodywork, $m_{TARGET} = 50\ [kg/kW] \times P_N\ [kW]$ is calculated either in compliance with conditions above (see N_2, N_3 category) or the test mass m_T of the vehicle shall be $0.9\ m_{RO} \leq m_T \leq 1.1\ m_{RO}$.
Incomplete $M_2 (M > 3,500\ kg)$, M_3	If the tests are carried with an incomplete vehicle not having a bodywork, $m_{TARGET} = 50\ [kg/kW] \times P_N\ [kW]$ is calculated either in compliance with conditions above (see N_2, N_3 category), or the test mass m_T of the vehicle shall be $0.9\ m_{RO} \leq m_T \leq 1.1\ m_{RO}$. where $m_{RO} = m_{CHASSIS\ M2M3} + m_{XLOAD\ M2M3}$

2.2.2. At the applicant's request the vehicle of a category M_2, M_3, N_2 or N_3 is deemed representative of its completed type if the tests are carried out to an incomplete vehicle not having a bodywork. In the test of an incomplete vehicle all relevant soundproofing materials, panels and noise reduction components and systems shall be fitted on the vehicle as designed by the manufacturer except a part of bodywork which is built in a later stage.

No new test shall be required due to fitting of a supplement fuel tank or re-location of the original fuel tank on condition that other parts or structures of the vehicle apparently affecting sound emissions have not been altered.

The tyres to be used for the test shall be representative for the vehicle and shall be selected by the vehicle manufacturer and recorded in Addendum to the Communication form (Annex 1, Appendix 1). They shall correspond to one of the tyre sizes designated for the vehicle as original equipment. The tyre is or will be

commercially available on the market at the same time as the vehicle.¹ The tyres shall be inflated to the pressure recommended by the vehicle manufacturer for the test mass of the vehicle. The tyres shall have at least 1.6 mm tread depth.

When performing indoor testing, tyre/road sound is evaluated independently on the test track with the tyres to be used, according to this paragraph. Propulsion sound is independently evaluated on the dynamometer using tyres and other sound control measures to produce tyre/road sound which does not influence the measurement result.

2.2.3. Before the measurements are started, the engine shall be brought to its normal operating conditions.

2.2.4. If the vehicle is fitted with more than two-wheel drive, it shall be tested in the drive which is intended for normal road use.

2.2.5. If the vehicle is fitted with fan(s) having an automatic actuating mechanism, this system shall not be interfered with during the measurements.

2.2.6. If the vehicle is equipped with an exhaust system containing fibrous materials, it might be necessary to carry out a conditioning test prior to testing. The provisions of Annex 4, paragraph 1. in conjunction with the flowchart (Figure 2) of the appendix to Annex 4 shall be followed.

2.2.7. Calculation procedure to determine extra loading of N₂ and N₃ vehicles only

2.2.7.1. Calculation of extra loading

The target mass, m_{TARGET} , (per kW rated power) for two-axle vehicles of category N₂ and N₃ is specified in the Table in paragraph 2.2.1: above.

$$m_{\text{TARGET}} = 50 [\text{kg} / \text{kW}] \times P_N [\text{kW}] \quad (1)$$

To reach the required target mass, m_{TARGET} , for a vehicle being tested, the unladen vehicle, including the mass of the driver, m_D , shall be loaded with an extra mass, m_{XLOAD} , which shall be placed above the rear axle as given in Formula (8):

$$m_{\text{TARGET}} = m_{\text{UNLADEN}} + m_D + m_{\text{XLOAD}} \quad (2)$$

The target mass, m_{TARGET} , shall be achieved with a tolerance of ± 5 per cent.

The vehicle mass of the test vehicle in the unladen condition, m_{UNLADEN} , is calculated by measuring on a scale the unladen front axle load, $m_{\text{FA LOAD UNLADEN}}$, and the unladen rear axle load, $m_{\text{RA LOAD UNLADEN}}$, as given in Formula (3):

$$m_{\text{UNLADEN}} = m_{\text{FA LOAD UNLADEN}} + m_{\text{RA LOAD UNLADEN}} \quad (3)$$

By using Formulae (2) and (3), the extra loading, m_{XLOAD} , is calculated as given in Formulae (4) and (5):

$$m_{\text{XLOAD}} = m_{\text{TARGET}} - (m_D + m_{\text{UNLADEN}}) \quad (4)$$

¹ Given that the tyre contribution for overall sound emission is significant, regard shall be given for existing regulatory provisions concerning tyre/road sound emissions. Traction tyres, snow tyres and special-use tyres as defined in paragraph 2. of Regulation No. 117 shall be excluded during type-approval and conformity of production measurements at the request of the manufacturer in accordance with Regulation No. 117.

$$m_{XLOAD} = m_{TARGET} - (m_D + m_{FA LOAD UNLADEN} + m_{RA LOAD UNLADEN}) \quad (5)$$

The sum of the extra loading, m_{XLOAD} , and the unladen rear axle load, $m_{RA LOAD UNLADEN}$, is limited to 75 per cent of the technically permissible maximum laden mass for the rear axle, $m_{AC RA MAX}$, as given in Formula (6):

$$0,75 m_{AC RA MAX} \geq m_{XLOAD} + m_{RA LOAD UNLADEN} \quad (6)$$

The m_{XLOAD} is limited according to Formula (7):

$$m_{XLOAD} \leq 0,75 m_{AC RA MAX} - m_{RA LOAD UNLADEN} \quad (7)$$

If the calculated extra loading, m_{XLOAD} , in Formula (5) fulfils Formula (7), then the extra loading is equal to Formula (5). The test mass, m_T , of the vehicle is as calculated from Formula (8):

$$m_T = m_{XLOAD} + m_D + m_{FA LOAD UNLADEN} + m_{RA LOAD UNLADEN} \quad (8)$$

In this case, the test mass of the vehicle is equal to the target mass

$$m_T = m_{TARGET} \quad (9)$$

If the calculated extra loading, m_{XLOAD} , in Formula (5) does not fulfil Formula (7), but rather fulfils Formula (10)

$$m_{XLOAD} > 0,75 m_{AC RA MAX} - m_{RA LOAD UNLADEN} \quad (10)$$

then, the extra loading, m_{XLOAD} , shall be as given by Formula (11):

$$m_{XLOAD} = 0,75 m_{AC RA MAX} - m_{RA LOAD UNLADEN} \quad (11)$$

and the test mass, m_T , of the vehicle shall be as given by Formula (12):

$$m_T = 0,75 m_{AC RA MAX} + m_D + m_{FA LOAD UNLADEN} \quad (12)$$

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

$$m_T < m_{TARGET} \quad (13)$$

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

2.2.7.2. Loading considerations if load cannot be aligned with the centre of rear axle

If the centre of gravity of the extra loading, m_{XLOAD} , cannot be aligned with the centre of the rear axle, the test mass of the vehicle, m_T , shall not exceed the sum of the unladen front axle load, $m_{FA LOAD UNLADEN}$, and the unladen rear axle load, $m_{RA LOAD UNLADEN}$, plus the extra loading, m_{XLOAD} , and the mass of the driver, m_D .

This means that if the actual front and rear axle loads are measured on a scale when the extra loading, m_{XLOAD} , is placed onto the vehicle and it is aligned with the centre of the rear axle, the test mass of the vehicle minus the mass of the driver is as given by Formula (14):

$$m_T - m_D = m_{FA LOAD LADEN} + m_{RA LOAD LADEN} \quad (14)$$

Where:

$$m_{FA LOAD LADEN} = m_{FA LOAD UNLADEN} \quad (15)$$

If the centre of gravity of the extra loading cannot be aligned with the centre of the rear axle, Formula (14) is still fulfilled, but

$$m_{FA LOAD LADEN} > m_{FA LOAD UNLADEN} \quad (16)$$

because the extra loading has partly distributed its mass to the front axle. In that case, it is not allowed to add more mass onto the rear axle to compensate for the mass moved to the front axle.

2.2.7.3. Test mass for vehicles with more than two axles

If a vehicle with more than two axles is tested, then the test mass of this vehicle shall be the same as the test mass for the two-axle vehicle.

If the unladen vehicle mass of a vehicle with more than two axles is greater than the test mass for the two-axle vehicle, then this vehicle shall be tested without extra loading.

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

When a vehicle family is not represented by a two-axle vehicle because it is physically not available, the vehicle family can be represented by a vehicle with more than two axles (V_{RF}). In that case the test mass of a virtual two-axle vehicle ($m_{T(2 \text{ axles virtual})}$) can be calculated in the following way:

For the calculation of the unladen vehicle mass of the virtual two-axle vehicle ($m_{UNLADEN(2 \text{ axles virtual})}$), take from the vehicle with more than two axles (V_{RF}) the measured unladen front axle load ($m_{FA(V_{RF}) \text{ LOAD UNLADEN}}$) and the measured unladen rear axle load of that driven rear axle ($m_{RA(V_{RF}) \text{ LOAD UNLADEN}}$) which has the highest unladen load.

If the vehicle (V_{RF}) has more than one front axle, take the one with the highest unladen front axle load.

$$\rightarrow m_{UNLADEN(2 \text{ axles virtual})} = m_{FA(V_{RF}) \text{ LOAD UNLADEN}} + m_{RA(V_{RF}) \text{ LOAD UNLADEN}}$$

$$\rightarrow m_{XLOAD(2 \text{ axles virtual})} = m_{TARGET} - (m_D + m_{UNLADEN(2 \text{ axles virtual})})$$

Due to the requirement that the sum of the extra loading ($m_{XLOAD(2 \text{ axles virtual})}$) and the unladen rear axle load, $m_{RA(V_{RF}) \text{ LOAD UNLADEN}}$, is limited to 75 per cent of the technically permissible maximum laden mass allowed for the rear axle, $m_{ACRA \text{ MAX}(2 \text{ axles virtual})}$, this value, $m_{ACRA \text{ MAX}(2 \text{ axles virtual})}$, has to be chosen in such a way that it represents the rear axle of the forecasted highest production-volume in the manufacturer's variation with a technically permissible maximum laden mass allowed for the rear axle ($m_{ACRA \text{ MAX}(chosen)}$) for the vehicle family as declared by the manufacturer.

$$\rightarrow m_{ACRA \text{ MAX}(4x2 \text{ virtual})} = m_{ACRA \text{ MAX}(chosen)}$$

$$\text{If } m_{XLOAD(2 \text{ axles virtual})} \leq 0,75 m_{ACRA \text{ MAX}(chosen)} - m_{RA(V_{RF}) \text{ LOAD UNLADEN}}$$

then

$$m_{T(2 \text{ axles virtual})} = m_{XLOAD(2 \text{ axles virtual})} + m_D + m_{FA(V_{RF}) \text{ LOAD UNLADEN}} + m_{RA(V_{RF}) \text{ LOAD UNLADEN}}$$

and

$$m_{T(2 \text{ axles virtual})} = m_{TARGET}$$

$$\text{If } m_{XLOAD(2 \text{ axles virtual})} > 0,75 m_{ACRA \text{ MAX}(chosen)} - m_{RA(V_{RF}) \text{ LOAD UNLADEN}}$$

then

$$m_{T(2 \text{ axles virtual})} = 0,75 m_{ACRA \text{ MAX}(chosen)} + m_D + m_{FA(V_{RF}) \text{ LOAD UNLADEN}}$$

and

$$m_T (2 \text{ axles virtual}) < m_{\text{TARGET}}$$

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

$$m_T (V_{\text{RF}}) = m_T (2 \text{ axles virtual})$$

and the extra loading is calculated as

$$m_{\text{XLOAD}} (V_{\text{RF}}) = m_T (2 \text{ axles virtual}) - m_D - m_{\text{UNLADEN}} (V_{\text{RF}})$$

3. Methods of testing

Outdoor tests shall be performed according to paragraph 3.1.

Indoor tests shall be performed according to paragraph 3.1. using the specifications of ISO 362-3:2016 **or later**, variant A. For indoor application, the manufacturer shall provide to the technical service, documentation according to Annex 8, paragraph 1. Variant A is a combination of indoor testing (power train sound) and outdoor testing (tyre/road sound).

3.1. Measurement of sound of vehicles in motion

3.1.1. General conditions of test

For outdoor testing, two lines, AA' and BB', parallel to line PP' and situated respectively $10 \text{ m} \pm 0.05 \text{ m}$ forward and $10 \text{ m} \pm 0.05 \text{ m}$ rearward of line PP' shall be marked out on the test runway.

For indoor testing, the virtual line AA' indicates the beginning of the test track, PP' indicates the virtual position of the two pass-by microphones, and BB' indicates the end of the test track. The simulated vehicle speed at AA', $v_{\text{AA'}}$, or vehicle speed at PP', $v_{\text{PP'}}$, is defined by the roller speed when the reference point of the vehicle passes the virtual line AA' or PP', respectively. The simulated vehicle speed at BB', $v_{\text{BB'}}$, is defined when the rear of the vehicle passes the virtual line BB'.

At least four measurements shall be made on each side of the vehicle and for each gear. Preliminary measurements may be made for adjustment purposes, but shall be disregarded.

The microphones shall be located **on both sides of the pathway** at a distance of $7.5 \text{ m} \pm 0.05 \text{ m}$ from the reference line CC' of the track and $1.2 \text{ m} \pm 0.02 \text{ m}$ above the ground.

The reference axis for free field conditions (see IEC 61672-1:2002 **or later**) shall be horizontal and directed perpendicularly towards the path of the vehicle line CC'.

3.1.2. Specific test conditions for vehicles

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

The path of the centreline of the vehicle shall follow line CC' as closely as possible throughout the entire test, from the approach to line AA' until the rear of the vehicle passes line BB' +20 m.

If the vehicle is fitted with 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.

The test mass of the vehicle shall be according to the table of paragraph 2.2.1.

The test speed v_{TEST} is 50 km/h $\pm$ 1 km/h. The test speed shall be reached, when the reference point is at line PP'.

If the test speed is modified according to paragraph 3.1.2.1.4.1.(d) of Annex 3 to this Regulation, the modified test speed shall be used for both the acceleration and constant speed test.

3.1.2.1.1. Power to mass ratio index (PMR)

PMR is defined as follows:

$PMR = (P_N / m_{RO}) * 1000$ kg/kW, where P_N is measured in kW and m_{RO} is measured in kg and defined according to paragraph 2.4. of the main body.

If two or more sources of propulsive power operate at the conditions of test specified in paragraph 3.1.2.1 of Annex 3 to this Regulation, the total engine net power, P_N , shall be the arithmetic sum of parallel propulsive engines on the vehicle. Applicable parallel propulsive engines are those power sources which provide forward motion to the vehicle in combination at the conditions of test specified in paragraph 3.1.2.1. of Annex 3 to this Regulation. Specified power for non-combustion engines shall be the power stated by the manufacturer.

The PMR with no dimension is used for the calculation of acceleration.

3.1.2.1.2. Calculation of acceleration

Acceleration calculations are applicable to M_1 , N_1 and $M_2 \leq 3,500$ kg technically permissible maximum laden mass categories only.

All accelerations are calculated using different speeds of the vehicle on the test track. ² The formulae given are used for the calculation of $a_{ACC\ i}$, $a_{ACC\ i+1}$ and $a_{ACC\ TEST}$. The speed either at AA' or PP' is defined as the vehicle speed when the reference point passes AA' ($v_{AA'}$) or PP' ($v_{PP'}$). The speed at BB' is defined when the rear of the vehicle passes BB' ($v_{BB'}$). The method used for determination of the acceleration shall be indicated in the test report.

Due to the definition of the reference point for the vehicle the length of the vehicle (l_{VEH}) is considered differently in the formula below. If the reference point is in the front of the vehicle, then $l = l_{VEH}$, mid: $l = \frac{1}{2} l_{VEH}$ and rear: $l = 0$.

At the choice of the vehicle manufacturer, front engine vehicles may use $l = 5$ m, and mid-engine vehicles may use $l = 2.5$ m.

3.1.2.1.2.1. Calculation procedure for vehicles with manual transmission, automatic transmission, adaptive transmissions and transmissions with continuous variable transmissions (CVT's) tested with locked gear ratios:

$$a_{ACC\ TEST} = ((v_{BB'}/3.6)^2 - (v_{AA'}/3.6)^2) / (2*(20+l))$$

$a_{ACC\ TEST}$ used in the determination of gear selection shall be the average of the four $a_{ACC\ TEST\ i}$ during each valid measurement run.

Pre-acceleration may be used. The point of depressing the accelerator before line AA' shall be reported in the Addendum to the Communication form (Annex 1, Appendix 1).

² See Annex 3, Appendix, Figure 1.

- 3.1.2.1.2.2. Calculation procedure for vehicles with automatic transmissions, adaptive transmissions and CVT's tested with non-locked gear ratios:

$a_{ACC\ TEST}$ used in the determination of gear selection shall be the average of the four $a_{ACC\ TEST\ i}$ during each valid measurement run.

If devices or measures described in paragraph 3.1.2.1.4.2. can be used to control transmission operation for the purpose of achieving test requirements, calculate $a_{ACC\ TEST}$ using the equation:

$$a_{ACC\ TEST} = ((v_{BB'}/3.6)^2 - (v_{AA'}/3.6)^2) / (2*(20+1))$$

Pre-acceleration may be used.

If devices or measures described in paragraph 3.1.2.1.4.2. are not used, calculate $a_{ACC\ TEST}$ using the equation:

$$a_{ACC\ TEST\ PP'-BB'} = ((v_{BB'}/3.6)^2 - (v_{PP'}/3.6)^2) / (2*(10+1))$$

Pre-acceleration shall not be used.

The location of depressing the accelerator shall be where the reference point of the vehicle passes line AA'.

- 3.1.2.1.2.3. Target acceleration

The target acceleration a_{URBAN} defines the typical acceleration in urban traffic and is derived from statistical investigations. This function depends on the PMR of a vehicle.

The target acceleration a_{URBAN} is defined by:

$$a_{URBAN} = 0.63 * \log_{10} (PMR) - 0.09$$

- 3.1.2.1.2.4. Reference acceleration

The reference acceleration $a_{ACC\ REF}$ defines the required acceleration during the acceleration test on the test track. It is a function depending on the power-to-mass ratio of a vehicle. That function is different for specific vehicle categories.

The reference acceleration $a_{ACC\ REF}$ is defined by:

$$a_{ACC\ REF} = 1.59 * \log_{10} (PMR) - 1.41 \quad \text{for } PMR \geq 25$$

$$a_{ACC\ REF} = a_{URBAN} = 0.63 * \log_{10} (PMR) - 0.09 \quad \text{for } PMR < 25$$

- 3.1.2.1.3. Partial power factor k_P

The partial power factor k_P (see paragraph 3.1.3.1.) is used for the weighted combination of the test results of the acceleration test and the constant speed test for vehicles of category M_1 and N_1 and $M_2 \leq 3,500$ kg technically permissible maximum laden mass

In cases other than a single gear test, $a_{ACC\ REF}$ shall be used instead of $a_{ACC\ TEST}$ (see paragraph 3.1.3.1.).

- 3.1.2.1.4. Gear ratio selection

The selection of gear ratios for the test depends on their specific acceleration potential a_{ACC} , according to the reference acceleration $a_{ACC\ REF}$ required for the acceleration test.

If the vehicle allows different transmission setups like automatic or manual gear selection and/or has different software programs or modes (e.g. sporty, winter, adaptive) leading to valid accelerations, the vehicle manufacturer shall prove to the satisfaction of the Technical Service, that the vehicle is tested in the mode which achieves an acceleration being closest to $a_{ACC\ REF}$.

The vehicle transmission, gear, or gear ratio may be controlled by electronic or mechanical measures **for prevention** of kick-down.

Appendix 1, Figure 4a to Figure 4e, give gear selection criteria and test run criteria for categories M_1 and M_2 having a technically permissible maximum laden mass not exceeding 3.500 kg and for category N_1 , in a flowchart form as an aid to test operation.

3.1.2.1.4.1. Vehicles with manual transmission, automatic transmissions, adaptive transmissions or CVTs tested with locked gear ratios

The following conditions for selection of gear ratios are possible:

- (a) If one specific gear ratio gives an acceleration in a tolerance band of ± 5 per cent of the reference acceleration $a_{ACC\ REF}$, not exceeding $2.0\ m/s^2$, test with that gear ratio.
- (b) If none of the gear ratios give the required acceleration, then choose a gear ratio i , with an acceleration higher and a gear ratio $i+1$, with an acceleration lower than the reference acceleration. If the acceleration value in gear ratio i does not exceed $2.0\ m/s^2$, use both gear ratios for the test. The weighting ratio in relation to the reference acceleration $a_{ACC\ REF}$ is calculated by:

$$k = (a_{ACC\ REF} - a_{ACC\ (i+1)}) / (a_{ACC\ (i)} - a_{ACC\ (i+1)})$$

- (c) If the acceleration value of gear ratio i exceeds $2.0\ m/s^2$, the first gear ratio shall be used that gives an acceleration below $2.0\ m/s^2$ unless gear ratio $i+1$ (or $i+2$, or $i+3$ or ...) provides acceleration less than a_{URBAN} . In this case, two gears, i and $i+1$ (or $i+2$, or $i+3$ or ...) shall be used, including the gear i with acceleration exceeding $2.0\ m/s^2$. In other cases, no other gear shall be used. The achieved acceleration $a_{ACC\ TEST}$ during the test shall be used for the calculation of the part power factor k_P instead of $a_{ACC\ REF}$.
- (d) If **maximum** engine speed n_{MAX} is exceeded in a gear i before the vehicle passes BB' the next higher gear $i+1$ shall be used. If the next higher gear $i+1$ results in an acceleration below a_{URBAN} , the vehicle test speed, v_{TEST} , in the gear ratio i shall be reduced by $2.5\ km/h$ and the gear ratio selection shall proceed as specified by the options given in this paragraph. In no case shall the vehicle test speed be reduced below $40\ km/h$.

If the **maximum** engine speed n_{MAX} is exceeded in gear ratio i before the vehicle passes BB' and the vehicle test speed is equal to $40\ km/h$, the higher gear ratio $i+1$ is allowed even if $a_{ACC\ TEST}$ does not exceed a_{URBAN} .

The vehicle test speed in the higher gear ratio $i+1$ shall be $50\ km/h$.

The maximum engine speed n_{MAX} is given by the formula below:

$$n_{MAX} = 1.56 \times PMR^{-0.227} \times S, \text{ but not more than 80\% of } S.$$

- (e) If no gear ratio is available with an acceleration below 2.0 m/s², the manufacturer shall, if possible take measures to avoid an acceleration value $a_{ACC\ TEST}$ greater than 2.0 m/s².

Table 1 in Appendix to Annex 3 provides examples for valid measures to control the downshift of gears or to avoid accelerations beyond 2.0 m/s². Any measure used by manufacturer for the above-mentioned purposes shall be documented in the test report.

- 3.1.2.1.4.2. Vehicles with automatic transmission, adaptive transmissions and CVTs tested with non-locked gear ratios:

Manufacturers may take measures to lock discrete gear ratios by electronic or mechanical measures and follow the gear selection provisions of paragraph 3.1.2.1.4.1. above. If so selected, this shall be stated in the test report.

Otherwise, the gear selector position for full automatic operation shall be used.

The acceleration value $a_{ACC\ TEST}$ shall be calculated as defined in paragraph 3.1.2.1.2.2.

The test may then include a gear change to a lower range and a higher acceleration **or a higher engine speed**. A gear change to a higher range and a lower acceleration is not allowed. A gear shifting to a gear ratio which is not **representative for urban traffic** shall be avoided.

Therefore, it is permitted to establish and use electronic or mechanical devices, including alternate gear selector positions, to **avoid**:

- **accelerations beyond 2.0 m/s². Any measure used by manufacturer for the above-mentioned purposes shall be documented in the test report. The achieved acceleration $a_{ACC\ TEST}$ shall be greater or equal to a_{URBAN} .**
- **a test engine speed exceeding n_{MAX} (see Appendix 1, figure 4f).**
 - o **Therefore, the vehicle test speed v_{TEST} may be reduced in steps by 2.5 km/h. In no case the vehicle test speed shall be reduced to a vehicle speed below 40 km/h, or**
 - o **The engine load is reduced to avoid a downshift to a gear ratio where n_{MAX} is exceeded.**

If possible, the manufacturer shall take measures to avoid an acceleration value $a_{ACC\ TEST}$ greater than 2.0 m/s².

If possible, the manufacturer shall take measures to avoid an engine speed higher than n_{MAX} .

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

The achieved acceleration $a_{ACC\ TEST}$ is then used for the calculation of the partial power factor k_P (see paragraph 3.1.2.1.3.) instead $a_{ACC\ REF}$.

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

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

The achieved acceleration a_{ACC_TEST} shall be greater or equal to a_{URBAN} .

If possible, the manufacturer shall take measures to avoid an acceleration value a_{ACC_TEST} greater than 2.0 m/s^2 .

Table 1 in Appendix to Annex 3 provides examples for valid measures to avoid accelerations beyond 2.0 m/s^2 . Any measure used by manufacturer for the above-mentioned purposes shall be documented in the test report.

The achieved acceleration a_{ACC_TEST} is then used for the calculation of the partial power factor k_P (see paragraph 3.1.2.1.3.) instead a_{ACC_REF} .

3.1.2.1.5. Acceleration test

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

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

In the case of articulated vehicles consisting of two non-separable units regarded as a single vehicle, the semi-trailer shall be disregarded in determining when line BB' is crossed.

3.1.2.1.6. Constant speed test

The constant speed test shall be carried out with the same gear(s) specified for the acceleration test and a constant speed of 50 km/h with a tolerance of $\pm 1\text{ km/h}$ between AA' and BB', or if applicable at the speed determined for the acceleration test according 3.1.2.1.4.1. (d) or 3.1.2.1.4.2. with a tolerance of $\pm 1\text{ km/h}$ between AA' and BB'.

During the constant speed test the acceleration control shall be positioned to maintain a constant speed between AA' and BB' as specified. If the gear is locked for the acceleration test, the same gear shall be locked for the constant speed test.

The constant speed test is not required for vehicles with a PMR < 25.

3.1.2.2. Vehicles of categories $M_2 > 3,500\text{ kg}$ technically permissible maximum laden mass, M_3 , N_2 , N_3 :

The path of the centreline of the vehicle shall follow line CC' as closely as possible throughout the entire test, from the approach to line AA' until the rear of the vehicle passes line BB'. The test shall be conducted without a trailer or semi-trailer. If a trailer is not readily separable from the towing vehicle the trailer shall be ignored when considering the crossing of line BB'. If the vehicle incorporates equipment such as a concrete mixer, a compressor, etc., this equipment shall not be in operation during the test. The test mass of the vehicle shall be according to the table of paragraph 2.2.1. of Annex 3 to this Regulation.

The value of $n_{BB'}$ and $v_{BB'}$ used in the determination of gear and vehicle speed selection shall be the average of the four $n_{BB', j}$ and $v_{BB', j}$ values during each valid measurement run.

The value of $n_{BB'}$ shall be reported to a precision of 10 revolutions per minute. The reported $n_{BB'}$ shall be used in all subsequent calculation.

The value of $v_{BB'}$ shall be reported to the first digit after the decimal (xx,x). The reported $v_{BB'}$ shall be used in all subsequent calculation.

Target conditions of category $M_2 > 3,500$ kg technically permissible maximum laden mass, N_2 :

When the reference point passes line BB', the engine speed $n_{BB'}$ shall be between 70 and 74 per cent of speed S, at which the engine develops its rated maximum net power, and the vehicle speed shall be $35 \text{ km/h} \pm 5 \text{ km/h}$. Between line AA' and line BB' a stable acceleration condition according to definition 2.26.1. shall be ensured.

Target conditions of category M_3 , N_3 :

When the reference point passes line BB', the engine speed $n_{BB'}$ shall be between 85 and 89 per cent of speed S, at which the engine develops its rated maximum net power, and the vehicle speed shall be $35 \text{ km/h} \pm 5 \text{ km/h}$. Between line AA' and line BB' a stable acceleration condition according to definition 2.26.1. shall be ensured.

3.1.2.2.1. Gear ratio selection

It is the responsibility of the manufacturer to determine the correct manner of testing to achieve the required conditions.

The vehicle transmission, gear, or gear ratio, shall be chosen to be able to fulfil the target conditions according to paragraphs 3.1.2.2.1.1. or 3.1.2.2.1.2. of Annex 3 to this Regulation. The vehicle transmission, gear, or gear ratio may be controlled by electronic or mechanical measures including exclusion of kick-down function.

Appendix 3, Figure 5a to Figure 5d, give gear selection criteria and test run criteria for categories M_2 having a technically permissible maximum laden mass exceeding 3,500 kg, and for category N_2 , M_3 and N_3 , in a flowchart as an aid to test operation.

3.1.2.2.1.1. Manual transmission, automatic transmissions, adaptive transmissions or transmissions with continuously variable gear ratios (CVTs) tested with locked gear ratios

Stable acceleration condition according to definition 2.26.1. shall be ensured. The gear choice is determined by the target conditions.

The following conditions for fulfilling the target conditions in paragraph 3.1.2.2. of Annex 3 to this Regulation are possible:

- (a) If one gear choice fulfils both target conditions for the rotational engine speed $n_{\text{TARGET BB'}}$ and for the vehicle speed $v_{\text{TARGET BB'}}$, test with that gear.
- (b) If more than one gear choice fulfils both target conditions for the rotational engine speed $n_{\text{TARGET BB'}}$ and for the vehicle speed $v_{\text{TARGET BB'}}$, test in gear i that gives velocity $v_{\text{BB' GEAR } i}$ closest to 35 km/h.
- (c) If two gear choices fulfil both target conditions for the rotational engine speed $n_{\text{TARGET BB'}}$ and for the vehicle speed $v_{\text{TARGET BB'}}$, and fulfil the following condition.

$$(v_{\text{TARGET BB'}} - v_{\text{BB' GEAR } i}) = (v_{\text{BB' GEAR } i+1} - v_{\text{TARGET BB'}})$$

then both gears are taken for further calculation of L_{URBAN} .

- (d) If one gear choice fulfils the target condition for the rotational engine speed $n_{\text{TARGET BB'}}$ but not the target condition for the vehicle speed $v_{\text{TARGET BB'}}$, use two gears, gear_X and gear_Y. The target conditions for the vehicle speed for these two gears are as follows:

gear_X

$$25 \text{ km/h} \leq v_{\text{BB'X}} \leq 30 \text{ km/h}$$

and

gear_Y

$$40 \text{ km/h} \leq v_{\text{BB'Y}} \leq 45 \text{ km/h}$$

Both gears, gear_X and gear_Y shall fulfil the target rotational engine speed $n_{\text{TARGET BB'}}$. Both gears shall be used for further calculation of L_{URBAN} .

If only one of the gears fulfils the target rotational engine speed, $n_{\text{TARGET BB'}}$, test with that gear. This gear shall be used for further calculation of L_{URBAN} .

- (e) If none of the two gears fulfils the target rotational engine speed $n_{\text{TARGET BB'}}$ under condition d) then condition f) shall be chosen.
- (f) If no gear choice fulfils the target rotational engine speed choose the gear that fulfils the target vehicle velocity $v_{\text{TARGET BB'}}$ and is closest to the target rotational engine speed $n_{\text{TARGET BB'}}$, but not higher than $n_{\text{TARGET BB'}}$.

$$v_{\text{BB' GEAR } i} = v_{\text{TARGET BB'}}$$

$$n_{\text{BB' GEAR } i} \leq n_{\text{TARGET BB'}}$$

A stable acceleration condition according to definition 2.26.1. shall be ensured. If such a stable acceleration cannot be ensured in a gear, this gear shall be disregarded. In all conditions, the rated engine speed shall not be exceeded while the reference point of the vehicle is in the measurement zone. If the rated engine speed is exceeded within the measurement zone, this gear shall be disregarded.

3.1.2.2.1.2. Automatic transmission, adaptive transmissions, and transmissions with variable gear ratio tested with non-locked gear ratios

The gear selector position for full automatic operation shall be used.

The test may then include a gear change to a lower range and a higher acceleration. A gear change to a higher range and a lower acceleration is not allowed. In any case a gear change to a gear ratio that is typically not used at the specified condition as defined by the manufacturer in urban traffic shall be avoided.

Therefore, it is permitted to establish and use electronic or mechanical devices, including alternative gear selector positions, to prevent a downshift to a gear ratio that is typically not used at the specified test condition as defined by the manufacturer in urban traffic.

Table 1 in Appendix to Annex 3 provides examples for valid measures to control the downshift of gears. Any measure used by manufacturer for the above-mentioned purposes shall be documented in the test report.

The following conditions for fulfilling the target conditions in paragraph 3.1.2.2. of Annex 3 to this Regulation are possible:

- (a) If the choice of the gear selector position fulfils both target conditions for the rotational engine speed $n_{\text{TARGET BB'}}$ and for the vehicle speed $v_{\text{TARGET BB'}}$, test with the gear selector in that position.
- (b) If the choice of the gear selector position fulfils the target condition for the rotational engine speed $n_{\text{TARGET BB'}}$ but not the target condition for the vehicle speed $v_{\text{TARGET BB'}}$, change the target condition for the vehicle speed to two vehicle target speeds as follows:

Define $v_{\text{BB'1}}$ as

$$25 \text{ km/h} \leq v_{\text{BB'1}} \leq 35 \text{ km/h}$$

and

Define $v_{\text{BB'2}}$ as

$$35 \text{ km/h} \leq v_{\text{BB'2}} \leq 45 \text{ km/h}.$$

Conduct two tests, one with $v_{\text{BB'1}}$ and one with $v_{\text{BB'2}}$.

Both test conditions are used for further calculation of L_{URBAN} .

- (c) If under condition b) the target rotational engine speed $n_{\text{TARGET BB'}}$ cannot be fulfilled, condition d) shall be chosen.
- (d) If the choice of the gear selector position cannot fulfil the target condition for the rotational engine speed $n_{\text{TARGET BB'}}$ but the target condition for the vehicle speed $v_{\text{TARGET BB'}}$, change the target condition for the vehicle speed to two vehicle target speeds as follows:

Define $v_{\text{BB'1}}$ as

$$25 \text{ km/h} \leq v_{\text{BB'1}} \leq 30 \text{ km/h}$$

and

Define $v_{\text{BB'2}}$ as

$$40 \text{ km/h} \leq v_{BB'2} \leq 45 \text{ km/h}.$$

Conduct two tests, one with $v_{BB'1}$ and one with $v_{BB'2}$.

Use the test where $n_{BB'}$ is closest to the target rotational engine speed $n_{TARGET BB'}$ but not higher than $n_{TARGET BB'}$.

$$n_{BB' i} \leq n_{TARGET BB'} \text{ for } i = 1, 2$$

If the vehicle cannot fulfil the condition:

$$n_{BB' i} \leq n_{TARGET BB'} \text{ for } i = 1, 2$$

condition (e) shall be used.

- (e) If the choice of the gear selector position cannot fulfil the target conditions for the rotational engine speed $n_{TARGET BB'}$ and the target condition for the vehicle speed $v_{TARGET BB'}$, change the target condition for the vehicle speed to the following:

$$v_{BB'} = v_{TARGET BB'} + 5 \text{ km/h}$$

Conduct the test with that vehicle speed $v_{BB'}$ where $n_{BB'}$ is closest to the target rotational engine speed $n_{TARGET BB'}$. A gear change to a higher range and a lower acceleration is allowed after the vehicle passes line PP'.

- (f) If the vehicle includes a transmission design that provides only a single gear selection (D) that limits engine speed during the test, the vehicle shall be tested using only the target vehicle speed $v_{TARGET BB'}$.

3.1.2.2.1.3. Powertrain with no combustion engine rotational engine speed available

Vehicles with a powertrain where no combustion engine rotational engine speed is available shall fulfil only the target condition for the vehicle speed $v_{TARGET BB'}$.

The following conditions for fulfilling the target condition $v_{TARGET BB'}$ in paragraph 3.1.2.2. of Annex 3 to this Regulation are possible.

- (a) If no rotational engine speed is available, it is necessary to fulfil only the target vehicle speed $v_{TARGET BB'}$.
- (b) If no rotational engine speed is available and the target vehicle speed $v_{TARGET BB'}$ cannot be fulfilled, two test conditions shall be conducted as follows:

$v_{BB'1}$ for the first test condition is defined as

$$25 \text{ km/h} \leq v_{BB'1} \leq 35 \text{ km/h}$$

and

$v_{BB'2}$ for the second test condition is defined as

$$35 \text{ km/h} \leq v_{BB'2} \leq 45 \text{ km/h}$$

Both test conditions are used for further calculation of L_{URBAN} .

- (c) If no rotational engine speed is available and the target vehicle speed $v_{TARGET BB'}$ and $v_{BB'1}$ defined as
- $$25 \text{ km/h} \leq v_{BB'1} \leq 35 \text{ km/h}$$

cannot be fulfilled, it is necessary to conduct, only one test with $v_{BB'2}$ where $v_{BB'2}$ is defined as

$$35 \text{ km/h} \leq v_{BB'2} \leq 45 \text{ km/h}$$

The test condition for $v_{BB'2}$ is taken for further calculation of L_{URBAN} .

3.1.2.2.2. Acceleration test

When the reference point of the vehicle reaches the line AA' the accelerator control shall be fully depressed (without operating the automatic downshift to a lower range than normally used in urban driving) and held fully engaged until the reference point reaches BB' + 5 m. The acceleration control unit can then be released on request of the manufacturer.

In the case of articulated vehicles consisting of two non-separable units regarded as a single vehicle, the semi-trailer shall be disregarded in determining when line BB' is crossed.

3.1.3. Interpretation of results

For vehicles of categories M₁ and M₂ having a maximum authorized mass not exceeding 3,500 kg, and category N₁ the maximum A-weighted sound pressure level indicated during each passage of the vehicle according to paragraphs 3.1.2.1.5. and 3.1.2.1.6. shall be rounded to the first significant digit after the decimal place (e.g. XX,X).

For vehicles of category M₂ having a maximum authorized mass exceeding 3,500 kg and categories M₃, N₂, and N₃ the maximum A-weighted sound pressure level indicated during each passage of the reference point of the vehicle between line AA' and line BB' + 5 m shall be rounded, to the first significant digit after the decimal place (e.g. XX,X).

For indoor testing, pass-by sound is simulated by measurement of power train sound on the dynamometer and energetical addition of the tyre/road sound (measured separately on an outdoor test track) according to Annex 8, paragraph 2 of this Regulation.

If a sound peak obviously out of character with the general sound pressure level is observed, the measurement shall be discarded. At least four measurements for each test condition shall be made on each side of the vehicle and for each gear ratio. Left and right sides may be measured simultaneously or sequentially. The first four valid consecutive measurement results, within 2 dB(A), allowing for the deletion of non-valid results (see paragraph 2.1.), shall be used for the calculation of the final result for the given side of the vehicle. The results of each side shall be averaged separately and rounded to the first decimal place.

All further calculations to derive L_{URBAN} shall be done separately for the left and right vehicle side. The final value to be reported as the test result mathematically rounded to the nearest integer shall be the higher value of the two sides.

The speed measurements at AA', BB', and PP' shall be noted and used in calculations to the first significant digit after the decimal place.

The calculated acceleration $a_{ACC \text{ TEST}}$ shall be noted to the second digit after the decimal place.

- 3.1.3.1. Vehicles of categories M_1 , N_1 and $M_2 \leq 3,500$ kg technically permissible maximum laden mass

The calculated values for the acceleration test and the constant speed test are given by:

$$L_{ACC\ REP} = L_{ACC\ (i+1)} + k * (L_{ACC\ (i)} - L_{ACC\ (i+1)})$$

$$L_{CRS\ REP} = L_{CRS\ (i+1)} + k * (L_{CRS\ (i)} - L_{CRS\ (i+1)})$$

$$\text{Where } k = (a_{ACC\ REF} - a_{ACC\ (i+1)}) / (a_{ACC\ (i)} - a_{ACC\ (i+1)})$$

In the case of a single gear ratio test the values are the test result of each test.

The final result is calculated by combining $L_{ACC\ REP}$ and $L_{CRS\ REP}$. The equation is:

$$L_{URBAN} = L_{ACC\ REP} - k_P * (L_{ACC\ REP} - L_{CRS\ REP})$$

The weighting factor k_P gives the part power factor for urban driving. In cases other than a single gear test, k_P is calculated by:

$$k_P = 1 - (a_{URBAN} / a_{ACC\ REF})$$

If only one gear was specified for the test, k_P is given by:

$$k_P = 1 - (a_{URBAN} / a_{ACC\ TEST})$$

In cases where $k_P a_{ACC\ TEST}$ is less than a_{URBAN} :

$$k_P = 0$$

In case of a vehicle with a PMR<25, the final result L_{URBAN} is equal to $L_{ACC\ REP}$.

- 3.1.3.2. Vehicles of categories $M_2 > 3,500$ kg technically permissible maximum laden mass, M_3 , N_2 , N_3

When the result of one test condition is used the final result L_{URBAN} is equal to the intermediate result.

When the results of two test conditions are used the arithmetic mean of the intermediate results of the two averages for each side of the two conditions shall be calculated. The final result L_{URBAN} is the higher value of the two calculated averages.

- 3.2. Measurement of sound emitted by stationary vehicles

- 3.2.1. Sound level in the vicinity of vehicles

The measurement results shall be entered into the Addendum to the Communication form (Annex 1, Appendix 1).

- 3.2.2. Acoustic measurements

A precision sound level meter as defined in paragraph 1.1 of this annex shall be used for the measurements.

- 3.2.3. Test site - local conditions (see appendix of Annex 3, Figure 2)

- 3.2.3.1. In the vicinity of the microphone, there shall be no obstacle that could influence the acoustical field and no person shall remain between the microphone and the sound source. The meter observer shall be positioned so as not to influence the meter reading.

- 3.2.4. Disturbance noise and wind interference
- Readings on the measuring instruments produced by ambient noise and wind shall be at least 10 dB(A) below the sound level to be measured. A suitable windscreen may be fitted to the microphone provided that account is taken of its effect on the sensitivity of the microphone (see paragraph 1.1. of this annex).
- 3.2.5. Measuring method
- 3.2.5.1. Nature and number of measurements
- The maximum sound level expressed in A-weighted decibels (dB(A)) shall be measured during the operating period referred to in paragraph 3.2.5.3.2.1.
- At least three measurements shall be taken at each measuring point.
- 3.2.5.2. Positioning and preparation of the vehicle
- The vehicle shall be located in the centre part of the test area with the gear selector in neutral position and the clutch engaged. If the design of the vehicle does not allow this, the vehicle shall be tested in conformity with the manufacturer's prescriptions for stationary engine testing. Before each series of measurements, the engine shall be brought to its normal operating condition, as specified by the manufacturer.
- If the vehicle is fitted with fan(s) having an automatic actuating mechanism, this system shall not be interfered with during the sound level measurements.
- The engine hood or compartment cover, if so fitted, shall be closed.
- 3.2.5.3. Measuring of noise in proximity to the exhaust (see appendix of Annex 3, Figure 3a)
- 3.2.5.3.1. Positions of the microphone
- 3.2.5.3.1.1. The microphone shall be located at a distance of $0.5 \text{ m} \pm 0.01 \text{ m}$ from the reference point of the exhaust pipe defined in Figure 2 and at an angle of $45^\circ (\pm 5^\circ)$ to the vertical plane containing the flow axis of the pipe termination. The microphone shall be at the height of the reference point, but not less than 0.2 m from the ground surface. The reference axis of the microphone shall lie in a plane parallel to the ground surface and shall be directed towards the reference point on the exhaust outlet.
- If two microphone positions are possible, the location farthest laterally from the vehicle longitudinal centreline shall be used.
- If the flow axis of the exhaust outlet pipe is at 90° to the vehicle longitudinal centreline, the microphone shall be located at the point, which is furthest from the engine.
- 3.2.5.3.1.2. For vehicles having an exhaust provided with outlets spaced more than 0.3 m apart or more than one silencer, one set of measurement is made for each outlet.

- 3.2.5.3.1.3. If a vehicle has two or more exhaust outlets spaced less than or equal to 0.3 m apart and connected to a single silencer, only one set of measurement shall be made. The microphone shall be located relative to the outlet furthest away from the vehicle longitudinal centreline, or when such outlet does not exist, to the outlet, which is highest above the ground.
- 3.2.5.3.1.4. For vehicles with a vertical exhaust (e.g. commercial vehicles) the microphone shall be placed at the height of the exhaust outlet. Its axis shall be vertical and oriented upwards. It shall be placed at a distance of $0.5 \text{ m} \pm 0.01 \text{ m}$ from the exhaust pipe reference point, but never less than 0.2 m from the side of the vehicle nearest to the exhaust.
- 3.2.5.3.1.5. For vehicles, where the reference point of the exhaust pipe is not accessible, or located under the vehicle body, as shown in Figure 3b and 3c in Annex 3, because of the presence of obstacles which form part of the vehicle (e.g. spare wheel, fuel tank, battery compartment), the microphone shall be located at least 0.2 m from the nearest obstacle, including the vehicle body, and shall not be located under the vehicle. Its axis of maximum sensitivity shall face the exhaust outlet from the position least concealed by the above-mentioned obstacles. In case the distance from the exhaust outlet to the other side of the vehicle is larger than 0.2 m (Figures 3c and 3d in Annex 3), the following distances of d_1 and d_2 shall be chosen:
- Case 1:
- d_1 shall be equal to 0.5 m and the distance from the side (outer border of the vehicle) shall be at least 0.2 m.
- d_2 shall be equal to 0.5 m and the distance from the side (outer border of the vehicle) shall be at least 0.2 m.
- Case 2 (if Case 1 is not fulfilled):
- d_1 shall be at least 0.5 m and the distance from the side (outer border of the vehicle) shall be equal to 0.2 m.
- d_2 shall be at least 0.5 m and the distance from the side (outer border of the vehicle) shall be equal to 0.2 m.
- When several positions are possible, as shown in Figure 3c, the microphone position giving the lowest value of d_1 or d_2 shall be used.
- 3.2.5.3.1.6. Examples of the position of the microphone, depending on the location of the exhaust pipe, are given in Figures 3a-3d in Appendix 1 to Annex 3.
- 3.2.5.3.2. Operating conditions of the engine
- 3.2.5.3.2.1. Target engine speed
- The target engine speed is defined as:
- (a) 75 per cent of the rated engine speed S for vehicles with a rated engine speed $\leq 5,000 \text{ min}^{-1}$;
 - (b) $3,750 \text{ min}^{-1}$ for vehicles with a rated engine speed above $5,000 \text{ min}^{-1}$ and below $7,500 \text{ min}^{-1}$;
 - (c) 50 per cent of the rated engine speed S for vehicles with a rated engine speed $\geq 7,500 \text{ min}^{-1}$.

If the vehicle cannot reach the engine speed as stated above, the target engine speed shall be 5 per cent below the maximum possible engine speed for that stationary test.

For vehicles for which the engine speed is a fixed value, (for example, but not limited to, series hybrids) either above or below the target engine speed and cannot be adjusted by the accelerator, the test shall be carried out at the fixed engine speed.

In case the engine speed deviates from the applicable target engine speed, the engine speed used for the test and the reason for the deviation shall be documented in the test report and at paragraph 2.2. of Appendix 1 to Annex 1.

3.2.5.3.2.2. Test procedure

The engine speed shall be gradually increased from idle to the target engine speed, not exceeding the tolerance band of ± 3 per cent of the target engine speed, and held constant. Then the throttle control shall be rapidly released and the engine speed shall be returned to idle. The sound pressure level shall be measured during a period of operation consisting of a maintaining constant engine speed of 1 second and throughout the entire deceleration period. The maximum sound level meter reading during this period of operation, mathematically rounded to the first decimal place, is taken as the test value.

3.2.5.3.2.3. Test validation

The measurement shall be regarded as valid if the test engine speed does not deviate from the target engine speed by more than ± 3 per cent for at least 1 second.

3.2.6. Results for sound emitted by stationary vehicles

3.2.6.1. Single test position (outlet)

For the vehicles equipped with one exhaust outlet or two or more exhaust outlets as specified in paragraph 3.2.5.3.1.3., the stationary sound of the vehicle shall be determined for one test position.

At least three measurements for a test position (outlet) shall be made.

The maximum A-weighted sound pressure level indicated during each of the three measurements shall be recorded to the first decimal place.

The first three valid consecutive measurement results, within 2 dB(A), allowing for the deletion of non-valid results (see paragraph 2.1. except the specifications of the test site), shall be used for the determination of the final result for the given measurement position.

The result for a test position (outlet) is the arithmetic average of the three valid measurements, mathematically rounded to the nearest integer value (e.g. 72.5 shall be noted as to 73 while 72.4 shall be noted as to 72).

3.2.6.2. Multiple test positions (outlets)

For vehicles equipped with multiple exhaust outlets as specified in paragraph 3.2.5.3.1.2., the stationary sound of the vehicle shall be determined for each test position, following the measurement and calculation principles above.

The reported sound pressure level shall be for the test position having the highest average sound pressure level.

3.2.6.3. Modes

If the vehicle has different modes according to the definition 2.25.1. the stationary sound of the vehicle shall be determined for each mode, following the measurement and calculation principles above.

The sound pressure level for each mode shall be reported according to 3.2.6.1. in case the vehicle has only a single test position (outlet) and according to 3.2.6.2. in case of multiple test positions (outlets).

3.2.7. Stationary sound pressure level representative for the vehicle type³

If the vehicle has only one mode and a single test position (outlet), the representative sound pressure level for the vehicle type is determined by the measurement result according to paragraph 3.2.6.1.

If the vehicle has only one mode but multiple test positions (outlets), the representative sound pressure level for the vehicle type is determined by the measurement result according to paragraph 3.2.6.2.

If the vehicle has multiple modes and one or more test positions (outlets), the representative sound pressure level for the vehicle type is determined by the measurement result according to paragraph 3.2.6.3. In the test report and paragraph 2.2. of Appendix 1 to Annex 1 the representative test result determined by the principles above and the name of the mode shall be documented for every mode. The representative sound pressure level for the vehicle type and its registration papers is the highest reported sound pressure level of all modes as documented in paragraph 2.2. of Appendix 1 to Annex 1.

4. Sound from the hybrid vehicle of categories M₁ in motion, where an internal combustion engine cannot operate when the vehicle is stationary (data reported to facilitate testing of the vehicle in use).

4.1. In order to facilitate in-use compliance test of hybrid vehicles – where an internal combustion engine cannot operate when the vehicle is stationary –, the following information relating to the sound-pressure level measurements carried out in accordance with paragraph 3.1. of Annex 3 for the motor vehicles in motion is referred to as in-use compliance reference data:

- (a) Gear (i) or, for vehicles tested with non-locked gear ratios, the position of the gear selector chosen for the test;
- (b) Position of the operating switch during measurement of the sound pressure level $L_{ACC(i)}$ (if switch is fitted);
- (c) The pre-acceleration length l_{PA} in m;
- (d) The average vehicle speed in km/h at the beginning of the acceleration for tests in gear (i); and
- (e) The sound pressure level $L_{ACC(i)}$ in dB(A) of the **acceleration** tests in gear (i), defined as the maximum of the two values resulting from

³ See Figure 6 of Annex 3, Appendix

averaging the individual measurement results at each microphone position separately.

- 4.2. The in-use compliance reference data shall be entered in the type approval certificate as specified in paragraph 2.3. of the Addendum to the Communication form (Annex 1, Appendix 1).

Annex 3 - Appendix

Figure 1
Measuring positions for vehicles in motion

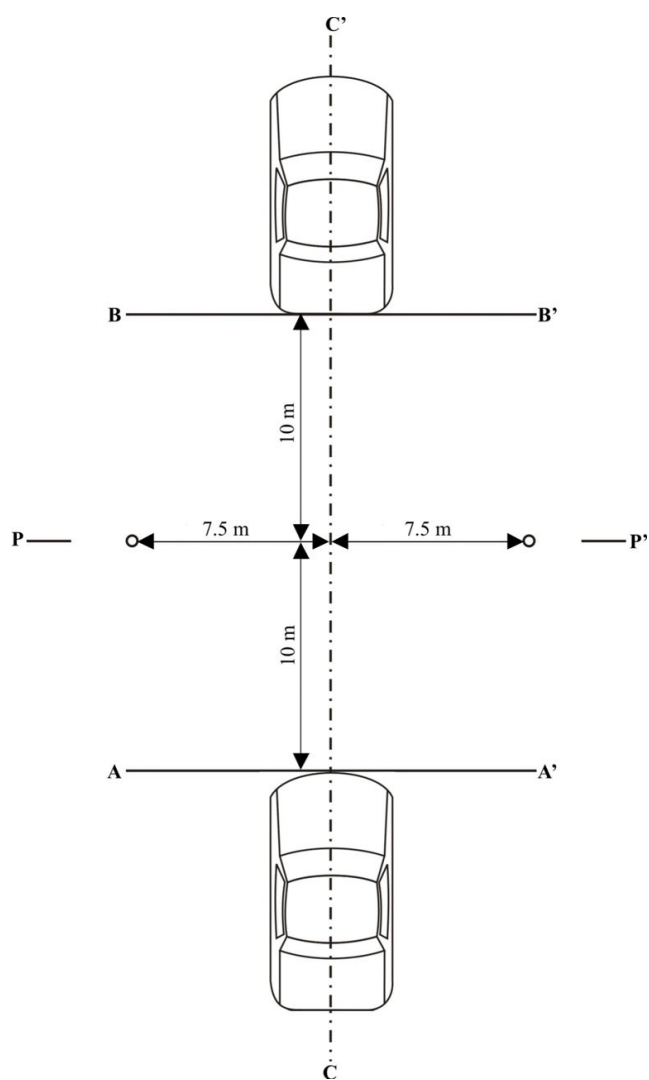
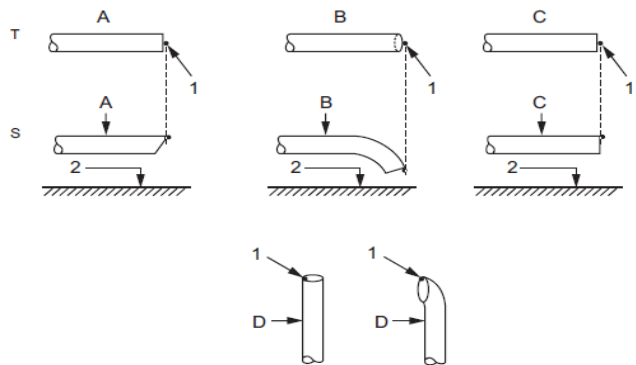


Figure 2
Reference point for measurement of sound emitted by stationary vehicles



- Key**
- T top view
 - S side view
 - 1 reference point
 - 2 road surface
 - A mitered pipe
 - B bent down pipe
 - C straight pipe
 - D vertical pipe

Figure 3a

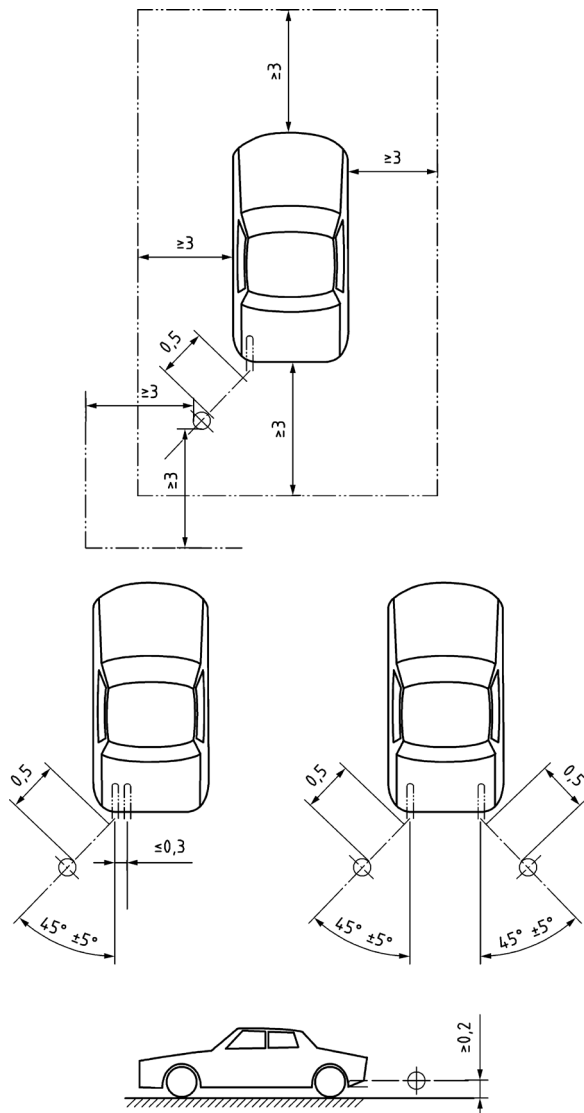


Figure 3b

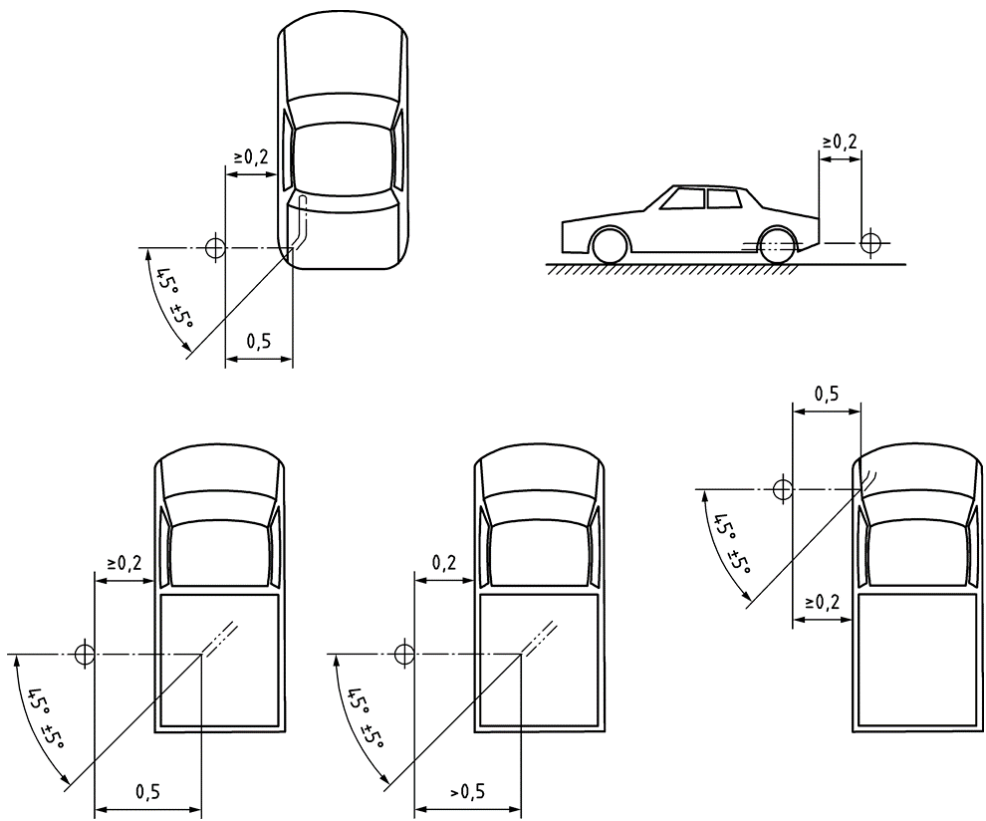


Figure 3c

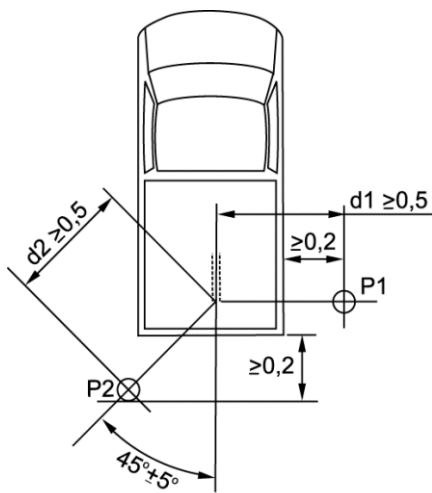


Figure 3d

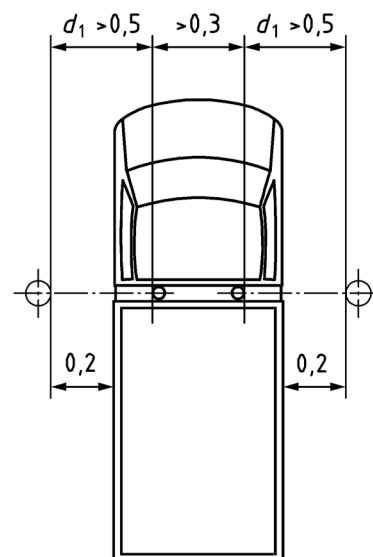
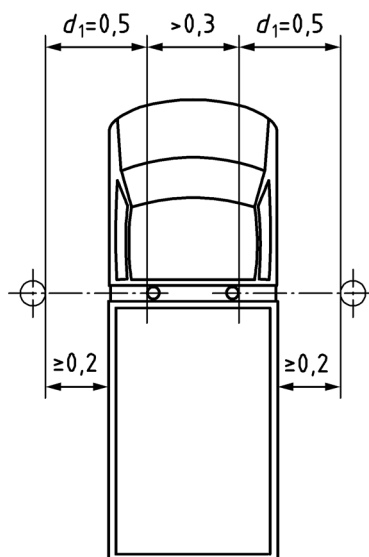
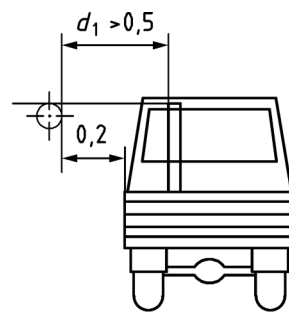
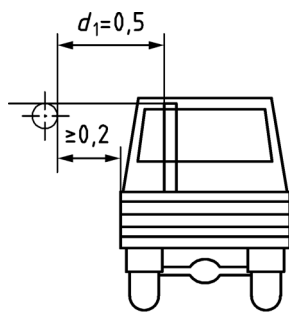


Figure 4a

Flowchart for vehicles tested according to paragraph 3.1.2.1. of Annex 3 to this Regulation – L_{URBAN} computation

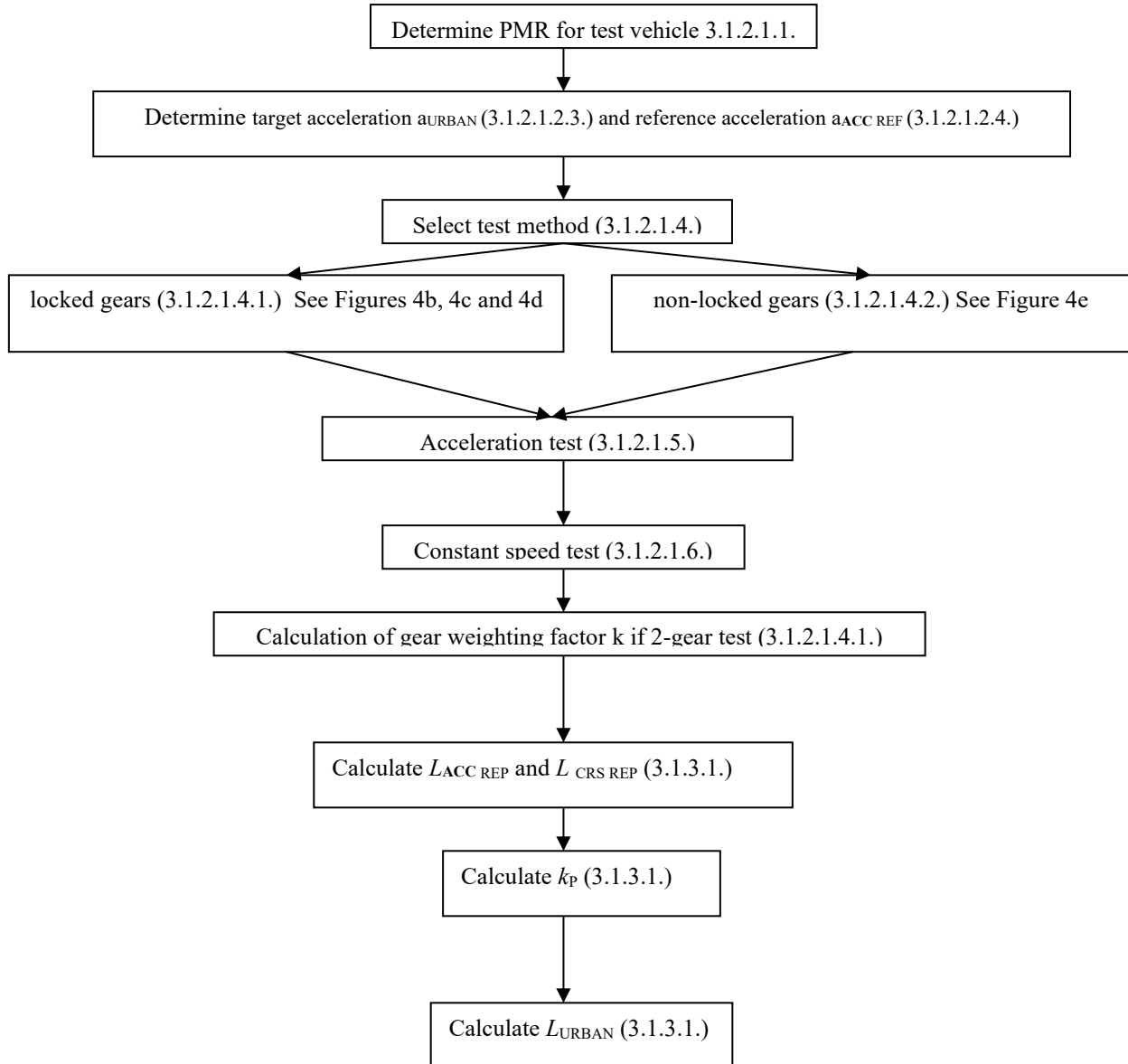


Figure 4b

Flowchart for vehicles tested according to paragraph 3.1.2.1. of Annex 3 to this Regulation -
Gear selection using locked gear PART 1

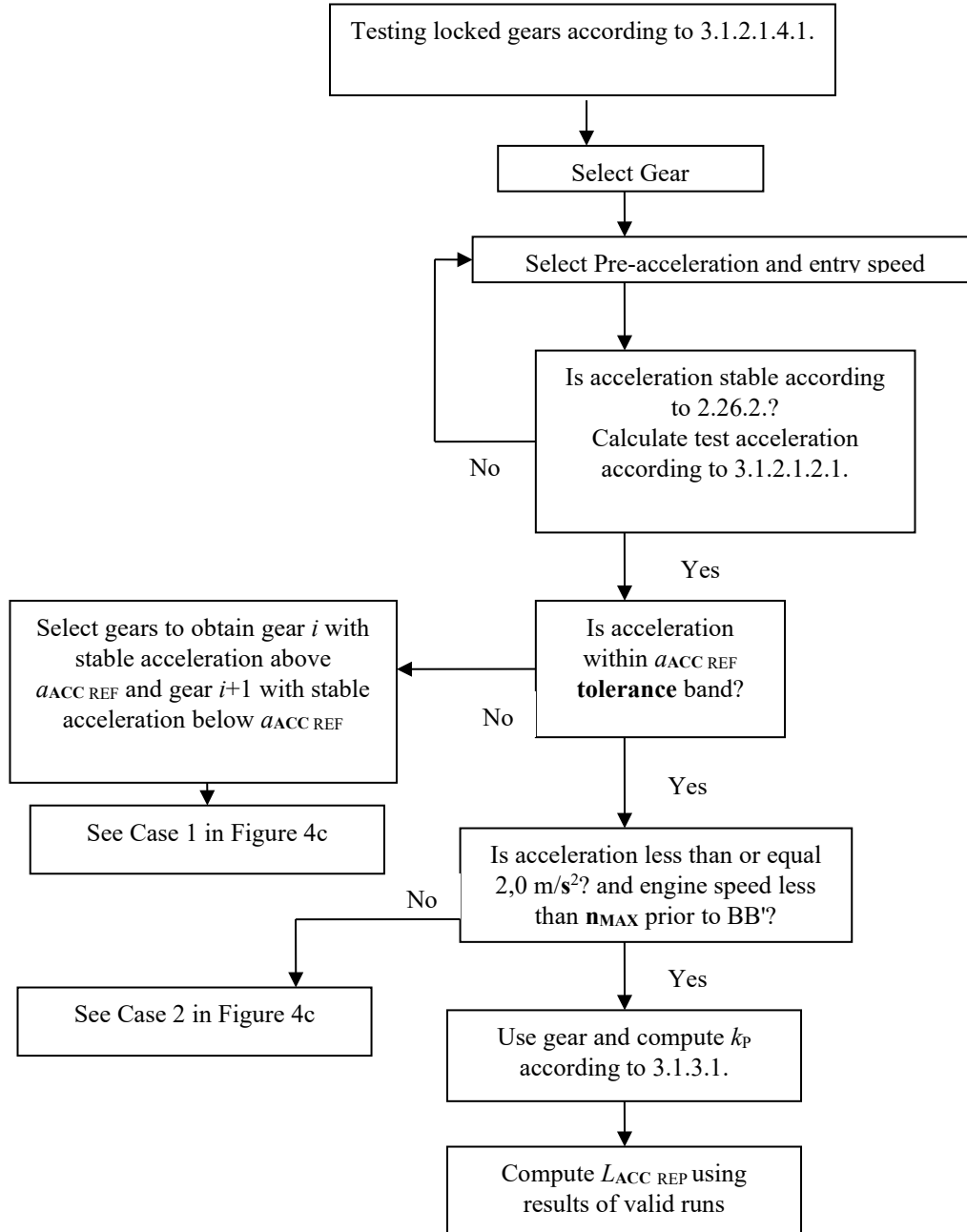


Figure 4c

**Flowchart for vehicles tested according to paragraph 3.1.2.1. of Annex 3 to this Regulation –
Gear selection using locked gear PART 2**

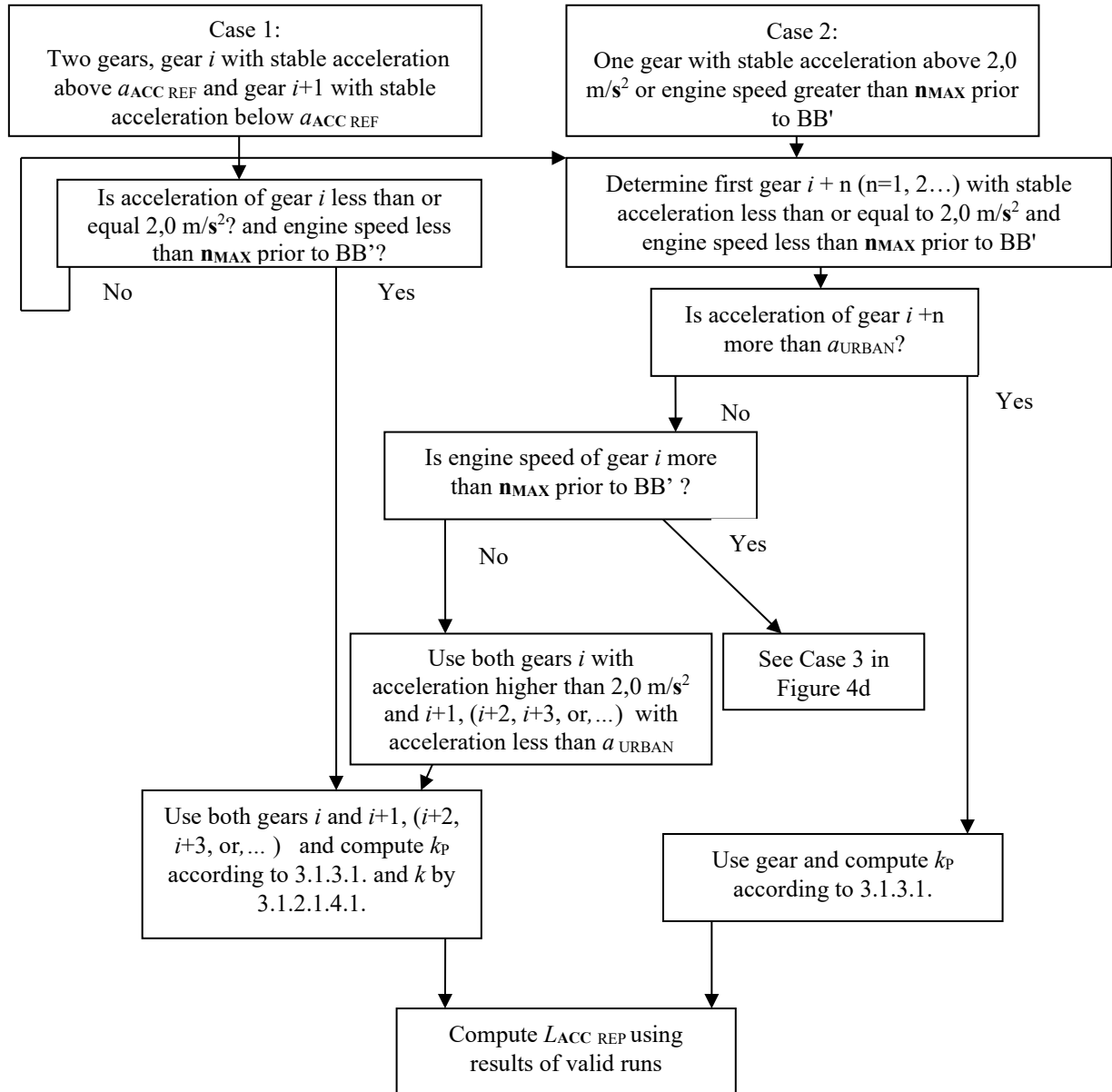


Figure 4d

Flowchart for vehicles tested according to paragraph 3.1.2.1. of Annex 3 to this Regulation –
Gear selection using locked gear PART 3

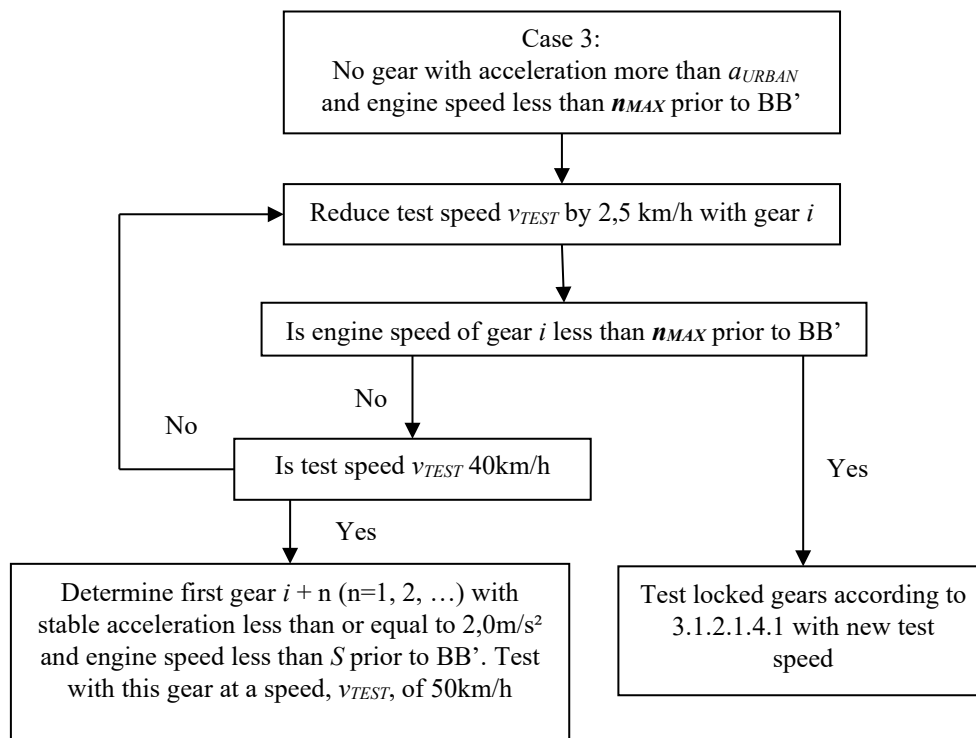


Figure 4e
Flowchart for vehicles tested according to paragraph 3.1.2.1. of Annex 3 to this Regulation –
Gear Selection using non-locked gears

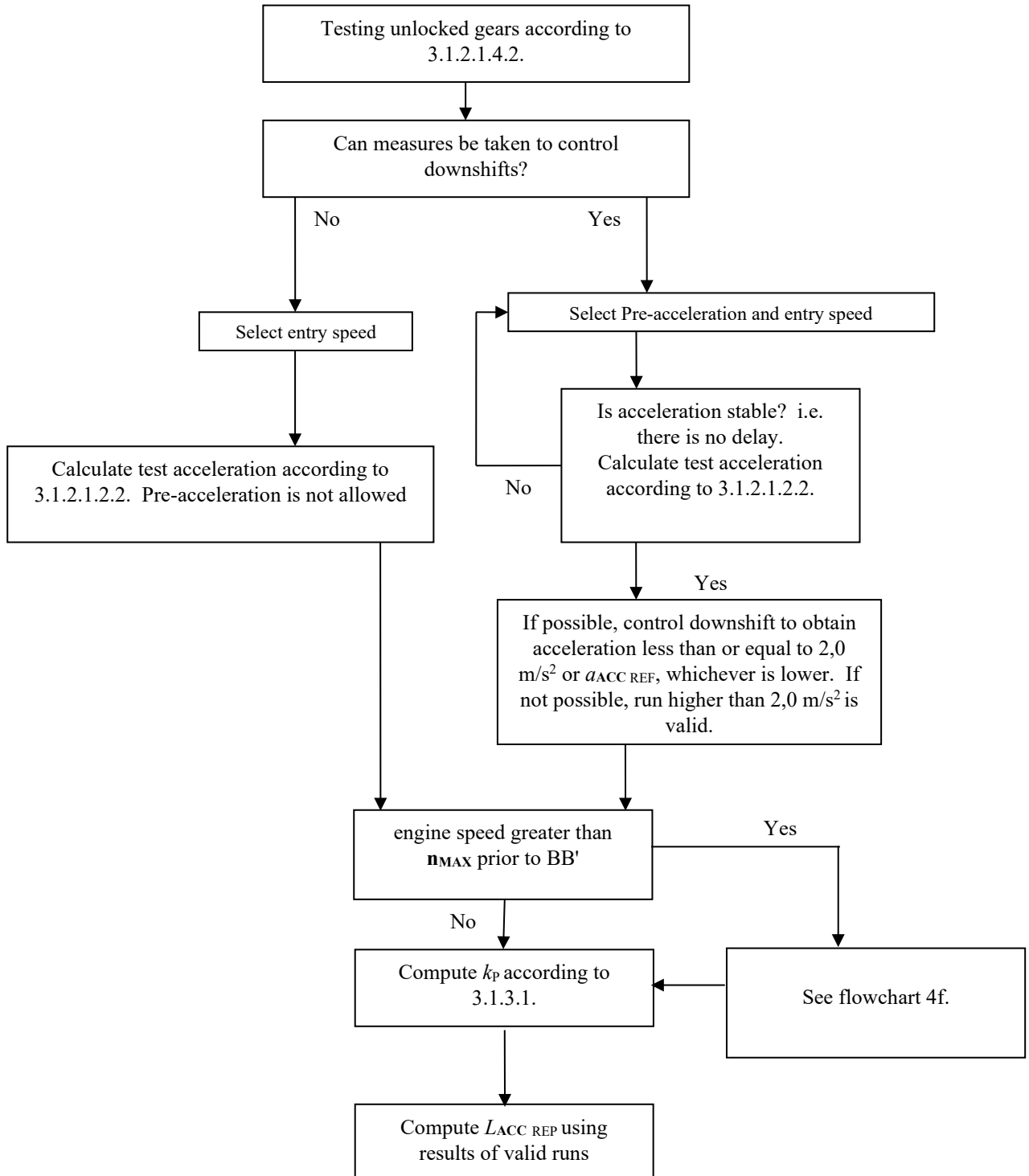


Figure 4f
Flowchart for vehicles tested according to paragraph 3.1.2.1.4.2. of Annex 3 to this Regulation –
Gear Selection using non-locked gears

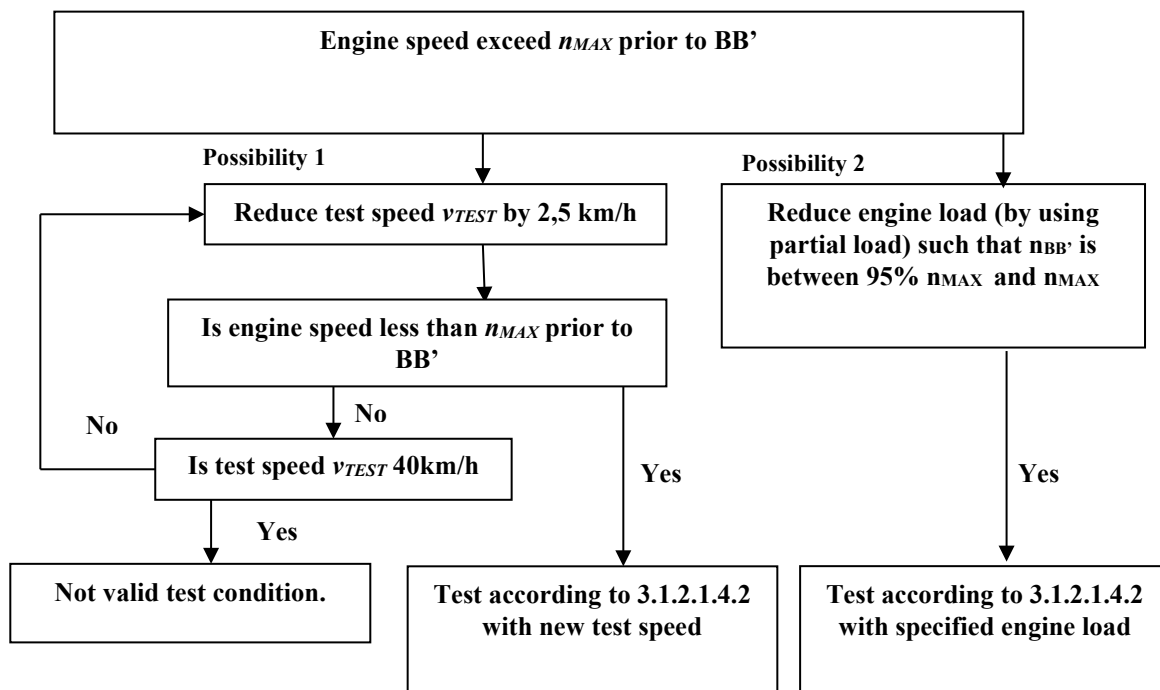


Figure 5a*

Flowchart for vehicles tested according to paragraph 3.1.2.2. of Annex 3 to this Regulation –
Test in locked gears

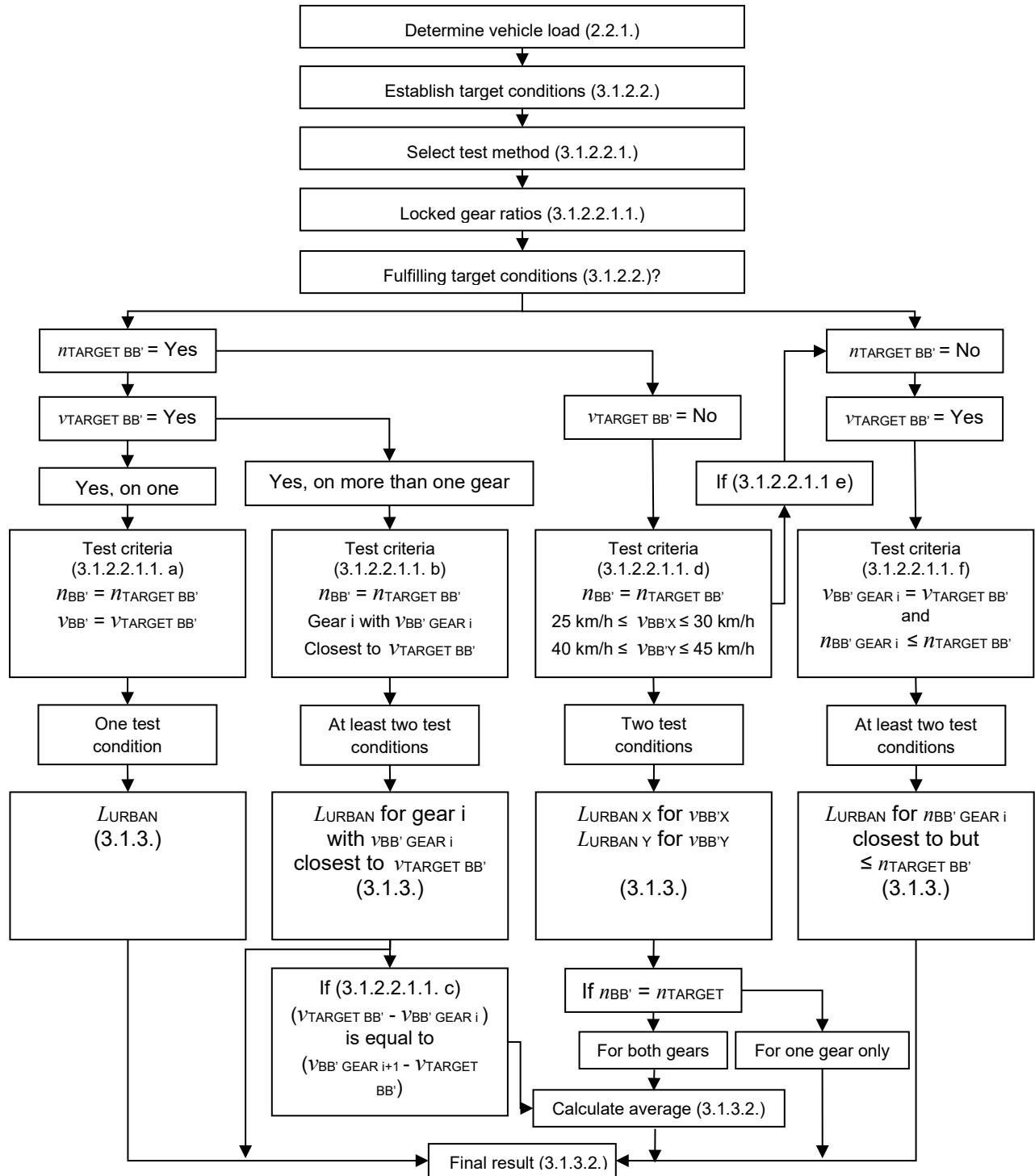


Figure 5b*

**Flowchart for vehicles tested according to paragraph 3.1.2.2. of Annex 3 to this Regulation –
Test in non-locked gears PART 1**

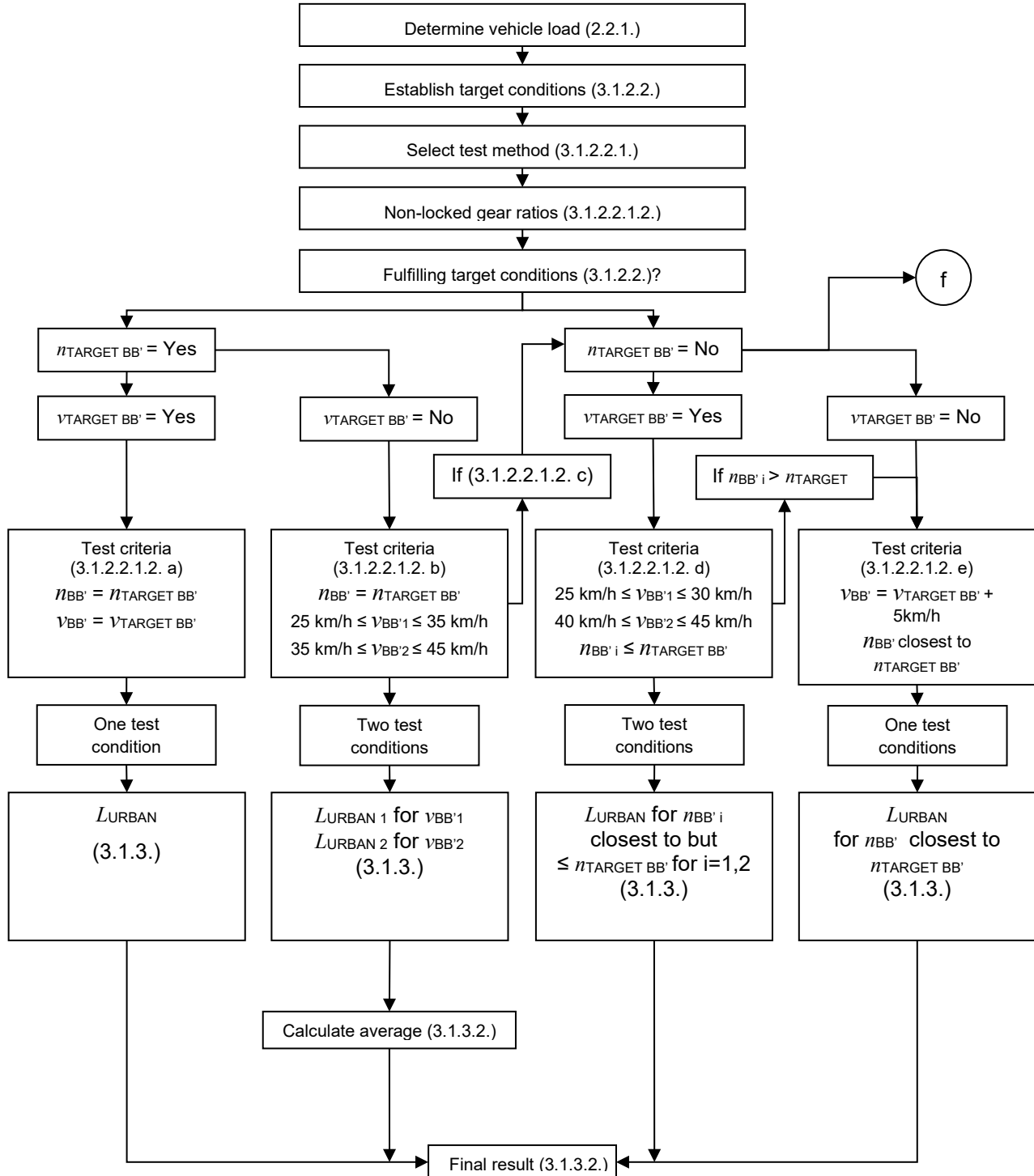


Figure 5c*
Flowchart for vehicles tested according to paragraph 3.1.2.2. of Annex 3 to this Regulation –
Test in non-locked gears PART 2

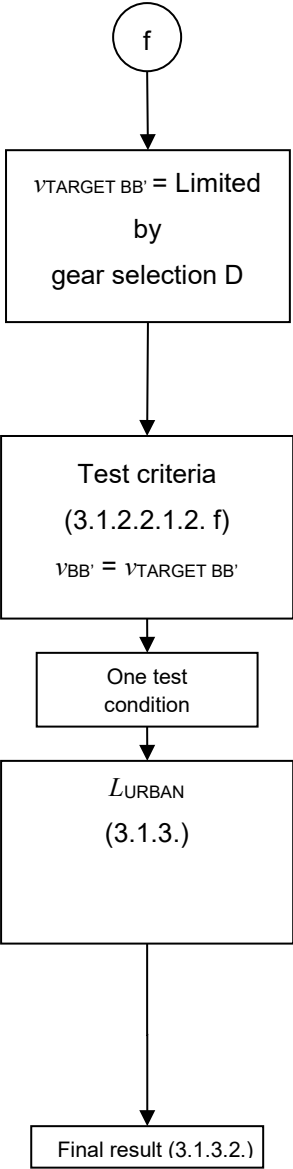
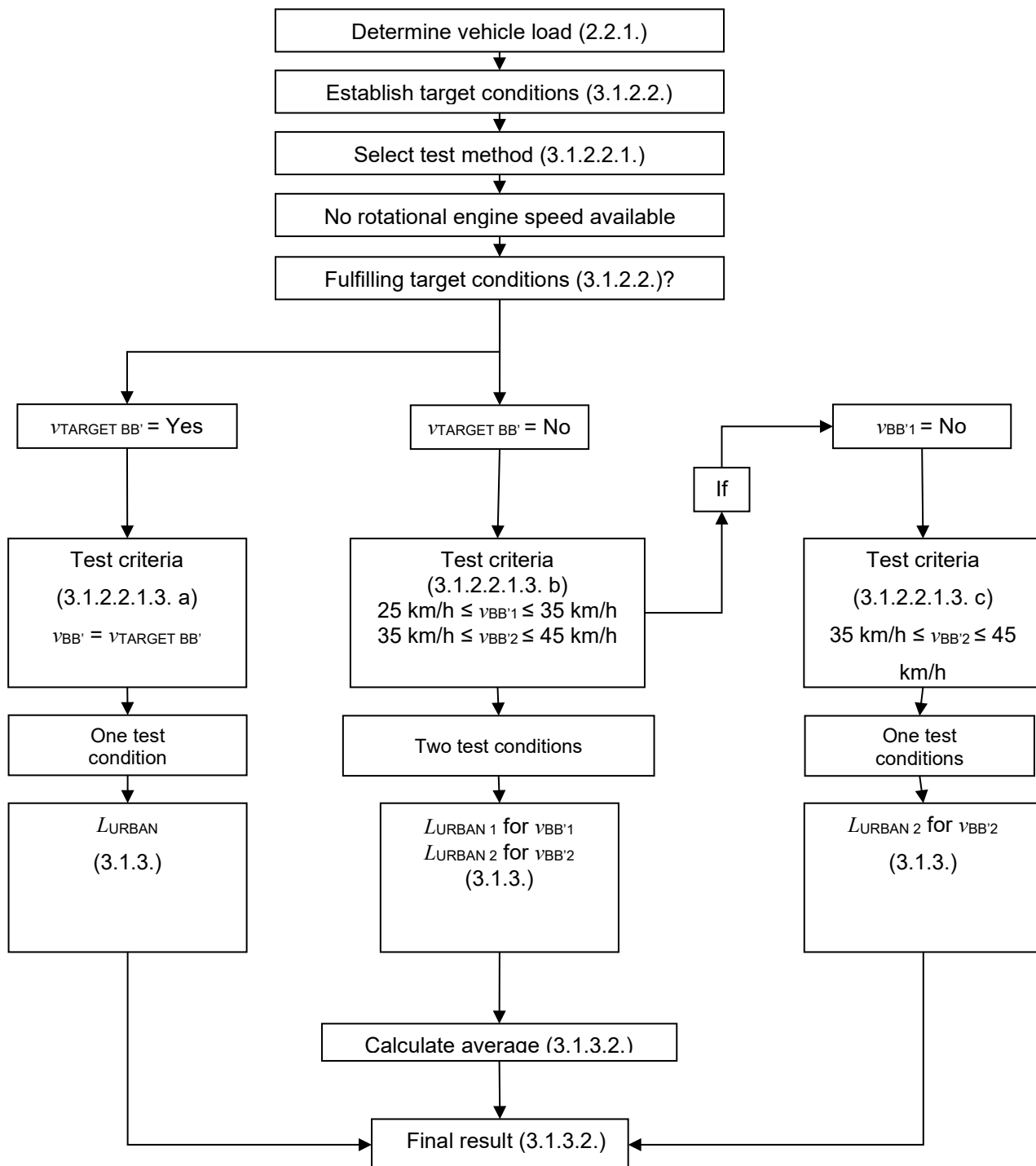


Figure 5d*

Flowchart for vehicles tested according to paragraph 3.1.2.2. of Annex 3 to this Regulation –
Test for no- combustion engine speed available



Note:

- * Broaden the window for the target vehicle speed $v_{\text{TARGET BB'}}$ for vehicles of category $M_2 > 3,500$ kg technically permissible maximum laden mass and for vehicles of category N_2 , M_3 and N_3 .

The target vehicle velocity $v_{\text{TARGET BB'}}$ is defined as $v_{\text{TARGET BB'}} = 35 \text{ km/h} \pm 5 \text{ km/h}$ which results in a window for the velocity $v_{\text{BB'}}$, when the reference point passes line BB', from 30 km/h to 40 km/h. If the target vehicle velocity $v_{\text{TARGET BB'}}$ is changed into two target vehicle velocities, a lower and a higher one, the following is meant: The lower target vehicle velocity is defined as the target vehicle velocity $v_{\text{TARGET BB'}}$ reduced by 5 km/h ($v_{\text{TARGET BB'}} - 5 \text{ km/h}$) which results in a window for the velocity $v_{\text{BB'1}}$, when the reference point passes line BB', from 25 km/h to 35 km/h.

$$25 \text{ km/h} \leq v_{\text{BB'1}} \leq 35 \text{ km/h}.$$

The higher target vehicle velocity is defined as the target vehicle velocity $v_{\text{TARGET BB'}}$ increased by 5 km/h ($v_{\text{TARGET BB'}} + 5 \text{ km/h}$) which results in a window for the velocity $v_{\text{BB'2}}$, when the reference point passes line BB', from 35 km/h to 45 km/h.

$$35 \text{ km/h} \leq v_{\text{BB'2}} \leq 45 \text{ km/h}.$$

Figure 6
Flowchart for measurement and data processing of stationary sound according to paragraph 3.2.

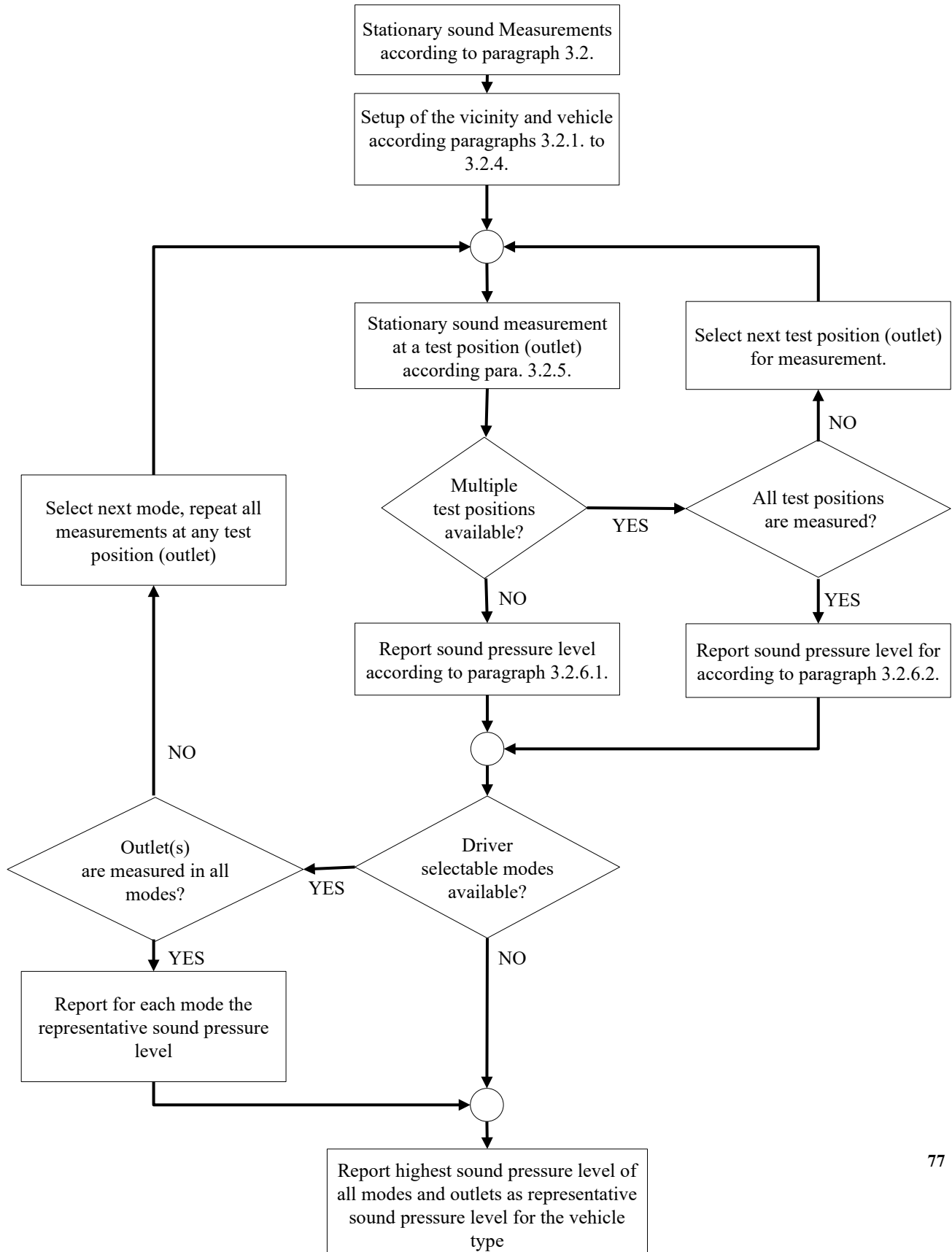


Table 1
Examples for Devices and Measures to Enable a Vehicle Tested within the Acceleration Boundaries

No.	Impact	Sub No.	Measure	Additional Requirements
1	Lock of a discrete gear ratio	1*	A discrete gear ratio can be locked by the driver	none
		2	A discrete gear ratio is available onboard, but is not available to the driver. Locking can be activated by the manufacturer with an onboard (hidden) function or with an external device	none
2	Controlled gear shift management: Applicable to transmissions which cannot be locked, or where no locked gear provides a valid test result	1*	Kickdown is deactivated	none
		2	Gear shift change(s) can happen during the test, gear shift is controlled by activation of an internal function or external device	Acceleration** shall be between a_{URBAN} and $a_{ACC,REF}$, not exceeding 2.0 m/s^2 .
3	Defined partial load driving****	1	Acceleration is limited by a mechanical device	Defined acceleration** shall be between a_{URBAN} and $a_{ACC,REF}$, not exceeding 2.0 m/s^2 . For RD-ASEP** , the reference point parameter is calculated by: $L_{ACC \text{ ANCHOR}} = (L_{ACC} - k_p * L_{CRS}) / (1 - k_p)$ where $k_p = 1 - (a_{URBAN} / a_{ACC \text{ TEST}})$ $n_{BB'} \text{ ACC ANCHOR} = n_{BB'} \text{ TEST} * 3.6 / \sqrt{v_{BB'} \text{ TEST}} * (a_{ACC \text{ REF}} * (20 + 2 * 1) + 192,9)^{0.5}$
		2	External Programming for partial load acceleration***	
4	Mixed Solution (Mode): This measure will be a mix of the above solutions combined in a specific mode	1*	Mode is available onboard and can be selected by the driver	none
		2	Mode is available onboard and can only be activated by the manufacturer with a hidden function or an external device	none
		3	Mode is not available onboard, an external software overrides the internal software	Acceleration** shall be between a_{URBAN} and $a_{ACC,REF}$, not exceeding 2.0 m/s^2 .

* Comment: This is a standard situation, already covered by the Regulation text.

** Applicable to vehicles of category M₁, N₁ and M₂ ≤ 3,500 kg.

*** Partial load shall be achieved by simulation of the travel restriction of the accelerator. It is not allowed to interfere with the engine control management.

**** Applicable to vehicles of categories M₁, N₁ and M₂ ≤ 3,500 kg, for the further calculation of L_{URBAN} in Annex 3 the sound level measured under partial load shall replace the sound level under acceleration test.

The achieved acceleration under partial load during the test shall be used for the calculation of the part power factor k_P instead of $a_{ACC\ REF}$.

The test procedure and the data processing follow the same principle. Although it is tested in partial load, symbols x_{ACC} (e.g. L_{ACC} , a_{ACC} , ...) shall be used.

Annex 4

Exhaust silencing systems containing acoustically absorbing fibrous materials

1. General

Sound absorbing fibrous materials may be used in silencing systems or components thereof only if

- (a) The exhaust gas is not in contact with the fibrous materials; or if
- (b) The silencing system or components thereof are of the same design family as systems or components for which it has been proven, in the course of type approval process in accordance with the requirements of this Regulation for another vehicle-type, that they are not subject to deterioration.

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

1.1. Continuous road operation for 10,000 km

1.1.1. 50 ± 20 per cent of this operation shall consist of urban driving and the remaining operation shall be long-distance runs at high speed; continuous road operation may be replaced by a corresponding test-track programme.

1.1.2. The two speed regimes shall be alternated at least twice.

1.1.3. The complete test programme shall include a minimum of 10 breaks of at least three hours duration in order to reproduce the effects of cooling and any condensation which may occur.

1.2. Conditioning on a test bench

1.2.1. Using standard parts and observing the vehicle manufacturer's instructions, the silencing system or components thereof shall be fitted to the vehicle referred to in paragraph 3.3. of this Regulation or the engine referred to in paragraph 3.4. of this Regulation. In the former case the vehicle shall be mounted on a roller dynamometer. In the second case, the engine shall be coupled to a dynamometer.

1.2.2. The test shall be conducted in six six-hour periods with a break of at least 12 hours between each period in order to reproduce the effects of cooling any condensation which may occur.

1.2.3. During each six-hour period, the engine shall be run, under the following conditions:

- (a) Five minutes at idling speed;
- (b) One-hour sequence under 1/4 load at 3/4 of rated maximum speed (S);
- (c) One-hour sequence under 1/2 load at 3/4 of rated maximum speed (S);
- (d) 10-minute sequence under full load at 3/4 of rated maximum speed (S);

- (e) 15-minute sequence under 1/2 load at rated maximum speed (S);
- (f) 30-minute sequence under 1/4 load at rated maximum speed (S).

Each period shall comprise two sequenced sets of the six above-mentioned conditions in consecutive order from (a) to (f).

- 1.2.4. During the test, the silencing system or components thereof shall not be cooled by a forced draught simulating normal airflow around the vehicle. Nevertheless, at the request of the manufacturer, the silencing system or components thereof may be cooled in order not to exceed the temperature recorded at its inlet when the vehicle is running at maximum speed.

1.3. Conditioning by pulsation

- 1.3.1. The silencing system or components thereof shall be fitted to the vehicle referred to in paragraph 3.3. of this Regulation or the engine referred to in paragraph 3.4. of this Regulation. In the former case the vehicle shall be mounted on a roller dynamometer.

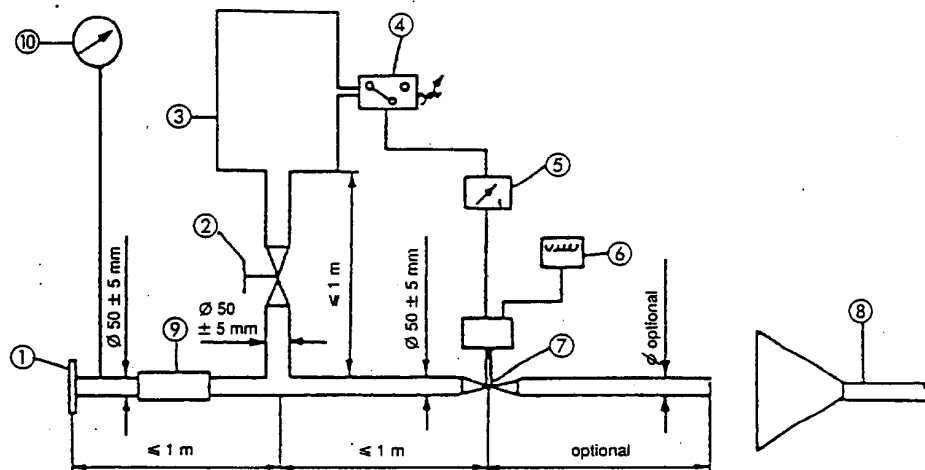
In the second case, the engine shall be mounted on a dynamometer. The test apparatus, a detailed diagram of which is shown in Figure 1 of the appendix to this annex shall be fitted at the outlet of the silencing system. Any other apparatus providing equivalent results is acceptable.

- 1.3.2. The test apparatus shall be adjusted in such a way that the exhaust-gas flow is alternatively interrupted and re-established by the quick-action valve for 2,500 cycles.
- 1.3.3. The valve shall open when the exhaust-gas back pressure, measured at least 100 mm downstream of the intake flange, reaches a value of between 35 and 40 kPa. It shall close when this pressure does not differ by more than 10 per cent from its stabilized value with the valve open.
- 1.3.4. The time-delay switch shall be set for the duration of gas exhaust resulting from the provisions laid down in paragraph 1.3.3. above.
- 1.3.5. Engine speed shall be 75 per cent of the rated engine speed (S) at which the engine develops rated maximum net power.
- 1.3.6. The power indicated by the dynamometer shall be 50 per cent of the full-throttle power measured at 75 per cent of rated engine speed (S).
- 1.3.7. Any drain holes shall be closed off during the test.
- 1.3.8. The entire test shall be completed within 48 hours.

If necessary, one cooling period will be observed after each hour.

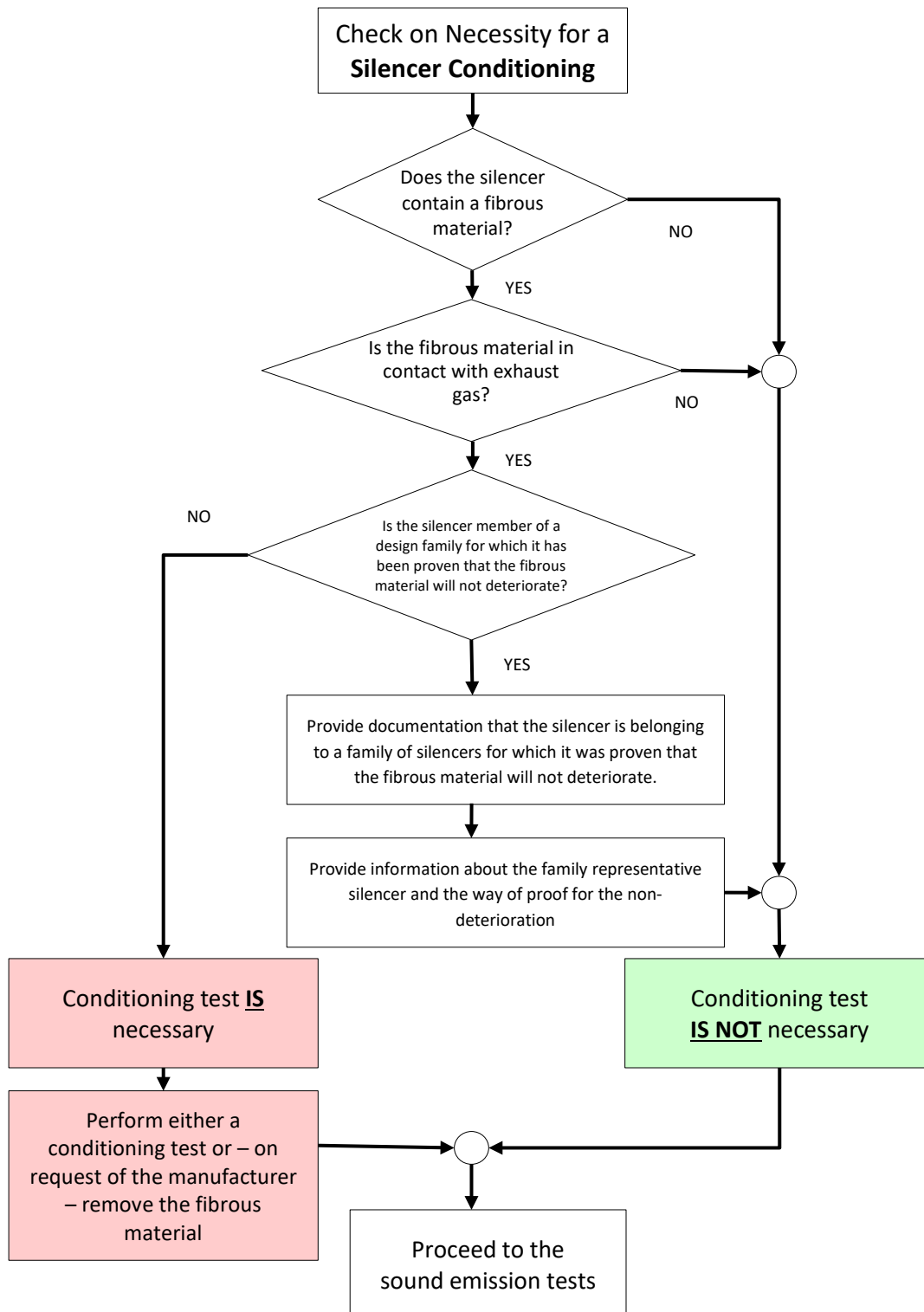
Annex 4 - Appendix

Figure 1
Test apparatus for conditioning by pulsation



1. Inlet flange or sleeve for connection to the rear of the test exhaust system.
2. Hand-operated regulating valve.
3. Compensating reservoir with a maximum capacity of 40 l and a filling time of not less than one second.
4. Pressure switch with an operating range of 0.05 to 2.5 bar.
5. Time delay switch.
6. Pulse counter.
7. Quick-acting valve, such as exhaust brake valve 60 mm in diameter, operated by a pneumatic cylinder with an output of 120 N at 4 bar. The response time, both when opening and closing, shall not exceed 0.5 second.
8. Exhaust gas evacuation.
9. Flexible pipe.
10. Pressure gauge.

Figure 2: Flowchart for the check on the necessity for a silencer conditioning test



Annex 5

Compressed air noise

1. Method of measurement

The measurement is performed at microphone positions 2 and 6 according to Figure 1, with the vehicle stationary. The highest A-weighted sound level is registered during venting the pressure regulator and during ventilating after the use of both the service and parking brakes.

The noise during venting the pressure regulator is measured with the engine at idling speed. The ventilating noise is registered while operating the service and parking brakes; before each measurement, the air-compressor unit has to be brought up to the highest permissible operating pressure, and then the engine switched off.

2. Evaluation of the results

For all microphone positions two measurements are taken. In order to compensate for inaccuracies of the measuring equipment, the meter reading is reduced by 1 dB(A), and the reduced value is taken as the result of measurement. The results are taken as valid if the difference between the measurements at one microphone position does not exceed 2 dB(A). The highest value measured is taken as the result. If this value exceeds the sound limit by 1 dB(A), two additional measurements are to be taken at the corresponding microphone position.

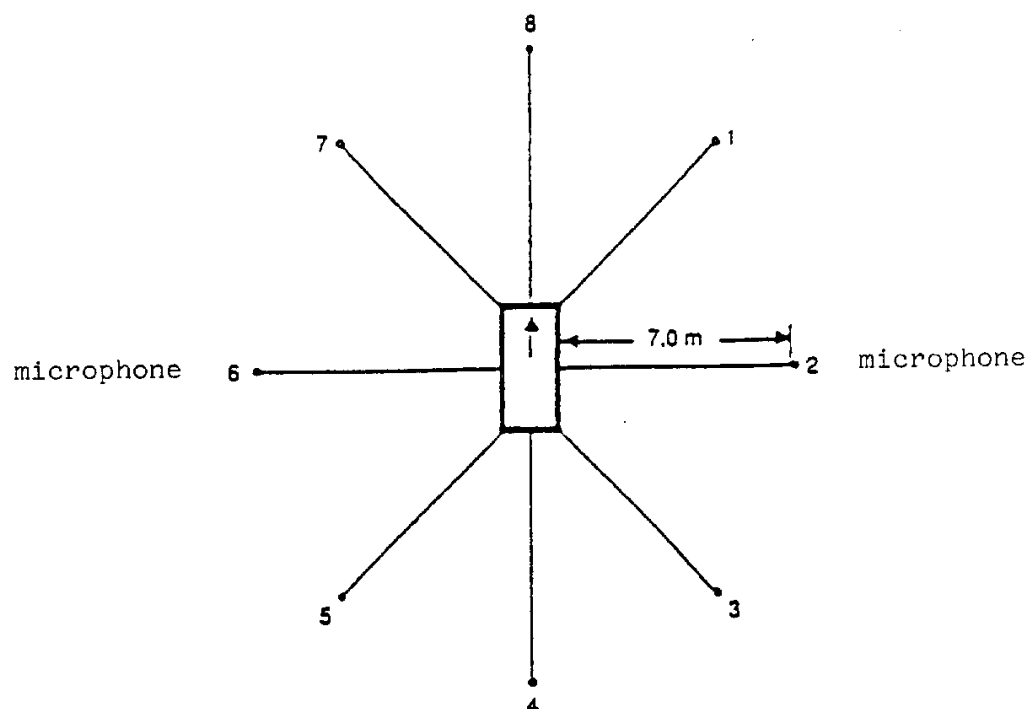
In this case, three out of the four results of measurement obtained at this position have to comply with the sound limit.

3. Limiting value

The sound level shall not exceed the limit of 72 dB(A).

Annex 5 - Appendix

Figure 1
Microphone positions for measurement of compressed air noise



The measurement is performed at the stationary vehicle according to Figure 1, using two microphone positions at a distance of 7 m from the contour of the vehicles, and at 1.2 m above ground.

Annex 6

Checks on conformity of production

1. General

These requirements are consistent with the test for checking Conformity of Production (COP) according to paragraph 8. of this Regulation.
2. Testing procedure

The test site and measuring instruments shall be those as described in Annex 3.

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

For vehicles of category M₁, N₁ and M₂ ≤ 3,500 kg technically permissible maximum laden mass,

 - the same mode, gear(s)/gear ratio(s), gear weighting factor k and partial power factor k_P as determined during the type approval process **shall** be used, provided this information are available from the type approval test report for the applicable vehicle variant of the family. If not, this information shall be determined anew. The test report shall document which way of data processing was selected;
 - the test mass m_T of the vehicle shall be between $0.9m_{RO} \leq m_T \leq 1.2m_{RO}$
 - 2.2. Compressed air noise

Vehicles having maximum mass exceeding 2,800 kg and equipped with compressed air systems shall be subjected to an additional test for measurement of the compressed air noise as described in paragraph 1. of Annex 5.
 - 2.3. **Real Driving Additional Sound Emission Provisions (RD-ASEP)**

The vehicle manufacturer shall assess the compliance with **RD-ASEP** by an appropriate evaluation. **This can be** for example, but not limited to, part checks, test as described in Annex 7 **either outdoors or indoors as described in Annex 8, or by virtual assessment.**

If test according to Annex 7 are carried out, they shall be randomised over the whole control range of RD-ASEP and shall be at least 3 runs and not more than 5 runs.
3. Sampling and evaluation of the results

One vehicle shall be chosen and subjected to the tests set out in point 2. If the sound level of the vehicle tested does not exceed by more than 1 dB(A) the limit value specified in paragraph 6.2.2. **and 6.2.3.** of this Regulation, and, where appropriate, paragraph 3. of Annex 5, the vehicle type shall be considered to conform to the requirements of this Regulation.

If one of the test results does not fulfil the COP requirements of this annex and of paragraph 8. of the main body of this Regulation two more vehicles of the same type shall be tested pursuant to paragraph 2. above.

If the test results for the second and the third vehicle fulfil the COP requirements of this annex and of paragraph 8. of the main body of this Regulation, the vehicle is considered in compliance with regard to the COP.

If one of the test results of the second or third vehicle does not fulfil the COP requirements of this annex and of paragraph 8. of the main body of this Regulation the vehicle type shall be considered not to conform to the requirements of this Regulation and the manufacturer shall take the necessary measures to re-establish the conformity.

Annex 7

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

This annex is applicable to vehicles as specified in paragraph 6.2.3. of this Regulation.

1. General

Any vehicle operating conditions within the control range, as specified in paragraph 2.3. of Annex 7 are typical on road driving conditions and are covered by RD-ASEP.

Exterior sound enhancement system(s) shall operate as designed during the type-approval test and not be interfered with.

2. Facilities

Due to limitations of test facilities¹ not every test condition may be performed on every test facility.

Notwithstanding such restrictions, the type approval shall be granted on these test facilities, however the vehicle has to comply to all provisions of this Annex 7. In these cases, the vehicle manufacturer shall explain to the satisfaction of the authority present at type approval that the vehicle fulfils the requirements which could not be tested due to the restriction of the test facility.

Tests for Annex 7 may be carried out on different test facilities² 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.

3. Measurement method

3.1. 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.

3.2. 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.

3.3. Control range

¹ Facilities may provide restriction for safety reasons, such as for vehicle speed.

² Tests for Annex 3 and Annex 7 may be carried out on different test facilities if documentation exists that demonstrates that the differences in sound performance are neglectable.

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/s ²	4 m/s ²
Performance	0 m ² /s ³	35 m ² /s ³
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.

3.4. 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.

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 $\pm 10\%$ 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 2.26.1. 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]

(to be revised after refinement of the sound model)

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.

3.5. Test of the vehicle

3.5.1. 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.

3.5.2. 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.

3.5.3. 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}). **(symbol to be checked)**

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 readings at lines AA' and PP', when the vehicle reference point passes these lines, shall be rounded and reported with the first significant digit after the decimal place ($V_{AA'}$ TEST; $V_{PP'}$ TEST). *(symbol to be checked)*
- 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). *(symbols to be checked)*
- 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). *(symbol to be checked)*

All measured values shall be entered into the test report sheet according to the table of Appendix 3 of this Annex.

3.5.4. Calculated values

All calculated values shall be entered into the test report sheet according to the table of Appendix 3 of this Annex.

3.5.4.1. Acceleration a

The accelerations shall be calculated between lines PP' to BB', in accordance to 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. *(symbol to be checked)*

3.5.4.2. Performance v-a

The performance shall be calculated from the reported vehicle speed at line BB' and the acceleration result from paragraph 3.5.4.1. and rounded to the first digit after the decimal place.

3.5.4.3. Expected sound pressure level L_{EXP}

For the calculation of the expected sound pressure level, the measured values according to paragraph 3.5.3. and calculated values according to paragraphs 3.5.4.1. and 3.5.4.2. shall be used. All calculations are done according to Appendix 1 to this Annex.

4. Compliance assessment

4.1. 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 3.5.4.3. *(rounded to integer needed or not → to be decided later)*

$$L_{\text{TEST}} \leq L_{\text{TEST EXP}}$$

4.2. Case 2

If not more than **[two]** valid runs of the specified runs exceed the expected sound pressure level of paragraph 3.5.4.3. by not more than **[2]** dB(A) the compliance of the vehicle is acceptable.

4.3. Case 3

If more than [two] valid runs of the specified runs exceed the expected sound pressure level of paragraph 3.5.4.3. then the vehicle is non-compliant with RD-ASEP.

4.4. Case 4

If one or more valid runs exceed the expected sound pressure level of paragraph 3.5.4.3. by more than [2 dB(A)], the vehicle is non-compliant with RD-ASEP.

Annex 7 – Appendix 1 – Sound Expectation Model

1. General

XXXXX

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.

For a better understanding on the procedure, guidance is provided by the flowchart 2 in the Appendix 4 to Annex 7.

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 overtaken without any temperature or test track correction. Engine speed is not requested for Annex 3. However, for the purpose of Annex 7 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 to the Appendix of Annex 3, measures No.3 Sub.No.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 to the Appendix of Annex 3, measures No.3. Sub.No.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 $v_{BB'\ CRS}$, 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 the Appendix 2 to this Annex.

2.3.1. Discrete Determination of the factor x

On request of the manufacturer the x – factor 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 $L_{REF TR}$

$$L_{REF TR} = 10 \times \log(x * 10^{0.1 L_{CRS ANCHOR}})$$

- 2.5. Calculate the Reference Power Train Mechanics Sound Level $L_{REF PT}$

$$L_{REF PT} = 10 \times \log((1 - x) * 10^{0.1 L_{CRS ANCHOR}})$$

- 2.6. Calculate the Reference Dynamic Sound Level $L_{REF DYN}$

$$L_{REF DYN} = L_{REF PT} - 15$$

- 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

$$\Delta L_{DYN} = 10 \times \log(10^{0.1 L_{ACC ANCHOR}} - 10^{0.1 L_{REF TR ADJ}} - 10^{0.1 L_{REF PT ADJ}}) - L_{REF DYN}$$

with

$$L_{REF TR ADJ} = \theta_{TR LO} * \log\left(\frac{v_{BB' ACC ANCHOR}}{v_{REF}}\right) + L_{REF TR}$$

$$L_{REF PT ADJ} = \theta_{PT LO} * \log\left(\frac{(n_{BB' ACC ANCHOR} + n_{SHIFT PT})}{(n_{BB' CRS ANCHOR} + n_{SHIFT PT})}\right) + L_{REF PT}$$

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(A), the vehicle dynamic delta sound level ΔL_{DYN} is set to 10 dB(A).

$$\Delta L_{DYN} = 10 \text{ dB(A)}$$

- 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 3.4 and 3.5 of Annex 7.

3. Calculation of the expected sound level $L_{TEST EXP}$

- 3.1. For each single test run performed, for the purpose of Annex 7, an expected sound level $L_{TEST EXP}$ shall be calculated.

The **flowchart 3 in the Appendix 4** to Annex 7 provides guidance through the necessary calculation steps provided by the following paragraphs.

- 3.2. Necessary input data for the sound model are taken from the pass-by measurement according to paragraph 3.5.1. of Annex 7.
- 3.2.1. For the calculation of the expected sound level the parameters listed in paragraphs 3.5.3. and 3.5.4.1 and 3.5.4.2 of Annex 7 are needed.
- In addition, the vehicle speed to engine speed ratio κ_{TEST} , expressed in km/h per 1000 min⁻¹ and calculated by the formula below, rounded to the second decimal
- $$\kappa_{TEST} = v_{BB' TEST} / n_{BB' TEST} \times 1000$$
- The vehicle speed to engine speed ratio κ_{TEST} of the first operation condition according to paragraph 3.6.1 of Annex 7 is defined as reference vehicle speed to engine speed ratio κ_{REF} .
- 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 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.
- $$n_{BB' TEST} = (v_{BB' TEST} / 30) \times 1000$$
- 3.2.3. Virtual engine speed for hybrid electric vehicles
- In case that an internal combustion engine is mechanically coupled with drive axel 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 50km/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

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

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 $a_{ACC\ REF}$ or an acceleration not exceeding $2.0\ m/s^2$, whichever is lower. 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

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

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

Limit: see the limit value in the table of paragraph 6.2.2. of main body to this Regulation for the valid phase.

3.2.3.4. Case 4 – Internal combustion engine does not operate in both acceleration test and 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 50km/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 $a_{ACC\ REF}$ or an acceleration not exceeding $2.0\ m/s^2$, whichever is lower. 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

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

The adjusted sound pressure level for the acceleration test is

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

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

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- 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
$$L_{CRS,ANCHOR'} = L_{CRS,ANCHOR} + 0.5 \text{ dB}$$
- 3.2.4.3. Case 3 – Internal combustion engine is operational during constant speed test but not during the acceleration test

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 gear ratio of [20] km/h per 1000 min⁻¹. Calculate the engine speed with the gear ratio of that gear.
- 3.2.4.3.1. 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
$$L_{ACC,ANCHOR'} = (Limit - k_P \times L_{CRS,ANCHOR}) / (1 - k_P)$$

where Limit is the applicable limit for this vehicle type and k_P is the determined k_P -factor from the Annex 3 test.
- 3.2.4.4. Case 4 – Internal combustion engine is neither operational during the acceleration test nor during the constant speed test
- 3.2.4.4.1. Assignment of engine speed
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.

For the acceleration test, determine a virtual uniform gear ratio of [20] km/h per 1000 min⁻¹. Calculate the engine speed with the gear ratio of that gear.

3.2.4.4.2. Adjustment of sound pressure level

The adjusted sound pressure level for the constant speed test is

$$L_{CRS\ ANCHOR_i} = L_{CRS\ ANCHOR} + 0.5\ dB$$

The adjusted sound pressure level for the acceleration test is

$$L_{ACC\ ANCHOR_i} = (Limit - k_p \times L_{CRS\ ANCHOR_i}) / (1 - k_p)$$

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

The vehicle for PMR<25 is tested in Annex3 without constant speed test. The constant speed test result has to be assigned in Annex7.

3.2.5.1 The virtual constant speed test result $L_{CRS,ANCHOR'}$ is determined by

$$L_{CRS\ REP} = L_{ACC\ REP} - [1,1]\ dB(A)$$

3.2.5.2 Assignment of engine speed

3.2.5.2.1 Annex 3 acceleration test done in locked gear

If an engine speed information is available for the acceleration test result. For the constant speed test, the engine speed is calculated with the same transmission gear ratio of acceleration test in Annex3.

$$n_{BB'CRS\ ANCHOR} = \frac{v_{TEST}}{v_{BB'ACC\ ANCHOR}} \times n_{BB'ACC\ ANCHOR}$$

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

$$n_{BB'CRS\ REP} = \frac{v_{TEST}}{30} \times 1000$$

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.

$$n_{BB'CRS\ REP} = \frac{v_{TEST}}{30} \times 1000$$

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_{REF} , $L_{TR EXP}$ is calculated by

$$L_{TR EXP} = \theta_{TR LO} \times \log(v_{BB' TEST}/v_{BB' CRS}) + L_{REF TR} \text{ with } \theta_{TR LO} = [20]$$

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

$$L_{TR EXP} = \theta_{TR HI} \times \log(v_{BB' TEST}/v_{BB' CRS}) + L_{REF TR} \text{ with } \theta_{TR HI} = [40]$$

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 $L_{PT EXP} = \theta_{PT LO} \times$

$$\log((n_{BB' TEST} + n_{SHIFT PT})/(n_{BB' CRS ANCHOR} + n_{SHIFT PT})) + L_{REF PT} \text{ with } \theta_{PT LO} = [60]$$

$$n_{SHIFT PT} = [5000]$$

For engine speeds exceeding $n_{BB' CRS ANCHOR}$, $L_{PT EXP}$ is calculated by

$$L_{PT EXP} = \theta_{PT HI} \times \log((n_{BB' TEST} + n_{SHIFT PT})/(n_{BB' CRS ANCHOR} + n_{SHIFT PT})) + L_{REF PT} \text{ with } \theta_{PT HI} = [115]$$

$$n_{SHIFT PT} = [5000]$$

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

$$L_{DYN EXP} = \theta_{DYN LO} \times \log((n_{BB' TEST} + n_{SHIFT DYN})/(n_{BB' ACC ANCHOR} + n_{SHIFT DYN})) + L_{REF DYN}$$

$$\text{With } \theta_{DYN LO} = [50]$$

$$n_{SHIFT DYN} = [5000]$$

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

$$\begin{aligned} L_{DYN EXP} &= \theta_{DYN HI} \\ &\times \log((n_{BB' TEST} + n_{SHIFT DYN})/(n_{BB' ACC ANCHOR} + n_{SHIFT DYN})) \\ &+ L_{REF DYN} \end{aligned}$$

$$\text{with } \theta_{DYN HI} = [105]$$

$$n_{SHIFT DYN} = [5000]$$

3.6. Calculation of expected dynamic delta sound component $\Delta L_{DYN EXP}$

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 shall be performed 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. a_{TEST} and $v \cdot a_{TEST}$ may exceed the control range.

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 3.5.4.1. of Annex 7.

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

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

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/s^2 and the vehicle speed expressed in km/h by

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

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 a reference performance.

If the achieved performance does not exceed the reference performance $v \cdot a_{REF}$ according to the parameter coefficient table 1, 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

$$\Delta L_{DYN va} = \beta \times \log \left(\frac{v \cdot a_{TEST}}{v \cdot a_{REF}} \right)$$

with

$$\beta = [8]$$

The maximum dynamic performance component $\Delta L_{DYN v \cdot a}$ is limited to 8 dB(A)

3.6.3.3. Aggregation of dynamic sound components

The final dynamic delta sound component $\Delta L_{DYN,EXP}$ dynamic is calculated by

$$\Delta L_{DYN EXP} = (\Delta L_{DYN} + \Delta L_{DYN va}) \times (1 - \alpha / (LOAD_{TEST} + \alpha)) / (1 - \alpha)$$

With $\alpha = [0, 111]$

3.7. Calculation of the expected sound level $L_{TEST EXP}$

The calculation results of the paragraphs 3.3. to 3.6. 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

$$L_{TEST\ EXP} = 10 \times \log(10^{0,1 \times L_{TR\ EXP}} + 10^{0,1 \times L_{PT\ EXP}} + 10^{0,1 \times (L_{DYN\ EXP} + \Delta L_{DYN\ EXP})}) + 2dB(A)$$

- 3.8. Proceed with the compliance assessment according to paragraph 4 of Annex 7

Annex 7 – Appendix 2 – Statement of Compliance with the Additional Sound Emission Provisions

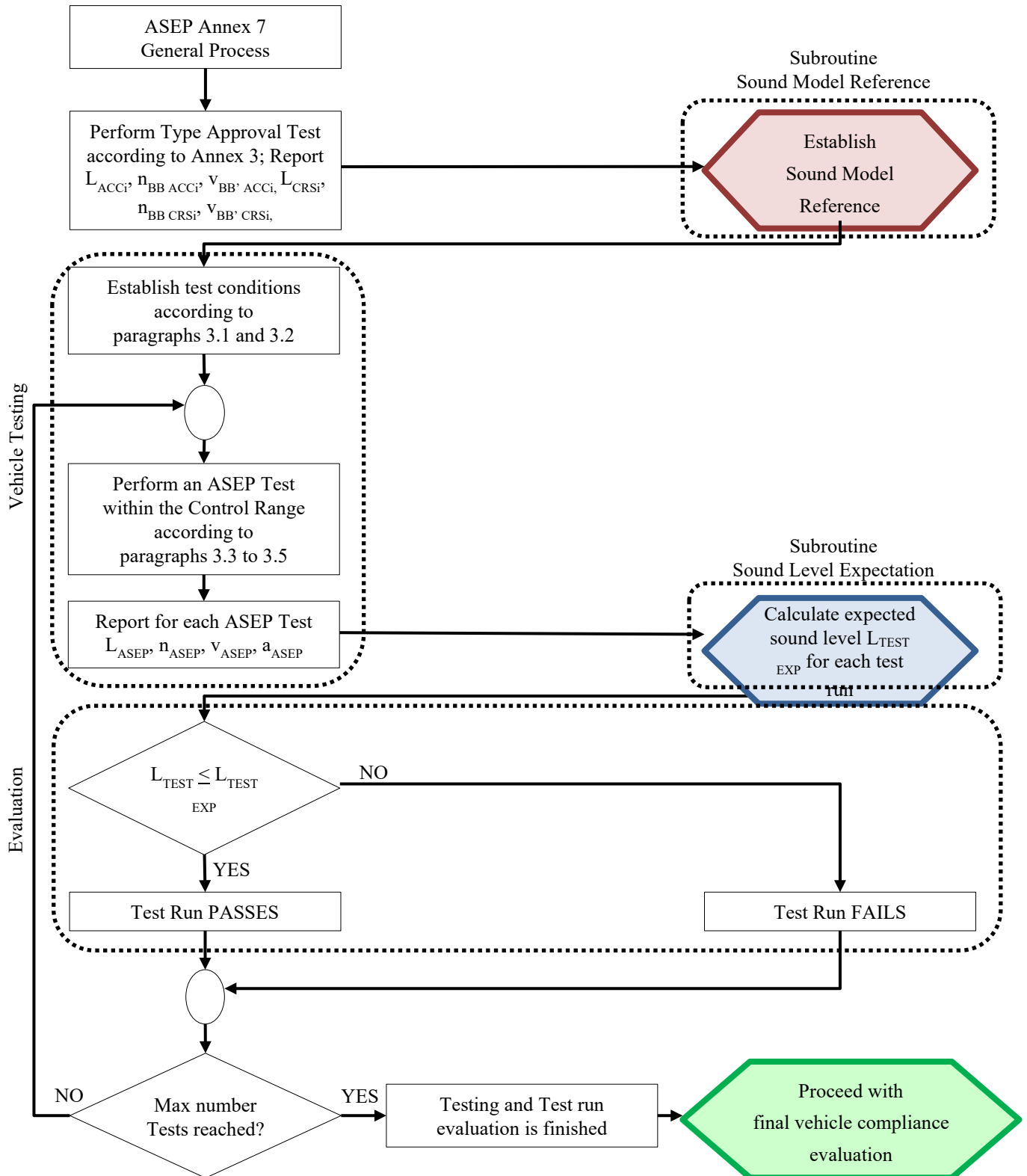
[to be confirmed]

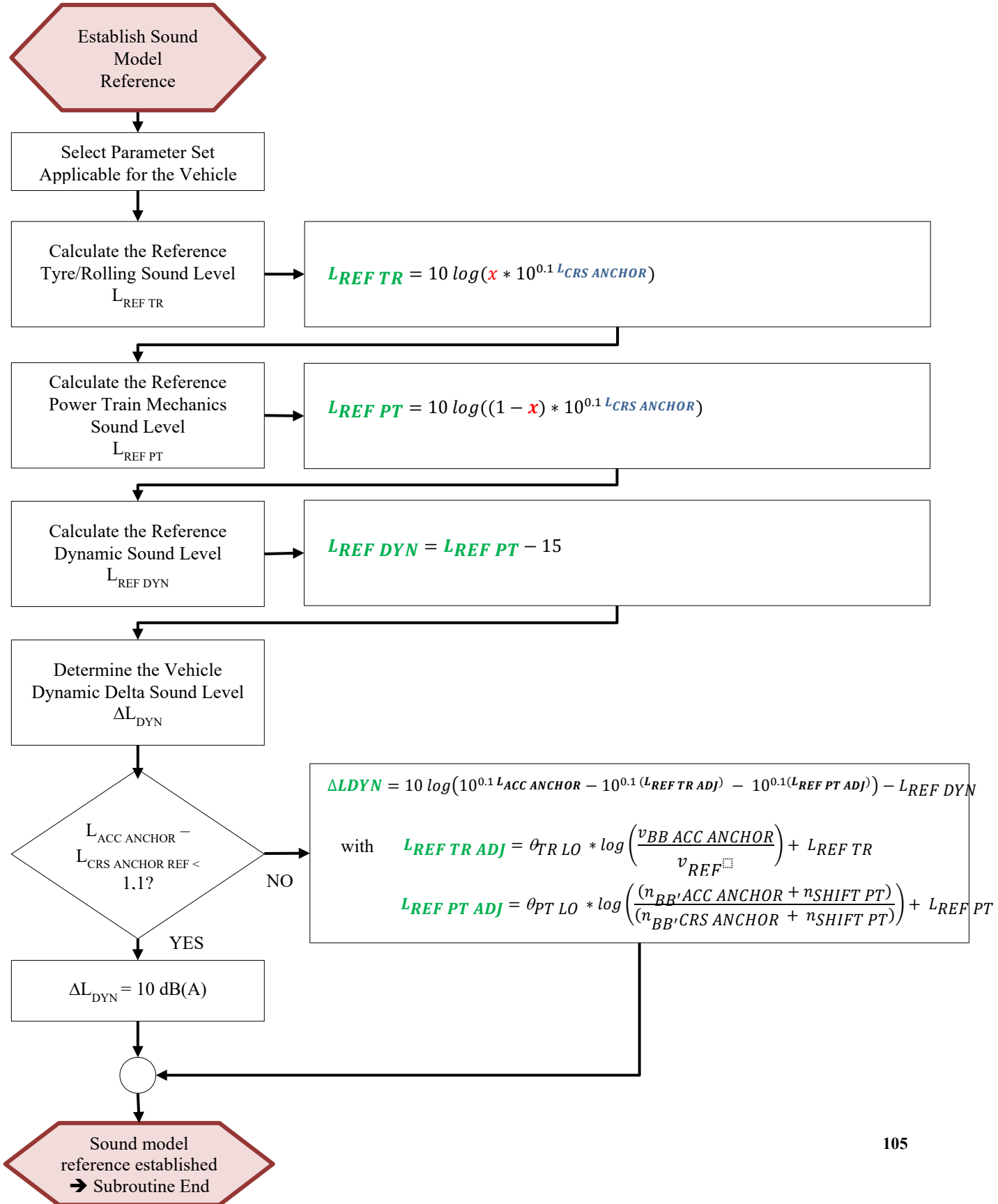
Model Part	Parameter	Symbol	Unit	M1/N1		
				ICE	BEV FCEV	HEV
TYRE	Reference Vehicle Speed	v_{REF}	km/h	50 or $v_{BB'} CRS$ min.40	50 or $v_{BB'} CRS$ min.40	50 or $v_{BB'} CRS$ min.40
	Tyre Rolling Sound Energy Fraction of Annex 3 Cruise Test $L_{CRS ANCHOR}$	x	%	90 or measure	98	90 or measure
	T/R Sound Slope ≤ 50 km/h	$\theta_{TR LO}$	dB/log(v/v_{REF})	20	20	20
	T/R Sound Slope > 50 km/h	$\theta_{TR HI}$	dB/log(v/v_{REF})	40	40	40
MECHANIC NO LOAD	P/T Sound Slope $\leq n_{BB'} CRS' ANCHOR$	$\theta_{PT LO}$	dB/Log(n/n_{REF})	60	60	60
	P/T Sound Slope $> n_{BB'} CRS' ANCHOR$	$\theta_{PT HI}$	dB/Log(n/n_{REF})	115	115	115
	Form Factor for the logarithm function of the mechanic sound model	$n_{SHIFT PT}$	1/min	5000	5000	5000
DYNAMIC LOAD	Dynamic Sound Slope $\leq n_{BB'} ACC ANCHOR$	$\theta_{DYN LO}$	dB/Log(n/n_{REF})	50	50	50
	Dynamic Sound Slope $> n_{BB'} ACC ANCHOR$	$\theta_{DYN HI}$	dB/Log(n/n_{REF})	105	105	105
	Form Factor for the logarithm function of the dynamic sound model	$n_{SHIFT DYN}$	1/min	5000	5000	5000
DYNAMIC $v \cdot a$	Reference Performance	$v \cdot a_{REF}$	m^2/s^3	28	28	28
	Dynamic $v \cdot a$ Factor β	β	dB(A)	8	8	8
	Partial Load Form Factor a	a	---	0,111	0,111	0,111
GENERAL	Base Margin	m	dB(A)	2	2	2

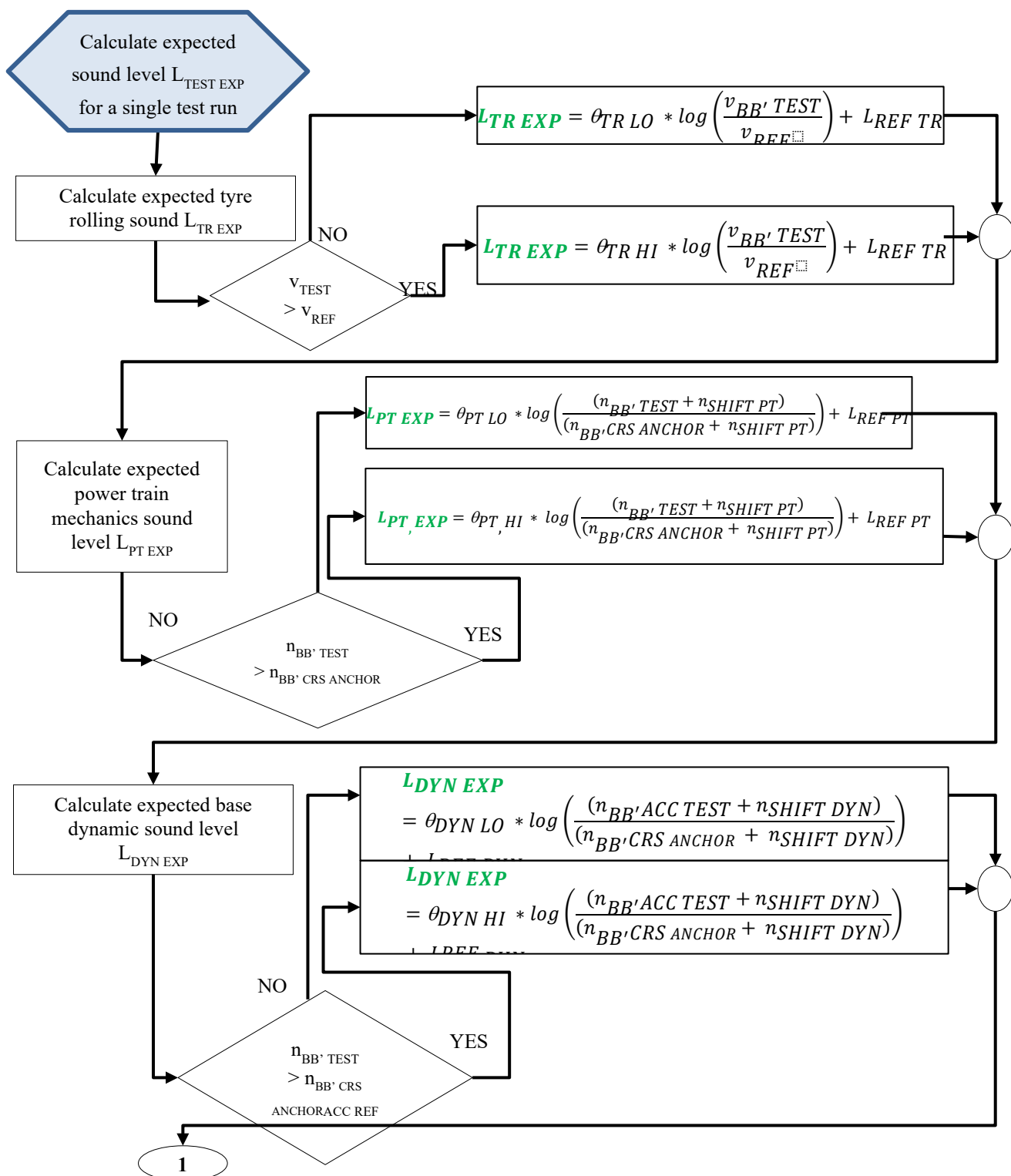
Annex 7 – Appendix 3 – Test report sheet (example) *[to be completed]*

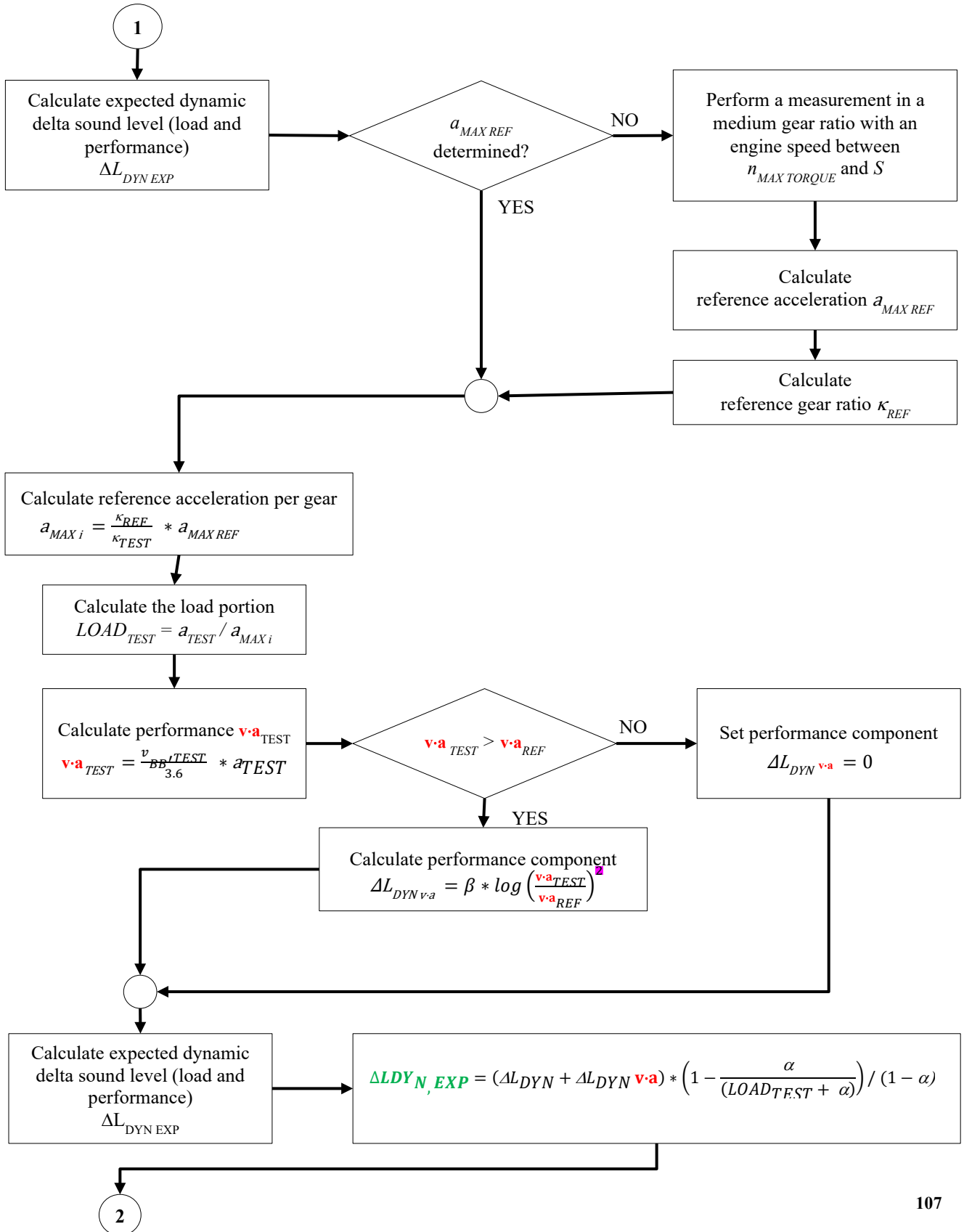
Run	Target Condition				Measured Values									Calculated Values				Conformity			
	Gear Selector Position	Mode	Entry Speed	Accelerator Position	Starting Point of Acceleration	Entry Speed	Microphone Speed	Exit Speed	Max Engine Speed	Exit Engine Speed	Maximum Sound Pressure Level Left Side	Maximum Sound Pressure Level Right Side	Run Valid	Run comment	Acceleration AA'-BB'	Acceleration PP'-BB'	Vehicle Performance	Expected Sound Pressure Level	Vehicle Pass x	Vehicle Pass x + y	Vehicle Fail
Nr	Gear/Nr				I	V _{AA'}	V _{PP'}	V _{BB'}	n _{MAX}	n _{BB'}	L _{LEFT}	L _{RIGHT}	Yes/No		a _{AA'} ,BB'	a _{PP'} ,BB'	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	1/min	dB(A)	dB(A)			m/s²	m/s²	m²/s³	dB(A)			
1																					
2																					
3																					
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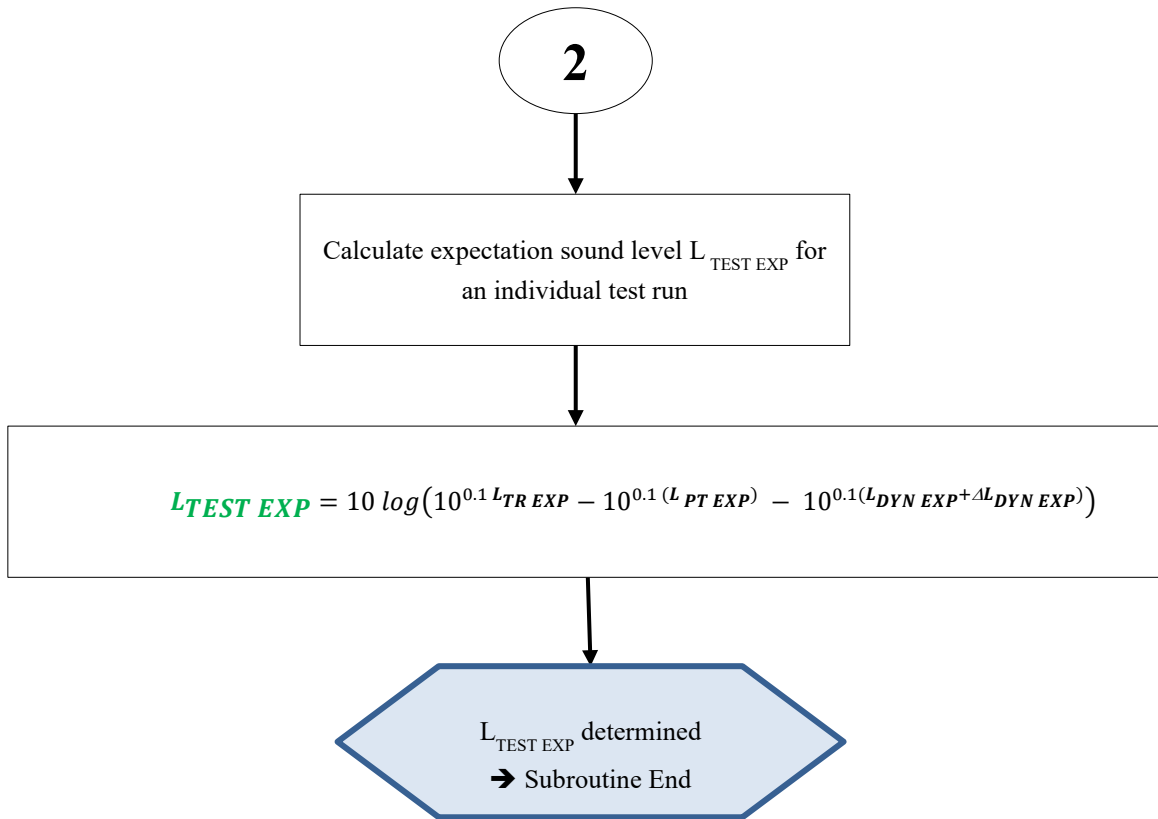
Annex 7 – Appendix 4 – Flowcharts

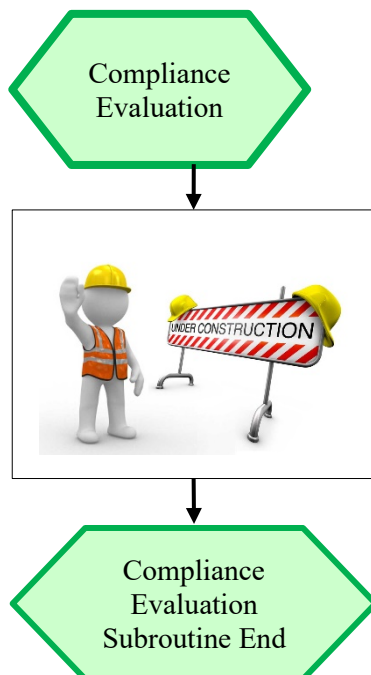


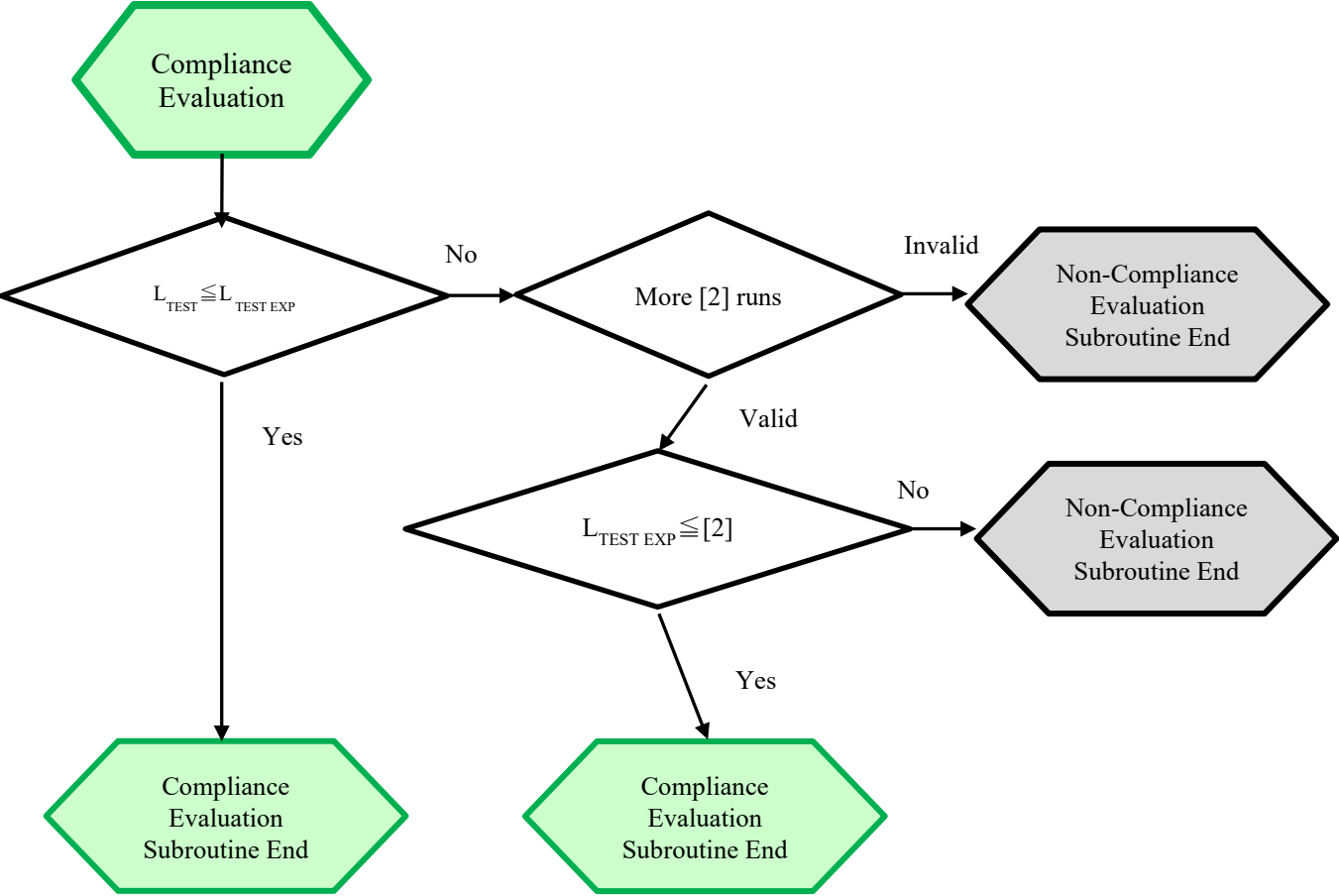


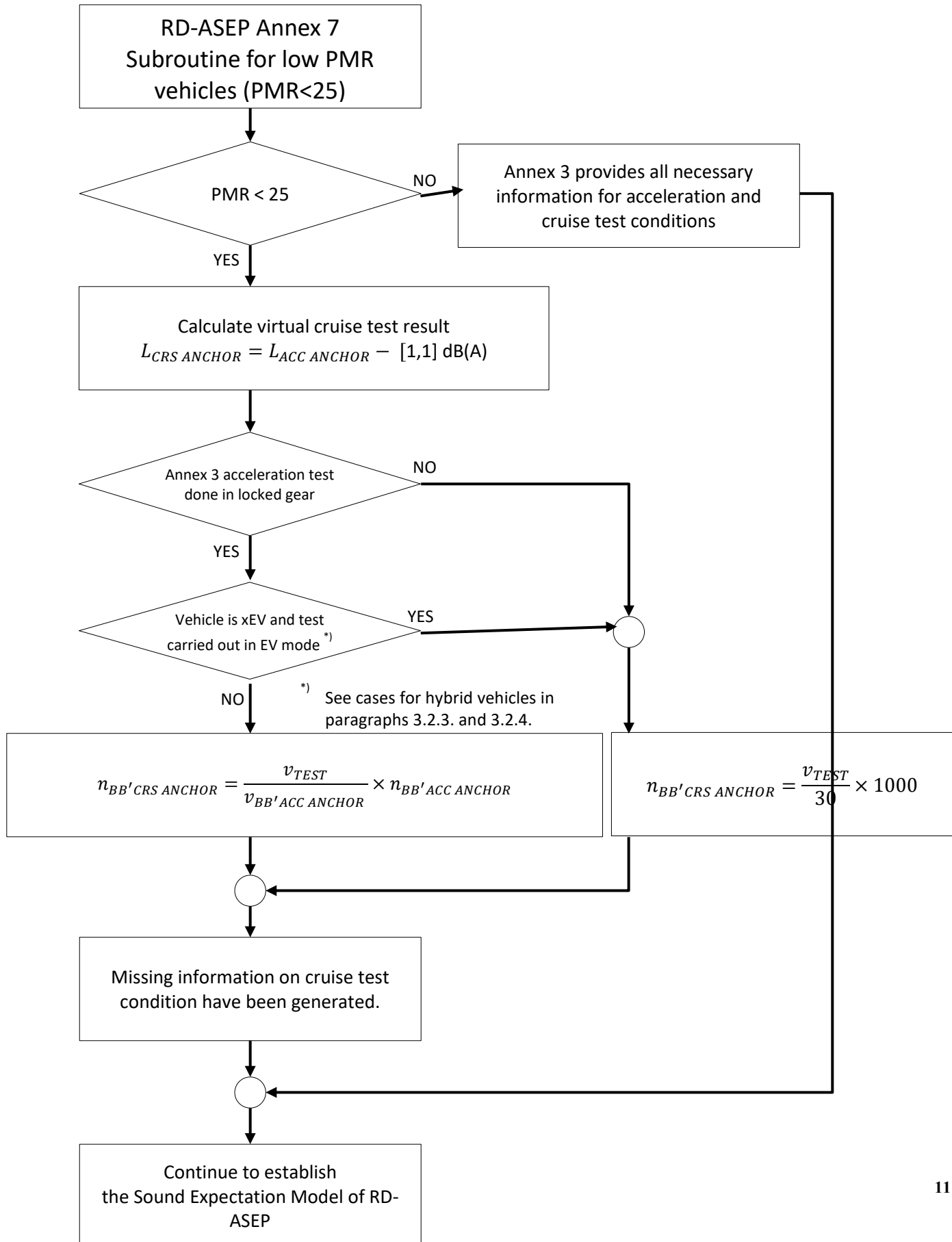












Annex 8

Indoor testing

1. Documentation for indoor application
Documentation shall include:
 - (a) Validation of facility, e.g. free field propagation, dyno and air handling background noise level, dyno dynamic performance, software.
 - (b) Procedures to be applied for indoor testing, e.g. dyno and software set-up, loading and tie-down, air-handling and vehicle's temperature management.
 - (c) Coast down and tyre sound level data used for calculation of dynamometer load coefficients and tyre sound data used for determination of final reported results.
 - (d) Test results on a representative selection of the manufacturer's production to demonstrate that indoor testing delivers comparable results as outdoor testing within acceptable accuracy.
2. Vehicle tested indoor using Variant A **for Annex 3.**
Indoor pass-by test is simulated by measurement of power train sound on the dynamometer and energetical addition of the tyre/road sound (measured separately on an outdoor test track).
 - 2.1. General
This method is a combination of indoor testing (power train sound) and outdoor testing (tyre/road sound). It is not necessary to repeat the measurement of the tyre/road sound every time a vehicle is tested. The data of several tyres can be stored in a database and a matching data set from the database can then be used for the test.
 - 2.2. Power train sound
It shall be ensured that there is no remaining tyre/road sound affecting the measurements. In any case it shall be ensured that the remaining tyre/road sound shall be at least 10 dB below the maximum A-weighted sound pressure level produced by the vehicle under test. If this condition cannot be fulfilled, a correction shall be carried out. This correction procedure is described in ISO 362-3:2016 Annex B, paragraph B.6.
The vehicle shall be measured according to the operating condition specified in paragraphs 3.1.2.1. or 3.1.2.2. of Annex 3 of this Regulation.
 - 2.3. Tyre/road sound
The measurements of the tyre/road sound shall be performed on a test track as described paragraph 2.1.1. of Annex 3 of this Regulation. The evaluation of tyre/road sound consists of two procedures, namely:
 - (a) Evaluation of free rolling sound;
 - (b) Evaluation of tyre/road sound including torque influence which can be derived from a) by a simplified method.

- All conditions for evaluation of tyre/road sound shall be done according to paragraph 3. of this Annex.
- 2.4. Calculation of the total vehicle sound
- The total vehicle sound is the energetical sum of tyre/road sound and power train sound. This calculation shall be carried out for each single run as describe in ISO 362-3:2016, paragraph 10.2.4.
- 2.5. Procedure for measurement, evaluation, and calculation of tyre/road sound when using variant A
- All conditions for evaluation of tyre/road sound, free rolling sound, and torque influence are described in ISO 362-3:2016, Annex B.
3. **Vehicle tested indoor for Annex7**
- 3.1. **General**
- The use of indoor testing for Annex 7 may not require tire/road data gathered on an outdoor track.**
- 3.2. **Measurement method**
- The vehicle shall be measured according to paragraph 3. of Annex 7 of this Regulation.**
- 3.3. **Compliance assessment**
- The compliance of the vehicle shall be followed in paragraph 4. of Annex 7 of this Regulation.**
- 3.4. **Determination of reference data**
- The necessary reference data to establish the sound estimation model are taken from the pass-by and from the cruise-by test of one gear of the Annex 3 tests.**
- 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.**
- These reference data shall be measured in the same indoor facility as measurement of paragraph 3.2 in this Annex.**
4. Adjustment of room dimensions
- To cater for the smaller size test rooms, the maximum levels shall be evaluated with caution though to avoid missing them according to ISO 362-3:2016, Annex E.