

**Economic and Social Council**Distr.: General
11 January 2012

English only

Economic Commission for Europe

Inland Transport Committee

World Forum for Harmonization of Vehicle Regulations**Working Party on Noise****Fifty-fifth session**

Geneva, 7–9 February 2012

Item 3(b) of the provisional agenda

Regulation No. 51 (Noise of M and**N categories of vehicles)–New sound limit values****Proposal for the 03 series of amendments to Regulation
No. 51 (Noise of M and N categories of vehicles)*****Submitted by the experts of the Netherlands and of the International
Organization of Vehicle Manufacturers¹**

The text reproduced below was prepared by the experts of the Netherlands and of the International Organization of Vehicle Manufacturers (OICA) in order to provide a further improvement to the consolidate version of the proposal of 03 series of amendments to Regulation No. 51. This document is based on TRANS/WP.29/GRB/2012/2 incorporating the amendments of two documents without symbol (GRB–54–05 and GRB–54–06) distributed during the forty-fourth session of the working party on noise (see ECE/TRANS/GRB/55, paras. 4 and 24). The modifications to the text of TRANS/WP.29/GRB/2012/2 are marked in bold for new or strikethrough for deleted characters.

* This document was submitted late due to delayed inputs from other sources.

¹ In accordance with the programme of work of the Inland Transport Committee for 2010–2014 (ECE/TRANS/208, para. 106 and ECE/TRANS/2010/8, programme activity 02.4), the World Forum will develop, harmonize and update Regulations in order to enhance the performance of vehicles. The present document is submitted in conformity with that mandate.

I. Proposal

Regulation No. 51

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

Contents

	<i>Page</i>
1. Scope	
2. Definitions	
3. Application for approval	
4. Markings	
5. Approval	
6. Specifications	
7. Modification and extension of approval of a vehicle type	
8. Conformity of production.....	
9. Penalties for non-conformity of production	
10. Production definitely discontinued.....	
11. Transitional provisions.....	
12. Names and addresses of Technical Services responsible for conducting approval tests and of Type Approval Authorities.....	
 Annexes	
1. Communication	
2. Arrangements of the approval mark	
3. Methods and instruments for measuring the noise sound made by motor vehicles	
1. Measuring instruments.....	
1.1. Acoustic measurements	
1.2. Compliance with requirements	
1.3. Calibration of the entire acoustic measurement system for measurement session.....	
1.4. Instrumentation for speed measurements.....	
1.5. Meteorological instrumentation.....	
2. Conditions of measurement	

Annexes

Page

	2.1. Test site and ambient conditions	
	2.2. Vehicle	
	3. Methods of testing	
	3.1. Measurement of sound of vehicles in motion	
	3.2. Measurement of sound emitted by stationary vehicles	
4	Classification of vehicles	
	1. Category L (not applicable for this Regulation)	
	2. Category M – power driven vehicles having at least four wheels and used for the carriage of passengers	
	2.1. Category M ₁	
	2.2. Category M ₂	
	2.3. Category M ₃	
	2.4. Vehicles of category M ₂ and M ₃ belong to	
	2.5. Remarks	
	3. Category N – power driven vehicles having at least four wheels and used for the carriage of goods	
	3.1. Category N ₁	
	3.2. Category N ₂	
	3.3. Category N ₃	
	3.4. Remarks	
5	Silencing systems containing acoustically absorbing fibrous materials	
	1. General	
	1.1. Continuous road operation for 10,000 km	
	1.2. Conditioning on a test bench	
	1.3. Conditioning by pulsation	
6	Compressed air noise sound	
	1. Method of measurement	
	2. Evaluation of the results	
	3. Limiting value	
7	Checks on conformity of production	
	1. General	
	2. Testing procedure	
	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	
	2.2. Compressed air sound	

	2.3.	Additional sound emission provisions	
	3.	Sampling and evaluation of the results	
8		Specifications for the test site	
	1.	Introduction	
	2.	Required characteristics of the surface	
	2.1.	Residual voids content	
	2.2.	Sound absorption coefficient	
	2.3.	Texture depth	
	2.4.	Homogeneity of the surface	
	2.5.	Period of testing	
	3.	Test surface design	
	3.1.	Area	
	3.2.	Design and preparation of the surface	
	4.	Test method	
	4.1.	Measurement of the residual voids content	
	4.2.	Sound absorption coefficient	
	4.3.	Volumetric macro texture measurement	
	5.	Stability in time and maintenance	
	5.1.	Age influence	
	5.2.	Maintenance of the surface	
	5.3.	Repaving the test area	
	6.	Documentation of the test surface and of tests performed on it	
	6.1.	Documentation of the test surface	
	6.2.	Documentation of vehicle sound tests conducted on the surface	
9		Symbols used	
10		Measuring method to evaluate compliance with the additional sound emission provisions.....	
11		Example for measurement procedure for vehicles of category $M_1, N_1, M_2 \leq 3500$ kg	
12		Example for measurement procedure for vehicles of category $M_2 > 3500$ kg, N_2, N_3, M_3	

1. Scope

This Regulation contains provisions relating to the **noise sound** emitted by motor vehicles of categories M and N. ²

The specifications in this Regulation are intended to reproduce the **noise sound** levels which are generated by vehicles during normal driving in urban 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 **noise sound**;
- 2.2. "*Vehicle type*" means motor vehicles which do not differ essentially in such respects as:
 - 2.2.1. The shape or materials of the bodywork (particularly the engine compartment and its soundproofing);
 - 2.2.2. The length and width of the vehicle;
 - 2.2.3. 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 carburetors or injection system, arrangement of valves, rated maximum power and corresponding engine speed(s), or the type of electric motor;
 - 2.2.4. The transmission system, the number of gears and ratios;
 - 2.2.5. The **noise sound** reduction system as defined in the following paragraphs 2.3. and 2.4.
 - 2.2.6. Notwithstanding the provisions of paragraphs 2.2.2. and 2.2.4., vehicles other than those in categories M₁ and N₁¹ having the same type of engine and/or different overall gear ratios, may be regarded as vehicles of the same type. However, if the above differences provide for a different test method, these differences are to be considered as a change of type.
- 2.3. "*Noise sound reduction system*" means a complete set of components necessary for limiting the **noise sound** made by a motor vehicle and its exhaust;
- 2.4. "*Noise sound reduction systems of different types*" means noise reduction systems which differ in such essential respects as:

That their components as specified in paragraph 4.1., bear different trade names or marks;

That the characteristics of the materials constituting a component are different or that the components differ in shape or size, a change in the

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

plating procedure (galvanization, aluminium coating, etc.) is not deemed to produce a difference of type;

That the operating principles of at least one component are different;

That their components are assembled differently;

That the number of the intake and/or exhaust silencers is different.

- 2.5. "~~Noise sound~~ *reduction system component*" means one of the individual parts which together form the **noise sound** reduction system.

Such—components include, but are not limited to: the intake and exhaust pipes, the expansion chamber(s), the silencer itself, the components of acoustic insulating capsule (screen). Manifolds are not considered component of the **noise** reduction system.

- 2.6. "*Maximum authorized mass*" of the vehicle is defined as the kerb mass plus maximum authorized payload.

- 2.7. "*Kerbmass of a vehicle in running order (m_{kerb})*" means the mass of an unladen vehicle with bodywork, and with coupling device in the case of a towing vehicle, or the mass of the chassis with cab if the manufacturer does not fit the bodywork and/or coupling device, including coolant, oils, 90 per cent of fuel, 100 per cent of other liquids except used waters, tools, spare wheel, driver (75 kg) and, for buses and coaches, the mass of the crew member (75 kg) if there is a crew seat in the vehicle.

- 2.8. "*Mass of a vehicle in running order (m_{rv})*" means the mass of an unladen vehicle with bodywork and with a coupling device in the case of a towing vehicle, or the mass of the chassis with cab if the manufacturer does not fit the bodywork and/or coupling device, including coolant, oils, 90 per cent of fuel, 100 per cent of other liquids except used waters, tools, spare wheel, driver (75 kg) and, for buses and coaches, the mass of the crew member (75 kg) if there is a crew seat in the vehicle.

- 2.9. "*Rated engine power (P_n)*" means the **combustion** engine power expressed in kW (ECE) and measured by the ECE method pursuant to Regulation No. 85

- 2.9.1. **Calculation of total engine power for hybrid vehicles**

If the vehicle is equipped with two or more sources of propulsive power, which can operate simultaneously, they shall do so at the conditions of tests specified in this regulation. Applicable parallel propulsive engines are those power sources which provide forward motion to the vehicle in combination at the conditions of test specified in this regulation. The total engine power P_n , used for the calculation of the power to mass ratio and target acceleration, shall be the arithmetic sum of parallel propulsive engines on the vehicle. Specified power for non-combustion engines shall be the power stated by the manufacturer. The intent of this paragraph is to insure that vehicles with 2 or more sources of propulsive power which can operate at the same time in a parallel fashion, i.e. hybrid vehicles, use the sum of available electric and combustion power.

- 2.9.2. **Battery state of charge**

If so equipped, propulsion batteries shall have a state-of-charge sufficiently high to enable all key functionalities per the manufacturer's specifications. Propulsion batteries shall be within their component-temperature window to enable all key functionalities. Any other type of

rechargeable energy storage system shall be ready to operate during the test

- 2.10. "Rated engine speed, S " means the declared **combustion** engine speed in min^{-1} (rpm) at which the engine develops its rated maximum net power pursuant to Regulation No. 85. If the rated maximum net power is reached at several engine speeds, the highest engine speed shall be used.
- 2.11. "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 ~~according to the equation:~~
- $$\text{PMR} = \frac{P_n}{m_t} \times 1000 \text{ kg/kW}$$
- 2.12. "Reference point" means a point depending on the design and category of the vehicle.
- 2.12.1. Category $M_1, M_2 \leq 3,500 \text{ kg}, N_1$:
- For front engine vehicles: the front end of the vehicle;
 - For mid engine vehicles: the centre of the vehicle;
 - For rear engine vehicles: the rear end of the vehicle.
- 2.12.2. Category $M_2 > 3,500 \text{ kg}, M_3, N_2, N_3$
- for front engine vehicle, it is the front end of the vehicle;**
 - for all other vehicles, it is the border of the engine closest to the front to the vehicle.**
- 2.13. "Engine" means the power source without detachable accessories.
- 2.14. "Target acceleration" means an acceleration at a partial throttle condition in urban traffic and is derived from statistical investigations.
- 2.15. "Reference acceleration" means the required acceleration during the acceleration test on the test track.
- 2.16. "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.
- 2.17. "Partial power factor kp " 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.
- 2.18. "Pre-acceleration" means application of acceleration control device prior to AA' for the purpose of achieving stable acceleration between AA' and BB'.
- 2.19. "Locked gear ratios" means the control of transmission such that the transmission gear cannot change during a test.
- 2.20. "Design family of silencing system or silencing system components"
- Silencing systems or components thereof belong to the same design family if all of the following characteristics are the same:
- The exhaust gases in contact with the absorbing fibrous material have net gas flow through this material: (yes or no);

- (b) The type of the fibres (e.g. basalt wool, biosil wool, glass wool, Etype wool, etc.);
- (c) Binder material specifications (if applicable);
- (d) Average fibre dimensions (thickness, length);
- (e) Minimum bulk material packing density (kg/m³);
- (f) Maximum contact surface between the gas flow and the absorbing material (e.g. perforation open area).

3. Application for approval

- 3.1. The application for approval of a vehicle type with regard to **noise sound** shall be submitted by its manufacturer or by his duly accredited representative.
- 3.2. It shall be accompanied by the under mentioned documents and the following particulars:
 - (a) 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;
 - (b) a list of the components, duly identified, constituting the **noise sound** reduction system;
 - (c) drawings of the assembled **noise sound** reduction system and an indication of its position on the vehicle;
 - (d) drawings and part numbers of each component to enable it to be easily located and identified, and a specification of the materials used.
- 3.3. In the case of paragraph 2.2.6. 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, as that with the lowest mass in running order with the shortest length and following the specification laid down in Annex 3.
- 3.4. If the methods described in paragraph 3. or 4. of Annex 5 are used, the technical service conducting approval tests may request , the vehicle manufacturer to submit the intake and exhaust pipes, the expansion chamber(s)and the silencer itself and an engine of at least the same cylinder capacity and rated maximum power or at least equivalent in terms of air/gas flow as that fitted to the vehicle in respect of which type-approval is sought.

4. Markings

- 4.1. The components of the **noise sound** reduction system, excluding fixing hardware and piping, shall bear:
 - 4.1.1. The trade name or mark of the manufacturer of the **noise sound** reduction system and of its components; and
 - 4.1.2. The manufacturer's trade description;
- 4.2. These markings shall be clearly legible and be indelible even after fitting.

5. Approval

- 5.1. If the vehicle type submitted for approval pursuant to this Regulation
- 5.2. An approval number shall be assigned to each type approved. Its first two digits - (at present 03 corresponding to the 03 series of amendments which entered into force on [dd.mm.yyyy] 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 may not assign the same number to the same vehicle type equipped with another type of **noise sound** reduction system or to another vehicle type.
- 5.3. Notice of approval or of extension or of refusal or withdrawal of approval or of production definitely 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:
 - (a) a circle surrounding the letter "E" followed by the distinguishing number of the country which has granted approval³;
 - (b) the number of this Regulation, followed by the letter "R", a dash and the approval number to the right of the circle prescribed in this paragraph.
- 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. needs 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.
- 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.
- 5.9. The test report (see Annex 1) shall at least include the following information:
 - (a) details of the test site (e.g. surface temperature, **reference to compliance report of test site** ~~absorption coefficient~~, etc.), test site location, site orientation and weather conditions including wind speed and air temperature, direction, barometric pressure, humidity;
 - (b) the type of measuring equipment including the windscreen;

³ The distinguish numbers of the Contracting Parties to the 1958 Agreement are reproduced in Annex 3 to Consolidated Resolution on the Construction of Vehicles (R.E.3), document ECE/TRANS/WP.29/78/Rev.2.

- (c) the A-weighted sound pressure level typical of the background noise;
- (d) the identification of the vehicle, its engine, its transmission system, including available transmission ratios, size and type of tyres, tyre pressure, tyre production type, power, test mass, power to mass ratio index, a wot ref, a urban, vehicle length and location of the reference point; the transmission gears or gear ratios used during the test;
- (e) the vehicle speed and engine speed at the beginning of the period of acceleration and the location of the beginning of the acceleration;
- (f) the vehicle speed and engine speed at PP' and at end of the acceleration;
- (g) method used for calculation of the acceleration;
- (h) intermediate measurement results per gears used:
 - point of depressing accelerator,
 - a_{wot} ,
 - L_{wot} ,
 - L_{cruise}
- (i) final measurement results:
 - k_p
 - k
 - L_{urban}
- (j) the auxiliary equipment of the vehicle, where appropriate, and its operating conditions;
- (k) all valid A-weighted **noise sound** pressure level values measured for each test, listed according to the side of the vehicle and the direction of the vehicle movement on the test site;
- (l) measurement results from compressed air **noise sound** tests for each side of the vehicle
 - and all relevant information necessary to obtain the different **noise sound** emission levels.

6. Specifications for noise levels

6.1. General specifications

The vehicle, its engine and its **noise** 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.

In addition the **noise** 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.

In the case of an exhaust system containing fibrous materials, the requirements of Annex 5 shall be applied.

6.2. Specifications regarding **noise sound** levels

6.2.1. Methods of measurement

The **noise sound** made by the vehicle type submitted for approval shall be measured by the methods described in Annex 3 to this Regulation for the vehicle in motion and for the vehicle when stationary⁴; in the case of a vehicle powered by an electric motor, the emitted **noise sound** shall only be measured in motion.

Vehicles having a maximum permissible mass exceeding 2,800 kg shall be subjected to an additional measurement of the compressed air **noise sound** with the vehicle stationary in accordance with the specifications of Annex 6, if the corresponding brake equipment is part of the vehicle. The values measured in decibels, mathematically rounded to the nearest integer value, shall be recorded in the test report and the test results on a form conforming to the model.

The values measured as specified in paragraph 6.2.1.1. above must be recorded in a test report and a certificate corresponding to the model shown in Annex 1.

[6.2.2. **Noise sound** level limits

6.2.2.1. Subject to the provisions of paragraph 6.2.2.2. below, the noise level of vehicle types, as reported by the method described in paragraph 3.1. of Annex 3 to this Regulation, shall not exceed the following limits:

Vehicle categories	Limit values (dB(A))
6.2.2.1.1. Vehicles used for the carriage of passengers and capable of having not more than nine seats, including the driver's seat	74
6.2.2.1.2. Vehicles used for the carriage of passengers having more than nine seats, including the driver's seat, and a maximum authorized mass of more than 3.5 tonnes	
6.2.2.1.2.1. with an engine power less than 150 kW (ECE)	78
6.2.2.1.2.2. with an engine power of 150 kW (ECE) or above	80
6.2.2.1.3. Vehicles used for the carriage of passengers having more than nine seats, including the driver's seat; vehicles used for the carriage of goods	
6.2.2.1.3.1. with a maximum authorized mass not exceeding 2 tonnes	76
6.2.2.1.3.2. with a maximum authorized mass greater than 2 tonnes but not exceeding 3.5 tonnes	77
6.2.2.1.4. Vehicles used for the transport of goods with a maximum authorized mass exceeding 3.5 tonnes	
6.2.2.1.4.1. with an engine power less than 75 kW (ECE)	77
6.2.2.1.4.2. with an engine power of 75 kW (ECE) or above but less than 150 kW (ECE)	78

⁴ 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 categories	Limit values (dB(A))
6.2.2.1.4.3. with an engine power of 150 kW (ECE) or above	80

6.2.2.2. However,

6.2.2.2.1. For the vehicle types mentioned in paragraphs 6.2.2.1.1. and 6.2.2.1.3. equipped with a compression ignition and direct injection internal combustion engine, the limit values shall be increased by 1 dB(A);

6.2.2.2.2. For vehicle types designed for off-road⁵ use and with a maximum authorized mass above 2 tonnes, the limit values shall be increased:

6.2.2.2.2.1. By 1 dB(A) if they are equipped with an engine having a power of less than 150 kW (ECE);

6.2.2.2.2.2. By 2 dB(A) if they are equipped with an engine having a power of 150 kW (ECE) or above.

6.2.2.2.3. For vehicle types mentioned in paragraph 6.2.2.1.1. fitted with a gear box having more than four forward gears, equipped with an engine developing a maximum power greater than 140 kW (ECE) and having a maximum-power/maximum-mass ratio greater than 75 kW/t, the limit values shall be increased by 1 dB(A), if the speed at which the rear of the vehicle passes the line BB' in third gear is greater than 61 km/h.]

6.2.3. Additional sound emission provisions.

The additional sound emission provisions (ASEP) apply only to vehicles of categories M₁ and N₁ equipped with an internal combustion engine.

Vehicles are deemed to fulfil the requirements of Annex 10, if the vehicle manufacturer provides technical documents to the type approval authority showing, that the difference between maximum and minimum engine speed of the vehicles at BB' for any test condition inside the ASEP control range defined in paragraph 3.3. of Annex 10 to this Regulation (including Annex 3 conditions) does not exceed 0.15 x S. This article is intended especially for non-lockable transmissions with variable gear ratios (CVT).

Vehicles of category N₁ are exempted from ASEP if one of the following conditions is fulfilled:

- (a) The engine capacity is not exceeding 660 ccm and the power-to-mass ratio PMR calculated by using the maximum authorized vehicle mass is not exceeding 35.
- (b) The payload is at least 850 kg and the power-to-mass ratio PMR calculated by using the maximum authorized vehicle mass is not exceeding 40.

The additional ~~noise sound~~ noise emission provisions are preventive requirements. The purpose of these requirements is to ensure that the ~~noise sound~~ noise emission of the vehicle under typical driving conditions different from the conditions of the type approval test in Annex 3 shall not deviate considerably from what can be expected from the Annex 3 test result for this specific vehicle.

⁵ As defined in the Consolidated resolution on the Construction of vehicles (R.E.3), document ECE/TRANS/WP.29/78/Rev.2, para.2.

- 6.2.3.1. The vehicle manufacturer shall not intentionally alter, adjust, or introduce any mechanical, electrical, thermal, or other device or procedure solely for the purpose of fulfilling the noise emission requirements as specified in this Regulation and as determined by the test procedure of Annex 3 but which will not be operational during typical on-road operation under conditions applicable to ASEP. These measures are commonly referred to as "cycle detection".
- 6.2.3.2. The vehicle shall meet the requirements of Annex 10 to this Regulation.
- 6.2.3.3. In the application for type approval the manufacturer shall provide a statement (in conformity with ~~the~~ Appendix 4 of Annex 10) that the vehicle type to be approved complies with the requirements of paragraph 6.2.3. of this Regulation.
- 6.3. Specifications regarding exhaust systems containing fibrous materials
- ~~6.3.1.~~ The requirements of Annex 5 shall be ~~met~~ 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 department may then either:
- 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
- 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 Contracting Parties to the Agreement applying this Regulation.
- 7.3. The competent 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

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

- 8.1. Vehicles approved according to this Regulation shall be so manufactured as to conform to the type approved by meeting the requirements set forth in paragraph 6 above. The limit values set forth in paragraph 6. and referenced appendices apply with an additional margin of 1 dB(A).
- 8.2. The minimum requirements for conformity of production control procedures set forth in Annex 7 to this Regulation shall be complied with

- 8.3. The authority which has granted type-approval may at any time verify the conformity control methods applied in each production facility. The normal frequency of these verifications shall be one every two years.

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 definitely 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 03 series of amendments, no Contracting Party applying this Regulation shall refuse to grant ECE approval under this Regulation as amended by the 03 series of amendments.
- 11.2. As from the official date of entry into force of the 03 series of amendments, Contracting Parties applying this Regulation may not refuse first national registration (first entry into service) of a vehicle which does meet the requirements of the 03 series of amendments to this Regulation.
- 11.3. [x] years after official entry into force, Contracting Parties applying this Regulation shall grant ECE approvals only if the vehicle type to be approved meets the requirements of the 03 series of amendments to this Regulation.
- 11.4. [x] after official entry into force, Contracting Parties applying this Regulation may refuse first national registration (first entry into service) of a vehicle which does not meet the requirements of the 03 series of amendments to this Regulation.
- 11.5. For the first five years after the official entry into force of the 03 series of amendments to this Regulation, vehicles with a serial hybrid drive train which have an additional combustion engine with no mechanical coupling to the power train are excluded from the requirements of paragraph 6.2.3.

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:⁷ APPROVAL GRANTED
 APPROVAL EXTENDED
 APPROVAL REFUSED
 APPROVAL WITHDRAWN
 PRODUCTION DEFINITELY DISCONTINUED

of a vehicle type with regard to its ~~noise~~ ~~sound~~ emission pursuant ECE to Regulation No. 51

Approval No. Extension No.

1. Trade name or mark of the vehicle:
2. Vehicle type:
- 2.1. Maximum permissible mass including semi-trailer (where applicable)

3. Manufacturer's name and address
4. If applicable, name and address of manufacturer's representative

5. Engine:
 - 5.1. Manufacturer:
 - 5.2. Type:
 - 5.3. Model:
 - 5.4. Rated maximum power (ECE): kW at rev/min.
 - 5.5. Kind of engine: e.g. positive-ignition, compression ignition, etc.⁸

⁶ Distinguishing numed/withdrawn approval (see approval provisions in the Regulation).
⁷ Delete what does not apply
⁸ If a non-conventional engine is used, this should be stated.
~~[4 The measurement values are given with the 1 dB(A) deduction in accordance with the provisions of paragraph 6.2.2.1.]~~

-
- 5.6. Cycles: two stroke or four-stroke (if applicable)
- 5.7. Cylinder capacity (if applicable).....
6. Transmission: non-automatic gearbox/automatic gearbox²
- 6.1. Number of gears
7. Equipment:
- 7.1. Exhaust silencer:
- 7.1.1. Manufacturer or authorized representative (if any)
- 7.1.2. Model:
- 7.1.3. Type: in accordance with drawing No.:
- 7.2. Intake silencer:
- 7.2.1. Manufacturer or authorized representative (if any)
- 7.2.2. Model:
- 7.2.3. Type: in accordance with drawing No.:
- 7.3. Elements of capsulation
- 7.3.1. Elements of ~~noise sound~~ encapsulation as defined by the vehicle manufacturer
- 7.3.2. Manufacturer or authorized representative (if any)
- 7.4. Tyres
- 7.4.1. Tyre size(s) (by axle):
8. Measurements:
- 8.1. Length of the vehicle (lveh):mm
- 8.2. Point of accelerator depression:m before line AA'
- 8.2.1. Engine speed in gear i at: AA' / PP' 2/ min-1 (rpm)
BB' min-1 (rpm)
- 8.2.2. Engine speed in gear (i+1) at: AA' / PP' 2/ min-1 (rpm)
BB' min-1 (rpm)
- 8.3. Type approval number of tyre(s):
- if not available, the following information shall be provided:
- 8.3.1. Tyre manufacturer
- 8.3.2. Commercial description(s) of the type of tyre (by axle), (e.g. trade name, speed index, load index):
- 8.3.3. Tyre size (by axle):
- 8.3.4. Type approval number (if available):
- 8.4. Noise noise level of moving vehicle:
- Test result (lurban):.....dB(A)

- Test result (lwot):.....dB(A)
- Test result (lcruise):dB(A)
- kp – factor:.....
- 8.5. **Noise level of stationary vehicle:**
 Position and orientation of microphone (according to figure 2 in the appendix of Annex 3)
- 8.6. **Noise level of compressed air noise:**
Test result for
 (a) **service brake:**dB(A)
 (b) **parking brake:**dB(A)
 (c) **during the pressure regulator actuation:**.....dB(A)
- 9. Vehicle submitted for approval on:.....
- 10. Technical Service responsible for type-approval tests:.....

- 11. **Number and date** ~~Date~~ of test report issued by that service:
- ~~12. Number of test report issued by that service:.....~~
- 12. **Number and date of report verifying the compliance of the test track with the requirements in Annex 8:**
- 13. Position of approval mark on the vehicle
- 14. Place:
- 15. Date:
- 16. Signature:.....
- 17. The following documents, bearing the approval number shown above, are annexed to this document:

 drawings and/or photographs, diagrams and plans of the engine and of the noise reduction system;
 list of components, duly identified constituting the noise reduction system.
- 18. Reason for extension of approval :
- 19. Remarks:.....

Annex 2

Arrangements of the approval mark

Model A

(See paragraph 5.4. of this Regulation)

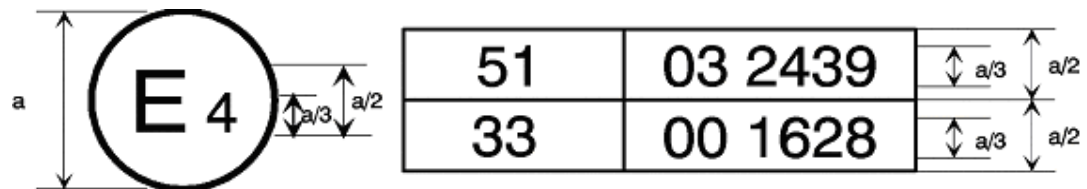


a = 8 mm min.

The above approval mark affixed to a vehicle shows that the vehicle type concerned has, with regard to its ~~noise sound~~ emission, been approved in the Netherlands (E 4) pursuant to Regulation No. 51 under approval No. 03 2439. The first two digits of the approval number indicate that Regulation No. 51 already included the 03 series of amendments when the approval was granted.

Model B

(See paragraph 5.5. of this Regulation)



a = 8 mm

min.

The above approval mark affixed to a vehicle shows that the vehicle type concerned has been approved in the Netherlands (E 4) pursuant to Regulations Nos. 51 and 33.⁹ The approval numbers indicate that, at the dates when the respective approvals were granted, Regulation No. 51 included the 03 series of amendments while Regulation No. 33 was in its original form.

⁹ The latter number is given as an example only.

Annex 3

Methods and instruments for measuring the noise sound made by motor vehicles

1. Measuring instruments

1.1. Acoustic measurements.

The apparatus used for measuring the **noise** level must 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: Precision sound level meters", second edition, of the International Electrotechnical Commission (IEC).

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".

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 with the instructions of the instrument manufacturer.

1.2. 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 must be conducted by a laboratory, which is authorized to perform calibrations traceable to the appropriate standards.

1.3. Calibration of the entire acoustic measurement system for measurement session.

At the beginning and at the end of every measurement session the entire acoustic measurement system shall be checked by means of a sound calibrator that fulfils the requirements for sound calibrators of at least precision Class 1 according to IEC 60942:2003942:1988. Without any further adjustment the difference between the readings of two consecutive checks shall be less than or equal to 0.5 dB.

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

1.4. Instrumentation for speed measurements

The rotational speed of the engine 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 ± 0.2 km/h when using continuous measurement devices.

If testing uses independent measurements of speed, this instrumentation must 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) a temperature measuring device, $\pm 1^\circ\text{C}$;
- (b) a wind speed-measuring device, ± 1.0 m/s
- (c) a 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 test site shall be substantially level. The surface of the test track shall be dry. The surface of the site shall be in accordance with the provisions given in Annex 8 to this Regulation. The test site shall be such that when a small omnidirectional sound source is placed on its surface at the central point (intersection of the microphone line PP' and the centre line of the vehicle lane CC') as shown in Figure 1 of Annex 8, deviations from hemispherical acoustic divergence shall not exceed ± 1 dB.~~

~~This condition is deemed to be satisfied if the following requirements are met:~~

The surface of the test track shall meet the provisions of Annex 8 to this Regulation. In the document describing the vehicle noise test(s), it shall be stated whether all the requirements of Annex 8 were fulfilled or not. Reference shall be given to (a document according to chapter 5 of Annex 8.

- ~~(a)~~—Within a radius of 50 m from the centre of the track the space **shall be** free of large reflecting objects such as fences, rocks, bridges or buildings.
- ~~(b)~~—The test track and the surface of the site **shall be** dry and free from absorbing materials such as powdery snow, or loose debris.
- ~~(c)~~—In the vicinity of the microphone, there are **shall be** no obstacles that could influence the acoustical field, ~~and~~ No person is **shall be** positioned between the microphone and the sound source. ~~The A meter observer is~~ **shall be** positioned so as not to influence the meter reading.

Measurements shall not be made under adverse weather conditions. It must 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 $1.2 \text{ m} \pm 0.02 \text{ m}$. The measurements shall be made when the ambient air temperature is within the range from 5°C to 40°C .

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

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

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

The background noise shall be measured for a 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 below the A-weighted sound pressure level produced by the vehicle under test.

The following correction shall be applied to the individual measured test value.

<i>10</i>	<i>11</i>	<i>12</i>	<i>13</i>	<i>14</i>	<i>>14</i>
-0,5	-0,4	-0,3	-0,2	-0,1	0,0

2.2. Vehicle

2.2.1. The vehicle shall be representative of vehicles to be put on the market as specified by the manufacturer. Measurements shall be made without any trailer, except in the case of non-separable vehicles. Measurements shall be made on vehicles at the test mass m_t specified according to the following table:

<i>Vehicle Category</i>	<i>Vehicle Test Mass</i>
M₁	$m_t = m_{kerb} + 75$ kg for the driver The test mass shall be achieved with a tolerance of ± 5 per cent.
N₁	$m_t = m_{kerb} + 75$ kg for the driver The test mass shall be achieved with a tolerance of ± 5 per cent.
N₂, N₃	<p>$m_{target} = 50$ kg per kW rated power</p> <p>Extra loading to reach the target mass of the vehicle shall be placed above the rear axle.</p> <p>The sum of the extra loading and the unladen rear axle load, is limited to 75 % of the maximum axle capacity, $m_{ac ra max}$, allowed for the rear axle. The target mass shall be achieved with a tolerance of ± 5 %.</p> <p>If the centre of gravity of the extra loading cannot be aligned with the centre of the rear axle, the test mass of the vehicle shall not exceed the sum of the unladen front axle load and the unladen rear axle load plus the extra loading and the mass of driver.</p>

<i>Vehicle Category</i>	<i>Vehicle Test Mass</i>
	<p>The test mass for vehicles with more than two axles shall be the same as for a two-axle vehicle.</p> <p>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.</p>
M₂, M₃	m_t = m_{r0} The test mass in running order shall be achieved with a tolerance of ± 5 per cent.

- 2.2.2. 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 Annex 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.¹⁰ The tyres shall be inflated to the pressure recommended by the vehicle manufacturer for the test mass of the vehicle. The tyres shall have a tread depth of at least 80 per cent of the full tread depth.
- 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, the exhaust system is to be conditioned before the test according to Annex 5.
3. Methods of testing
- 3.1. Measurement of ~~sound~~ **noise** of vehicles in motion
- 3.1.1. General conditions of test
- Two lines, AA' and BB', parallel to line PP' and situated respectively 10 m forward and 10 m rearward of line PP' shall be marked out on the test runway (see ~~appendix Annex 8~~, figure 1)
- 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 microphone shall be located at a distance of 7.5 m ± 0.052 m from the reference line CC' (~~Annex 8~~, appendix, Figure 1) of the track and 1.2 m ± ~~2~~ ± 0.024 m above the ground.

¹⁰ The tyre contribution for overall sound emission being important, this Regulation has taken into account the tyre/road **noise** emission regulations. Traction tyres, snow tyres and special use tyres according to UNECE Regulation No. 117 shall be excluded during type-approval- and COP-measurements on request of the manufacturer.

The reference axis for free field conditions (see IEC 61672-1:2002) 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, M₂ ≤ 3,500 kg, N₁

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' (see **appendix**, Figure 1 of ~~Annex 8~~). If the vehicle is fitted with more than two-wheel drive, test it in the drive selection which is intended for normal road use.

If the vehicle is fitted with an auxiliary manual transmission or a multi-gear axle, the position used for normal urban driving shall be used. In all cases, the gear ratios for slow movements, parking or braking shall be excluded.

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 ± 1 km/h. The test speed must be reached, when the reference point is at line PP'. **If the test speed is modified according to 3.1.2.1.4.1., 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 a **dimensionless index** defined as follows:

$$\text{PMR} = (P_n / m_v) * 1000 \text{ kg/kW}$$

The power to mass ratio index (PMR) is used in this standard for the calculation of acceleration.

3.1.2.1.2. Calculation of acceleration

All accelerations in this paper are calculated using different speeds of the vehicle on the test track (see ~~Annex 8~~ **appendix**, figure 1). The formulas given are used for the calculation of $a_{\text{wot } i}$, $a_{\text{wot } i+1}$ and $a_{\text{wot test}}$. The speed either at AA' or PP' is defined as the vehicle speed when the reference point passes AA' ($v_{\text{AA}'}$) or PP' ($v_{\text{PP}'}$). The speed at BB' is defined when the rear of the vehicle passes BB' ($v_{\text{BB}'}$) **or the front of the vehicle passes BB' +5m($v_{\text{BB}'}$)**. 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 is considered differently in the formula below. If the reference point is in the front of the vehicle, then $l = l_{\text{veh}}$, mid: $l = \frac{1}{2} l_{\text{veh}}$ and rear: $l = 0$. **At the choice of vehicle manufacturer, front engine vehicles may use $l_{\text{veh}}=5\text{m}$, and mid-engine vehicles may use $l_{\text{veh}}=2.5\text{m}$.**

Acceleration calculations are applicable to M₁, N₁ and M₂ < 3,500 kg categories only.

3.1.2.1.2.1. Calculation procedure for vehicles with manual transmission, automatic transmission, adaptive transmissions and CVTs tested with locked gear ratios:

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

$a_{\text{wot test}}$ used in the determination of gear selection shall be the average of the four $a_{\text{wot test}, i}$ during each valid measurement run.

Pre-acceleration may be used ~~[review data]~~. The location of depressing the accelerator shall be reported in the communication form (Annex 1).

- 3.1.2.1.2.2. Calculation procedure for vehicles with automatic transmissions, adaptive transmissions and CVTs tested with non-locked gear ratios.

awot test used in the determination of gear selection shall be the average of the four awot test_i during each valid measurement run.

If devices or measures, as described in paragraph 3.1.2.1.4.2., can be used to control transmission operation for the purpose of achieving test requirements, calculate awot test using the equation:

$$a_{\text{wot test}} = ((v_{\text{BB}}/3,6)^2 - (v_{\text{AA}}/3,6)^2) / (2*(20+1))$$

Pre-acceleration may be used.

If no devices or measures, as described in paragraph 3.1.2.1.4.2., are used, calculate awot test using the equation:

$$a_{\text{wot test PP-BB}} = ((v_{\text{BB}}/3,6)^2 - (v_{\text{PP}}/3,6)^2) / (2*(10+1))$$

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. It is a function depending on the power-to-mass ratio index (PMR) of a vehicle.

The target acceleration a_{urban} is defined by

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

- 3.1.2.1.2.4. Reference acceleration

The reference acceleration a_{wot ref} defines the required acceleration during the accelerated 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_{wot ref} is defined by:

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

$$a_{\text{wot ref}} = a_{\text{urban}} = 0.63 * \log_{10}(\text{PMR}) - 0.09 \quad \text{for PMR} < 25$$

- 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 M₁ and N₁.

In cases other than a single gear test a_{wot ref} has to be used instead of awot 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_{wot} under full throttle condition, according to the reference acceleration a_{wot ref} required for the full throttle acceleration test.

Some vehicles may have different software programs or modes for the transmission (e.g. sporty, winter, adaptive etc.). If the vehicle has different modes leading to valid accelerations, the vehicle manufacturer has to prove to the satisfaction of the technical service, that the vehicle is tested in the mode which achieves an acceleration being closest to $a_{wot\ ref}$.

The vehicle transmission, gear, or gear ratio, shall be chosen to provide acceleration nearest to $a_{wot\ ref}$ according to 3.1.2.1.4.1. and 3.1.2.1.4.2.. The vehicle transmission, gear, or gear ratio may be controlled by electronic or mechanical measures including exclusion of kick-down function.

3.1.2.1.4.1. Manual transmission, automatic transmissions, adaptive transmissions or transmissions with variable gear ratios (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 $a_{wot\ ref}$, not exceeding $3.0\ m/s^2$, 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 $3.0\ m/s^2$, use both gear ratios for the test. The weighting ratio in relation to the reference acceleration $a_{wot\ ref}$ is calculated by:

$$k = (a_{wot\ ref} - a_{wot\ (i+1)}) / (a_{wot\ (i)} - a_{wot\ (i+1)})$$

- (c) if the acceleration value of gear ratio i exceeds $3.0\ m/s^2$, the first gear ratio shall be used that gives an acceleration below $3.0\ m/s^2$ unless gear ratio $i+1$ provides acceleration less than a_{urban} . In this case, two gears, i and $i+1$ shall be used, including the gear i with acceleration exceeding $3.0\ m/s^2$. In other cases, no other gear shall be used. The achieved acceleration $a_{wot\ test}$ during the test shall be used for the calculation of the part power factor k_p instead of $a_{wot\ ref}$.
- (d) If the vehicle has a transmission in which there is only one selection for the gear ratio the acceleration test is carried out in this vehicle gear selection. The achieved acceleration is then used for the calculation of the part power factor k_p instead of $a_{wot\ ref}$.
- (e) If rated engine speed is exceeded in a gear ratio before the vehicle passes BB' the next higher gear shall be used.
- (f) **If the next higher gear results in an acceleration below a_{urban} , the vehicle test speed v_{test} 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 $40\ km/h$. In this case, a gear ratio, is allowed even if $a_{wot\ test}$ does not exceed a_{urban} .**

3.1.2.1.4.2. Automatic transmission, adaptive transmissions and transmissions with variable gear ratios (CVTs) tested with non locked gear ratios.

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

The acceleration value $a_{wot\ test}$ 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. A gear change to a higher range and a lower acceleration is not allowed. A gear shifting to a gear ratio which is not used in urban traffic shall be avoided.

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

The achieved acceleration a_{wot} test shall be greater or equal to a_{urban} .

If possible, the manufacturer shall take measures to avoid an acceleration value a_{wot} test greater than $2.0 \text{ m/s}^2 a_{wot \text{ ref}}$.

The achieved acceleration a_{wot} test is then used for the calculation of the partial power factor k_p (see paragraph 3.1.2.1.3.) instead $a_{wot \text{ ref}}$.

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 point of fully depressing the accelerator shall be reported in the communication form (Annex 1). The technical service shall have the possibility of pretesting.

In the case of articulated vehicles consisting of two nonseparable 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 gears specified for the acceleration test and a constant speed of 50 km/h with a tolerance of ± 1 km/h between AA' and BB'. **If the test speed is modified according to 3.1.2.1.4.1., the modified test speed shall be used.** 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 M2 > 3,500 kg, M3, N2, N3~~

~~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' (see Annex 8, Figure 1). 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.~~

~~Target conditions of category M2 > 3,500 kg, N2:~~

~~When the reference point passes line BB', the engine revolution $n_{BB'}$ shall be between 70 per cent and 74 per cent of speed S, at which the engine~~

~~develops its rated maximum 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 shall be ensured.~~

~~Target conditions of Category M3, N3:~~

~~When the reference point passes line BB', the engine revolution $n_{BB'}$ shall be between 85 per cent and 89 per cent of speed S, at which the engine develops its rated maximum 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 shall be ensured.~~

~~3.1.2.2.1. Gear ratio selection~~

~~3.1.2.2.1.1. Manual transmissions~~

~~Stable acceleration condition shall be ensured. The gear choice is determined by the target conditions. If the difference in speed exceeds the given tolerance, then two gears should be tested, one above and one below the target speed.~~

~~If more than one gear fulfils the target conditions select that gear which is closest to 35 km/h . If no gear fulfils the target condition for v_{test} two gears shall be tested, one above and one below v_{test} . The target engine speed shall be reached in any condition.~~

~~A stable acceleration condition shall be ensured. If a stable acceleration cannot be ensured in a gear, this gear has to be disregarded.~~

~~3.1.2.2.1.2. Automatic transmissions, adaptive transmissions and transmissions with variable gear ratio (CVTs)~~

~~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. A gear shifting to a gear ratio which is not used in urban traffic, at the specified test condition, shall be avoided. Therefore, it is permitted to establish and use electronic or mechanical devices to prevent a downshift to a gear ratio which is typically not used at the specified test condition in urban traffic.~~

~~If the vehicle includes a transmission design, which provides only a single gear selection (Drive), which limits engine speed during the test, the vehicle shall be tested using only a target vehicle speed. If the vehicle uses an engine and transmission combination that does not fulfill paragraph 3.1.2.2.1.1., the vehicle shall be tested using only the target vehicle speed. The target vehicle speed for the test is $v_{BB'} = 35 \text{ km/h} \pm 5 \text{ km/h}$. A gear change to a higher range and a lower acceleration is allowed after the reference point of the vehicle passes line PP'. Two tests must be performed, one with the end speed of $v_{\text{test}} = v_{BB'} + 5 \text{ km/h}$, and one with the end speed of $v_{\text{test}} = v_{BB'} - 5 \text{ km/h}$. The reported sound level is that result which is related to the test with the highest engine speed obtained during the test from AA' to BB'.~~

~~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 depressed until the rear of the vehicle passes BB', but the reference point shall be at least 5 m behind BB'. The accelerator control shall then be released.~~

~~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.~~

3.1.2.2. Vehicles of categories $M_2 > 3,500$ kg, 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' and the reference point is 5 m behind line BB' (see Annex 8 appendix, figure 1). 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.

Target conditions of category $M_2 > 3,500$ kg, N_2 :

When the reference point passes BB', the engine rotational speed $n_{BB'}$ shall fulfil the target engine rotational speed $n_{target BB'}$. $n_{target BB'}$ is defined as an interval in-between 70 per cent and 74 per cent of the speed S. When the reference point passes BB', the vehicle speed $v_{BB'}$ shall fulfil the target vehicle speed $v_{target BB'}$. $v_{target BB'}$ is defined as 35 km/h \pm 5 km/h.

Target conditions of Category M_3 , N_3 :

When the reference point passes BB', the engine rotational speed $n_{BB'}$ shall fulfil the target engine rotational speed $n_{target BB'}$. $n_{target BB'}$ is defined as an interval in-between 85 per cent and 89 per cent of the speed S. When the reference point passes BB', the vehicle speed $v_{BB'}$ shall fulfil the target vehicle speed $v_{target BB'}$. $v_{target BB'}$ is defined as 35 km/h \pm 5 km/h.

3.1.2.2.1. Gear ratio selection

3.1.2.2.1.1. General

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

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

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

The following conditions for fulfilling the target conditions in 3.1.2.2. are possible.

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

$$(v_{\text{target BB}'} - v_{\text{BB}' \text{ gear } i}) = (v_{\text{BB}' \text{ gear } i+1} - v_{\text{target BB}'})$$

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 the following gear_x

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

and

gear_y

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

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, condition f, shall be chosen.
- (f) If no gear choice fulfils the target rotational engine speed, choose the gear which fulfils the target vehicle speed $v_{\text{target BB}'}$ and is closest to the target rotational engine speed $n_{\text{target BB}'}$ but not higher than $n_{\text{target BB}'}$.

$$v_{\text{BB}' \text{ gear } i} = v_{\text{target BB}'}$$

and

$$n_{\text{BB}' \text{ gear } i} \leq n_{\text{target BB}'}$$

A stable acceleration condition shall be ensured for all the above mentioned tests. If a stable acceleration cannot be ensured in a gear, this gear has to be disregarded.

3.1.2.2.1.3. 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 which 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.

The following conditions for fulfilling the target conditions in 3.1.2.2. 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:

$v_{\text{BB}'1}$ is defined as

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

and

$v_{\text{BB}'2}$ is defined 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:

$v_{\text{BB}'1}$ is defined as

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

and

$v_{\text{BB}'2}$ is defined as

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

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

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

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

If the vehicle cannot fulfil the condition

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

condition e, shall be used.

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

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

Conduct the test with that vehicle speed $v_{\text{BB}'}$, where $n_{\text{BB}'}$ is closest to the target rotational engine speed $n_{\text{target BB}'}$.

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, which 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 $v_{\text{target BB}'}$.

3.1.2.2.1.4. Powertrains with no rotational engine speed available

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

The following conditions for fulfilling the target condition $v_{\text{target BB}'}$ in 3.1.2.2. are possible.

- (a) If no rotational engine speed is available only the target vehicle speed $v_{\text{target BB}'}$ has to be fulfilled.
- (b) If no rotational engine speed is available and the target vehicle speed $v_{\text{target BB}'}$ cannot be fulfilled two test conditions shall be conducted as follows

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

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

and

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

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

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

- (c) If no rotational engine speed is available and the target vehicle speed $v_{\text{target BB}'}$ and

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

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

cannot be fulfilled, only one test shall be conducted with $v_{\text{BB}'2}$.

$v_{\text{BB}'2}$ is defined as

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

The test condition for $v_{\text{BB}'2}$ is used 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 depressed until the rear of the vehicle passes BB', but the reference point shall be at least 5 m behind BB'. The accelerator control shall then be released.

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

The maximum A-weighted sound pressure level indicated during each passage of the vehicle between the two lines AA' and BB' (see ~~Annex 8 appendix~~, figure 1) shall be noted **to the first significant digit after the decimal place (e.g. XX,X)**. If a ~~noise sound~~ peak obviously out of character with the general ~~noise 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 side 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 appropriate intermediate or the final result for the given side of the vehicle**. The results of each side shall be averaged separately. ~~The intermediate result is the higher value of the two averages mathematically rounded to the first decimal place. The intermediate results for each side shall be the average value, mathematically 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 shall be the higher value of the two sides.~~

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

The calculated acceleration a_{wot} test shall be noted to the second digit after the decimal place.

3.1.3.1. Vehicles of categories M₁, N₁ and M₂ ≤ 3,500 kg

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

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

$$L_{wot\ rep} = L_{wot\ (i+1)} + k * (L_{wot\ (i)} - L_{wot\ (i+1)})$$

$$L_{crs\ rep} = L_{crs\ (i+1)} + k * (L_{crs\ (i)} - L_{crs\ (i+1)})$$

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

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_{wot rep} and L_{crs rep}. The equation is:

$$L_{urban} = L_{wot\ rep} - k_p * (L_{wot\ rep} - L_{crs\ rep})$$

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:

$$k_p = 1 - (a_{urban} / a_{wot\ ref})$$

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

$$k_p = 1 - (a_{urban} / a_{wot\ test})$$

In cases where a_{wot test} is less than a_{urban}:

$$k_p = 0$$

3.1.3.2. Vehicles of categories M₂ > 3,500 kg, M₃, N₂, N₃ ~~When one gear is tested the final result is equal to the intermediate result. When two gears are tested the arithmetic mean of the intermediate results shall be calculated.~~

When one test condition is tested, the final result, L_{urban} , is the maximum value as specified in 3.1.3.

When the results of two test conditions are used, the arithmetic mean of the two averages for each side of these two conditions shall be calculated. The final result, L_{urban} , is the maximum value of the two calculated averages.

- 3.2. Measurement of ~~sound~~ **noise**-emitted by stationary vehicles
- 3.2.1. **Noise** ~~Sound~~ level in the vicinity of vehicles.
- In order to facilitate subsequent checks on vehicles in use, the **noise** ~~sound~~ level shall be measured close to the exhaust system outlet in accordance with the following requirements and the measurement results entered **into** the test report drawn up for the purpose of issuing the certificate referred to in Annex 1.
- 3.2.2. Acoustic measurements.
- A precision sound level meter, **or equivalent measuring system**, as defined in paragraph 1.1. of this annex **shall** ~~must~~ be used for the measurements.
- 3.2.3. Test site - local conditions (see appendix, figure 2 and 3a to 3d).
- 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 **noise** ~~sound~~ source. The meter observer shall be positioned so as not to influence the meter reading.
- 3.2.4. Disturbance ~~sound~~ **noise** and wind interference
- Readings on the measuring instruments produced by ambient ~~sound~~ **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 **noise** ~~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 the 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 must 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 **noise** ~~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, figures 2 and 3)

3.2.5.3.1. Microphone orientation

- 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° ($\pm 5^\circ$) 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, one measurement is made for each outlet as if it were the only one, and the highest sound pressure level shall be noted.
- 3.2.5.3.1.3. If a vehicle has two or more exhaust outlets spaced less than 0.3 m apart and connected to a single silencer, only one measurement shall be made. The microphone shall be located relative to the outlet farthest 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 as defined in figure 2, 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 figures 3b and 3c, 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 its axis of maximum sensitivity shall face the exhaust outlet from the position least concealed by the above mentioned obstacles.

When several positions are possible, as shown in figure 3c, the microphone position giving the lowest value of d1 or d2 shall be used.

Note: Figures 3a to 3d show examples of the position of the microphone, depending on the location of the exhaust pipe.

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 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 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.

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 ± 5 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 consisting of constant engine speed of at least one second and throughout the entire deceleration period. The maximum sound level meter reading shall be 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 ± 5 per cent for at least one second.

3.2.6. Results

- 3.2.6.1. Measurements shall be made according to the microphone location(s) described in paragraph 3.2.5.3.1.

- 3.2.6.2. The maximum A-weighted sound pressure level indicated during the test shall be noted, mathematically rounded to the first significant figure before the decimal place.

- 3.2.6.3. The test shall be repeated until three consecutive measurements at each outlet are obtained, which are within 2 dB of each other, allowing for deletion of non valid results.

- 3.2.6.4. The result for a given outlet is the arithmetic average of the three valid measurements, mathematically rounded as given above and shall be reported as the A-weighted sound pressure level L_{Arep} .

- 3.2.6.5. For vehicles equipped with multiple gas outlets, the sound pressure level reported L_{Arep} shall be for the outlet having the highest average sound pressure level.

Figure 2
Measuring positions for stationary vehicles (examples)

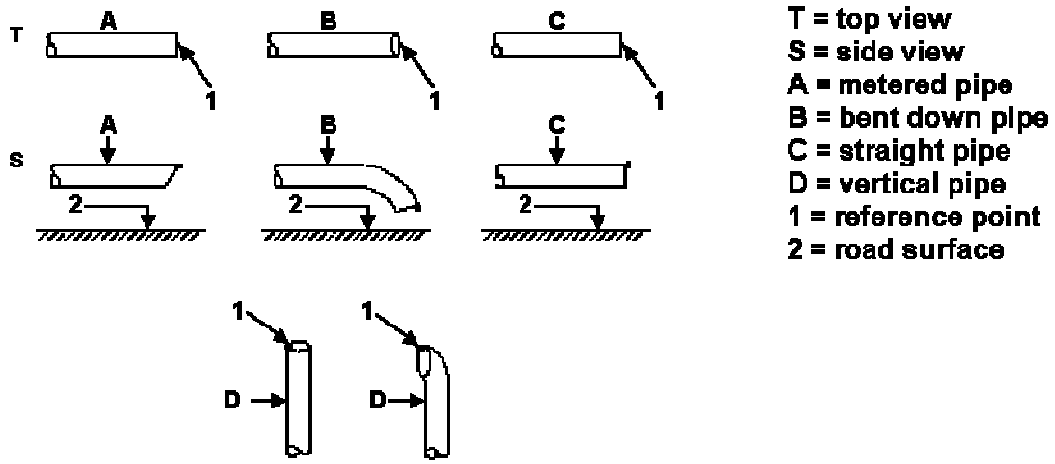


Figure 3a

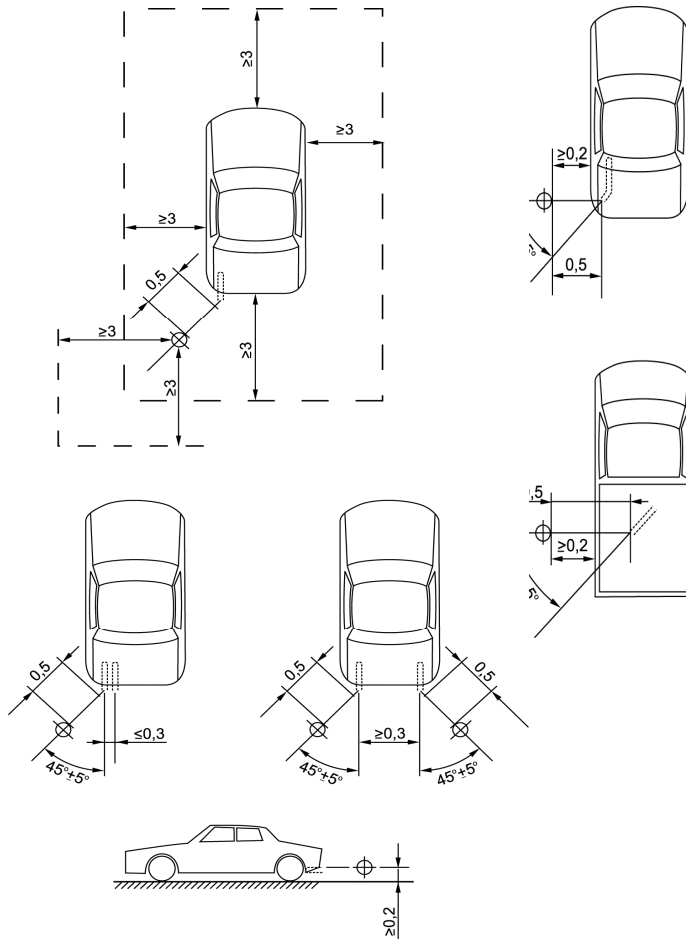


Figure 3b

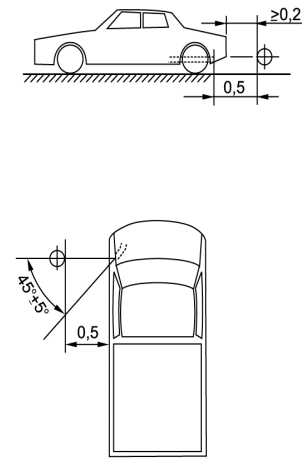


Figure 3c

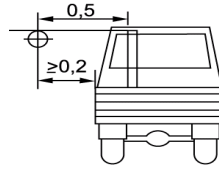
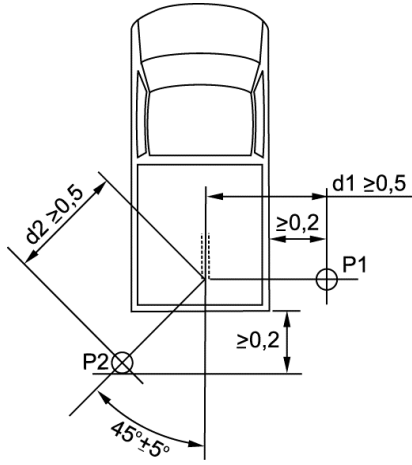
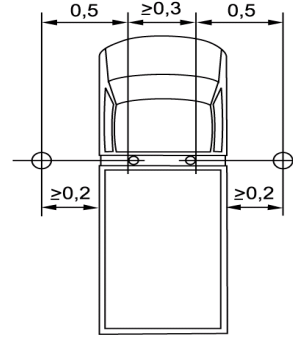


Figure 3d



Annex 4

Classification of vehicles ¹¹

1. Category L
(Not applicable for this Regulation)
2. Category M - power-driven vehicles having at least four wheels and used for the carriage of passengers
 - 2.1. Category M₁: Vehicles used for the carriage of passengers and comprising not more than eight seats in addition to the driver's seat.
 - 2.2. Category M₂: Vehicles used for the carriage of passengers, comprising more than eight seats in addition to the driver's seat, and having a maximum mass not exceeding 5 tonnes.
 - 2.3. Category M₃: Vehicles used for the carriage of passengers, comprising more than eight seats in addition to the driver's seat, and having a maximum mass exceeding 5 tonnes.
 - 2.4. Vehicles of categories M₂ and M₃ belong to:
 - 2.4.1. Class I, Class II, Class III) in accordance with Regulation Nos. 36 and 107;
 - (a) one or more of the three classes :
 - (b) one of the two classes (Class A, Class B) in accordance with Regulation No. 52.
 - 2.4.1. Class I:
Vehicles constructed with areas for standing passengers, to allow frequent passenger movement.
 - 2.4.2. Class II:
Vehicles constructed principally for the carriage of seated passengers, and designed to allow the carriage of standing passengers in the gangway and/or in an area which does not exceed the space provided for two double seats.
 - 2.4.3. Class III:
Vehicles constructed exclusively for the carriage of seated passengers.
 - 2.4.4. Class A:
Vehicles designed to carry standing passengers: a vehicle of this class has seats, and may have provisions for standing passengers.
 - 2.4.5. Class B:
Vehicles not designed to carry standing passengers; a vehicle of this class has no provision for standing passengers
 - 2.5. Remarks

¹¹ As defined in the Consolidated resolution on the Construction of vehicles (R.E.3), document ECE/TRANS/WP.29/78/Rev.2, para.2.

- 2.5.1. Articulated bus or coach' is a vehicle which consists of two or more rigid sections which articulate relative to one another; the passenger compartments of each section intercommunicate so that passengers can move freely between them; the rigid sections are permanently connected so that they can only be separated by an operation involving facilities which are normally only found in a workshop.
- 2.5.2. Articulated buses or coaches comprising two or more non-separable but articulated units shall be considered as single vehicles.
- 2.5.3. In the case of a towing vehicle designed to be coupled to a semitrailer (tractor for semi-trailer), the mass to be considered for classifying the vehicle is the mass of the tractor vehicle in running trim, increased by the mass corresponding to the maximum static vertical load transferred to the tractor vehicle by the semi-trailer and, where applicable, by the maximum mass of the tractor vehicle's own load.
- 2.5.4. "*Mass of a vehicle in running order*" means the mass of an unladen vehicle with bodywork, and with coupling device in the case of a towing vehicle, or the mass of the chassis with cab if the manufacturer does not fit the bodywork and/or coupling device, including coolant, oils, 90 per cent of fuel, 100 per cent of other liquids except used waters, tools, spare wheel, driver (75 kg) and, for buses and coaches, the mass of the crew member (75 kg) if there is a crew seat in the vehicle.
3. Category N - power-driven vehicles having at least four wheels and used for the carriage of goods.
 - 3.1. Category N₁: Vehicles used for the carriage of goods and having a maximum mass not exceeding 3.5 tonnes.
 - 3.2. Category N₂: Vehicles used for the carriage of goods and having a maximum mass exceeding 3.5 tonnes but not exceeding 12 tonnes.
 - 3.3. Category N₃: Vehicles used for the carriage of goods and having a maximum mass exceeding 12 tonnes.
 - 3.4. Remarks
 - 3.4.1. In the case of a towing vehicle designed to be coupled to a semitrailer (tractor for semi-trailer), the mass to be considered for classifying the vehicle is the mass of the tractor vehicle in running trim, increased by the mass corresponding to the maximum static vertical load transferred to the tractor vehicle by the semi-trailer and, where applicable, by the maximum mass of the tractor vehicle's own load.
 - 3.4.2. The equipment and installations carried on certain special purpose vehicles (crane vehicles, workshop vehicles, publicity vehicles, etc.) are regarded as being equivalent to goods.

Annex 5

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.

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 program 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.

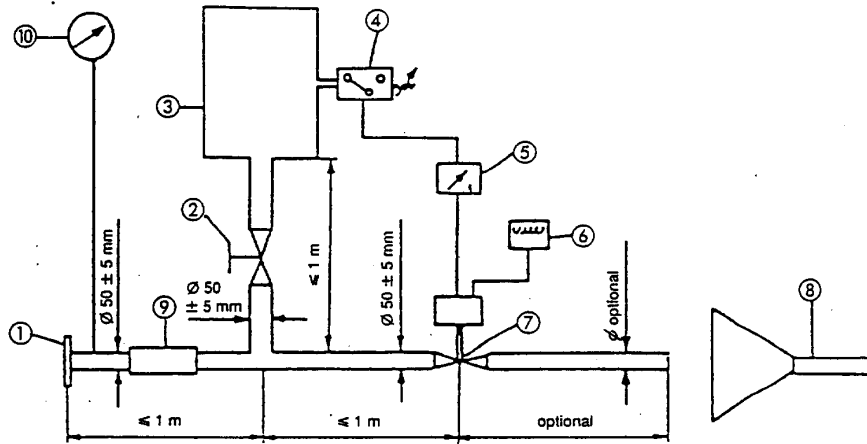
In the second case, the engine shall be mounted on a dynamometer. The test apparatus, a detailed diagram of which is shown in Figure 3 of the appendix to this annex shall be fitted at the outlet of the silencing system. Any other apparatus providing equivalent results is acceptable.

- 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 speed (S) at which the engine develops maximum 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 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 5 - Appendix

Figure 3
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, must not exceed 0.5 second.
8. Exhaust gas evacuation.
9. Flexible pipe.
10. Pressure gauge.

Annex 6

Compressed air noise sound

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 **noise** level is registered during venting the pressure regulator and during ventilating after the use of both the service and parking brakes.

The **noise sound** during venting the pressure regulator is measured with the engine at idling speed. The ventilating **noise sound** 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 metre 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 noise limit by 1 dB(A), two additional measurements are to be taken at the corresponding microphone position.

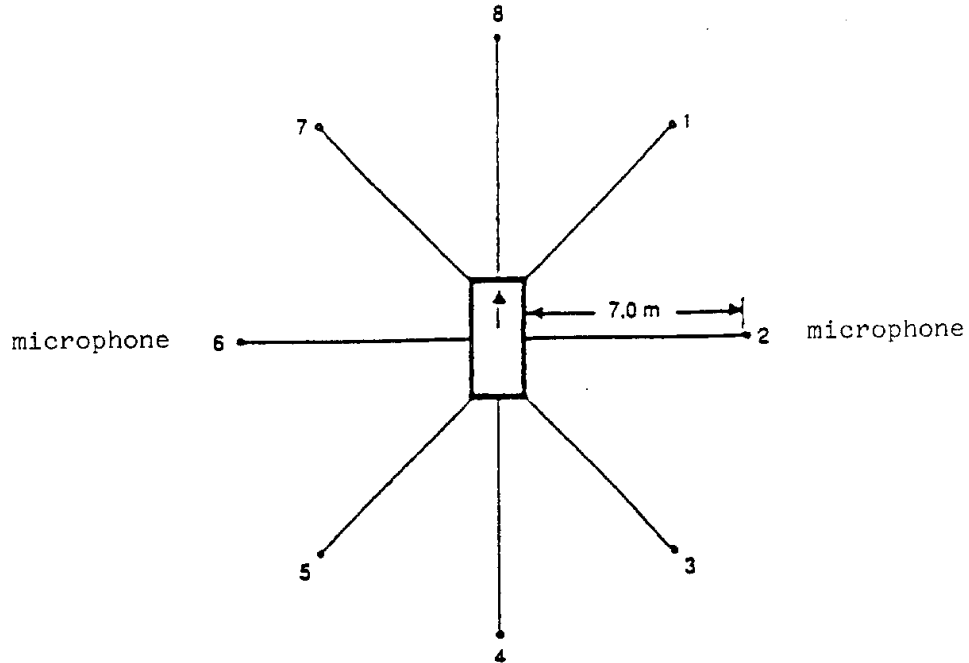
In this case, three out of the four results of measurement obtained at this position have to comply with the **noise sound** limit.

3. Limiting value

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

Annex 6 - Appendix

Figure 1:
Microphone positions for measurement of compressed air noise sound



The measurement is performed at the stationary vehicle according to Figure 1, using two microphone positions **2 and 6** at a distance of 7 m from the contour of the vehicles, and at 1.2 m above ground.

Annex 7

Checks on conformity of production

1. General

These requirements are consistent with the test to be held to check conformity of production (COP) according to paragraphs 8.3.5. and 8.4.3. of this Regulation.
2. Testing procedure

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

 - 2.1. **Noise of vehicle in motion**

The vehicle(s) under test shall be subjected to the test for measurement of ~~sound~~ noise of vehicle in motion as described in paragraph 3.1. of Annex 3.
 - 2.2. **Compressed air ~~sound~~ noise**

Vehicles having maximum mass exceeding 2,800 kg and equipped with compressed air systems must be subjected to an additional test for measurement of the compressed air ~~sound~~ noise as described in paragraph 1 of Annex 6.
 - 2.3. **Additional sound emission provisions**

The vehicle manufacturer shall assess the compliance with ASEP by an appropriate evaluation (for example, but not limited to, part checks) or may perform the test described in Annex 10.
3. Sampling and evaluation of the results

One vehicle has to be chosen and subjected to the tests of paragraph 2. above. If the test results fulfil the COP requirements of paragraph 8. of the main body of this Regulation, the vehicle is considered to be in compliance with the COP provisions.

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

If the test results for the second and the third vehicle fulfil the COP requirements 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 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 8

Specifications for the test site

1. Introduction

This annex describes the specifications relating to the physical characteristics and the laying of the test track. These specifications based on a special standard ¹² describe the required physical characteristics as well as the test methods for these characteristics.

The surface design given in this Annex:

produces consistent levels of tyre/road noise emission under a wide range of operating conditions;

including those appropriate to vehicle noise testing;

minimizes inter-site variation;

provides minor absorption of the vehicle noise sources;

is consistent with road-building practice.

2. Terms and definitions

For the purposes of this document, the following terms and definitions apply.

2.1. Sound absorption coefficient α

Fraction of the sound power incident on the test object that is absorbed within the test object for a plane wave at normal incidence.

NOTE: Expressed as a percentage, it is called sound absorption.

2.2. Surface profile

2.2.1. Texture profile

Two-dimensional sample of pavement texture generated if a sensor, such as the tip of a needle or a laser spot, continuously touches or shines on the pavement surface while it is moved along a line on the surface.

NOTE: It is described by two coordinates: one along the surface plane, called “distance” (the abscissa), and the other in a direction normal to the surface plane, called “amplitude” (the ordinate).

2.2.2. Irregularity

Maximum distance of a surface from the measurement edge of the straightedge between two contact points of the straight edge when placed perpendicular to the surface.

NOTE: Pavement characteristics at longer wavelengths than 0.5 m are considered to be above that of texture and are referred to here as irregularity.

¹² ISO 10844:2011.

- 2.2.2.1. Longitudinal irregularity**
Irregularity in the longitudinal axis of the track.
- 2.2.2.2. Transversal irregularity**
Irregularity in the direction perpendicular to the axis of the track.
- 2.2.3. Straight edge**
Device used for measuring the deviation from a plane.
- 2.2.4. Megatexture**
Deviation of a pavement surface from a true planar surface with the characteristic dimensions along the surface of 50 mm to 500 mm, corresponding to texture wavelengths with one-third-octave bands including the range 63 mm to 500 mm of centre wavelengths.
NOTE: Peak-to-peak amplitudes normally vary in the range 0.1 mm to 50 mm. This type of texture is the texture which has wavelengths in the same order of size as a tyre/road interface and is often created by potholes or “waviness”. It is usually an unwanted characteristic resulting from defects in the surface. Surface roughness with longer wavelengths than megatexture is referred to as irregularity.
- 2.2.5. Macrotexture**
Deviation of a pavement surface from a true planar surface with the characteristic dimensions along the surface of 0.5 mm to 50 mm, corresponding to texture wavelengths with one-third-octave bands including the range 0.63 mm to 50 mm of centre wavelengths.
- 2.2.6. Microtexture**
Deviation of a pavement surface from a true planar surface with the characteristic dimension along the surface below 0.5 mm, corresponding to texture wavelengths with one-third-octave bands with centre wavelengths less than or equal to 0.50 mm.
- 2.3. Gradient and cross fall**
- 2.3.1. Gradient**
Ratio of the height difference and the length measured along the longitudinal axis of the drive lane, expressed as a percentage.
- 2.3.2. Cross fall**
Height difference expressed as a percentage of the length measured along the transversal axis of the drive lane.
- 2.4. Propagation area**
Part of the test track on each side of the drive lane (see Figure 1).
- 2.5. Drive lane**
Part of the test track where the vehicle runs.
- 2.6. Stiffness**
Ratio of a normal force and resulting displacement.
- 2.7. Dense asphalt concrete**

Asphalt in which the aggregate particles are essentially continuously graded to form an interlocking structure.

2.8. Mean profile depth

Average value of the height difference between the profile and a horizontal line through the highest peak (the peak level) over a 100 mm long baseline.

3. Requirements of the test track

A surface is considered to conform to this standard if the following requirements have been met.

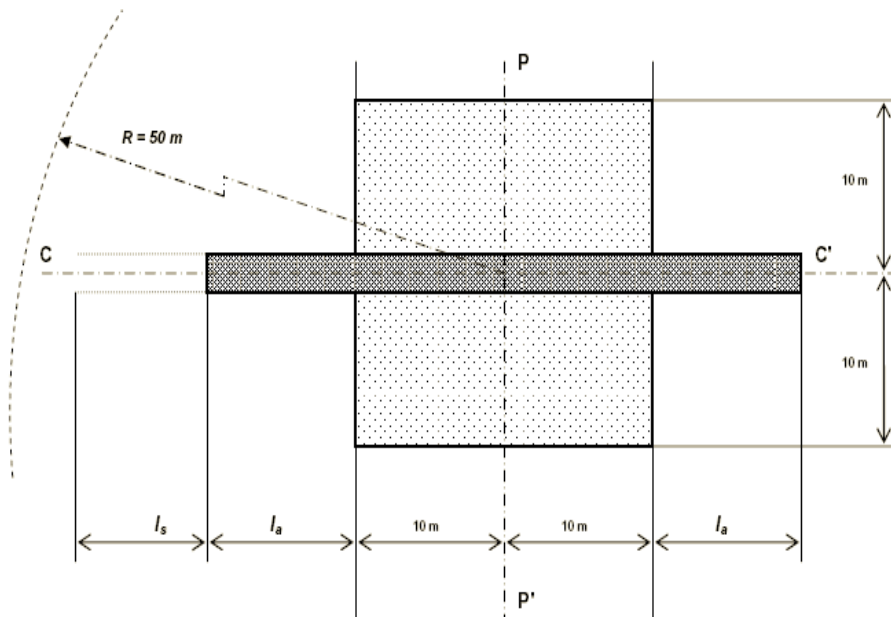
3.1. Size and geometry

3.1.1. Size

The test track shall consist of two areas, a drive lane and a propagation area. The dimensions shall comply with Figure 1 and Table 1.

Figure
Size of the test track

1



Key

- l_s construction run-up section
- l_a drive lane extension beyond propagation area
- CC' drive lane centre line
- PP' microphone line
- Light shaded area propagation area
- Dark shaded area drive lane

A drive lane with a length of l_a and width of at least 3.0 m that is centered around line PP'. The value of l_a is defined in Table 1.

Table 1
Minimum drive lane extension length

<i>Length</i>	<i>For testing tyres, passenger cars, motorcycles, light duty vehicles, trucks</i>	<i>For testing tyres, passenger cars, motorcycles, light duty vehicles, trucks For long vehicles with rear engine, having a distance of more than 10 m between reference point and the front axle</i>
l_a	10 m	20 m ^a

^a 20 m is necessary only for the exit side (BB') of the test track according to the purpose of this requirement

NOTE: For the stabilization of the laying process, a minimum length of $l_s = 60$ m is recommended on at least one side.

The propagation area shall extend at least 10 m from the centre of the drive lane and at least 10 m at both sides of the line PP'.

Within a radius of 50 m around the centre of the track the space shall be free of large reflecting objects such as fences, rocks, bridges or buildings.

NOTE: Buildings outside the 50 m radius can have significant influence if their reflection focuses on the test track.

3.1.2. Geometry

(a) Drive lane

The drive lane shall fulfil the following requirements:

- (i) For acceptance of the test track only, transverse irregularities equal to or less than 0.003 m and longitudinal irregularities equal to or less than 0.002 m measured with the straightedge according to EN 13036-7;
- (ii) For periodical checking of the test track only, transverse irregularities equal to or less than 0.005 m and longitudinal irregularities equal to or less than 0.005 m measured with the straightedge according to EN 13036-7;
- (iii) For acceptance only, deviation from the horizontal plane in transverse direction of 1.0 per cent maximum (see Figure 2) and in a longitudinal direction of 0.5 per cent maximum.

It is recommended that the irregularities requirements be fulfilled starting from the microphone line to cover the drive lane plus 10 m from the end of the section l_a on both sides.

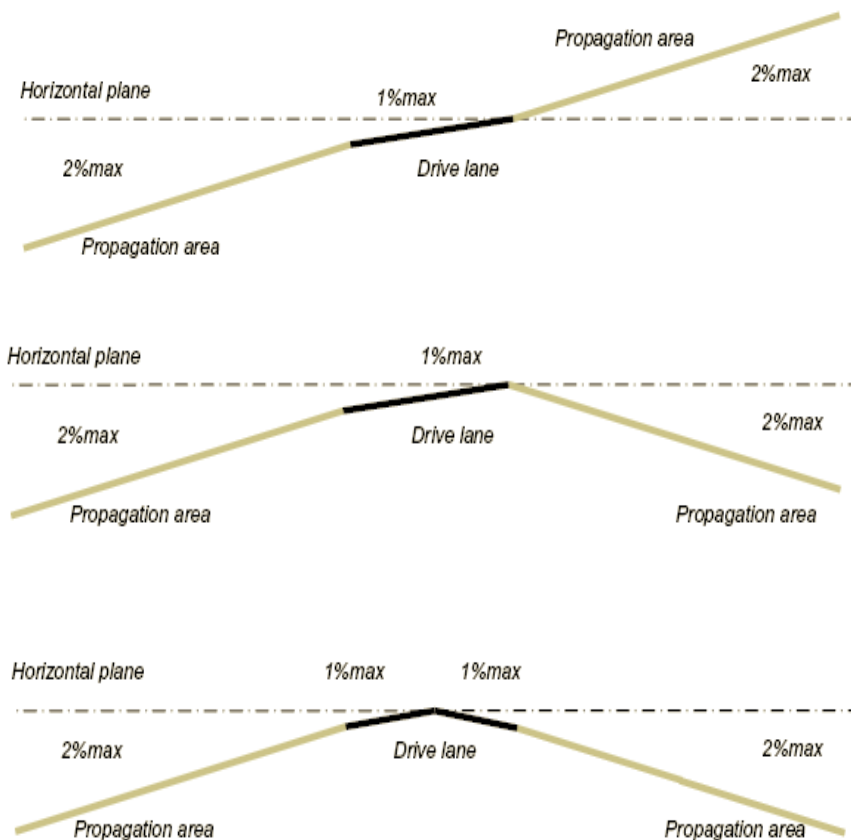
(b) Propagation area

- (i) The propagation area shall have irregularities equal to or less than 0.02 m measured with the straightedge according to EN 13036-7;
- (ii) The propagation area may have one or both sides lower than the drive lane. Cross fall in transverse direction,

measured using an appropriate instrument, shall be equal or less than 2.0 per cent (see Figure 2);

NOTE: The slope should be designed in such a way that the draining of water is possible.

Figure 2
Propagation area slope in transverse direction



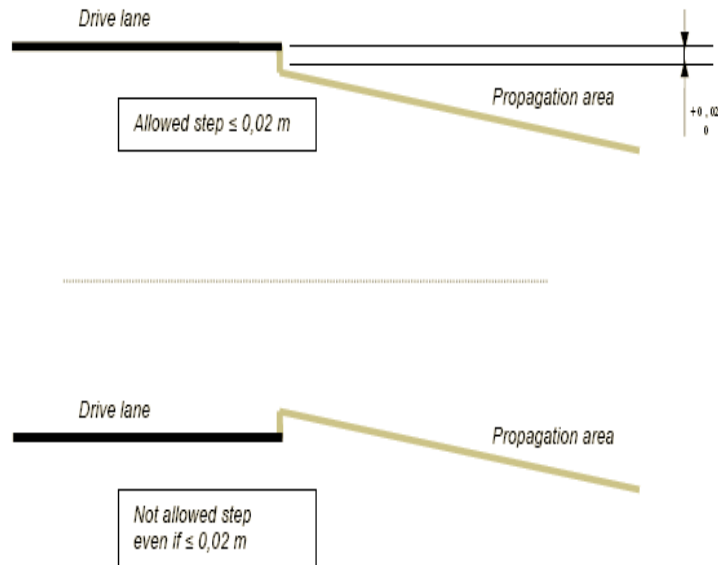
Key

1 per cent max: allowed drive lane cross fall

2 per cent max: allowed propagation area cross fall

Steps or discontinuities between the propagation area and the drive lane shall be between 0 and +0,02 m. Negative steps are not allowed (see Figure 3).

Figure 3
Propagation area – Steps or discontinuities



3.2. Surface properties of the propagation area

The average of the values of the sound absorption in each one-third-octave band between 315 Hz and 1 600 Hz central frequency shall be less than or equal to 10 per cent. The sound absorption coefficient shall be measured according to 4.3.

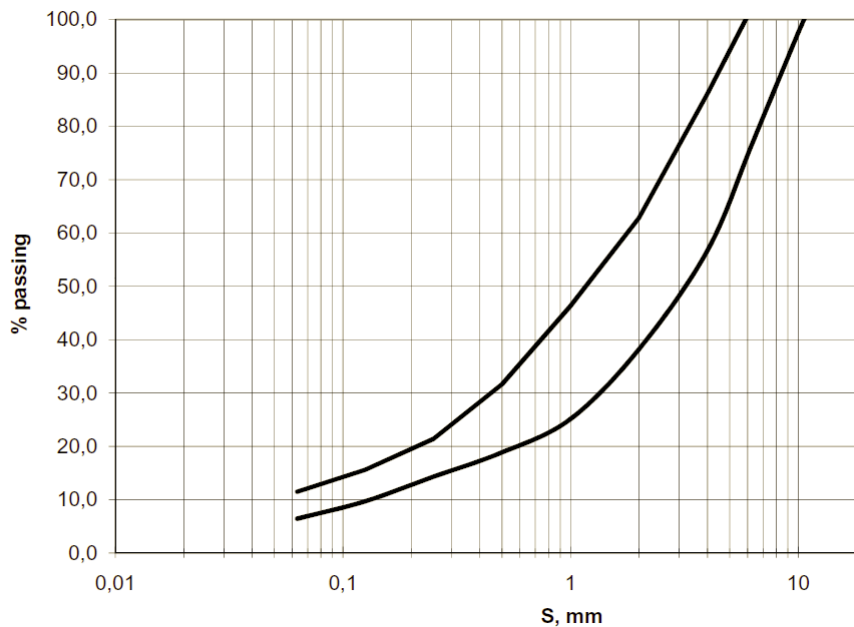
Location and number of measurement points are given in 3.4.

3.3. Surface properties of the drive lane

The surface of the drive lane shall:

- (a) be dense asphalt concrete;
- (b) exhibit a sound absorption equal to or less than 8 per cent in any one-third octave band between 315 Hz and 1 600 Hz when measured according to 4.3;
- (c) have a maximum chipping size of 8 mm (tolerance allowed between 6.3 mm to 10 mm);
- (d) have a thickness of the wearing course greater or equal than 30 mm;
- (e) have a Mean Profile Depth measured according to ISO 13473-1 of $0.5 \text{ mm} \pm 0.2 \text{ mm}$;
- (f) have a target sieving curve for the aggregate as described in Figure 4.

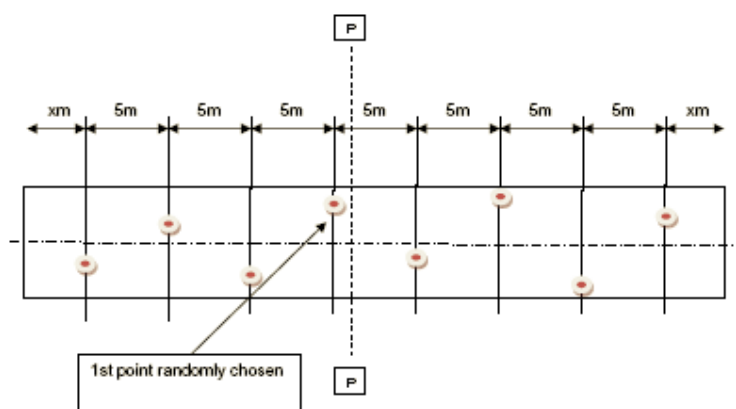
Figure 4
Sieving curve area



3.4. Conformity tests

- (a) The surface properties for each requirement shall be determined at the following occasions before the acceptance of the track (refer to Table 2);
- (b) During the periodical checking of the track (refer to Table 2);
- (c) All measurements shall be made along the total length of the drive lane in each wheel track according to the following scheme (see an example in Figure 5);
- (d) For sound absorption, texture, geometrical compliance, the first point shall be chosen randomly on each side in the vicinity of the line PP' and the subsequent measurements shall be performed at 5 m intervals not on the same axis of the centre line to cover the whole track;

Figure 5
Measurement positions on test track, example for $l = 40$ m



- (e) After construction, take a total of four cores, preferably at 10 m intervals outside the wheel tracks on the driving lane run up section, and measure the sieving curve from these samples.

For checking the surface properties of the propagation area, take at least two measurements randomly chosen on each side.

In addition, sound absorption of the propagation area shall be measured at both sides of the drive lane between the microphone location and the centre of drive lane in the vicinity of the line PP'.

Table 2
Periodicity for checking the requirements during acceptance and periodical checking

	<i>For acceptance</i>		<i>For periodical checking</i>	
<i>Requirements for the track</i>	Drive lane	Propagation area	Drive lane	Propagation area
Gradient	× (0,5 %)	N.A.	N.A.	N.A.
Slope				
Cross fall	× (1 %)	× (2 %)	N.A.	N.A.
Longitudinal irregularity	× (≤2 mm)	× (≤20 mm) randomly	× (≤5 mm) 2 years ^a	N.A.
Transverse irregularity	× (≤3 mm)		× (≤5 mm)	N.A.

<i>Requirements for the track</i>	<i>For acceptance</i>		<i>For periodical checking</i>	
	Drive lane	Propagation area	Drive lane	Propagation area
			2 years ^a	
Texture	×	N.A.	×	N.A.
	MPD		MPD	
	0.5mm ± 0.2mm		0.5mm ± 0.2mm	
			2 years ^a	
Absorption	×	×	×	N.A.
	(8 % max)	(10 %max)	(8 % max)	
			4 years ^a	
Grading curve	×	N.A.	N.A.	N.A.
× to be checked				
N.A. not applicable				
^a Periodicity.				

3.5. Homogeneity of surface properties

In order to ensure that the properties of the drive lane and the properties of the propagation area are homogeneous, the average of all positions and 80 per cent of the samples shall meet the requirements with respect to:

acoustic absorption;

surface texture;

geometrical compliance.

3.6. Stability with time and maintenance

The test track is a test instrument and shall be protected from damage and be taken care of. The test track should be used only for noise measurements.

Loose debris or dust which could significantly reduce the texture depth shall be removed from the surface.

Sealing of cracks is acceptable as long as acoustical performances (as per 3.2 and 3.3) of the test track are not affected.

3.7. Break-in of the test track

The texture and absorption characteristics shall be checked not earlier than 4 weeks after construction or 1 000 passes after construction.

If the surface is exclusively used for testing heavy vehicles (M₂ above 3,5 t, M₃, N₂ and N₃) this break-in period is not necessary.

4. Measurement methods and data processing

4.1. Irregularity measurement methods

The irregularity of the drive lane shall be determined according to EN 13036-7 using a straight edge consisting of a beam of 3.0 m length and wedge with 1 mm steps on the oblique side.

4.2. Texture measurements methods

4.2.1. Profile measurement

The profile is measured according to ISO 13473-1 for MPD and ISO 13473-3 for ENDT. The measurement instrumentation shall meet the requirements of class DE defined in ISO 13473-3.

Additional details to ISO 13473-1 — MPD shall be measured in the wheel tracks of the driving lane and the following two options may be used:

Continuous measurement: MPD is measured continuously over the entire driving lane. The measured profile shall be divided into eight sections, each 5 m long, for which MPD shall be evaluated separately as average over the section. A total of two measurement runs shall be made in each wheel track,

Segmented measurement: MPD is measured at a minimum of four locations in each of the two wheel tracks (eight if the test track is used for two-wheeled vehicles). These locations shall be evenly distributed over the driving lane length. At each such location, a minimum length of 2.0 m of profiles shall be measured, each one at least 0.8 m long and positioned in a way which give statistically independent MPD values.

The MPD requirement in 3.3 shall be met at each of the eight locations or sections.

When calculating ENDT, the wavelength spectrum from 100 mm to 5 mm one-third octave band of the profile shall be obtained according to the specifications of ISO/TS 13473-4. A tapered cosine window is preferred (refer to ISO 13472-4).

4.2.2. Texture profile data pre-processing

Removal of spike data is necessary. For details refer to ISO/TS 13473-6.

4.3. Acoustic absorption measurement method

The acoustic absorption shall be measured in the frequency range from 280 Hz to 1 800 Hz with an in-situ device meeting the specifications of ISO 13472-2. The results shall be expressed in the one-third octave band coefficients according to the procedure described in ISO 13472-2.

5. Conformity report

The test report for each pavement test surface shall contain all information required for construction approval or periodical inspection, whatever is applicable.

Example:

- (a) General information
 - (i) Owner

- (ii) Contractor's name
- (iii) Date of construction of the test track
- (iv) Location of the test track
- (v) Certifying authority (if applicable)
- (vi) Certification status
- (vii) Main use of the test track (e.g. truck tyre coast by, testing, passenger car drive by)
- (viii) Notable features (e.g. under track, heating)
- (b) Size and geometry
 - (i) Size
 - a. Dimensions of the driving lane
 - i. Total length (m)
 - ii. Width (m)
 - iii. l_a (m)
 - iv. l_s (m)
 - b. Dimensions of the propagation area
 - i. Length (m)
 - ii. Width (m)
 - c. Free space
 - Radius (m)
 - Notable feature
 - (ii) Geometry
 - a. Drive lane
 - i. Transverse and longitudinal irregularities (m)
 - ii. Deviation from the horizontal plane in transverse direction (per cent)
 - b. Propagation area
 - i. Irregularities (m)
 - ii. Slope in transverse direction (per cent)
 - iii. Steps or discontinuities (m)
- (c) Surface properties
 - (i) Material
 - c. Drive lane
 - i. Sound absorption
 - ii. Maximum chipping size
 - iii. Thickness of wearing course

- iv. Texture
 - v. Sieving curve
 - vi. Elastic material
 - d. Propagation area
 - i. Sound absorption
 - (ii) Homogeneity statement of surface properties
 - (d) Proving the requirements
 - (i) Scheme of the measuring point
 - (ii) Measuring material description
 - (iii) Description of the measuring methods
 - (e) Homogeneity of surface properties
- 6. Documentation of vehicle noise-tests conducted on the surface

In the document describing the vehicle noise test(s) it shall be stated whether all the requirements of this were fulfilled or not. Reference shall be given to a document according to which the results are verified.

Annex 9

Symbols used

<i>Symbol</i>	<i>Unit</i>	<i>Paragraph</i>	<i>Explanation</i>
a_{urban}	m/s^2	3.1.1.2.3.	Target acceleration respective urban traffic acceleration
$a_{\text{wot } i}$	m/s^2	3.1.1.2.	Acceleration at wide open throttle in gear i
$a_{\text{wot } i+1}$	m/s^2	3.1.1.2.	Acceleration at wide open throttle in gear i+1
$a_{\text{wot ref}}$	m/s^2	3.1.1.2.4.	Reference acceleration rate for the wide open throttle test
$a_{\text{wot test}}$	m/s^2	3.1.1.2.	Acceleration at wide open throttle in single gear test cases
Gear ratio i		3.1.3.2.1.1.	The first of two gear ratio for use in the vehicle test
Gear ratio i+1		3.1.2.1.1.	The second of two gear ratio with an engine speed lower than gear ratio i
k		3.1.2.1.1.	Gear weighing factor
k_p		3.1.1.3.	Partial power
l	m	3.1.1.2.	Reference length
L_{crs}	dB	3.1.3.1.	Vehicle noise at constant speed test
$L_{\text{crs rep}}$	dB	3.1.3.1.	Reported vehicle noise at constant speed test
l_{veh}	m	3.1.1.2.	Length of vehicle
L_{wot}	dB	3.1.3.1.	Vehicle noise at wide open throttle
$L_{\text{wot rep}}$	dB	3.1.3.1.	Reported vehicle noise at wide open throttle
m_{kerb}	kg	2.2.1.	Kerb mass of the vehicle
m_t	kg	2.2.1.	Test mass of the vehicle
$n_{\text{BB}'}$	min-1	3.1.2.2.	Engine rotation speed of the vehicle, when the reference point passes BB'
PMR	-	3.1.1.2.3.	Power to mass ratio index to be used for calculations
P_n	kW	3.1.1.2.5.	Rated engine power
S	min-1	2.5.3.2.1.	Rated engine speed, synonymous with the engine speed at maximum power
$V_{\text{AA}'}$	km/h	3.1.1.2.1.	Vehicle speed at the approach of AA'
$V_{\text{BB}'}$	km/h	3.1.1.2.1.	Vehicle speed at the end of the test track
$V_{\text{PP}'}$	km/h	3.1.1.2.2.	Vehicle speed at PP'
V_{test}	km/h	3.1.2.1.	Vehicle test speed

Annex 10

Measuring method to evaluate compliance with the additional sound emission provisions

Only applicable for vehicles as specified in paragraph 6.2.3. of this Regulation

1. General

This annex describes a measuring method to evaluate compliance of the vehicle with the additional sound emission provisions (ASEP) conforming with paragraph 6.2.3. of this Regulation.

The vehicle shall meet the requirements in this annex. It is not mandatory to perform actual tests when applying for type approval. The manufacturer shall sign a declaration of compliance conforming to Appendix 1 of this annex. The type approval authority shall have the possibility to ask for additional information about the declaration of compliance and/or carry out the tests described below.

The analysis of Annex 10 requires the performance of a test according to Annex 3. The test specified in Annex 3 to this Regulation has to be performed on the same test track under similar conditions as the tests according to this annex.

2. Measuring method

2.1. Measuring instruments and condition of measurements

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

If the vehicle has different modes that affect ~~noise sound~~ emission, all modes shall comply with the requirements in this annex. In the case where the manufacturer has performed tests to prove to the approval authority compliance with the above requirements, the modes used during those tests shall be reported in a test report.

2.2. 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 measured and evaluated.

2.3. Control range

Operation conditions are as follows:

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

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

Engine speed n_{BB_ASEP} : $n_{BB} \leq 2.0 * \text{pmr}^{-0.222} * \text{s}$ or

$n_{BB} \leq 0.9 * \text{s}$, whichever is the lowest
gears

$k \leq \text{gear ratio } i \text{ as determined in Annex 3}$

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

Vehicle speed V_{BB_ASEP} :

if n_{BB_ASEP} is reached in one gear $v_{BB} \leq 70$ km/h

in all other cases $v_{BB} \leq 80$ km/h

~~gears $k \leq$ gear ratio i as determined in Annex 3~~

NOTE: If the vehicle, in the lowest valid gear, does not achieve the maximum engine speed below 70 km/h, the vehicle speed limit is 80 km/h.

2.4. Gear ratios

The ASEP requirements apply to every gear ratio k that leads to test results within the control range as defined in paragraph 2.3. of this annex.

In case of vehicles with automatic transmissions, adaptive transmissions and CVT's tested with non-locked gear ratios, the test may include a gear ratio change to a lower range and a higher acceleration. A gear change to a higher range and a lower acceleration is not allowed. A gear shift which leads to a condition that is not in compliance with the boundary conditions shall be avoided. In such a case, it is permitted to establish and use electronic or mechanical devices, including alternate gear selector positions.

2.5. Target conditions

The ~~noise sound~~ emission shall be measured in each valid gear ratio at the four test points as specified below.

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

The fourth test point P_4 is defined by the maximum vehicle speed at BB' in that gear ratio within the boundary conditions according to paragraph 2.3.

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

Test Point P_j : $v_{BB_j} = v_{BB_1} + ((j - 1) / 3) * (v_{BB_4} - v_{BB_1})$ for $j = 2$ and 3

Where:

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

v_{BB_4} = vehicle speed at BB' of test point P_4

Tolerance for v_{BB_j} : ± 3 km/h

For all test points the boundary conditions as specified in paragraph 2.3. shall be met.

2.6. Test of the vehicle

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

At line AA' the accelerator shall be fully depressed. To achieve a more stable acceleration or to avoid a down shift between line AA' and BB' pre-acceleration before line AA' may be used. The accelerator shall be kept in depressed condition until the rear of the vehicle reaches line BB' .

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

The maximum A-weighted sound pressure level of both sides of the vehicle, indicated during each passage of the vehicle between the two lines AA' and BB', shall be mathematically rounded to the first decimal place ($L_{wot,kj}$). If a sound peak obviously out of character with the general sound pressure level is observed, the measurement shall be discarded. Left and right side may be measured simultaneously or separately.

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

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

The calculated acceleration shall be determined in accordance to the formula in paragraph 3.1.2.1.2. of Annex 3 and reported to the second digit after the decimal place ($a_{wot,test,kj}$).

3. Analysis of results

3.1. Determination of the anchor point for each gear ratio

For measurements in gear i and lower, the anchor point consists of the maximum ~~noise sound~~ level L_{woti} , the reported engine speed n_{woti} and vehicle speed v_{woti} at BB' of gear ratio i of the acceleration test in Annex 3.

$$L_{anchor,i} = L_{woti,Annex\ 3}$$

$$n_{anchor,i} = n_{BB,woti,Annex\ 3}$$

$$v_{anchor,i} = v_{BB,woti,Annex\ 3}$$

~~For measurements in gear $i+1$ the anchor point consists of the maximum sound level L_{woti+1} , the reported engine speed n_{woti+1} and vehicle speed v_{woti+1} at BB' of gear ratio $i+1$ of the acceleration test in Annex 3.~~

~~$$L_{anchor,i+1} = L_{woti+1,Annex\ 3}$$~~

~~$$n_{anchor,i+1} = n_{BB,woti+1,Annex\ 3}$$~~

~~$$v_{anchor,i+1} = v_{BB,woti+1,Annex\ 3}$$~~

3.2. Slope of the regression line for each gear

The ~~noise sound~~ measurements shall be evaluated as function of engine speed according to paragraph 3.2.1.

3.2.1 Calculation of the slope of the regression line for each gear

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

$$Slope_k = \frac{\sum_{j=1}^5 (n_j - \bar{n})(L_j - \bar{L})}{\sum_{j=1}^5 (n_j - \bar{n})^2} \quad (\text{in dB/1000 min}^{-1})$$

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

where n_j = engine speed measured at line BB'

- 3.2.2 Slope of the regression line for each gear
- The Slope_k of a particular gear for the further calculation is the derived result of the calculation in paragraph 3.2.1 rounded to the first decimal place, but not higher than 5 dB/1000 min⁻¹."
- 3.3. Calculation of the linear **noise sound** level increase expected for each measurement
- The **noise sound** level $L_{ASEP,kj}$ for measurement point j and gear k shall be calculated using the engine speeds measured for each measurement point, using the slope specified in paragraph 3.2. above to the specific anchor point for each gear ratio.
- For $n_{BB,kj} \leq n_{anchor,k}$:
- $$L_{ASEP,kj} = L_{anchor,k} + (Slope_k - Y) * (n_{BB,kj} - n_{anchor,k}) / 1000$$
- For $n_{BB,kj} > n_{anchor,k}$:
- $$L_{ASEP,kj} = L_{anchor,k} + (Slope_k + Y) * (n_{BB,kj} - n_{anchor,k}) / 1000$$
- Where Y= 1
- 3.4. Samples
- On request of the type approval authority two additional runs within the boundary conditions according to paragraph 2.3. of this annex shall be carried out.
4. Interpretation of results
- Every individual noise measurement shall be evaluated.
- The sound level of every specified measurement point shall not exceed the limits given below:
- $$L_{kj} \leq L_{ASEP,kj} + x$$
- With:
- x = 3 dB(A) for vehicle with a non-lockable automatic transmission or non-lockable CVT
- x = 2 dB(A) + limit value - L_{urban} of Annex 3 for all other vehicles
- If the measured noise level at a point exceeds the limit, two additional measurements at the same point shall be carried out to verify the measurement uncertainty. The vehicle is still in compliance with ASEP, if the average of the three valid measurements at this specific point fulfils the specification.
5. Reference **noise sound** assessment
- The reference **noise sound** is assessed at a single point in one discrete gear, simulating an acceleration condition starting with an entry speed at v_{aa} equal to 50 km/h and assuming an exit speed at v_{bb} equal to 61 km/h. The **noise sound** compliance at this point can either be calculated using the results of paragraph 3.2.2. and the specification below or be evaluated by direct measurement using the gear as specified below.

- 5.1. The determination of gear k is as follows:
- $k = 3$ for all manual transmission and for automatic transmission with up to 5 gears;
- $k = 4$ for automatic transmission with 6 or more gears.
- If no discrete gears are available, e.g. for non-lockable automatic transmissions or non-lockable CVTs, the gear ratio for further calculation shall be determined from the acceleration test result in Annex 3 using the reported engine speed and vehicle speed at line BB'.
- 5.2. Determination of reference engine speed $n_{ref,k}$
- The reference engine speed, $n_{ref,k}$, shall be calculated using the gear ratio of gear k at the reference speed of $v_{ref} = 61$ km/h.
- 5.3. Calculation of L_{ref}
- $$L_{ref} = L_{anchor,k} + Slope_k * (n_{ref,k} - n_{anchor,k}) / 1000$$
- L_{ref} shall be less than or equal to 76 dB(A).
- For vehicles fitted with a manual gear box having more than four forward gears and equipped with an engine developing a maximum power greater than 140 kW (according to Regulation No. 85) and having a maximum-power/maximum-mass ratio greater than 75 kW/t, L_{ref} shall be less than or equal to 79 dB(A).
- For vehicles fitted with an automatic gear box having more than four forward gears and equipped with an engine developing a maximum power greater than 140 kW (according to Regulation No. 85) and having a maximum-power/maximum-mass ratio greater than 75 kW/t, L_{ref} shall be less than or equal to 78 dB(A).
6. Evaluation of ASEP using the principle of L_{Urban}
- 6.1. General
- This evaluation procedure is an alternative selected by the vehicle manufacturer to the procedure described in paragraph 3. of this annex and is applicable for all vehicle technologies. It is the responsibility of the vehicle manufacturer to determine the correct manner of testing. Unless otherwise specified, all testing and calculation shall be as specified in Annex 3 to this Regulation.
- 6.2. Calculation of L_{Urban_ASEP}
- From any L_{wot_ASEP} as measured according to this annex, L_{Urban_ASEP} shall be calculated as follows:
- Calculate $a_{wot_test_ASEP}$ using acceleration calculation from paragraph 3.1.2.1.2.1. or 3.1.2.1.2.2. of Annex 3 to this Regulation, as applicable;
 - Determine the vehicle speed (v_{BB_ASEP}) at BB during the L_{wot_ASEP} test;
 - Calculate kp_ASEP as follows:

$$kp_ASEP = 1 - (a_{urban} / a_{wot_test_ASEP})$$

Test results where $a_{wot_test_ASEP}$ are less than a_{urban} shall be disregarded.
 - Calculate $L_{Urban_Measured_ASEP}$ as follows:

$$L_{\text{Urban_Measured_ASEP}} = L_{\text{wot_ASEP}} - k_{\text{p_ASEP}} * (L_{\text{wot_ASEP}} - L_{\text{crs}})$$

For further calculation, use the L_{Urban} from Annex 3 to this Regulation without rounding, including the digit after the decimal (xx.x).

- (e) Calculate $L_{\text{Urban_Normalized}}$ as follows:

$$L_{\text{Urban_Normalized}} = L_{\text{Urban_Measured_ASEP}} - L_{\text{Urban}}$$

- (f) Calculate $L_{\text{Urban_ASEP}}$ as follows:

$$L_{\text{Urban_ASEP}} = L_{\text{Urban_Normalized}} - (0.15 * (V_{\text{BB_ASEP}} - 50))$$

- (g) Compliance with limits:

$L_{\text{Urban_ASEP}}$ shall be less than or equal to 3.0 dB.

Annex 10

Appendix

Statement of compliance with the Additional Sound Emission Provisions

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

..... (Name of manufacturer) attests that vehicles of this type
(type with regard to its noise emission pursuant to Regulation No. 51) comply with the requirements of paragraph 6.2.3. of Regulation No. 51.

..... (Name of manufacturer) makes this statement in good faith, after having performed an appropriate evaluation of the sound emission performance of the vehicles.

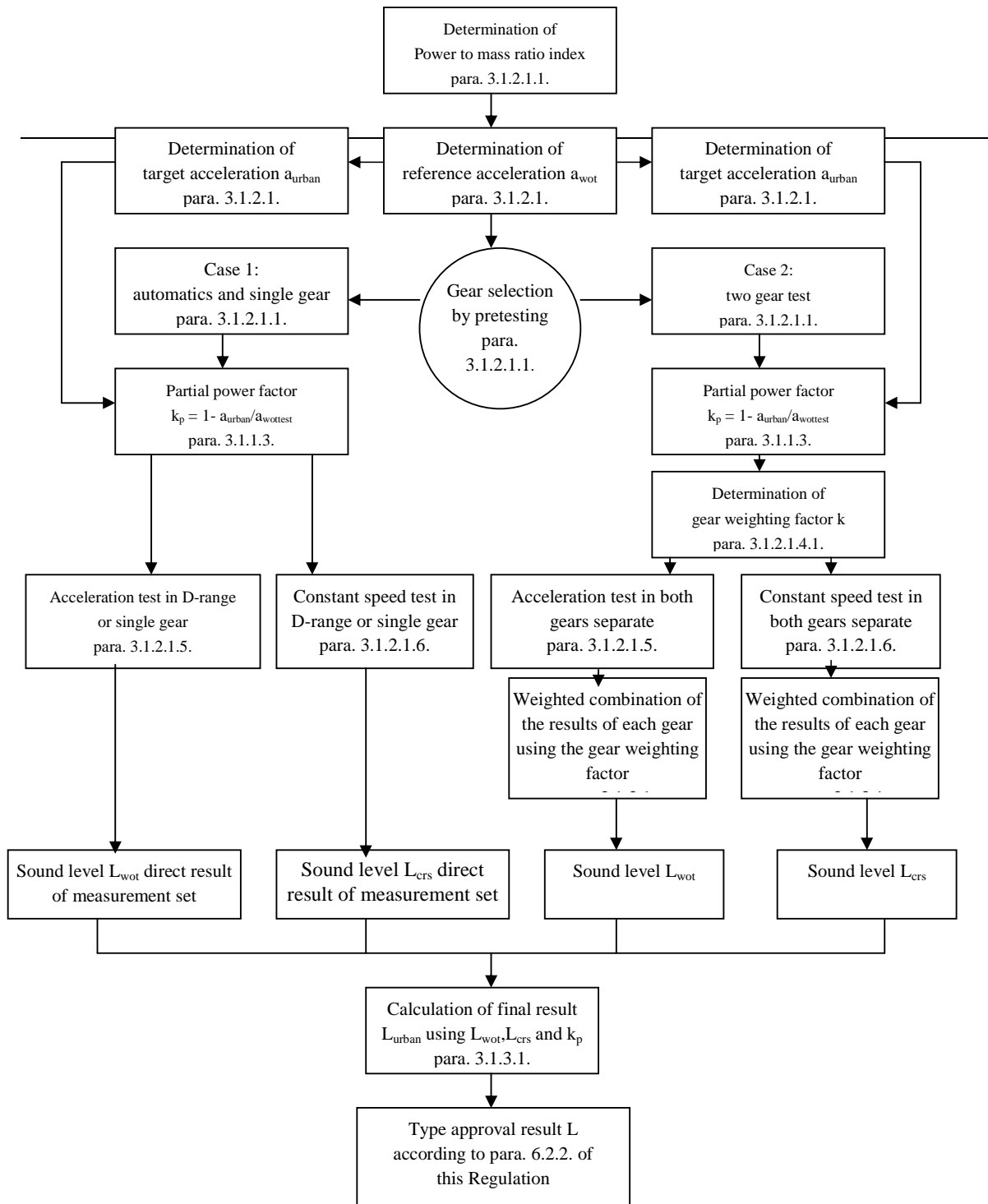
Date:

Name of authorized representative:

Signature of authorized representative:

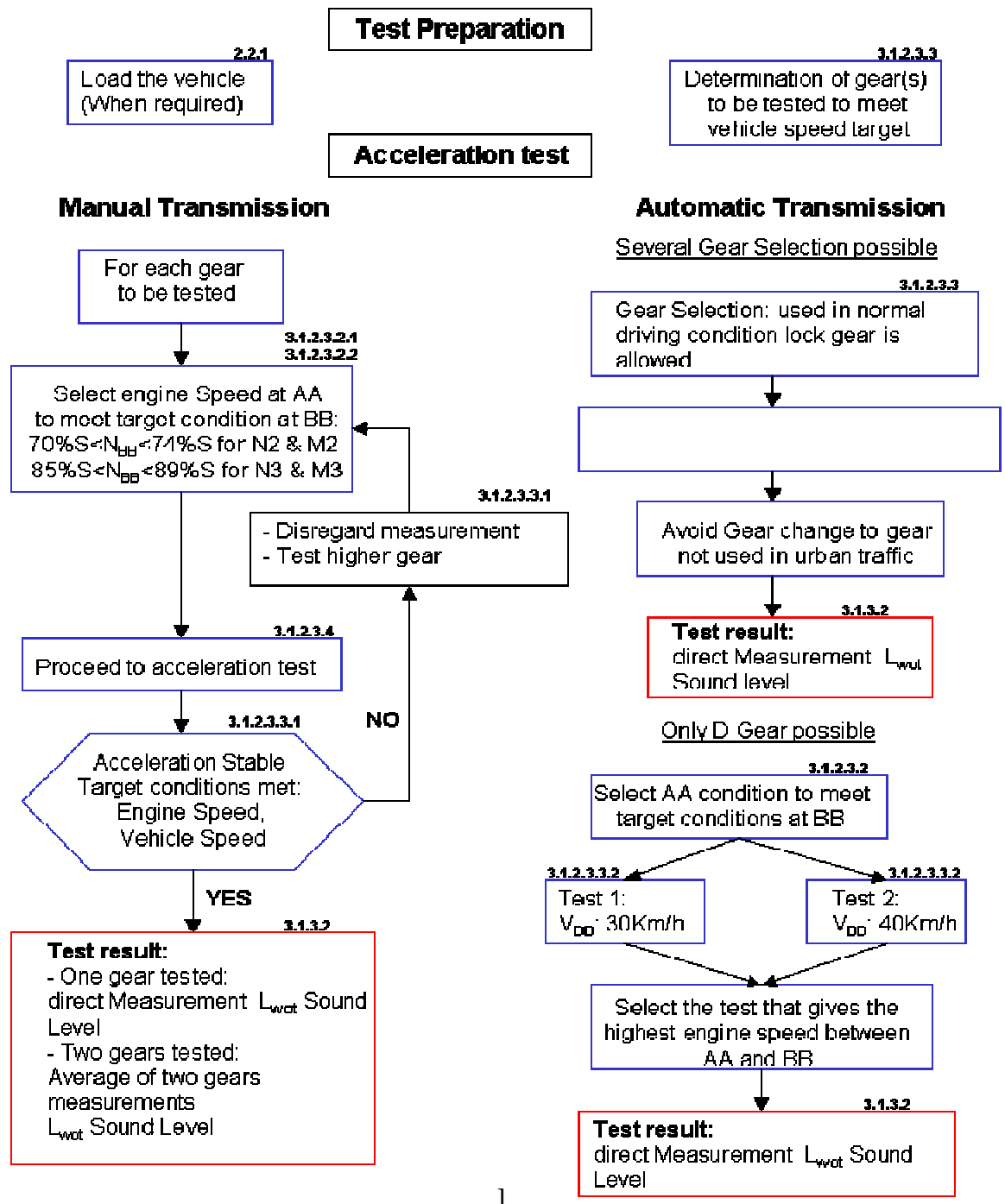
Annex 11

Example for measurement procedure for vehicles of category M_1, N_1 ,
 $M_2 \leq 3,500$ Kg all references to annex 3 except otherwise indicated



[Annex 12

[needs to be updated] Example for measurement procedure for vehicles of category $M_2 > 3,500$ Kg, N_2 , M_3 , N_3]



II. Justification

This document is based on TRANS/WP.29/GRB/2012/2 and intends to incorporate the following changes:

<i>Issue</i>	<i>Paragraphs effected</i>	<i>Reference document</i>
Wording Sound/Noise	Whole document	GRB-54-05
Update of ISO 10844 Test Track standard With ISO 10844:2011	Annex 8	GRB-54-06
Update of ISO 362 measurement method With 3 year review	Whole document, mainly Annex 3	GRB-54-06
