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### World Forum for Harmonization of Vehicle Regulations

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Item 4.6.2 of the provisional agenda

#### **1958 Agreement – Consideration of draft amendments to existing Regulations submitted by GRB**

### **Proposal for the 03 series of amendments to Regulation No. 51 (Noise of M and N categories of vehicles)**

#### **Submitted by the Working Party on Noise\***

The text reproduced below was adopted by the Working Party on Noise (GRB) at its sixtieth session (ECE/TRANS/WP.29/GRB/58, para. 5). It is based on ECE/TRANS/WP.29/GRB/2014/5, as amended by Annex III to ECE/TRANS/WP.29/GRB/58. It is submitted to the World Forum for Harmonization of Vehicle Regulations (WP.29) and to the Administrative Committee AC.1 for consideration.

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\* In accordance with the programme of work of the Inland Transport Committee for 2012–2016 (ECE/TRANS/224, para. 94 and ECE/TRANS/2012/12, 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.

## Regulation No. 51

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

#### **1. Scope**

This Regulation contains provisions on the sound emitted by motor vehicles and applies to vehicles of categories M and N.<sup>1</sup>

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

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<sup>1</sup> As defined in the Consolidated Resolution on the Construction of Vehicles (R.E.3.), document ECE/TRANS/WP.29/78/Rev.3, para. 2 - [www.unece.org/trans/main/wp29/wp29wgs/wp29gen/wp29resolutions.html](http://www.unece.org/trans/main/wp29/wp29wgs/wp29gen/wp29resolutions.html)

- 2.2.2.3. Vehicles having the same type of engine and/or different overall gear ratios may be regarded as vehicles of the same type;
- 2.3. However, if the differences in paragraph 2.2.2. provide for different target conditions, as described in paragraph 3.1.2.2. of Annex 3, these differences are to be considered as a change of type;
- 2.4. "*Mass of a vehicle in running order*" ( $m_{ro}$ ) means
- (a) In the case of a motor vehicle:

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

The mass of the vehicle including the fuel and liquids, fitted with the standard equipment in accordance with the manufacturer's specifications, and, when they are fitted, the mass of the bodywork, additional coupling(s), the spare wheel(s) and the tools.
- 2.5. "*Technically permissible maximum laden mass*" (M) means the maximum mass allocated to a vehicle on the basis of its construction features and its design performances; the technically permissible laden mass of a trailer or of a semi-trailer includes the static mass transferred to the towing vehicle when coupled;
- 2.6. "*Vehicle length*" means a dimension which is measured according to ISO standard 612-1978, term No. 6.1. In addition to the provisions of that standard, when measuring the vehicle structural length the following devices shall not be taken into account:
- (a) Wiper and washer devices;
  - (b) Front or rear marker-plates;
  - (c) Customs sealing devices and their protection;
  - (d) Devices for securing the tarpaulin and their protection;
  - (e) Lighting equipment;
  - (f) Rear view mirrors;
  - (g) Rear space watching aids;
  - (h) Air-intake pipes;
  - (i) Length stops for demountable bodies;
  - (j) Access steps;
  - (k) Ram rubbers;
  - (l) Lifting platforms, access ramps and similar equipment in running order, not exceeding 200 mm, provided that the loading capacity of the vehicle is not increased;
  - (m) Coupling devices for motor vehicles.

- 2.7. "*Vehicle width*" means a dimension which is measured according to ISO standard 612-1978, term No. 6.2. In addition to the provisions of that standard, when measuring the vehicle structural width the following devices shall not be taken into account:
- (a) Customs sealing devices and their protection;
  - (b) Devices for securing the tarpaulin and their protection;
  - (c) Tyre failure tell-tale devices;
  - (d) Protruding flexible parts of a spray-suppression system;
  - (e) Lighting equipment.
- 2.8. "*Rated maximum net power*"  $P_n$  means the engine power expressed in kW and measured by the method pursuant to Regulation No. 85.
- 2.9. "*Rated engine speed, S*" means the declared engine speed in  $\text{min}^{-1}$  (rpm) at which the engine develops its rated maximum net power pursuant to Regulation No. 85 or, where the rated maximum net power is reached at several engine speeds, the highest one of those speeds.
- 2.10. "*Power to mass ratio index (PMR)*" means a numerical quantity (see annex 3, paragraph 3.1.2.1.1.) with no dimension used for the calculation of acceleration.
- 2.11. "*Reference point*" means one of the following points:
- 2.11.1. In the case of vehicles of categories  $M_1$ ,  $N_1$  and  $M_2 \leq 3,500$  kg technically permissible maximum laden mass:
- (a) For front engine vehicles: the front end of the vehicle;
  - (b) For mid-engine vehicles: the centre of the vehicle;
  - (c) For rear engine vehicles: the rear end of the vehicle.
- 2.11.2. In the case of vehicles of categories  $M_2 > 3,500$  kg technically permissible maximum laden mass,  $M_3$ ,  $N_2$ ,  $N_3$ :
- The border of the engine closest to the front of the vehicle.
- 2.12. "*Engine*" means the power source without detachable accessories.
- 2.13. "*Target acceleration*" means acceleration at a partial throttle condition in urban traffic and is derived from statistical investigations.
- 2.14. "*Reference acceleration*" means the required acceleration during the acceleration test on the test track.
- 2.15. "*Gear ratio weighting factor k*" means a dimensionless numerical quantity used to combine the test results of two gear ratios for the acceleration test and the constant speed test.
- 2.16. "*Partial power factor  $k_p$* " means a numerical quantity with no dimension used for the weighted combination of the test results of the acceleration test and the constant speed test for vehicles.
- 2.17. "*Pre-acceleration*" means application of acceleration control device prior to AA' for the purpose of achieving stable acceleration between AA' and BB' as referred to in figure 1 of Appendix 1 to Annex 3.

- 2.18. *"Locked gear ratios"* means the control of transmission such that the transmission gear cannot change during a test.
- 2.19. *"Silencing system"* means a complete set of components necessary for limiting the noise produced by an engine and its exhaust.
- 2.20. *"Design family of silencing system or silencing system components"* means a group of silencing systems or components thereof in which all of the following characteristics are the same:
- (a) The presence of net gas flow of the exhaust gases through the absorbing fibrous material when in contact with that material;
  - (b) The type of the fibres;
  - (c) Where applicable, binder material specifications;
  - (d) Average fibre dimensions;
  - (e) Minimum bulk material packing density in kg/m<sup>3</sup>;
  - (f) Maximum contact surface between the gas flow and the absorbing material.
- 2.21. *"Silencing system of different types"* means silencing systems which significantly differ in respect of at least one of the following:
- (a) Trade names or trademarks of their components;
  - (b) The characteristics of the materials constituting their components, except for the coating of those components;
  - (c) The shape or size of their components;
  - (d) The operating principles of at least one of their components;
  - (e) The assembly of their components;
  - (f) The number of exhaust silencing systems or components.
- 2.22. *"Replacement silencing system"* means any part of the silencing system or its components intended for use on a vehicle, other than a part of the type fitted to this vehicle when submitted for type-approval pursuant to this Regulation.

### **3. Application for approval**

- 3.1. The application for approval of a vehicle type with regard to sound shall be submitted by its manufacturer or by his duly accredited representative.
- 3.2. It shall be accompanied by the undermentioned documents and the following particulars in triplicate:
- 3.2.1. A description of the vehicle type with regard to the items mentioned in paragraph 2.2. above. The numbers and/or symbols identifying the engine type and the vehicle type shall be specified;
  - 3.2.2. A list of the components, duly identified, constituting the sound reduction system;
  - 3.2.3. A drawing of the assembled sound reduction system and an indication of its position on the vehicle;

- 3.2.4. Detailed drawings of each component to enable it to be easily located and identified, and a specification of the materials used.
- 3.2.5. A technical information document including the information as outlined in Annex 1.
- 3.3. In the case of paragraph 2.2.2. the single vehicle, representative of the type in question, will be selected by the Technical Service conducting approval tests, in accordance with the vehicle manufacturer, as that with the lowest mass in running order with the shortest length and following the specification laid down in paragraph 3.1.2.2. in Annex 3.
- 3.4. At the request of the Technical Service conducting approval tests, the vehicle manufacturer shall, in addition, submit a sample of the sound reduction system and an engine of at least the same cylinder capacity and rated maximum net power as that fitted to the vehicle in respect of which type-approval is sought.
- 3.5. The competent authority shall verify the existence of satisfactory arrangements for ensuring effective control of the conformity of production before type approval is granted.

## **4. Markings**

- 4.1. The components of the sound reduction system, excluding fixing hardware and piping, shall bear:
  - 4.1.1. The trade name or mark of the manufacturer of the 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.
- 4.3. A component may carry several approval numbers if it has been approved as component of several replacement silencing systems.

## **5. Approval**

- 5.1. Type approval shall only be granted if the vehicle type meets the requirements of paragraphs 6. and 7. below.
- 5.2. An approval number shall be assigned to each type approved. Its first two digits (at present 03 corresponding to the 03 series of amendments) shall indicate the series of amendments incorporating the most recent major technical amendments made to the Regulation at the time of issue of the approval. The same Contracting Party shall not assign the same number to another vehicle type.
- 5.3. Notice of approval or of extension or of refusal or withdrawal of approval or of production definitively discontinued of a vehicle type pursuant to this Regulation shall be communicated to the Parties to the Agreement applying this Regulation, by means of a form conforming to the model in Annex 1 to this Regulation.

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

## 6. Specifications

- 6.1. General specifications
- 6.1.1. The vehicle, its engine and its sound reduction system shall be so designed, constructed and assembled as to enable the vehicle, in normal use, despite the vibration to which it may be subjected, to comply with the provisions of this Regulation.
- 6.1.2. The sound reduction system shall be so designed, constructed and assembled as to be able to reasonably resist the corrosive phenomena to which it is exposed having regard to the conditions of use of the vehicle, including regional climate differences.
- 6.2. Specifications regarding sound levels
- 6.2.1. Methods of measurement
- 6.2.1.1. The 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 stationary<sup>3</sup>; in the case of a vehicle where an internal combustion engine cannot operate when the vehicle is stationary, the emitted sound shall only be measured in motion. In the case

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<sup>2</sup> The distinguishing numbers of the Contracting Parties to the 1958 Agreement are reproduced in Annex 3 to the Consolidated Resolution on the Construction of Vehicles (R.E.3), document ECE/TRANS/WP.29/78/Rev. 3, Annex 3 - [www.unece.org/trans/main/wp29/wp29wgs/wp29gen/wp29resolutions.html](http://www.unece.org/trans/main/wp29/wp29wgs/wp29gen/wp29resolutions.html)

<sup>3</sup> 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.

of a hybrid electrical vehicle of category M<sub>1</sub> where an internal combustion engine cannot operate when the vehicle is stationary, the emitted sound shall be measured according to Annex 3, paragraph 4.

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

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

6.2.2. Sound level limits

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

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

6.2.2.1. For vehicle types of category M<sub>1</sub> derived from N<sub>1</sub> vehicle types having a technically permissible maximum laden mass above 2.5 tons and a R-point height greater than 850 mm from the ground, the limits of vehicles types of category N<sub>1</sub> having a technically permissible maximum laden mass above 2.5 tons apply.



6.2.2.2. For vehicle types designed for off-road<sup>4</sup> use, the limit values shall be increased by 2 dB(A) for M<sub>3</sub> and N<sub>3</sub> vehicles category and 1 dB(A) for any other vehicle category.

For vehicle types of category M<sub>1</sub> the increased limit values for off-road vehicles are only valid if the technically permissible maximum laden mass > 2 tons.

6.2.2.3. Limit values shall be increased by 2 dB(A) for wheelchair accessible vehicles of category M<sub>1</sub> constructed or converted specifically so that they accommodate one or more persons seated in their wheelchairs when travelling on the road, and armoured vehicles, as defined in paragraph 2.5.2. of R.E.3.

6.2.2.4. For vehicle types of category M<sub>3</sub> having a gasoline only engine, the applicable limit value is increased by 2 dB(A).

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

6.2.3. Additional sound emission provisions

The additional sound emission provisions (ASEP) apply only to vehicles of categories M<sub>1</sub> and N<sub>1</sub> equipped with an internal combustion engine.

Vehicles are deemed to fulfil the requirements of Annex 7, if the vehicle manufacturer provides technical documents to the type approval authority showing, that the difference between maximum and minimum engine speed of the vehicles at BB' for any test condition inside the ASEP control range defined in paragraph 3.3. of Annex 7 to this Regulation (including Annex 3 conditions) does not exceed 0.15 x S. This article is intended especially for non-lockable transmissions with variable gear ratios (CVT).

Vehicles of category N<sub>1</sub> are exempted from ASEP if one of the following conditions is fulfilled:

- (a) The engine capacity does not exceed 660 cc and the power-to-mass ratio PMR calculated by using the technically permissible maximum laden mass does not exceed 35.
- (b) The payload is at least 850 kg and the power-to-mass ratio calculated by using the technically permissible maximum laden mass does not exceed 40.

The sound emission of the vehicle under typical on-road driving conditions, which are different from those under which the type-approval test set out in Annex 3 and Annex 7 was carried out, shall not deviate from the test result in a significant manner.

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<sup>4</sup> As defined in the Consolidated Resolution on the Construction of Vehicles (R.E.3.), document ECE/TRANS/WP.29/78/Rev.3, para. 2 - [www.unece.org/trans/main/wp29/wp29wgs/wp29gen/wp29resolutions.html](http://www.unece.org/trans/main/wp29/wp29wgs/wp29gen/wp29resolutions.html)

- 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 sound emission requirements as specified under this Regulation which is not operational during typical on-road operation.
- 6.2.3.2. The vehicle shall meet the requirements of Annex 7 to this Regulation.
- 6.2.3.3. In applying for type approval, the manufacturer shall provide a statement, in conformity with the Appendix of Annex 7, 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. Requirements of Annex 4 shall be applied.

## **7. Modification and extension of approval of a vehicle type**

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

## **8. Conformity of production**

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 of paragraph 6. above.
- 8.2. The minimum requirements for conformity of production control procedures of Annex 6 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 definitively discontinued**

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

## **11. Transitional provisions**

- 11.1. As from the official date of entry into force of the 03 series of amendments to this Regulation, no Contracting Party applying this Regulation shall refuse to grant or refuse to accept type-approvals under this Regulation as amended by the 03 series of amendments.
- 11.2. Transitional Provisions for Phase 1 (see paragraph 6.2.2. above)
  - 11.2.1. As from 1 July 2016, Contracting Parties applying this Regulation shall grant type-approvals only if the vehicle type to be approved meets the requirements of phase 1 (see paragraph 6.2.2. above) of this Regulation as amended by the 03 series of amendments.

As from the official date of entry into force of the 03 series of amendments, Contracting Parties applying this Regulation shall grant type approvals to the vehicle type which meets the requirements of phase 2 or phase 3 of this Regulation as amended by the 03 series of amendments.
  - 11.2.2. Contracting Parties applying this Regulation shall not refuse to grant extensions of type approvals for existing types which have been granted according to the 02 series of amendments to this Regulation.
  - 11.2.3. Until 1 July 2022, no Contracting Party applying this Regulation shall refuse national or regional type approval of a vehicle type-approved to the 02 series of amendments to this Regulation.
  - 11.2.4. As from 1 July 2022, Contracting Parties applying this Regulation shall not be obliged to accept for the purpose of national or regional type approval, a vehicle type approved to the preceding series of amendments to this Regulation.
  - 11.2.5. Even after the date of entry into force of the 03 series of amendments to this Regulation, Contracting Parties applying this Regulation may continue for national or regional purposes granting type approvals and extensions of type approvals to the preceding series of amendments to this Regulation.

- 11.3. Transitional Provisions for Phase 2 (see paragraph 6.2.2. above)
- 11.3.1. As from 1 July 2020 for vehicle types other than N<sub>2</sub> and as from 1 July 2022 for vehicles types of category N<sub>2</sub>, Contracting Parties applying this Regulation shall grant type approvals only if the vehicle type to be approved meets the requirements of phase 2 (see paragraph 6.2.2. above) of this Regulation as amended by the 03 series of amendments.
- Furthermore, as from the official date of entry into force of the 03 series of amendments, Contracting Parties applying this Regulation shall grant type approvals to the vehicle type which meets the requirements of phase 3 of this Regulation as amended by the 03 series of amendments.
- 11.3.2. Contracting Parties applying this Regulation shall not refuse to grant extensions of type approvals for existing types which have been granted according to phase 1 (see paragraph 6.2.2. above) or the 02 series of amendments to this Regulation.
- 11.3.3. Until 1 July 2022 for vehicle types other than N<sub>2</sub> and as from 1 July 2023 for vehicles types of category N<sub>2</sub>, no Contracting Party applying this Regulation shall refuse national or regional type approval of a vehicle type-approved to phase 1 (see paragraph 6.2.2. above) or the 02 series of amendments to this Regulation.
- 11.3.4. As from 1 July 2022 for vehicle types other than N<sub>2</sub> and as from 1 July 2023 for vehicles types of category N<sub>2</sub>, Contracting Parties applying this Regulation shall not be obliged to accept for the purpose of national or regional type approval, a vehicle type approved to phase 1 (see paragraph 6.2.2.1. above) or the preceding series of amendments to this Regulation.
- 11.3.5. Even after the date of entry into force of the 03 series of amendments to this Regulation, Contracting Parties applying this Regulation may continue for national or regional purposes granting type approvals and extensions of type approvals to phase 1 (see paragraph 6.2.2. above) or the preceding series of amendments to this Regulation.
- 11.4. Transitional Provisions for Phase 3 (see paragraph 6.2.2. above)
- 11.4.1. As from 1 July 2024 for vehicle types other than N<sub>2</sub>, N<sub>3</sub> and M<sub>3</sub> and as from 1 July 2026 for vehicles types of category N<sub>2</sub>, N<sub>3</sub> and M<sub>3</sub>, Contracting Parties applying this Regulation shall grant type-approvals only if the vehicle type to be approved meets the requirements of phase 3 (see paragraph 6.2.2. above) of this Regulation as amended by the 03 series of amendments.
- 11.4.2. Contracting Parties applying this Regulation shall not refuse to grant extensions of type approvals for existing types which have been granted according to phase 2 according to paragraph 6.2.2. above.
- 11.4.3. Until 1 July 2026 for vehicle types other than N<sub>2</sub>, N<sub>3</sub> and M<sub>3</sub> and as from 1 July 2027 for vehicles types of category N<sub>2</sub>, N<sub>3</sub> and M<sub>3</sub>, no Contracting Party applying this Regulation shall refuse national or regional type approval of a vehicle type-approved to phase 2 according to paragraph 6.2.2. above.
- 11.4.4. As from 1 July 2026 for vehicle types other than N<sub>2</sub>, N<sub>3</sub> and M<sub>3</sub> and as from for vehicles types of category N<sub>2</sub>, N<sub>3</sub> and M<sub>3</sub>, Contracting Parties applying this Regulation shall not be obliged to accept for the purpose of national or regional type approval, a vehicle type approved to phase 2 according to paragraph 6.2.2. above.

- 11.4.5. Even after the date of entry into force of the 03 series of amendments to this Regulation, Contracting Parties applying this Regulation may continue for national or regional purposes granting type approvals and extensions of type approvals to phase 1 or phase 2 (see paragraph 6.2.2. above) or the preceding series of amendments to this Regulation.
- 11.5. Notwithstanding the transitional provisions above, Contracting Parties whose application of this Regulation comes into force after the date of entry into force of the most recent series of amendments are not obliged to accept type approvals which were granted in accordance with any of the preceding series of amendments to this Regulation.
- 11.6. Until 30 June 2019, vehicles with a serial hybrid drive train which have a combustion engine with no mechanical coupling to the power train are excluded from the requirements of paragraph 6.2.3. above.
- 11.7. Until 30 June 2019, Contracting Parties applying this Regulation can continue to grant approvals using test sites which comply with the specifications of the preceding series of amendments to this Regulation as an alternative to Annex 3, paragraph 2.1. of this Regulation.

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

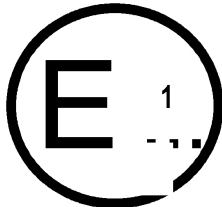
The Contracting Parties to the 1958 Agreement applying this Regulation shall communicate to the United Nations Secretariat the names and addresses of the Technical Services responsible for conducting approval tests and of the Type Approval Authorities which grant approval and to which forms certifying 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:



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.....  
.....

concerning:<sup>2</sup> Approval granted  
Approval extended  
Approval refused  
Approval withdrawn  
Production definitively discontinued

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

Approval No. ....

Extension No. ....

#### SECTION I

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

#### SECTION II

- 1. Additional information (where applicable): See Addendum
- 2. Technical service responsible for carrying out the tests:

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

<sup>2</sup> Delete what does not apply.

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

<sup>4</sup> As defined in the R.E.3.

3. Date of test report:
4. Number of test report:
5. Remarks (if any): See Addendum
6. Place:
7. Date:
8. Signature:
9. Reasons for Extensions:

## Attachments:

- Information package
- Test report(s)

### Addendum to the communication form No ...

1. Additional information
  - 1.1. Power plant
    - 1.1.1. Manufacturer of the engine:
    - 1.1.2. Manufacturer's engine code:
    - 1.1.3. Rated maximum net power: ..... kW at ..... min<sup>-1</sup>  
or maximum continuous rated power (electric motor) ..... kW<sup>(2)</sup>
    - 1.1.4. Pressure charger(s), Make and Type:
    - 1.1.5. Air filter, Make and Type:
    - 1.1.6. Intake silencer(s), Make and Type:
    - 1.1.7. Exhaust Silencer(s), Make and Type:
    - 1.1.8. Catalyst(s), Make and Type:
    - 1.1.9. Particulate Trap(s), Make and Type:
  - 1.2. Transmission
    - 1.2.1. Type (mechanical, hydraulic, electric, etc.):
  - 1.3. Non-engine devices designed to reduce noise:
2. Test results
  - 2.1. Sound level of moving vehicle: ..... dB(A)
  - 2.2. Sound level of stationary vehicle: ..... dB(A) at ..... min<sup>-1</sup>
    - 2.2.1. Sound level of compressed air, service brake: ..... dB(A)
    - 2.2.2. Sound level of compressed air, parking brake: ..... dB(A)
    - 2.2.3. Sound level of compressed air, during the pressure regulator actuation: ..... dB(A)
  - 2.3. Data to facilitate in-use compliance test of hybrid vehicles, where an internal combustion engine cannot operate when the vehicle is stationary
    - 2.3.1. Gear (i) or position of the gear selector chosen for the test:

- 2.3.2. Position of the operating switch during measurement  $L_{wot}$  (i), (if switch is fitted)
- 2.3.3. Pre-acceleration length  $l_{PA}$  (Point of the acceleration depression in meter before line AA')
- 2.3.5. Sound pressure level  $L_{wot}$  (i) ..... dB(A)
- 3. Remarks

## Technical Information Document

- 0. General
  - 0.1. Make (trade name of manufacturer):
  - 0.2. Means of identification of type, if marked on the vehicle<sup>3</sup>:
    - 0.2.1. Location of that marking:
  - 0.3. Category of vehicle<sup>4</sup>:
  - 0.4. Company name and address of manufacturer:
  - 0.5. Name and address of the manufacturer's representative (if any):
  - 0.6. Name(s) and Address(es) of assembly plant(s):
- 1. General construction characteristics of the vehicle
  - 1.1. Photographs and/or drawings of a representative vehicle:
  - 1.2. Number of axles and wheels: <sup>5</sup>
    - 1.2.1. Powered axles (number, position, interconnection):
  - 1.3. Position and arrangement of the engine:
- 2. Masses and dimensions<sup>6</sup> (in kg and mm) (Refer to drawing where applicable):
  - 2.1. Range of vehicle dimensions (overall):
    - 2.1.1. For chassis without bodywork:
      - 2.1.1.1. Length:
      - 2.1.1.2. Width:
    - 2.1.2. For chassis with bodywork
      - 2.1.2.1. Length:
      - 2.1.2.2. Width:

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<sup>5</sup> Only for the purpose of defining "off-road vehicles".

<sup>6</sup> Standard ISO 612: 1978 — Road vehicles — Dimensions of motor vehicles and towed vehicles - terms and definitions.

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

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



- 2.2. Mass in running order<sup>7</sup>
- (a) Minimum and maximum for each variant:
- (b) Mass of each version (a matrix shall be provided):
- 2.3. Technically permissible maximum laden mass stated by the manufacturer: <sup>8,9</sup>
3. Power plant <sup>10</sup>
- 3.1. Manufacturer of the engine:
- 3.1.1. Manufacturer's engine code (as marked on the engine, or other means of identification):
- 3.2. Internal combustion engine
- 3.2.1. Specific engine information
- 3.2.1.1. Working principle: positive ignition/compression ignition, cycle four stroke/two stroke/rotary<sup>2</sup>
- 3.2.1.2. Number and arrangement of cylinders:
- 3.2.1.2.1. Firing order:
- 3.2.1.3. Engine capacity: <sup>11</sup> .... cm<sup>3</sup>
- 3.2.1.4. Rated maximum net power: .... kW at .... min<sup>-1</sup> (manufacturer's declared value)
- 3.2.2. Fuel feed
- 3.2.2.1. By fuel injection (compression ignition only): yes/no <sup>2</sup>
- 3.2.2.1.1. Working principle: Direct injection/pre-chamber/swirl chamber <sup>2</sup>
- 3.2.2.1.2. Governor
- 3.2.2.1.2.1. Type:
- 3.2.2.1.2.2. Speed at which Cut-off starts under load: .... min<sup>-1</sup>
- 3.2.2.2. By fuel injection (positive ignition only): yes/no<sup>2</sup>
- 3.2.2.2.1. Working principle: Intake manifold (single-/multi-point<sup>2</sup>)/direct injection/other (specify) <sup>2</sup>
- 3.2.3. Intake system

<sup>7</sup> The mass of the driver is assessed at 75 kg. The liquid containing systems (except those for used water that shall remain empty) are filled to 90 per cent of the capacity specified by the manufacturer. The information referred to in points 2.2. (b) do not need to be provided for vehicle categories N<sub>2</sub>, N<sub>3</sub>, M<sub>2</sub> and M<sub>3</sub>.

<sup>8</sup> For vehicles coupled with a trailer or a semi-trailer, which exert a significant vertical load on the coupling device or the fifth wheel, this load, divided by standard acceleration of gravity, is included in the maximum technically permissible mass. Please fill in here the upper and lower values for each variant.

<sup>9</sup> Please fill in here the upper and lower values for each variant.

<sup>10</sup> In the case of a vehicle that can run either on petrol, diesel, etc., or also in combination with another fuel, items shall be repeated. In the case of non-conventional engines and systems, particulars equivalent to those referred here shall be supplied by the manufacturer.

<sup>11</sup> This value shall be calculated ( $\pi = 3.1416$ ) and rounded off to the nearest cm<sup>3</sup>.

- 3.2.3.1. Air filter, drawings, or
  - 3.2.3.1.1. Make(s):
  - 3.2.3.1.2. Type(s):
- 3.2.3.2. Intake silencer, drawings,
  - 3.2.3.2.1. Make(s):
  - 3.2.3.2.2. Type(s):
- 3.2.4. Exhaust system
  - 3.2.4.1. Description and/or drawing of the exhaust system:
  - 3.2.4.2. Exhaust silencer(s):
    - Type, marking of exhaust silencer(s):
    - Where relevant for exterior noise, reducing measures in the engine compartment and on the engine:
  - 3.2.4.3. Location of the exhaust outlet:
  - 3.2.4.4. Exhaust silencer containing fibrous materials:
- 3.2.5. Catalytic convertor: yes/no <sup>2</sup>
  - 3.2.5.1. Number of catalytic convertors and elements (provide the information below for each separate unit):
- 3.3. Electric motor
  - 3.3.1. Type (winding, excitation):
    - 3.3.1.1. Maximum hourly output: .... kW
    - 3.3.1.2. Operating voltage: .... V
- 3.4. Engine or motor combination:
  - 3.4.1. Hybrid electric vehicle: yes/no <sup>2</sup>
  - 3.4.2. Category of hybrid electric vehicle: off-vehicle charging/not off-vehicle charging: <sup>2</sup>
  - 3.4.3. Operating mode switch: with/without <sup>2</sup>
    - 3.4.3.1. Selectable modes
      - 3.4.3.1.1. Pure electric: yes/no<sup>2</sup>
      - 3.4.3.1.2. Pure fuel consuming: yes/no<sup>2</sup>
      - 3.4.3.1.3. Hybrid modes: yes/no<sup>2</sup> (if yes, short description):
  - 3.4.4. Electric motor (describe each type of electric motor separately)
    - 3.4.4.1. Make:
    - 3.4.4.2. Type:
    - 3.4.4.3. Rated maximum net power: ..... kW

4. Transmission<sup>12</sup>
- 4.1. Type (mechanical, hydraulic, electric, etc.):
- 4.2. Gear ratios

<i>Gear</i>	<i>Internal gearbox ratios (ratios of engine to gearbox output shaft revolutions)</i>	<i>Final drive ratio(s) (ratio of gearbox output shaft to driven wheel revolutions)</i>	<i>Total gear ratios</i>
Maximum for CVT <sup>13</sup>			
1			
2			
3			
...			
Minimum for CVT			
Reverse			

- 4.3. Maximum vehicle design speed (in km/h):<sup>14</sup> .....
5. Suspension
- 5.1. Tyres and wheels
- 5.1.1. Tyre/wheel combination(s)
- (a) For tyres indicate size designation, load-capacity index and speed category symbol;
- (b) For wheels indicate rim size(s) and off-set(s).
- 5.1.2. Upper and lower limits of rolling radii
- 5.1.2.1. Axle 1:
- 5.1.2.2. Axle 2:
- 5.1.2.3. Axle 3:
- 5.1.2.4. Axle 4:
- etc.
6. Bodywork
- 6.1. Type of bodywork:
- 6.2. Materials used and methods of construction:
7. Miscellaneous
- 7.1. Details of any non-engine devices designed to reduce noise (if not covered by other items):

Signed:

Position in company:

Date:

<sup>12</sup> The specified particulars are to be given for any proposed variants.

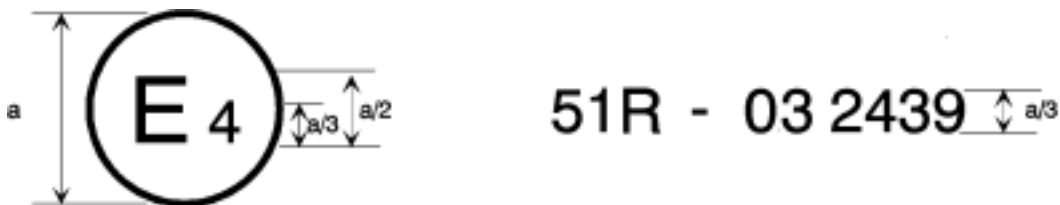
<sup>13</sup> Continuous Variable Transmission (CVT): transmission with variable gear ratios.

<sup>14</sup> With respect to trailers, maximum speed permitted by the manufacturer.

## Annex 2

### Arrangements of the approval mark

Model A  
(See paragraph 5.4. of this Regulation)

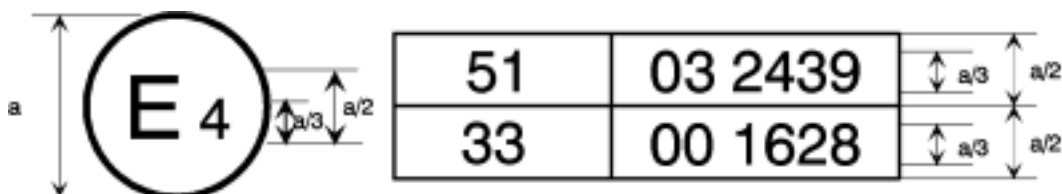


$a = 8 \text{ mm min.}$

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

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)



$a = 8 \text{ mm min.}$

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.<sup>1</sup> 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.

<sup>1</sup> The latter number is given as an example only.

## Annex 3

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

#### 1. Measuring instruments

##### 1.1. Acoustic measurements

The apparatus used for measuring the sound level shall be a precision sound-level meter or equivalent measurement system meeting the requirements of class 1 instruments (inclusive of the recommended windscreen, if used). These requirements are described in "IEC 61672-1:2002: 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 to the instructions of the instrument manufacturer.

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

At the beginning and at the end of every measurement session the entire measurement system shall be checked by means of a sound calibrator that fulfils the requirements for sound calibrators of at least precision Class 1 according to IEC 60942:2003. 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.

##### 1.3. Compliance with requirements

Compliance of the acoustic measurement instrumentation shall be verified by the existence of a valid certificate of compliance. These certificates shall be deemed to be valid if certification of compliance with the standards was conducted within the previous 12 month period for the sound calibration device and within the previous 24 month period for the instrumentation system. All compliance testing shall be conducted by a laboratory, which is authorized to perform calibrations traceable to the appropriate standards.

##### 1.4. Instrumentation for speed measurements

The engine speed shall be measured with instrumentation having an accuracy of  $\pm 2$  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  $\pm 0.5$  km/h, when using continuous measurement devices.

If testing uses independent measurements of speed, this instrumentation shall meet specification limits of at least  $\pm 0.2$  km/h.

1.5. Meteorological instrumentation

The meteorological instrumentation used to monitor the environmental conditions during the test shall include the following devices, which meet at least the given accuracy:

- (a) Temperature measuring device,  $\pm 1$  °C;
- (b) Wind speed-measuring device,  $\pm 1.0$  m/s;
- (c) Barometric pressure measuring device,  $\pm 5$  hPa;
- (d) A relative humidity measuring device,  $\pm 5$  per cent.

2. Conditions of measurement

2.1. Test Site and ambient conditions

The surface of the test track and the dimensions of the test site shall be in accordance with ISO 10844:2011.

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

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

The meteorological instrumentation should be positioned adjacent to the test area at a height of  $1.2 \text{ m} \pm 0.02 \text{ m}$ . 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 sound measurement interval.

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

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

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

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

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

## 2.2. Vehicle

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

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

Measurements shall be made on vehicles at the test mass  $m_t$  specified according to the following table:

<i>Vehicle category</i>	<i>Vehicle test mass</i>
M <sub>1</sub>	$m_t = m_{r0}$
N <sub>1</sub>	$m_t = m_{r0}$
N <sub>2</sub> , N <sub>3</sub>	<p><math>m_t = 50</math> kg per kW rated engine maximum net power</p> <p>Extra loading to reach the test mass of the vehicle shall be placed above the driven rear axle(s). The extra loading is limited to 75 per cent of the technically permissible maximum laden mass allowed for the rear axle. The test mass shall be achieved with a tolerance of <math>\pm 5</math> per cent.</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 front axle and the rear axle load in an unladen condition plus the extra loading.</p> <p>The test mass for vehicles with more than two axles shall be the same as for a two-axle vehicle.</p>
M <sub>2</sub> , M <sub>3</sub>	<p><math>m_t = m_{r0}</math> – mass of the crew member (if applicable) or, if the tests are carried out to an incomplete vehicle not having a bodywork,</p> <p><math>m_t = 50</math> kg per kW rated engine maximum net power respectively in compliance with conditions above (see N<sub>2</sub>, N<sub>3</sub> category).</p>

2.2.2. At the applicant's request the vehicle of a category M<sub>2</sub>, M<sub>3</sub>, N<sub>2</sub> or N<sub>3</sub> is deemed representative of its completed type if the tests are carried out to an incomplete vehicle not having a bodywork. In the test of an incomplete vehicle all relevant soundproofing materials, panels and noise reduction components and systems shall be fitted on the vehicle as designed by the manufacturer except a part of bodywork which is built in a later stage.

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

The tyres to be used for the test shall be representative for the vehicle and shall be selected by the vehicle manufacturer and recorded in Addendum to the Communication form (Annex 1, Addendum). 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.<sup>1</sup> The tyres shall be inflated to the pressure recommended by the vehicle manufacturer for the test mass of the vehicle. The tyres shall have at least 1.6 mm tread depth.

- 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 4.

### 3. Methods of testing

#### 3.1. Measurement of sound 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 ± 0.05 m forward and 10 m ± 0.05 m rearward of line PP' shall be marked out on the test runway.

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 ± 0.05 m from the reference line CC' of the track and 1.2 m ± 0.02 m above the ground.

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 M<sub>1</sub>, M<sub>2</sub> ≤ 3,500 kg technically permissible maximum laden mass, N<sub>1</sub>

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

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



## 3.1.2.1.1. Power to mass ratio index (PMR)

PMR is defined as follows:

$PMR = (P_n / m_i) * 1000 \text{ kg/kW}$ , where  $P_n$  is measured in kW and  $m_i$  is measured in kg according to paragraph 2.2.1. of this annex.

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

## 3.1.2.1.2. Calculation of acceleration

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

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

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

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

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

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

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

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

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

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

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

Pre-acceleration may be used.

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

$$a_{wot\ test\ PP-BB} = ((v_{BB'}/3.6)^2 - (v_{PP'}/3.6)^2) / (2*(10+l))$$

Pre-acceleration shall not be used.

<sup>2</sup> See Annex 3, Appendix, Figure 1.

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

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

The reference acceleration  $a_{\text{wot ref}}$  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  $M_1$  and  $N_1$  and  $M_2 \leq 3,500$  kg technically permissible maximum laden mass

In cases other than a single gear test,  $a_{\text{wot ref}}$  shall be used instead of  $a_{\text{wot test}}$  (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  $a_{\text{wot}}$  under full throttle condition, according to the reference acceleration  $a_{\text{wot ref}}$  required for the full throttle acceleration test.

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

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

The following conditions for selection of gear ratios are possible:

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

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

- (c) If the acceleration value of gear ratio  $i$  exceeds  $2.0 \text{ m/s}^2$ , the first gear ratio shall be used that gives an acceleration below  $2.0 \text{ m/s}^2$  unless gear ratio  $i+1$  provides acceleration less than  $a_{\text{urban}}$ . In this case, two gears,  $i$  and  $i+1$  shall be used, including the gear  $i$  with acceleration exceeding  $2.0 \text{ m/s}^2$ . In other cases, no other gear shall be used. The achieved acceleration  $a_{\text{wot test}}$  during the test shall be used for the calculation of the part power factor  $k_p$  instead of  $a_{\text{wot ref}}$ .
- (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  $a_{\text{wot ref}}$ .
- (e) If rated engine speed is exceeded in a gear ratio before the vehicle passes BB' the next higher gear shall be used.

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

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

The acceleration value  $a_{\text{wot test}}$  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 for the specified test condition in urban traffic.

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

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

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

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 Addendum to the Communication form (Annex 1, Addendum). The Technical Service shall have the possibility of pretesting.

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

## 3.1.2.1.6. Constant speed test

The constant speed test shall be carried out with the same gear(s) specified for the acceleration test and a constant speed of 50 km/h with a tolerance of  $\pm 1$  km/h between AA' and BB'. During the constant speed test the acceleration control shall be positioned to maintain a constant speed between AA' and BB' as specified. If the gear is locked for the acceleration test, the same gear shall be locked for the constant speed test.

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

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

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

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

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

Target conditions of category  $M_3$ ,  $N_3$ :

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

## 3.1.2.2.1. Gear ratio selection

## 3.1.2.2.1.1. Vehicles with 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  $v_{\text{test}}$ , two gears shall be tested, one above and one below  $v_{\text{test}}$ . 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 shall be disregarded.

## 3.1.2.2.1.2. Vehicles with automatic transmissions, adaptive transmissions 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 fulfil 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 shall 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.

#### 3.1.3. Interpretation of results

The maximum A-weighted sound pressure level indicated during each passage of the vehicle between the two lines AA' and BB' shall be noted. If a sound peak obviously out of character with the general sound pressure level is observed, the measurement shall be discarded. At least four measurements for each test condition shall be made on each side of the vehicle and for each gear ratio. Left and right 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 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 speed measurements at AA', BB', and PP' shall be noted and used in calculations to the first significant digit after the decimal place.

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

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

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  $M_2 > 3,500$  kg technically permissible maximum laden mass,  $M_3$ ,  $N_2$ ,  $N_3$

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.

- 3.2. Measurement of noise emitted by stationary vehicles

- 3.2.1. Sound level in the vicinity of vehicles

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

- 3.2.2. Acoustic measurements

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

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

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

- 3.2.4. Disturbance noise and wind interference

Readings on the measuring instruments produced by ambient noise and wind shall be at least 10 dB(A) below the sound level to be measured. A suitable windscreen may be fitted to the microphone provided that account is taken of its effect on the sensitivity of the microphone (see paragraph 1.1. of this annex).

- 3.2.5. Measuring method

- 3.2.5.1. Nature and number of measurements

The maximum sound level expressed in A-weighted decibels (dB(A)) shall be measured during the operating period referred to in paragraph 3.2.5.3.2.1.

At least three measurements shall be taken at each measuring point.

3.2.5.2. Positioning and preparation of the vehicle

The vehicle shall be located in the centre part of the test area with the gear selector in neutral position and the clutch engaged. If the design of the vehicle does not allow this, the vehicle shall be tested in conformity with the manufacturer's prescriptions for stationary engine testing. Before each series of measurements, the engine shall be brought to its normal operating condition, as specified by the manufacturer.

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

The engine hood or compartment cover, if so fitted, shall be closed.

3.2.5.3. Measuring of noise in proximity to the exhaust

(see appendix of Annex 3, figure 2)

3.2.5.3.1. Positions of the microphone

3.2.5.3.1.1. The microphone shall be located at a distance of  $0.5 \text{ m} \pm 0.01 \text{ m}$  from the reference point of the exhaust pipe defined in Figure 2 and at an angle of  $45^\circ$  ( $\pm 5^\circ$ ) to the vertical plane containing the flow axis of the pipe termination. The microphone shall be at the height of the reference point, but not less than 0.2 m from the ground surface. The reference axis of the microphone shall lie in a plane parallel to the ground surface and shall be directed towards the reference point on the exhaust outlet.

If two microphone positions are possible, the location farthest laterally from the vehicle longitudinal centreline shall be used.

If the flow axis of the exhaust outlet pipe is at  $90^\circ$  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. The highest level shall be recorded.

3.2.5.3.1.3. In the case of an exhaust provided with two or more outlets spaced less than 0.3 m apart and which are connected to the same silencer; the microphone position is related to the outlet nearest to one extreme edge of the vehicle or, when such outlet does not exist, to the outlet, which is highest above the ground.

3.2.5.3.1.4. For vehicles with a vertical exhaust (e.g. commercial vehicles) the microphone shall be placed at the height of the exhaust outlet. Its axis shall be vertical and oriented upwards. It shall be placed at a distance of  $0.5 \text{ m} \pm 0.01 \text{ m}$  from the exhaust pipe reference point, but never less than 0.2 m from the side of the vehicle nearest to the exhaust.

3.2.5.3.1.5. For exhaust outlets located under the vehicle body, the microphone shall be located a minimum of 0.2 m from the nearest part of the vehicle, at a point closest to, but never less than 0.5 m from the exhaust pipe reference point, and at a height of 0.2 m above the ground, and not in line with the exhaust flow. The angularity requirement in paragraph 3.2.5.3.1.2. may not be met in some cases.

3.2.5.3.1.6. Examples of the position of the microphone, depending on the location of the exhaust pipe, are given in Figures 3a-3d in Appendix 1 to Annex 3.

3.2.5.3.2. Operating conditions of the engine

3.2.5.3.2.1. Target engine speed

The target engine speed is defined as:

- (a) 75 per cent of the rated engine speed  $S$  for vehicles with a rated engine speed  $\leq 5,000 \text{ min}^{-1}$ ;
- (b)  $3,750 \text{ min}^{-1}$  for vehicles with a rated engine speed above  $5,000 \text{ min}^{-1}$  and below  $7,500 \text{ min}^{-1}$ ;
- (c) 50 per cent of the rated engine speed  $S$  for vehicles with a rated engine speed  $\geq 7,500 \text{ min}^{-1}$ .

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

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  $\pm 3$  per cent of the target engine speed, and held constant. Then the throttle control shall be rapidly released and the engine speed shall be returned to idle. The sound pressure level shall be measured during a period of operation consisting of a maintaining constant engine speed of 1 second and throughout the entire deceleration period. The maximum sound level meter reading during this period of operation, mathematically rounded to the first decimal place, is taken as the test value.

3.2.5.3.2.3. Test validation

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

3.2.6. Results

At least three measurements for each test position shall be made. The maximum A-weighted sound pressure level indicated during each of the three measurements shall be recorded. The first three valid consecutive measurement results, within 2 dB(A), allowing for the deletion of non-valid results (see paragraph 2.1. except the specifications of the test site), shall be used for the determination of the final result for the given measurement position. The maximum sound level, for all measurement positions, and of the three measurement results, constitutes the final result.

4. Sound from the hybrid vehicle of categories  $M_1$  in motion, where an internal combustion engine cannot operate when the vehicle is stationary (data reported to facilitate testing of the vehicle in use).

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

- (a) Gear (i) or, for vehicles tested with non-locked gear ratios, the position of the gear selector chosen for the test;



- (b) Position of the operating switch during measurement of the sound pressure level  $L_{wot}$  (i) (if switch is fitted);
- (c) The pre-acceleration length lPA in m;
- (d) The average vehicle speed in km/h at the beginning of the full throttle acceleration for tests in gear (i); and
- (e) The sound pressure level  $L_{wot}$  (i) in dB(A) of the wide-open-throttle tests in gear (i), defined as the maximum of the two values resulting from averaging the individual measurement results at each microphone position separately.

4.2. The in-use compliance reference data shall be entered in the Type-Approval Certificate as specified in paragraph 2.3. of the Addendum to Appendix 2 to Annex 1.

### Annex 3 - Appendix

#### Measuring positions for vehicles in motion

Figure 1  
Measuring positions for vehicles in motion

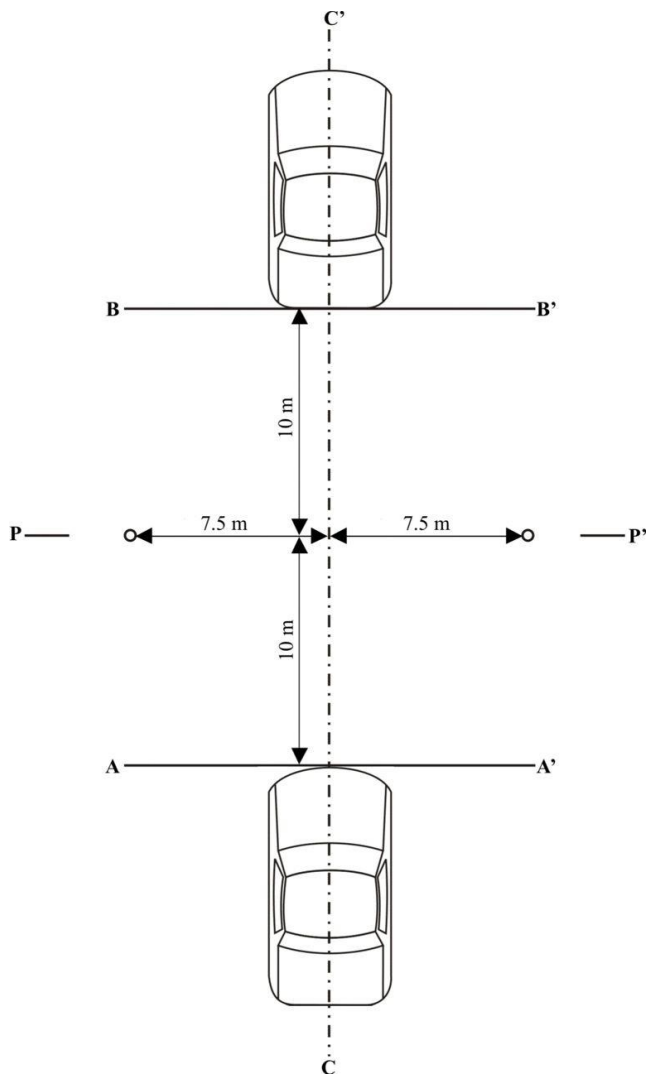
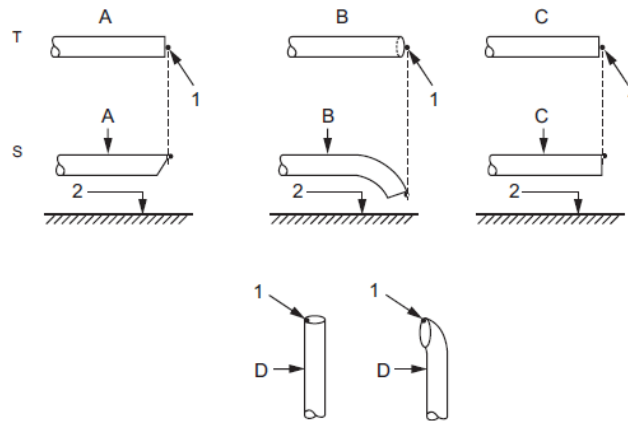


Figure 2  
Reference point



**Key**

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

Figure 3a

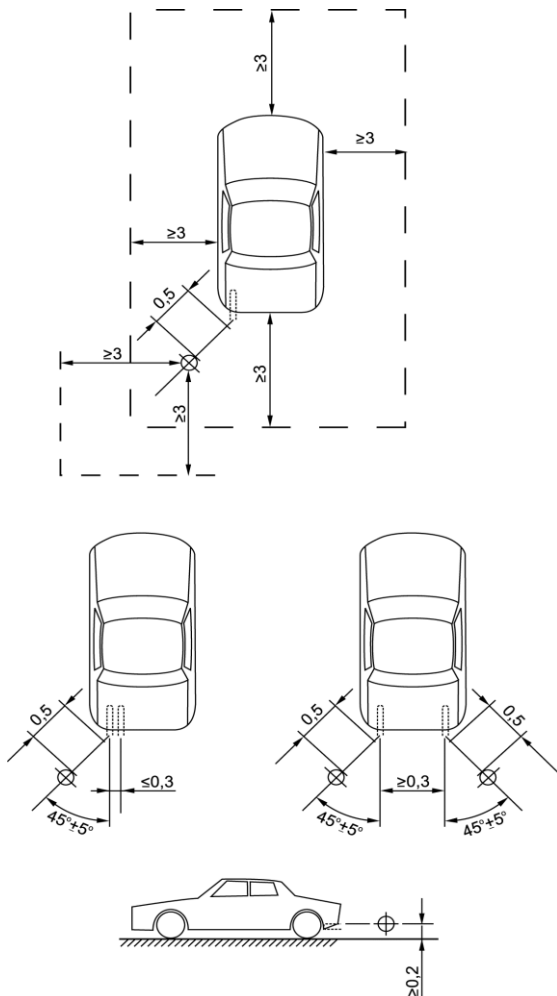


Figure 3b

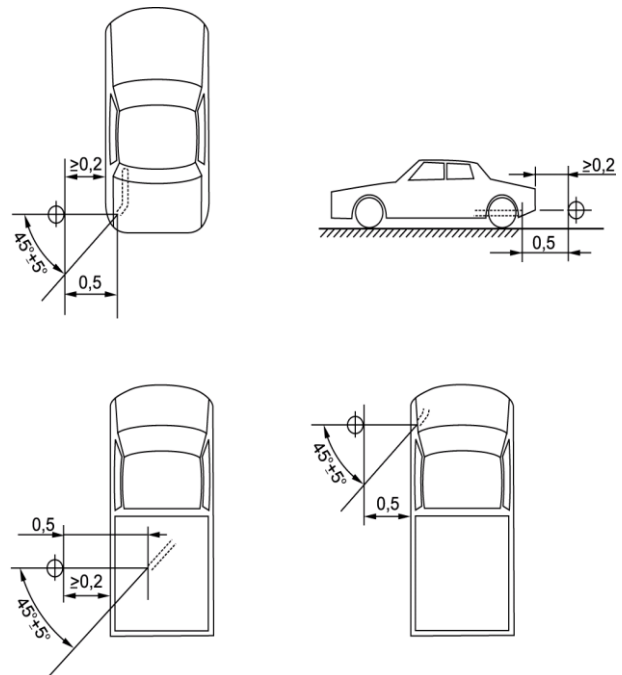


Figure 3c

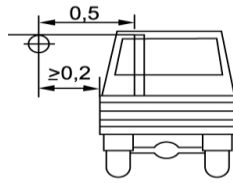
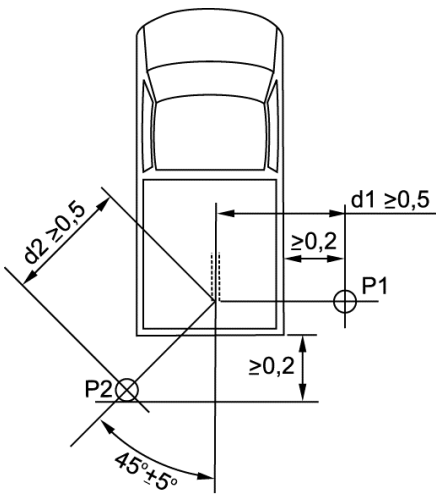
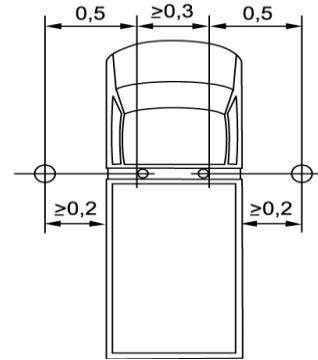


Figure 3d



## Annex 4

### Exhaust silencing systems containing acoustically absorbing fibrous materials

#### 1. General

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

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

Unless one of these conditions is fulfilled, the complete silencing system or components thereof shall be submitted to a conventional conditioning using one of three installations and procedures described below.

#### 1.1. Continuous road operation for 10,000 km

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

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

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

#### 1.2. Conditioning on a test bench

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

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

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

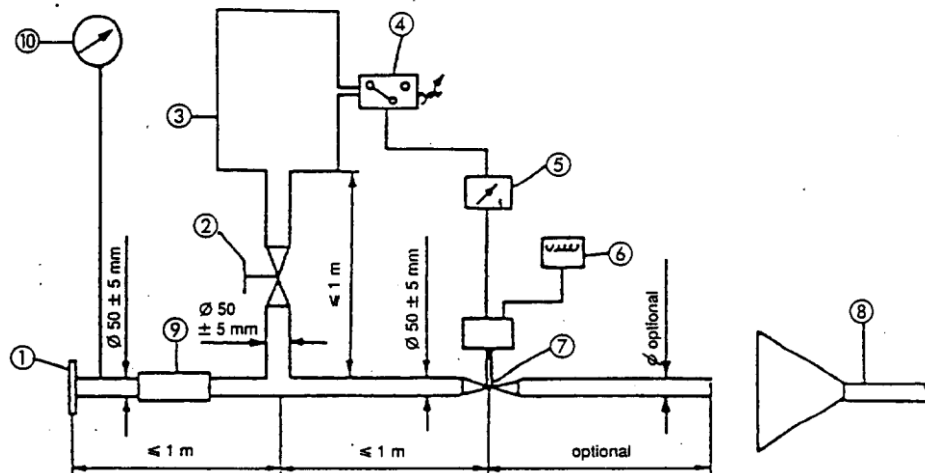
- (a) Five minutes at idling speed;
- (b) One-hour sequence under 1/4 load at 3/4 of rated maximum speed (S);
- (c) One-hour sequence under 1/2 load at 3/4 of rated maximum speed (S);
- (d) 10-minute sequence under full load at 3/4 of rated maximum speed (S);
- (e) 15-minute sequence under 1/2 load at rated maximum speed (S);
- (f) 30-minute sequence under 1/4 load at rated maximum speed (S).

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

- 1.2.4. During the test, the silencing system or components thereof shall not be cooled by a forced draught simulating normal airflow around the vehicle. Nevertheless, at the request of the manufacturer, the silencing system or components thereof may be cooled in order not to exceed the temperature recorded at its inlet when the vehicle is running at maximum speed.
- 1.3. Conditioning by pulsation
- 1.3.1. The silencing system or components thereof shall be fitted to the vehicle referred to in paragraph 3.3. of this Regulation or the engine referred to in paragraph 3.4. of this Regulation. In the former case the vehicle shall be mounted on a roller dynamometer.
- In the second case, the engine shall be mounted on a dynamometer. The test apparatus, a detailed diagram of which is shown in Figure 1 of the appendix to this annex shall be fitted at the outlet of the silencing system. Any other apparatus providing equivalent results is acceptable.
- 1.3.2. The test apparatus shall be adjusted in such a way that the exhaust-gas flow is alternatively interrupted and re-established by the quick-action valve for 2,500 cycles.
- 1.3.3. The valve shall open when the exhaust-gas back pressure, measured at least 100 mm downstream of the intake flange, reaches a value of between 35 and 40 kPa. It shall close when this pressure does not differ by more than 10 per cent from its stabilized value with the valve open.
- 1.3.4. The time-delay switch shall be set for the duration of gas exhaust resulting from the provisions laid down in paragraph 1.3.3. above.
- 1.3.5. Engine speed shall be 75 per cent of the rated engine speed (S) at which the engine develops rated maximum net power.
- 1.3.6. The power indicated by the dynamometer shall be 50 per cent of the full-throttle power measured at 75 per cent of rated engine speed (S).
- 1.3.7. Any drain holes shall be closed off during the test.
- 1.3.8. The entire test shall be completed within 48 hours.
- If necessary, one cooling period will be observed after each hour.

## Annex 4 - Appendix

Figure 1.  
Test apparatus for conditioning by pulsation



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

## Annex 5

### Compressed air noise

1. Method of measurement

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

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

2. Evaluation of the results

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

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

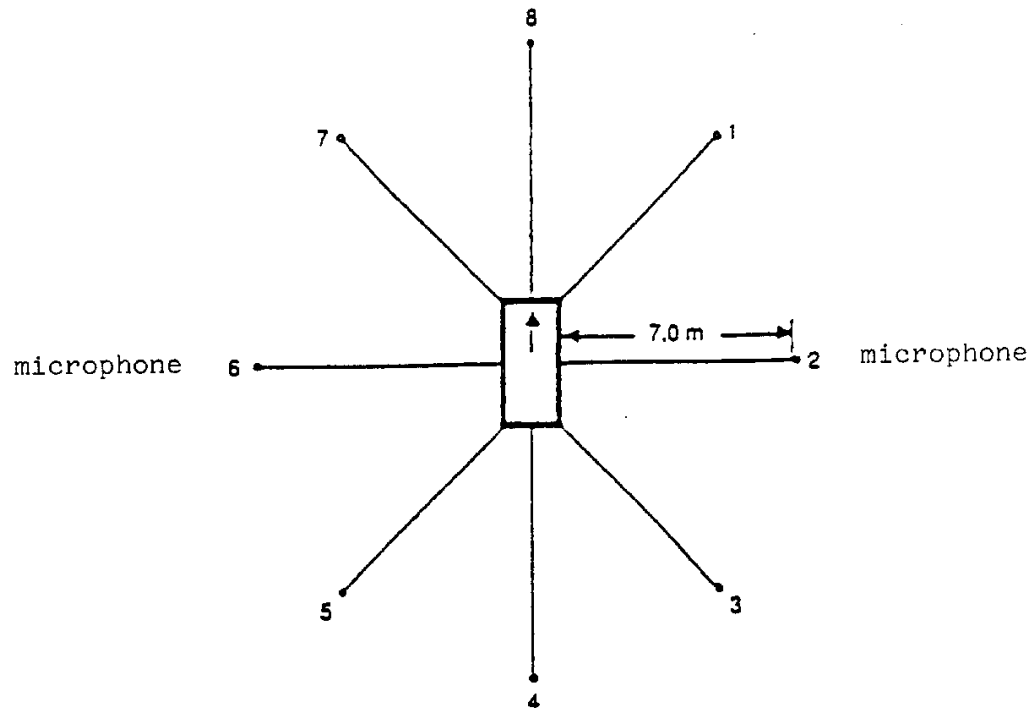
3. Limiting value

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



## Annex 5 - Appendix

Figure 1.  
Microphone positions for measurement of compressed air noise



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

## Annex 6

### Checks on conformity of production

1. General

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

The test site and measuring instruments shall be those as described in Annex 3.
- 2.1. The vehicle(s) under test shall be subjected to the test for measurement of sound of vehicle in motion as described in paragraph 3.1. of Annex 3.
- 2.2. Compressed air noise

Vehicles having maximum mass exceeding 2,800 kg and equipped with compressed air systems shall be subjected to an additional test for measurement of the compressed air noise as described in paragraph 1. of Annex 5.
- 2.3. 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 7.
3. Sampling and evaluation of the results

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

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

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

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

## Annex 7

### 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 to paragraph 6.2.3. of this Regulation.

It is not mandatory to perform actual tests when applying for type-approval. The manufacturer shall sign the declaration of compliance set out in Appendix 1. The approval authority may ask for additional information about the declaration of compliance and carry out the tests described below.

The procedure set out in this annex requires the performance of a test in accordance with Annex 3. The test specified in Annex 3 shall be carried out on the same test track under conditions similar to those required in the tests prescribed in 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 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  $V_{AA\_ASEP}$ :  $v_{AA} \geq 20$  km/h

Vehicle acceleration  $a_{WOT\_ASEP}$ :  $a_{WOT} \leq 5.0$  m/s<sup>2</sup>

Engine speed  $n_{BB\_ASEP}$ :  $n_{BB} \leq 2.0 * PMR^{-0.222} * S$  or

$n_{BB} \leq 0.9 * S$ , whichever is the lowest

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

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 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  $v_{BB,j}$ :  $\pm 3$  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 centreline 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 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 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.

$$Slope_k = \frac{\sum_{j=1}^5 (n_j - \bar{n})(L_j - \bar{L})}{\sum_{j=1}^5 (n_j - \bar{n})^2} \quad (\text{in dB(A)/1,000 min}^{-1})$$

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

where  $n_j$  = engine speed measured at line BB'

##### 3.2.2. Slope of the regression line for each gear

The slope<sub>k</sub> 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(A)/1,000 min<sup>-1</sup>.

- 3.3. Calculation of the linear sound level increase expected for each measurement
- The 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  $n_{BB,kj} \leq n_{anchor,k}$ :
- $$L_{ASEP,kj} = L_{anchor,k} + (Slope_k - Y) * (n_{BB,kj} - n_{anchor,k}) / 1,000$$
- For  $n_{BB,kj} > n_{anchor,k}$ :
- $$L_{ASEP,kj} = L_{anchor,k} + (Slope_k + Y) * (n_{BB,kj} - n_{anchor,k}) / 1,000$$
- 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 sound measurement shall be evaluated.
- The sound level of every specified measurement point shall not exceed the limits given below:
- $$L_{kj} \leq L_{ASEP,kj} + X$$
- With:
- $X = 3$  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 sound level at a point exceeds the limit, two additional measurements at the same point shall be carried out to verify the measurement uncertainty. The vehicle is still in compliance with ASEP, if the average of the three valid measurements at this specific point fulfils the specification.
5. Reference sound assessment
- The reference 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 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  $L_{ref}$

$$L_{ref} = L_{anchor\_k} + Slope_k * (n_{ref\_k} - n_{anchor\_k}) / 1,000$$

$L_{ref}$  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 rated maximum net power greater than 140 kW (according to Regulation No. 85) and having a maximum-power/maximum-mass ratio greater than 75,  $L_{ref}$  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 rated maximum net power greater than 140 kW (according to Regulation No. 85) and having a maximum-power/maximum-mass ratio greater than 75,  $L_{ref}$  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:

(a) 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;

(b) Determine the vehicle speed ( $v_{BB\_ASEP}$ ) at BB during the  $L_{wot\_ASEP}$  test;

(c) 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.

(d) Calculate  $L_{Urban\_Measured\_ASEP}$  as follows:

$$L_{Urban\_Measured\_ASEP} =$$

$$L_{wot\_ASEP} - kp\_ASEP * (L_{wot\_ASEP} - L_{crs})$$

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  $L_{Urban\_Normalized}$  as follows:

$$L_{Urban\_Normalized} = L_{Urban\_Measured\_ASEP} - L_{Urban}$$

- (f) Calculate  $L_{Urban\_ASEP}$  as follows:

$$L_{Urban\_ASEP} =$$

$$L_{Urban\_Normalized} - (0.15 * (V_{BB\_ASEP} - 50))$$

- (g) Compliance with limits:

$L_{Urban\_ASEP}$  shall be less than or equal to 3.0 dB(A).



## Annex 7 - 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 sound 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: .....

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