

Draft revision of Regulation No. 59 (Replacement silencing systems)

A. PROPOSAL

Note: For replacement silencing systems intended to be fitted on vehicles approved with the new measurement method of Regulation No. 51.

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ANNEXES

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UNIFORM PROVISIONS CONCERNING THE APPROVAL OF REPLACEMENT
SILENCING SYSTEMS

1. SCOPE

This Regulation contains provisions relating to the approval of silencing systems or components thereof to be fitted to one or more given types of motor vehicles in categories M₁ and N₁ as replacement parts.

2. DEFINITIONS

For the purpose of this Regulation,

- 2.1. "Silencing system" means a complete set of components necessary for limiting the noise produced by the engine of a motor vehicle and its exhaust;
- 2.2. "Silencing system component" means one of the separate components which together form the exhaust system (e.g. silencer proper, expansion chamber, resonator);
- 2.3. "Silencing system of different types" means silencing systems which differ significantly in such respects as:
 - 2.3.1. that their components bear different trade names or marks,
 - 2.3.2. that the characteristics of the materials constituting a component are different or that the components differ in shape or size, a modification regarding the coating (zinc coating, aluminium coating, etc.) is not considered changing the type.
 - 2.3.3. that the operating principles of at least one component are different,
 - 2.3.4. that their components are combined differently;
- 2.4. "Replacement silencing system or components of said system" means any part of the exhaust systems defined in paragraph 2.1. above intended for use on a vehicle, other than a part of the type fitted to this vehicle when submitted for type approval pursuant to this Regulation;
- 2.5. "Approval of a replacement silencing system or components of said system" means the approval of the whole or part of a silencing system adaptable to one or several specified types of motor vehicles, as regards the limitation of their noise level;
- 2.6. "Vehicle type" [see paragraph 2.2. of Regulation No. 51,] in the version to which that vehicle, equipped with the original silencing systems or components, was type approved.

3. APPLICATION OF APPROVAL

- 3.1. The application for approval of replacement silencing system or components of said system shall be submitted by its manufacturer or by his duly accredited representative.
- 3.2. It shall be accompanied by the under-mentioned documents in triplicate and the following particulars:

- 3.2.1. a description of the vehicle type(s) on which the system or components is intended to be mounted, with regard to the items mentioned in paragraph 2.6. above. The numbers and/or symbols identifying the engine type and the vehicle type shall be specified and the vehicle type approval number, if necessary;
 - 3.2.2. a description of the assembled silencing system showing the relative position of each of its components, as well as mounting instructions;
 - 3.2.3. detailed drawings of each component to enable it to be easily located and identified, and a specification of the material used.
- 3.3. On request of the technical service conducting the tests for approval, the manufacturer of the silencing system shall submit:
- 3.3.1. two samples of the system or components submitted for approval;
 - 3.3.2. a sample of the original silencing system with which the vehicle was equipped when submitted for type approval;
 - 3.3.3. a vehicle of the type to which the system is to be fitted which meets the requirements of paragraph 4.1. of Annex 7 to Regulation No. 51, in the version to which that vehicle, equipped with the original silencing systems or components, was type approved;
 - 3.3.4. A separate engine, corresponding to the type of vehicle described above.

4. MARKINGS

- 4.1. Each component of the replacement silencing system, excluding tubes and mounting accessories, shall bear:
 - 4.1.1. the trade name or mark of the manufacturer of the system or its components,
 - 4.1.2. the commercial description given by the manufacturer.
- 4.2. Such markings shall be clearly legible and indelible.

5. APPROVAL

- 5.1. If the type of replacement silencing system submitted for approval pursuant to this Regulation meets the requirements of paragraph 6. below, approval for that type shall be granted.
- 5.2. An approval number shall be assigned to each type approved. Its first two digits (at present 00 for the Regulation in its original form) shall indicate the series of amendments incorporating the most recent major technical amendments made to the Regulation at the time of issue of the approval. The same Contracting Party may not assign the same number to another type of replacement silencing system or component designed for the same type(s) of vehicle.
- 5.3. Notice of approval or of refusal of approval of a replacement silencing system or components of said system pursuant to this Regulation shall be communicated to the Parties to the Agreement which apply this Regulation, by means of a form conforming to the model in Annex 1 to the Regulation, and of drawings of the silencing system or components supplied by the applicant for approval, in a format not exceeding A4 (210 x 297 mm) or folded to that format and on an appropriate scale.

- 5.4. There shall be affixed to every component of silencing system conforming to a type approved under this Regulation an international approval mark consisting of:
 - 5.4.1. a circle surrounding the letter "E" followed by the distinguishing number of the country which has granted approval;
 - 5.4.2. The approval number to the right of the circle prescribed in paragraph 5.4.1.;
 - 5.4.3. The approval number shall be mentioned in the approval form, as well as the method used for approval tests.
- 5.5. The approval mark shall be easily legible and indelible, when the silencing system is mounted on the vehicle.
- 5.6. A component may be marked with more than one approval number if it has been approved as a part or more than one replacement silencing system; in this case the circle need not be repeated. Annex 2 to this Regulation gives an example of the arrangement of the approval mark.

6. SPECIFICATIONS

6.1. General specifications

- 6.1.1. The replacement exhaust system or components thereof must be designed, constructed and capable of being mounted so as to ensure that the vehicle complies with the provisions of this Regulation under normal conditions of use, notwithstanding any vibrations to which it may be subject.
- 6.1.2. The silencing system or components thereof must be designed, constructed and capable of being mounted so that reasonable resistance to the corrosion phenomenon to which it is exposed is obtained having regard to the conditions of use of the vehicle.

6.2. Specifications regarding noise levels.

- 6.2.1. The acoustic efficiency of the replacement silencing system or components of said system shall be verified by means of the methods described in paragraphs 3.1. and 3.2. of Annex 3 to Regulation No. 51 (the edition in force at the date when the concerned vehicle was granted type approval), as modified by paragraph 6.5. below.
- 6.2.2. When the replacement silencing system or components thereof is mounted on the vehicle described in paragraph 3.3.3. above:
 - 6.2.2.1. The noise level measured (to the first decimal place) with the running vehicle shall not exceed by more than 0.9 dB(A)
 - 6.2.2.1.1. [either the noise level of the running vehicle concerned when granted type approval.]
 - 6.2.2.1.2. or the noise level measured with the vehicle referred to in paragraph 3.3.3. above, when this is fitted with an exhaust silencing system corresponding to the type fitted to the vehicle when granted type approval;
 - 6.2.2.2. The noise level measured with the stationary vehicle shall not exceed by more than 3dB(A)
 - 6.2.2.2.1. either the noise level of the stationary vehicle concerned when granted type approval
 - 6.2.2.2.2. or the noise level measured on the vehicle referred to in paragraph 3.3.3. above, when this is fitted with an exhaust silencing system corresponding to the type fitted to the vehicle when granted type approval.

6.3. Measurement of the vehicle performances

6.3.1. The replacement silencing system or components thereof must be such as to ensure that vehicle performance is comparable with that achieved with the original equipment silencing system or component thereof.

6.3.2. The replacement silencing system or, depending on the manufacturer's choice, the components of said system shall be compared with an original silencing system or components, which are also in new condition, successively mounted on the vehicle mentioned in paragraph 3.3.3. above.

6.3.3. The verification shall be carried out by measuring the back pressure pursuant to paragraph 6.3.4. below.

The value measured with the replacement silencing system shall not exceed the value measured with the original standard silencing system by more than 25 per cent under the conditions mentioned below.

6.3.4. Test method.

6.3.4.1. Test method with engine.

The measurements shall be conducted on the engine referred to in paragraph 3.3.4. above coupled to a dynamometer. With the throttle completely open, the bench shall be adjusted so as to obtain the engine speed(s) corresponding to the rated maximum power of the engine.

For the measurement of back pressure, the distance at which the pressure tap shall be placed from the exhaust manifold is indicated in Annex 4 to this Regulation.

6.3.4.2. Test method with vehicle

The measurements shall be carried out on the vehicle referred to in paragraph 3.3.3. above.

The test shall be conducted : either on the road, or on a roller dynamometer.

With the throttle completely open, the engine must be loaded so as to obtain the engine speed corresponding to the rated maximum power of the engine (engine speed S).

For the measurement of back pressure, the distance at which the pressure tap shall be placed from the exhaust manifold is indicated in Annex 4 to this Regulation.

6.4. Additional specifications regarding silencing systems or components filled with fibrous materials.

Absorbing fibrous materials may be used in silencing systems or components only when it is established by appropriate means of design and manufacturing, that the efficiency of the system in traffic conditions is sufficient to comply with the existing regulations. Such a silencing system is deemed to be effective in traffic conditions if the exhaust gas is not in contact with the fibrous materials or if, the silencing system being emptied of its absorbing materials and tested on vehicle in conformity with the procedures described in Regulation No. 51, Annex 3, paragraphs 3.1. and 3.2., the acoustic pressure levels comply with the provisions laid down in paragraph 6.2. above.

If that condition is not fulfilled, the complete silencing system shall be submitted to conventional conditioning using one of the three installations and procedures described below. When the procedure described in paragraph 6.2.2.1 and 6.2.2.2 above is employed for comparison between the replacement silencing system and the silencing system corresponding to the type fitted to the vehicle when granting type approval, the

applicant for approval may ask for the emptying or the conditioning of the original silencing system.

6.4.1. Continuous road operation for 10.000 km

6.4.1.1. About half this operation shall consist of town driving and the other half of long-distance runs at high speed: continuous road operation can be replaced by a corresponding test-track programme.

6.4.1.2. The two engine speeds must be alternated several times.

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

6.4.2. Conditioning on a test bench

6.4.2.1. Using standard parts and observing the vehicle manufacturer's instructions, the silencer must be fitted to the engine, which is coupled to a dynamometer.

6.4.2.2. The test must 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 and any condensation which may occur.

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

- (1) five minutes at idling speed ;
- (2) one-hour sequence under $\frac{1}{4}$ load at $\frac{3}{4}$ of rated maximum speed (S) ;
- (3) one-hour sequence under $\frac{1}{2}$ load at $\frac{3}{4}$ of rated maximum speed (S) ;
- (4) 10-minutes sequence under full load at $\frac{3}{4}$ of rated maximum speed (S) ;
- (5) 15-minutes sequence under $\frac{1}{2}$ load at rated maximum speed (S) ;
- (6) 30-minutes sequence under $\frac{1}{4}$ load at rated maximum speed (S) ;

Total duration of the six sequences : three hours.

Each period must comprise two sets of the six above-mentioned sequences.

6.4.2.4. During the test, the silencer must not be cooled by a forced draught simulating normal airflow around the vehicle. Nevertheless, at the request of the manufacturer, the silencer may be cooled in order not to exceed the temperature recorded at its inlet when the vehicle is running at maximum speed.

6.4.3. Conditioning by pulsation

The silencing system or components of said system is/are fitted to the vehicle referred to in paragraph 3.3.3. above or the engine referred to in paragraph 3.3.4. In the former case, the vehicle must be mounted on a roller dynamometer, and, in the second case, the engine must be mounted on a dynamometer.

The test apparatus described below is fitted at the outlet of the silencing system.

6.4.3.1. Test apparatus

The test apparatus, a detailed diagram of which is shown in Annex 3 to this Regulation must be fitted at the outlet of the silencing system. Any other apparatus providing equivalent results is acceptable.

6.4.3.2. Test procedure

6.4.3.2.1. The test apparatus shall be adjusted in such a way that the exhaust gas flow is alternately interrupted and re-established by the quick action valve for 2,500 cycles.

6.4.3.2.2. The valve is opened when the exhaust gas pressure, measured at 100 mm at least downstream from the intake flange, reaches a value between 0.35 and 0.40 bar. It is

closed when this pressure does not differ by more than 10 per cent from its stabilized value, measured with the valve open.

- 6.4.3.2.3. The time delay switch shall be set for the duration of gas exhaust resulting from the provisions laid down in paragraph 6.4.3.2.2. above.
- 6.4.3.2.4. Engine speed shall be 75 per cent of the speed S at which, according to the manufacturer, the engine develops maximum power.
- 6.4.3.2.5. The power indicated by the dynamometer shall be 50 per cent of the full-throttle power measured at 75 per cent of engine speed (S).
- 6.4.3.2.6. Any drain holes shall be closed off during the test.
- 6.4.3.2.7. The entire test must be completed within 48 hours. If necessary, one cooling period will be observed after each hour.
- 6.4.3.2.8. After conditioning, the noise level is checked pursuant to paragraph 6.2. above.

6.5. Specific test conditions for noise measurement according to Annex 3 to Regulation No. 51.

- 6.5.1. The measurements shall be made when the ambient air temperatures is within the range from 0°C to 40°C.
- 6.5.2. The tyres fitted to the vehicle described in paragraph 3.3.3. above shall comply with commercial practice and be available on the market, they shall correspond to one of the tyre sizes designated for the vehicle by the vehicle manufacturer and meet the minimum tread depth of 1.6 mm in the main grooves of the tread surface. The tyres must be inflated to the pressure(s) appropriate to the test mass of the vehicle.
- 6.5.3. The gear selection for performing noise measurement on the vehicles fitted with the replacement silencing system shall be the same as for noise measurement on the vehicle fitted with a silencing system corresponding to the type fitted to the vehicle when submitted for type approval.
- 6.5.4. If the vehicle described in paragraph 3.3.3. above has an automatic gear box which cannot be locked, the tests will be performed at default settings.

7. EXTENSION OF APPROVAL

The silencing system manufacturer or his duly accredited representative may ask the administrative department which has granted the approval of the silencing system for one or several types of vehicles, for an extension of the approval to other types of vehicles.

The procedure is that described in paragraph 3. above.

Notice of the extension of approval (or refusal of extension) shall be communicated to the Parties to the Agreement which apply this Regulation in accordance with the procedure specified in paragraph 5.3. above.

8. MODIFICATION OF THE TYPE OF SILENCING SYSTEM.

- 8.1. Every modification of the type of replacement silencing system shall be notified to the administrative department which approved the type of silencing system. The said department may then either :
 - 8.1.1. consider that the modifications made are unlikely to have an appreciable adverse effect, or
 - 8.1.2. require a further test report from the technical service responsible for conducting the tests.

- 8.2. 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.

9. CONFORMITY OF PRODUCTION

Measure to ensure conformity of production shall be taken in accordance with the requirements laid down in Appendix 2 to the Revised 1958 Agreement (E/ECE/324/E/ECE/TRANS/505/Rev.2).

9.1. Special provisions

- 9.1.1. The text referred to in paragraph 2.3.5. of Appendix 2 to the Agreement are those prescribed in Annex 5 to this Regulation.
- 9.1.2. The frequency of inspections referred to in paragraph 2.4. of Appendix 2 to the Agreement is normally one every two years.

10. PENALTIES FOR NON-CONFORMITY OF PRODUCTION.

- 10.1. The approval granted in respect of a type of silencing system pursuant to this Regulation may be withdrawn if the requirements laid down in paragraph 9. above are not complied with, or if the silencing system or components fail to pass the tests provided for in paragraphs 9.3.5. and 9.4.3. above.
- 10.2. If a Party to the Agreement which applies 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 copy of the approval form bearing at the end in large letters, the signed and dated annotation "APPROVAL WITHDRAWN".

11. PRODUCTION DEFINITELY DISCONTINUED

If the holder of the approval completely ceases to manufacture a type of replacement silencing system or components of the said system 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 Agreement applying this Regulation, by means of a copy of the approval form bearing at the end, in large letters, the signed and dated annotation: "PRODUCTION DISCONTINUED".

12. NAMES AND ADDRESSES OF TECHNICAL SERVICES RESPONSIBLE FOR CONDUCTING APPROVAL TESTS, AND OF ADMINISTRATIVE DEPARTMENTS.

The Parties to the Agreement which apply 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 administrative departments which grant approval and to which forms certifying approval or refusal or withdrawal of approval, issued in other countries, are to be sent.

Annex 1

(Maximum format: A 4 (210 x 297 mm))



Name of administration

Communication concerning the approval (or extension or refusal or withdrawal of approval or production definitely discontinued) of a type of replacement silencing system or components of the said system pursuant to Regulation No. 59.

- Approval No.
1. Trade name or mark of the silencing system
 2. Type of the silencing system
 3. Manufacturer's name and address
 4. If applicable, name and address of manufacturer's representative
 5. Brief description of the silencing system (with/without^{*} fibrous material, etc.
 6. Trade name or mark of the vehicle type for which the silencing system is intended
 7. Vehicle type, starting from serial number:
 8. Kind of engine: positive-ignition, compression ignition
 9. Cycles: two-stroke or four-stroke
 10. Cylinder capacity
 11. Engine power (kW ECE)
 12. Number of gears
 13. Gears used
 14. Final drive ratio(s)
 15. Maximum power
 16. Load conditions of vehicles during test
 17. Sound levels:
 - Vehicle in motiondba at steady speed before acceleration ofkm/h
 - Vehicle stationarydba with engine running atr.p.m.
 18. Value of the back pressure:
 19. Silencing system submitted: For approval on
 - For extension of approval on
 20. Technical service responsible for conducting approval tests

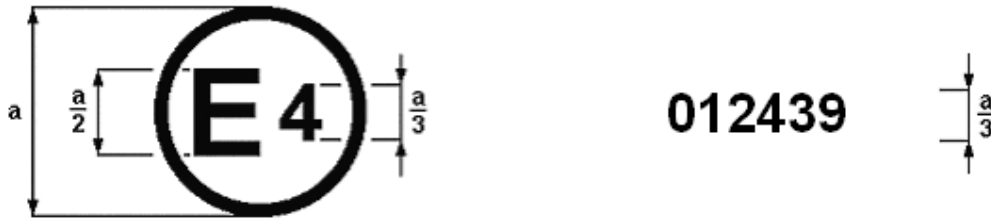
*/ Strike out whatever does not apply.

21. Date of report issued by that service
22. Number of report issued by that service
23. Approval granted/refused #/
24. Position of approval mark on the vehicle
25. Place
26. Date
27. Signature
28. The following documents, bearing the approval number shown above, are annexed to this communication:
 - drawings, diagrams and plans of the silencing system
 - photographs of the silencing system
 - list of components, duly identified constituting the silencing system

Annex 2

ARRANGEMENTS OF APPROVAL MARKS

(see paragraph 5.4. of this Regulation)



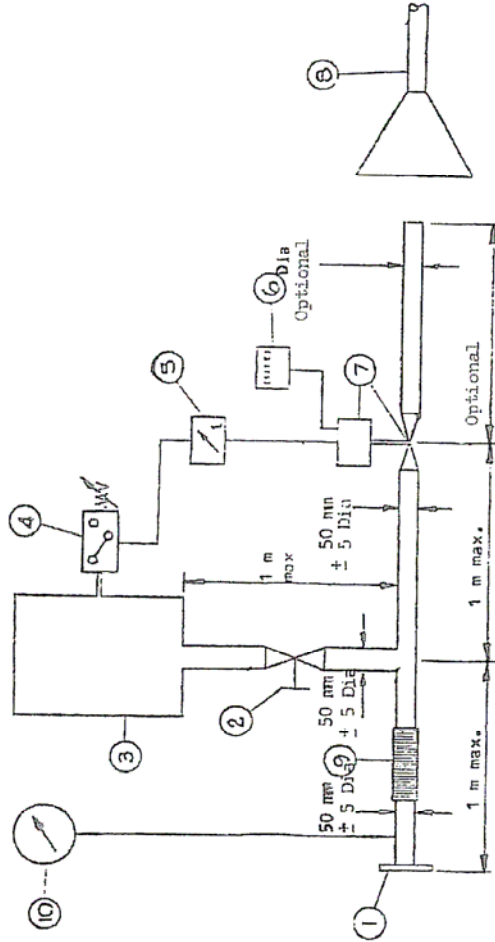
a = 8 mm min.

The above approval mark when affixed to a replacement silencing system shows that the type of replacement silencing system concerned, has been approved in the Netherlands (E4) under the approval number 2439. The first two digits of the approval number indicate that the approval was granted according to the requirements of this Regulation as amended by the 01 series of amendments.

Note: The approval number and additional symbol(s) must be placed close to the circle and either above or below the "E" or to the left or right of that letter. The digits of the approval number must be on the same side of the "E" and orientated in the same direction. The use of roman numerals as approval numbers should be avoided so as to prevent confusion with other symbols.

Annex 3

TEST APPARATUS

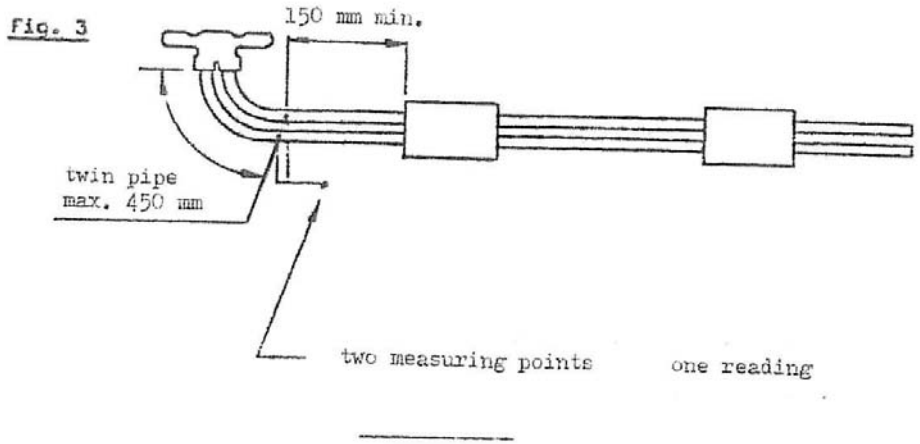
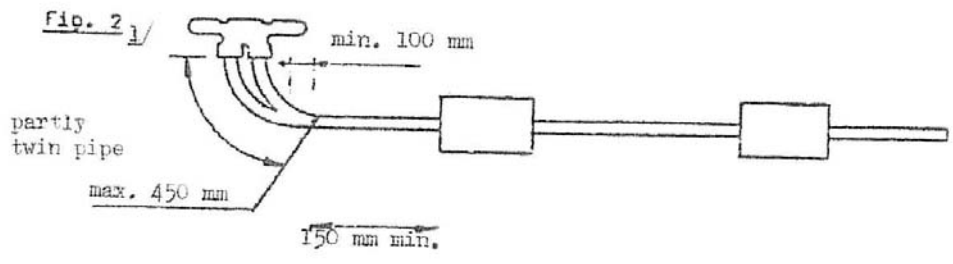
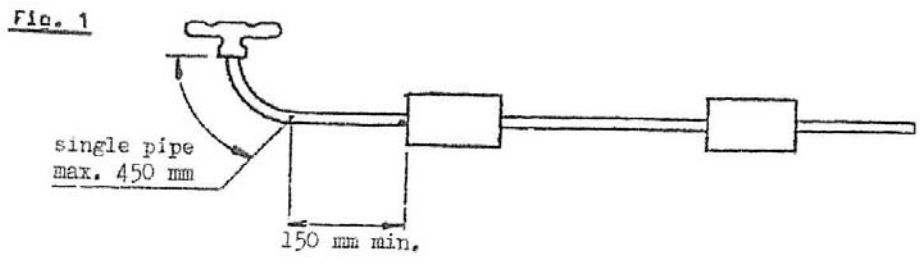


- 1 Inlet flange or sleeve - connection to the rear of complete silencing system to be tested
- 2 Regulation valve (hand operated)
- 3 Compensating reservoir from 35 to 40 l.
- 4 Pressure switch 0.05 to 2.5 bars - to open item 7
- 5 Time delay switch - to close item 7
- 6 Counter of impulses
- 7 Quick response valve - such as the valve of an exhaust brake system of 60 mm in diameter, operated by a pneumatic cylinder with an output of 120 N at 4 bars. The response time, both when opening and closing, must not exceed 0.5 s.
- 8 Exhaust gas evacuation
- 9 Flexible pipe
- 10 Pressure gauge.

Annex 4

MEASURING POINTS - BACK PRESSURE

Examples of possible measuring points for loss-of-pressure tests. The exact measuring point shall be specified in the test report. It shall be in an area where gas flow is regular.



^{1/} If not possible, refer to figure 3.

CHECKS ON CONFORMITY OF PRODUCTION

1. GENERAL

These requirements are consistent with tests to be held to check conformity of production, according to paragraph 9. of this Regulation.

2. TESTING PROCEDURES

The methods of testing, measuring instruments and interpretation of results shall be those described in paragraph 6. above. The replacement silencing system or component under test shall be subjected to the test as described in paragraphs 6.2., 6.3. and 6.4. above.

3. SAMPLING

A replacement silencing system or component has to be chosen. If after the test of paragraph 4.1., the sample is not considered to conform to the requirements of this Regulation two more samples have to be tested.

4. EVALUATION OF THE RESULTS

4.1. If the sound levels of the replacement silencing system or component tested pursuant to paragraphs 1. and 2., measured in accordance with paragraph 6.2. above, do not exceed by more than 1 dB(A) the level measured during the type-approval tests of this type of replacement silencing system or component, the replacement silencing system or component type shall be considered to conform to the requirements of this Regulation.

4.2. If the replacement silencing system or component tested according to paragraph 4.1. does not satisfy the requirements laid down in that paragraph, two more replacement silencing systems or components of the same type must be tested pursuant to paragraphs 1. and 2. above.

4.3. If the sound level of the second and/or third sample of paragraph 4.2. exceeds by more than 1 dB(A) the level measured during the type-approval tests of this type of replacement silencing system or component, the replacement silencing system or component 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.

B. JUSTIFICATION

The draft was established following the principles given in Informal document GRB-42-8.

Test method

A back-to-back comparison with the original equipment silencing system is proposed, using the new measurements method of Regulation No. 51. This method allows to discriminate between acceptable and unacceptable replacement silencers as it was demonstrated by the CLEPA test campaign presented at forty-second GRB session and summarized in Informal document GRB-42-6.

Test vehicle (para. 3.3.)

The test vehicle must be in line with the Conformity of Production (CoP) requirements of Regulation No. 51. This is the only limit the car manufacturer can be forced to meet with any vehicle type. It is the same requirement as in the EC Directive 1999/101/EC.

If the technical service is aware of the availability of vehicles with lower drive-by values, it may ask for such a vehicle to be used. Also if the technical service has some suspicion about the state of the test vehicle, it may ask for replacement of certain parts by parts conforming to the type approval Original Equipment (OE) parts.

Performance criteria for drive-by noise (para. 6.2.2.1.)

The noise of the test vehicle fitted with the replacement part must be lower or equal to the noise of the car fitted with the OE parts, or lower or equal to the vehicle type approval value. These are the criteria of current Regulation No. 59.

The CLEPA test campaign, Informal GRB-42-6, has shown that the differences between OE and After-Market (AM) values when measured with the new and old Regulation No. 51 methods remain the same.

A tolerance of maximum 0.9 dB(A) is proposed on the measured values in case of "back to back" measurements in order to avoid rejection of replacement systems which do deviate very little from the original equipment, but, which, due to the mathematical rounding-off procedure, might fall "on the wrong side" of the acceptance criteria.

In order to illustrate the inconsistency of the rounding –off procedure of the current version of the regulation, we hereunder give 2 examples of what can happen in case of a 0.9 dB(A) difference and 0.2 dB(A) difference.

Example 1

OEM value of the tested vehicle: 72.5 dB(A) after correction = 73 dB(A) result= 72 dB(A)

Replacement exhaust: 73.4 dB(A) after correction = 73 dB(A) result = 72 dB(A)

Difference = 0.9 dB(A) but NO effect on end result = OK

Example 2

OEM value of the tested vehicle: 72.4 dB(A) after correction = 72 dB(A)

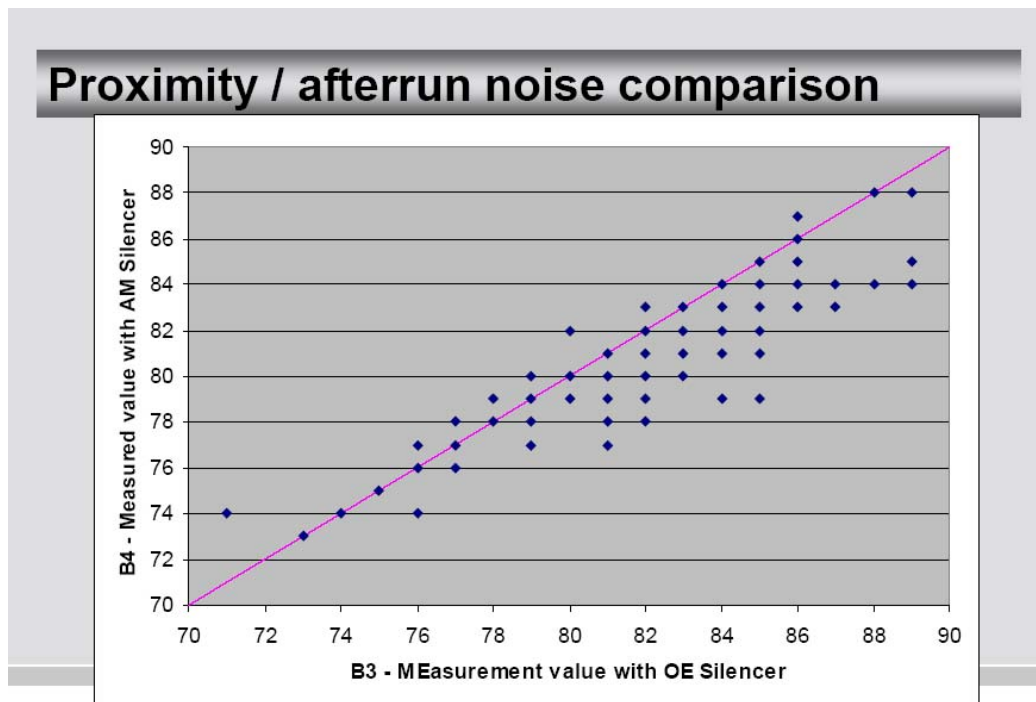
Replacement exhaust: 72.6 dB(A) after correction = 73 dB(A) = Not OK

Difference = 0.2 dB(A) exhaust system is rejected = Not OK

Under the newly proposed procedure the tolerance of 0.9 dB(A) on the measured values will in no way deteriorate the noise emission of the vehicle. This rule will only rationalize the acceptance criteria and thus avoid unnecessary redesign work for minor differences, which are in practice not noticeable.

Performance criteria for stationary noise (para. 6.2.2.2.)

A 3 dB(A) maximum tolerance is proposed, due to the large deviations in measuring this type of noise emissions (see the graph below).



Deviations and clarifications on the new noise test method of Regulation No. 51 (para. 6.5.)

These requirements are prepared to create a clear picture of the requirements concerning the test vehicle and the test conditions.

- Temperature range 0° C to 40°C will allow testing year long.
- Requirements on tyres will make sure that correct tyres are mounted and that they are according to the minimum requirements on tread depth. Slick tyres are thus forbidden.
- Gear to be used is clarified: the same as for the test with the original parts, or the default settings in the case of an automatic gear box which cannot be locked.

Approval mark (para. 5.4. and Annex 2)

Requirements in line with those of ECE Regulations on components = letter "R" and number of the Regulation are no longer required.
