

**Type approval requirements for retrofit particulate matter reduction systems for Euro 2 and Euro 3 motor vehicles that have been registered on the basis of an approval according to directive 88/77/EEC.**

**Courtesy translation.**

**Article 1.** Type approval

After entering into an agreement with the manufacturer of particulate reduction systems, the Road Transport Directorate (RDW) grants type approval for a type of particulate matter reduction system intended for installation on motor vehicles having been type approved concerning air pollution according to directive 2005/55/EC, if the following requirements are fulfilled.

**Article 2.** Definitions and abbreviations

*Particulate matter reduction system:* An exhaust gas after treatment device reducing particulate matter emissions by mechanical and/or aerodynamic separation as well as through the effects of diffusion and/or inertia. Engine-specific modifications to electronic units and components do not constitute particulate matter reduction systems.

*Class A particulate matter reduction system:* Particulate matter reduction system having a gravimetric particulate matter retention coefficient of at least 90 % as established according to articles 15 and 16.

*Class B particulate matter reduction system:* Particulate matter reduction system having a gravimetric particulate matter retention coefficient of at least 50<sup>1</sup>%, but less than 90 % as established according to articles 15 and 16.

*Continuously regenerating particulate matter reduction system:* Particulate matter reduction system where regeneration is not initiated by modified engine control parameters, additional systems or engine full load operating points. The continuous regeneration of the particulate matter reduction system takes place by itself during certain exhaust gas temperature conditions, or at least once every test cycle.

*Periodically regenerating particulate matter reduction system:* Particulate matter reduction system where regeneration takes place every maximum 100 hours of operation of the engine.

*Loading condition:* Constant particulate matter loading condition of the particulate matter reduction system under certain driving conditions without external regeneration measures.

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<sup>1</sup> For systems intended for engines having a swept volume of less than 0.75 dm<sup>3</sup> per cylinder and a rated speed of more than 3000 min<sup>-1</sup> a minimum of 30 % is applicable.

*Retention coefficient*: Ratio of particulate matter mass retained by the particulate matter reduction system to the particulate matter mass in the vehicle's initial state, measured in the ETC.

*Directive 72/306*: Council directive 72/306/EEC of 2 August 1972 (OJ 1972, L190) on the approximation of the laws of the Member States relating to the measures to be taken against the pollution by diesel engines for use in vehicles.

*Directive 88/77*: Council directive 88/77/EEC of 3 December 1987 (OJ 1988, L36) on the approximation of the laws of the Member States relating to the measures to be taken against the emission of gaseous pollutants from diesel engines for use in vehicles.

*Directive 91/542*: Council directive 91/542/EEC of 1 October 1991 (OJ 1991, L295) amending Directive 88/77.

*Directive 2005/55*: directive 2005/55/EC of the European Parliament and of the Council of 28 September 2005 (OJ 2005, L75) on the approximation of the laws of the Member States relating to the measures to be taken against the emission of gaseous and particulate pollutants from compression-ignition engines for use in vehicles, and the emission of gaseous pollutants from positive-ignition engines fuelled with natural gas or liquefied petroleum gas for use in vehicles.

*Directive 98/70*: directive 98/70/EC of the European Parliament and of the Council of 13 October 1998 (OJ 1998, L76) relating to the quality of petrol and diesel fuels and amending directive 93/12/EEG of the Council, as amended by directive 2003/17/EC of the European Parliament and of the Council of 3 March 2003 (OJ 2003, L76).

*ESC-test cycle*: test cycle comprising 13 static load conditions, according to appendix 1 of annex III to directive 2005/55.

*ELR -test cycle*: test cycle comprising a series of load steps, according to appendix 1 of annex III to directive 2005/55.

*ETC-test cycle*: test cycle comprising transient steps, according to appendix 2 of annex III to directive 2005/55.

*Particulate matter reduction system family*: family of all particulate matter reduction systems which, in terms of their function, are regarded as identical, technically speaking, pursuant to the conformity criteria in article 18.

*Engine family*: family of engines of a manufacturer that do not differ in the characteristics described in item 8.1 of annex I to directive 2005/55.

**Euro class:** the designations Euro 2 and Euro 3 indicating which stage of tightening of the requirements on air pollution a vehicle or an engine mounted in a vehicle fulfils.

**Euro 2:** the designation that the engine of a vehicle fulfils the emission limit values stated in line B of the table of item 6.2.1 of annex I to directive 88/77 as amended by directive 91/542, as it read before the entry into force of directive 2005/55.

**Euro 3:** the designation that the engine of a vehicle fulfils the emission limit values stated in line A of table 1 of item 6.2.1 of annex I to directive 2005/55.

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|--------------|---|
| $\eta$ :     | Retention coefficient   |
| $M_{pi}$ :   | Weighted total emission (g/kWh) of class A particulate matter reduction systems.  |
| $M_{si}$ :   | Averaged measured emission during multiple cycles without regeneration (g/kWh)  |
| $M_{ri}$ :   | Emission during regeneration  |
| $N_g$ :      | Retrofitted state   |
| $V_F$ :      | Volume of the particulate matter reduction system   |
| $V_H$ :      | Swept volume of the engine  |
| <b>PMRS:</b> | Particulate matter reduction system(s)  |
| <b>VERT:</b> | An approval scheme for particulate traps established by the Federal Office for the Environment of Switzerland. See also:<br><a href="http://www.bafu.admin.ch/luft/00632/00639/00644/index.html?lang=en">http://www.bafu.admin.ch/luft/00632/00639/00644/index.html?lang=en</a> |
| <b>EGR:</b>  | Exhaust Gas Recirculation   |

### **Article 3. Durability**

The applicant for the type-approval for a PMRS must substantiate and corroborate, by means of the tests described in the articles 6 up to and including 16, that the efficiency of this system is being guaranteed when operating in accordance with its intended use up to a mileage of 80.000 km or<sup>2</sup> 5 years for engines having a swept volume of less than 0,75 dm<sup>3</sup> per cylinder and a rated speed of more than 3000 min<sup>-1</sup>, otherwise for 200.000 km or<sup>2</sup> 5 years.

#### **Article 3a.**

If the applicant for type approval demonstrates by means the nomination of its type of PMRS on the VERT filter list and a copy of the test report of a laboratory authorised to test PMRS according to VERT that its PMRS fulfils the requirements of the VERT certification scheme, including the endurance test of 2 times 1000 hours, the tests and procedures prescribed in the articles 5 up to and including 17 are not applicable.

These VERT certified PMRS are classified as class A PMRS, and considered to

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<sup>2</sup> Depending on which criterion is reached first.

have continuous regeneration unless the applicant demonstrates the system is a periodically *regenerating PMRS*, having a periodically activated regeneration system by which the temperature of the exhaust gas is artificially increased at certain time intervals or when a certain threshold value of the exhaust gas back pressure is exceeded. Only VERT approved PMRS with on board regeneration are accepted.

**Article 4.** Temporarily disabling of the system

If the PMRS contains provisions that result in failure to meet the limit values for the reduction of emission of particulates under certain conditions, the applicant shall present proof:

- a. Under which conditions such provisions are activated / deactivated.
- b. That the provisions only serve to protect the engine or the PMRS and that they are not activated permanently.
- c. That after activation the provision is deactivated after at most two applicable test cycles in such a way that the original condition is restored. This shall be demonstrated in an endurance test which comprises at least five activations / deactivations.
- d. That the applicable durability criteria are met and
- e. That the driver is being informed about the activation of the provision.

**Article 5.** Conformity criteria

PMRS belong to the same type if they do not deviate in the following characteristics:

- a. Its type of retention, its modus operandi, its reduction material (metal, ceramics);
- b. The type of system: class A of class B;
- c. The kind of regeneration: periodically or continuously;
- d. The reduction design of the filter material (plates, mesh, knitted coils, minimal cell/material/fleece density, maximum porosity, pore diameter, the number of cavities/spheres, surface roughness, wire/sphere/fibre diameter);
- e. The minimum coating of the PMRS (g/ft<sup>3</sup>);
- f. Canning/packaging (vehicle bearing arrangement/holding fixture), modular design;
- g. Volume  $\pm$  30%. This provision is not applicable to VERT certified PMRS;
- h. Regeneration strategy (catalytic, thermal or electro thermal regeneration);
- i. The kind of fuel borne additive and its dosage (if any);
- j. The type of fuel borne additive (if any);
- k. Particulates of the installation (maximum + 0,5 m installation difference between turbo compressor outlet and the entrance of the PMRS);
- l. With or without an upstream oxidation catalyst.

**Article 6.** Specification of the endurance test

For the expert appraisal of the PMRS it is, as proof of operational reliability when subsequently used in the field, subjected to an endurance test of at least 25 ETC

test cycles. The endurance test shall serve as proof of operational reliability and system stability. The test of the PMRS takes place for each system or family of systems for the appropriate scope of application. This means that for each scope of application one system is tested.

Additionally the endurance test serves as proof to establish whether the system regenerates continuously or periodically.

Preceding the endurance test the PMRS is preconditioned by at least 2 hours running stage 8 of the ESC cycle, and subsequently conditioned by means of sufficient number of ETC cycles to stabilise particulate matter emissions.

#### **Article 7.** Verification of the continues regeneration

A regeneration process is deemed to be continues if during a period of at least 25 test cycles an appropriate parameter of the PMRS is found to be constant. Particulate matter emission and exhaust gas backpressure are considered appropriate parameters.

For the purpose of this requirement these parameters are deemed constant if the variance is not more than 15 % during at least 25 test cycles, during which the measurement of the exhaust gas backpressure takes place continuously, the measurement of the particulate matter emissions every fifth cycle.

The variance is calculated as follows:

$$\text{Variance} = \frac{\text{Standard deviation } X(n)}{\text{Average value } X(n)}$$

In which:

$$\text{Standard deviation} = \sqrt{\frac{n \sum x^2 - (\sum x)^2}{n^2}}$$

and

$$\text{Average value} = (a_1 + a_2 + \dots + a_n) / n$$

#### **Article 8.** Selecting the family test engine

The engine selected for the test should derive from an engine family corresponding to the intended scope of application

- a. The test engine for the selected scope of application should meet the following criteria:
  - 100 to 60 % of the engine power of the parent engine within the scope of application (parent engine of an engine family according to annex I item 8.2 of directive 2005/55)
  - Smallest used filter volume ( $V_{FI}$ ) within the scope of application.
  - The emission of gaseous and particulate pollutants of the engine shall fulfil the limit values that applied during the type approval of the engine, measured in the test cycle applied during the type approval.

**Article 9. Test cycle**

For the endurance test, the evaluation of the particulate matter emission, the determination of the type of regeneration and the NO<sub>2</sub>/NO ratio the ETC cycle shall be applied. Measuring the effect of the PMRS on the gaseous emissions takes place in an ESC cycle.

**Article 9a. Test equipment**

The tests prescribed in this regulation are carried out on a transient engine test bed with sampling and analysing equipment certified for carrying out tests according to directive 2005/55. As an alternative the test may be carried out on a transient chassis dynamometer or other transient equipment and using alternative sampling and analysing equipment if the applicant demonstrates adequate equivalence with the methods prescribed by directive 2005/55.

**Article 10. Loading test for class B systems**

Class B systems are subjected to a verification of their regeneration behaviour. This verification takes place by loading a system until it reaches a constant exhaust gas backpressure or during a period of maximum 100 hours, the boundary loading. The exhaust gas backpressure is deemed constant if after at least 50 hours the exhaust gas backpressure stays within a margin of 5 mbar during 30 minutes.

The absorbed torque during the loading is chosen such that a maximum exhaust gas temperature of 180°C at the entrance of the PMRS is not exceeded. The loading is preferably carried out at a constant engine speed of 50 to 75 % of the rated speed of the test engine. As an alternative the manufacturer may provide an already boundary loaded system for the regeneration test.

**Article 11. Thermal regeneration test class B systems**

After reaching the boundary loading or after maximum 100 hours a thermal regeneration is initiated, for example by running stage 8 of the ESC cycle. After completion of the regeneration, exhaust gas measurements in at least three test cycles are carried out according to article 9. The recorded exhaust gas data shall not deviate from the data before the loading test by more than 15 % for the gaseous emissions and more than 20 % for the particulate emissions.

The manufacturer must state that the exhaust gas temperatures occurring during the regeneration should be regarded as non-critical for the durability of the system.

**Article 12 Measurement of the opacity of the exhaust gases.**

The opacity of the exhaust gases is measured in an ELR test cycle according to the prescriptions of items 3 and 6 of appendix to annex III of directive 2005/55. For Euro 2 engines the opacity is measured during a free acceleration test according to directive 72/306. Annex I describes when this test is to be performed.

**Article 13. Test fuel**

The measurements for the testing of PMRS are carried out with commercially available fuels meeting the specifications of directive 98/70, having a maximum sulphur content of 10 ppm.

**Article 14. Length of the exhaust gas system of the test set up**

For the tests of a PMRS on an engine test bed the length of the exhaust pipe between the system and the outlet of the turbocharger shall be at least 2 meter. If the applicant demonstrates that within the subsequent scope of application a shorter distance may be considered as the maximum distance, this minimum length can be limited correspondingly. Insulation etc. of the exhaust pipe is only acceptable if it is also applied during the future application on the vehicles.

**Article 15. Assessment criteria for continuously regenerating PMRS**

The tests are performed according to annex I. The assessment of the system is deemed successful if the following criteria are fulfilled:

1. The retention coefficient  $\eta$  shall be:
  - a. At least 90 % for class A systems. In case of VERT certified PMRS the corresponding VERT criteria shall be fulfilled.
  - b. At least 30 % for class B systems for engines having a cylinder swept volume of less than 0,75 dm<sup>3</sup> and a rated speed of more than 3000 min<sup>-1</sup>, otherwise at least 50 %.
2. The regulated gaseous pollutants shall meet the limit values applicable to the originally approved Euro class in the initial state as well as in the retrofitted state.
3. The NO<sub>2</sub>/NO<sub>x</sub>-ratio of the exhaust gas is measured according to the procedure of annex III and recorded in the test report for the initial state as well as the retrofitted state.
4. The opacity for Euro 3 engines determined according to appendix 1 of annex III to directive 2005/55 shall not exceed the value of 0,8 m<sup>-1</sup> in the initial state as well as in the retrofitted state. For Euro 2 engines the opacity measured before and after retrofitting shall meet the value on the symbol meant in item 4 of annex I to directive 72/306. Annex I shows when these tests are carried out.

**Article 16. Assessment method for periodically regenerating PMRS**

The tests are performed according to annex I. The assessment of the system is deemed successful if the following criteria are fulfilled:

With periodically regenerating PMRS the particulate emissions are determined as follows:

$$PT = (n1 \times PT,n1 + n2 \times PT,n2) / (n1 + n2)$$

in which:

n1 = the number of ETC test cycles between two regenerations

- n2 = the number of ETC test cycles during the regeneration (minimum 1 test cycle)
- PT,n2 = emission during the regeneration
- PT,n1 = emission during the loading (arithmetical average of the measurement at the beginning of the loading and the measurement at the end of the loading. More than two measurements are acceptable)

For a periodically regenerating PMRS the emissions are measured in at least three ETC test cycles (once at the beginning of the loading, once at the end of the loading and once during the regeneration).

The regeneration process should occur at least once during an ETC test cycle. If more than two measurements between the regeneration stages are used, these measurements should take place at equidistant intervals, the arithmetical average of the results being used to calculate the emission.

The manufacturer indicates during which circumstances (loading, temperature, backpressure, time interval, etc.) the regeneration usually occurs. For the measurement of the emissions during regeneration, the applicant may provide a boundary-loaded system. During the regeneration stages the applicable limit values may be exceeded.

**Article 17.** Assessment criteria for system testing

1. The retention coefficient  $\eta$  shall be:
  - a. At least 90 % for class A systems. In case of VERT certified PMRS the corresponding VERT criteria shall be fulfilled.
  - b. At least 30 % for class B systems for engines having a cylinder swept volume of less than 0,75 dm<sup>3</sup> and a rated speed of more than 3000 min<sup>-1</sup>, otherwise at least 50 %
2. Taking into account the calculation below, the regulated gaseous pollutants (CO, HC and NO<sub>x</sub>) shall not exceed the limit values for the applicable euro class.
3. With periodically regenerating systems the emission of gaseous components is determined as follows:

$$M_{Gas} = (n1 \times M_{Gas,n1} + n2 \times M_{Gas,n2}) / (n1 + n2)$$

in which

- n1 = the number of ETC test cycles between two regenerations
- n2 = the number of ETC test cycles during regeneration (minimum 1 test cycle)
- M<sub>gas,n2</sub> = emission during regeneration

- M<sub>gas,n1</sub> = emission during the loading (arithmetical average of the measurement at the beginning of the loading and the measurement at the end of the loading. More than two measurements are acceptable)
4. The opacity for Euro 3 engines determined according to appendix 1 of annex III to directive 2005/55 shall not exceed the value of 0,8 m<sup>-1</sup> in the initial state as well as in the retrofitted state. For Euro 2 engines the opacity measured before and after retrofitting shall meet the value on the symbol meant in item 4 of annex I to directive 72/306. Annex I shows when these tests are carried out. [6.3]

**Article 18.** Composition of a family of PMRS

Families of systems may be composed with PMRS of different size (volume) respecting the following conformity criteria:

1. To determine the scope of application of a constructively identical PMRS, but with different volume, for different vehicle types, the tested systems shall not deviate with respect to the characteristics according to article 5. The limits of the scope of application of a system are determined by the selected test engine.
2. The scope of application of a family of PMRS extends over the engine family of an engine manufacturer covered by the test engine according to article 8. If the applicant demonstrates that another engine family of the same manufacture, with a scope covered by the test engine, respectively engine families of other manufacturers with scopes covered by the test engine, do not differ for the cylinder swept volume ( $\pm 15\%$ ) and the mode of aspiration (turbocharger or natural aspiration), the scope of application may be extended with these engine families. Provided these criteria are observed, a scope of application consisting of Euro 3 engines may be extended to Euro 2 engines.
3. If the test engine is not equipped with EGR the scope of application of the PMRS shall only be extended to engine types having EGR if the applicant demonstrates that the PMRS does not have any detrimental effects on the emissions of gaseous pollutants, or if a release by the engine manufacturer is submitted.
4. Families of VERT certified PMRS are established according to the VERT requirements and procedures.

**Article 19.** Additional requirements

1. The control function of vehicles having on board diagnostics may not be impaired by the installation of the retrofit system.
2. If the retrofitting with a PMRS necessitates other measures on emission relevant parts or system components (e.g. adaptation of the EGR control to guarantee its proper functioning) the engine manufacturer shall release this adaptation.

3. The installation of the particulate matter retention system may not impair operating performance or have any detrimental effects for vehicle safety.
4. In combination with class B particulate matter reduction systems the use of fuel additives facilitating regeneration is not permitted.
5. In case of a PMRS with additive supported regeneration, the applicant shall submit a statement of no objection against the combination of the additive and the system, issued by the RIVM or a similar statement (Unbedenklichkeitserklärung) by the Federal Environment Agency (Umwelt Bundes Amt) of the Federal Republic of Germany. This provision is not applicable to VERT certified PMRS.
6. If the original oxidation catalyst a vehicle is equipped with is of importance for the proper functioning of the PMRS, the installation manual of the PMRS shall specify the criteria on which this oxidation catalyst may have to be replaced. Catalysts showing visible defects shall be replaced in any case.
7. The applicant shall make a reasonable case, for example by presenting comparative measurements, for the expectation that the retrofitting will not cause a deterioration of the noise level. In case of PMRS that are installed additional to the original muffler noise measurements are not necessary.
8. If electronic units and/or control units are used, these must correspond to the provisions of directive 72/45/EEC.
9. The fuel consumption in the modified ETC test cycle of the retrofitted engine shall not exceed the fuel consumption in the original state by more than 4 %. The measurements for the fuel consumption shall coincide with the measurements according to article 15 for continuously regenerating systems or article 16 for periodically regenerating systems. This provision is not applicable to VERT certified PMRS.

**Article 20.** Obligations for the holder of a type approval

1. The holder of a type approval for a PMRS issued by the Road Transport Directorate (RDW) shall provide each system he puts on the market in the Netherlands with an installation manual fulfilling the requirements of annex II and with a copy of the type approval certificate.
2. De holder of a type approval for a PMRS shall, as part the conditions of sale and laid down in every contract to supply a system to the end user, commit himself to perform the necessary maintenance free of cost to the end user, as often as required, during a least the mileage he guarantees the proper functioning of the system (80.000 or 200.000 km or 5 years).

**Article 21.** Application for type approval

1. An application for type approval of a particulate matter reduction system for retrofit purposes is submitted to the Road Transport Directorate in Zoetermeer (Netherlands);
2. Preceding the application for type approval an agreement on this subject is concluded between the applicant and the Road Transport Directorate;

3. An application is accompanied by a completed document according to a model provided by the Road Transport Directorate;
4. Preceding the consideration of an application for type approval the applicant has to demonstrate he is capable of fulfilling the requirements that are described in article 23;
5. Basis for granting type approval is the report of a technical service certified by a EU member state to carry out tests according to directive 2005/55, in which the particulate matter reduction system is described and which states that the requirements of this regulation are fulfilled, or a demonstration by the applicant that the VERT requirements are being fulfilled, including the two times 1000 hours endurance test, or a type approval issued by the Federal motor vehicle agency (KBA) together with the test rapport on which this type approval is based, demonstrating that the corresponding requirements of the Federal Republic of Germany are fulfilled, after these requirements (Annex XXVII of the road traffic registration regulation (StVZO)) have come into force

**Article 22.** Withdrawal of type approval

A type approval for a PMRS is withdrawn:

1. A the request of the holder of the approval;
2. If the holder of the approval does not abide by the conditions attached to the approval;
3. If the surveillance on the conformity of production shows that the required quality is no longer guaranteed, and that measures to restore conformity of production fail to have the desired effect;
4. If information received from the Federal Republic of Germany shows that they have established that the conditions for granting the German type approval are no longer fulfilled.
5. If information is received from the Swiss Federal Office for the Environment showing that the VERT nomination has been withdrawn, e.g. for reasons of not fulfilling the maximum fail rate requirement.

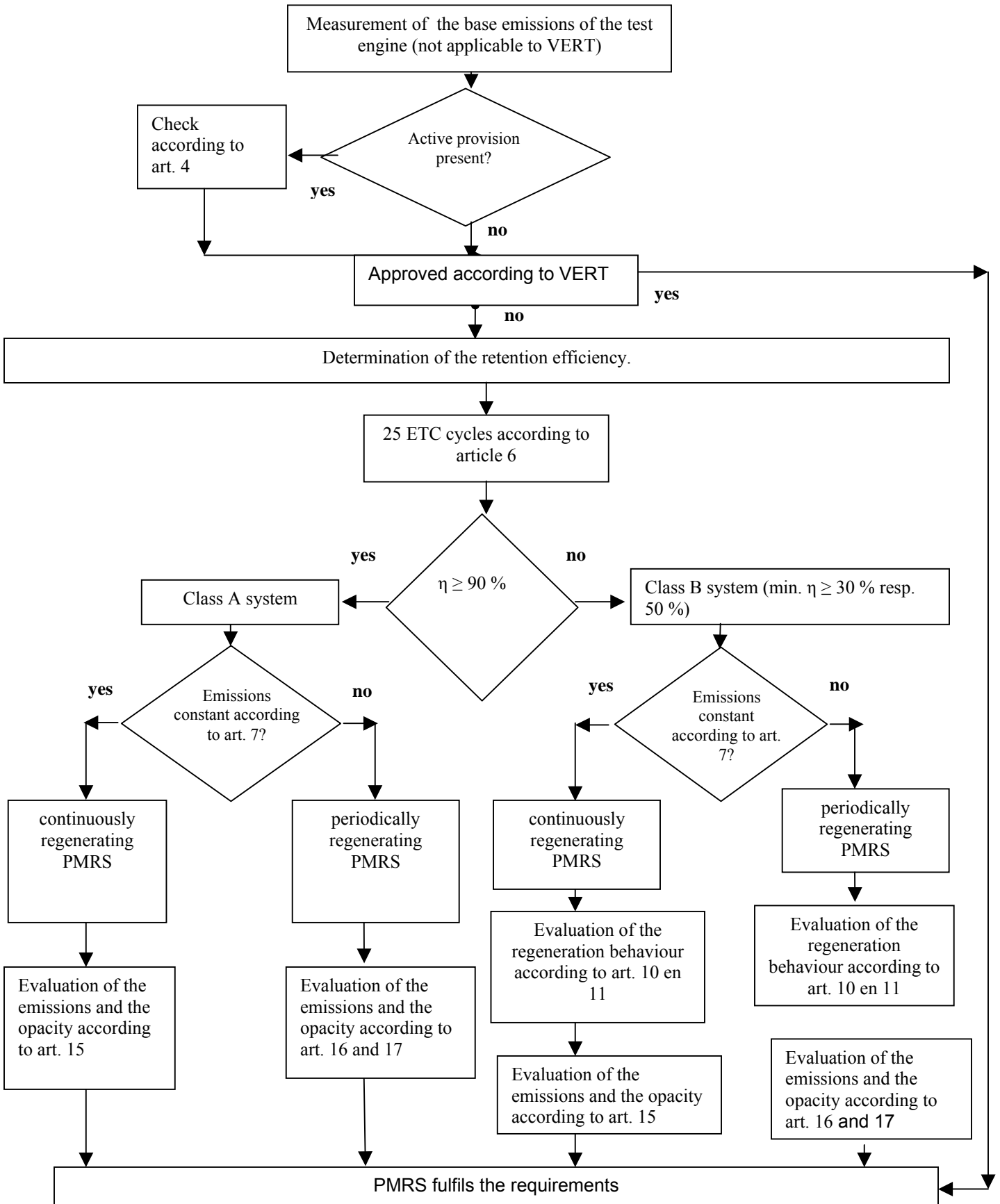
**Article 23.** Conformity of Production

1. The measures taken to guarantee conformity of production shall fulfil the requirements of article 10 of directive 70/156/EEC.
2. Special requirements
  - The checks as meant in section 2.2 of annex X of directive 70156/EEC include the checks on the conformity with the criteria of article 5 of this regulation.
  - For the application of section 3.5 of annex X to directive 70/156/EEC the tests described in the articles 6 up to and including 13 may be carried out. For VERT certified PMRS a sufficient number of data of periodic opacity measurement results on in use vehicles with PMRS during free acceleration are used in stead to demonstrate adequate functionality and durability of serially produced PMRS. The limit values for opacity to be

- applied during these measurements are established according to VERT requirements and procedures.
3. Before type approvals can be granted, the manufacturers shall submit the following data on conformity of production (in English, German or Dutch language) for the purpose of the initial assessment:
    - A completed and signed application form, according to a model to be provided by the RDW;
    - A description of the requested information, according to the annex to the application form;
    - A copy of the ISO9001:2000 certificate, or any equivalent quality system, with a relevant scope.
  4. Based on this information manufacturers who are having a certified quality system may be admitted, receiving an Initial Assessment Statement based on the appraisal of documents;
  5. In case the manufacturer does not have a certified quality system, a company assessment is carried out based on ISO9001:2000, including COP aspects;
  6. At least the following aspects of ISO9001:2000 are to be described and verified:
    - Quality management system;
    - Responsibilities of the board;
    - Management of resources;
    - Realisation of the product;
    - Measurement, analysis and improvement.
  7. To confirm the existence of adequate measures and procedures for an effective control on COP the manufacturer receives a Compliance Statement, at the published certificate fee;
  8. The statement has a stated validity;
  9. Before the expiration of the validity of both statements the RDW will carry out a COP audit by process control at the manufacturer, to verify the effectiveness of the applied COP controls;
  10. Practising its surveillance on the COP the RDW takes into consideration the surveillance carried out by the qualified authorities of other EU member states.

**Schematic test procedure.**

**Annex I [Anhang I]**



### **Requirements on the installation manual**

Every new retrofit particulate matter reduction system has to be accompanied by an installation manual in Dutch language containing at least the following information:

1. The name or trademark of the manufacturer of the particulate matter reduction system.
2. The type of particulate matter reduction system.
3. The Dutch type approval number, and, if applicable, the German type approval number.
4. Of the vehicle types (with indication of the model year) for which the particulate matter reduction system has been approved:
  - Make
  - Type (commercial name)
  - Type (manufacturer's code)
  - Model years if necessary in combination with VIN numbers
  - Engine type (Engine code)
  - Euro class(es) of the engine(s)
  - Engine capacity
  - Engine power
5. Adequate information for a qualified person to install the particulate matter reduction system on the vehicle.
6. The criteria and methods to verify whether the condition of the engine of the vehicle on which the system is to be installed is such that good working of the system during the desired life may be expected.
7. The location on the particulate matter reduction system where, after installation of the system on the vehicle, the final 4 digits of the VIN number may be stamped in or engraved.

### **Determination of the mass percentage NO<sub>2</sub>**

The mass percentage NO<sub>2</sub> is determined by:

$$NO_2[\text{mass}\%] = 100 \times \frac{NO_2[\text{g / test}]}{NO[\text{g / test}] + NO_2[\text{g / test}]}$$

The determination of the mass emissions of NO and NO<sub>2</sub> takes place by simultaneous sampling of NO<sub>x</sub> and NO in the raw exhaust gas applying the technical standards of ISO 16183:2002. The momentaneous NO<sub>2</sub> concentration is determined by the difference between the aligned momentaneous NO<sub>x</sub> signal and the aligned momentaneous NO signal.

$$C_{NO_2, i} = C_{NO_x, i} - C_{NO, i}$$

For the analysis of the exhaust gas instruments are used with a working principle based on chemoluminescence (CLD). It is possible to use two separate instruments, or to use one instrument with two measurement chambers, fulfilling the requirements of ISO 16183:2002.