L.N. 185 of 2011

ENVIRONMENT AND DEVELOPMENT PLANNING ACT (CAP. 504)

Measures against the Emission of Gaseous and Particulate Pollutants from Internal Combustion Engines (Non-road Mobile Machinery) (Amendment) Regulations, 2011

BY VIRTUE of the powers conferred by articles 61 and 62 of the Environment and Development Planning Act, the Prime Minister has made the following regulations:-

Citation.

L.N. 229 of 2001.

1. (1) The title of these regulations is the Measures against the Emission of Gaseous and Particulate Pollutants from Internal Combustion Engines (Non-road Mobile Machinery) (Amendment) Regulations, 2011 and they shall be read and construed as one with the Measures against the Emission of Gaseous and Particulate Pollutants from Internal Combustion Engines (Non-road Mobile Machinery) Regulations, 2001 hereinafter referred to as "the principal regulations".

(2) These regulations implement the provisions of Directive 2010/26/EC of the European Parliament and of the Council of 31st March 2010 amending Directive 97/68/EC on the approximation of the laws of the Member States relating to measures against the emission of gaseous and particulate pollutants from internal combustion engines to be installed in non-road mobile machinery.

Amends regulation 2 of the principal regulations.

2. In regulation 2 of the principal regulations, for the definition "competent authority" there shall be substituted the following:-

" "competent authority" means the Malta Standards Authority;".

Amends Annex 1 to the principal regulations.

3. Immediately after section 7 in Annex 1 to the principal regulations, there shall be added the following new section:

'8. TYPE APPROVAL REQUIREMENTS FOR STAGES IIIB AND IV

8.1. This section shall apply to the type-approval of electronically controlled engines, which uses electronic control to determine both the quantity and timing of injecting fuel (hereafter "engine"). This section shall apply irrespective of the technology applied to such engines to comply with the emission limit values set out in sections 4.1.2.5 and 4.1.2.6 of this Annex.

8.2. **Definitions**

For the purpose of this section, the following definitions shall apply:

8.2.1. "*emission control strategy*" means a combination of an emission control system with one base emission control strategy and with one set of auxiliary emission control strategies, incorporated into the overall design of an engine or non-road mobile machinery into which the engine is installed.

8.2.2. "*reagent*" means any consumable or non-recoverable medium required and used for the effective operation of the exhaust after-treatment system.

8.3. **General requirements**

8.3.1. *Requirements for base emission control strategy*

8.3.1.1. The base emission control strategy, activated throughout the speed and torque operating range of the engine, shall be designed as to enable the engine to comply with the provisions of this Directive

8.3.1.2. Any base emission control strategy that can distinguish engine operation between a standardised type approval test and other operating conditions and subsequently reduce the level of emission control when not operating under conditions substantially included in the type approval procedure is prohibited.

8.3.2. *Requirements for auxiliary emission control strategy*

8.3.2.1. An auxiliary emission control strategy may be used by an engine or a non-road mobile machine, provided that the auxiliary emission control strategy, when activated, modifies the base emission control strategy in response to a specific set of ambient and/or operating conditions but does not permanently reduce the effectiveness of the emission control system:

(a) where the auxiliary emission control strategy is activated during the type approval test, sections 8.3.2.2 and 8.3.2.3 shall not apply;

(b) where the auxiliary emission control strategy is not activated during the type approval test, it must be demonstrated that the auxiliary emission control strategy is active only for as long as required for the purposes identified in section 8.3.2.3.

8.3.2.2. The control conditions applicable to this section are all of the following:

(a) an altitude not exceeding 1 000 metres (or equivalent atmospheric pressure of 90 kPa);

(b) an ambient temperature within the range 275 K to 303 K (2 °C to 30 °C);

(c) the engine coolant temperature above 343 K (70 °C).

Where the auxiliary emission control strategy is activated when the engine is operating within the control conditions set out in points (a), (b) and (c), the strategy shall only be activated exceptionally.

8.3.2.3. An auxiliary emission control strategy may be activated in particular for the following purposes:

(a) by onboard signals, for protecting the engine (including air-handling device protection) and/or non-road mobile machine into which the engine is installed from damage;

(b) for operational safety and strategies;

(c) for prevention of excessive emissions, during cold start or warming-up, during shut-down;

(d) if used to trade-off the control of one regulated pollutant under specific ambient or operating conditions, for maintaining control of all other regulated pollutants, within the emission limit values that are appropriate for the engine concerned. The purpose is to compensate for naturally occurring phenomena in a manner that provides acceptable control of all emission constituents.

8.3.2.4. The manufacturer shall demonstrate to the technical service at the time of the type-approval test that the operation of any auxiliary emission strategy complies with the provisions of section 8.3.2. The demonstration shall consist of an evaluation of the documentation referred to in section 8.3.3.

8.3.2.5. Any operation of an auxiliary emission control strategy not compliant with section 8.3.2 is prohibited.

8.3.3. *Documentation requirements*

8.3.3.1. The manufacturer shall provide an information folder accompanying the application for type-approval at the time of submission to the technical service, which ensures access to any element of design and emission control strategy and the means by which the auxiliary strategy directly or indirectly controls the output variables. The information folder shall be made available in two parts:

(a) the documentation package, annexed to the application for type-approval, shall include a full overview of the emission control strategy. Evidence shall be provided that all outputs permitted by a matrix, obtained from the range of control of the individual unit inputs, have been identified. This evidence shall be attached to the information folder as referred to in Annex II;

(b) the additional material, presented to the technical service but not annexed to the application for type-approval, shall include all the modified parameters by any auxiliary emission control strategy and the boundary conditions under which this strategy operates and in particular:

(i) a description of the control logic and of timing strategies and switch points, during all modes of operation for the fuel and other essential systems, resulting in effective emissions control (such as exhaust gas recirculation system (EGR) or reagent dosing);

(ii) a justification for the use of any auxiliary emission control strategy applied to the engine, accompanied by material and test data, demonstrating the effect on exhaust emissions. This justification may be based on test data, sound engineering analysis, or a combination of both;

(iii) a detailed description of algorithms or sensors (where applicable) used for identifying, analysing, or diagnosing incorrect operation of the NO_x control system;

(iv) the tolerance used to satisfy the requirements in section 8.4.7.2, regardless of the used means.

8.3.3.2. The additional material referred to in point (b) of section 8.3.3.1 shall be treated as strictly confidential. It shall be made available to the type-approval authority on request. The type-approval authority shall treat this material as confidential.

8.4. **Requirements to ensure correct operation of NO_x control measures**

8.4.1. The manufacturer shall provide information that fully describes the functional operational characteristics of the NO_x control measures using the documents set out in section 2 of Appendix 1 to Annex II and in section 2 of Appendix 3 to Annex II.

8.4.2. If the emission control system requires a reagent, the characteristics of that reagent, including the type of reagent, information on concentration when the reagent is in solution, operational temperature conditions and reference to international standards for composition and quality must be specified by the manufacturer, in section 2.2.1.13 of Appendix 1 and in section 2.2.1.13 of Appendix 3 to Annex II.

8.4.3. The engine emission control strategy shall be operational under all environmental conditions regularly pertaining in the territory of the Community, especially at low ambient temperatures.

8.4.4. The manufacturer shall demonstrate that the emission of ammonia during the applicable emission test cycle of the type approval procedure, when a reagent is used, does not exceed a mean value of 25 ppm.

8.4.5. If separate reagent containers are installed on or connected to a non-road mobile machine, means for taking a sample of the reagent inside the containers must be included. The sampling point must be easily accessible without requiring the use of any specialised tool or device.

8.4.6. *Use and maintenance requirements*

8.4.6.1. The type approval shall be made conditional, in accordance with Article 4(3), upon providing to each operator of non-road mobile machinery written instructions comprising the following:

(a) detailed warnings, explaining possible malfunctions generated by incorrect operation, use or maintenance of the installed engine, accompanied by respective rectification measures;

(b) detailed warnings on the incorrect use of the machine resulting in possible malfunctions of the engine, accompanied by respective rectification measures;

(c) information on the correct use of the reagent, accompanied by an instruction on refilling the reagent between normal maintenance intervals;

(d) a clear warning, that the type-approval certificate, issued for the type of engine concerned, is valid only when all of the following conditions are met:

(i) the engine is operated, used and maintained in accordance with the instructions provided;

(ii) prompt action has been taken for rectifying incorrect operation, use or maintenance in accordance with the rectification measures indicated by the warnings referred to in point (a) and (b);

(iii) no deliberate misuse of the engine has taken place, in particular deactivating or not maintaining an EGR or reagent dosing system.

The instructions shall be written in a clear and non-technical manner using the same language as is used in the operator's manual on non-road mobile machinery or engine.

8.4.7. *Reagent control (where applicable)*

8.4.7.1. The type approval shall be made conditional, in accordance with the provisions of section 3 of Article 4, upon providing indicators or other appropriate means, according to the configuration of the non-road mobile machinery, informing the operator on:

(a) the amount of reagent remaining in the reagent storage container and by an additional specific signal, when the remaining reagent is less than 10 % of the full container's capacity;

(b) when the reagent container becomes empty, or almost empty;

(c) when the reagent in the storage tank does not comply with the characteristics declared and recorded in section 2.2.1.13 of Appendix 1 and section 2.2.1.13 of Appendix 3 to Annex II, according to the installed means of assessment.

(d) when the dosing activity of the reagent is interrupted, in cases other than those executed by the engine ECU or the dosing controller, reacting to engine operating conditions where the dosing is not required, provided that these operating conditions are made available to the type approval authority.

8.4.7.2. By the choice of the manufacturer the requirements of reagent compliance with the declared characteristics and the associated NO_x emission tolerance shall be satisfied by one of the following means:

(a) direct means, such as the use of a reagent quality sensor.

(b) indirect means, such as the use of a NO_x sensor in the exhaust to evaluate reagent effectiveness.

(c) any other means, provided that its efficacy is at least equal to the one resulting by the use of the means of points (a) or (b) and the main requirements of this section are maintained.'

4. Annex II to the principal regulations shall be amended as follows:

Amends Annex II to the principal regulations.

(a) instead of section 2 of Appendix 1 thereto, there shall be susbsituted the following:

'2. MEASURES TAKEN AGAINST AIR POLLUTION

2.1. Device for recycling crankcase gases: yes/no (*) .....

2.2. Additional anti-pollution devices (if any, and if not covered by another heading)

2.2.1. Catalytic converter: yes/no (*)

2.2.1.1. Make(s): .....

2.2.1.2. Type(s): .....

2.2.1.3. Number of catalytic converters and elements .....

2.2.1.4. Dimensions- and volume of the catalytic converter(s): .....

2.2.1.5. Type of catalytic action: .....

2.2.1.6. Total charge of precious metals: .....

2.2.1.7. Relative concentration: .....

2.2.1.8. Substrate (structure and material): .....

2.2.1.9. Cell density: .....

2.2.1.10. Type of casing for the catalytic converter(s): .....

2.2.1.11. Location of the catalytic converter(s) (place(s) and maximum/minimum distance(s) from engine): .....

2.2.1.12. Normal operating range (K): .....

2.2.1.13. Consumable reagent (where appropriate): .....

2.2.1.13.1. Type and concentration of reagent needed for catalytic action: .....

2.2.1.13.2. Normal operational temperature range of reagent: .....

2.2.1.13.3. International standard (where appropriate): .....

2.2.1.14. NO_x sensor: yes/no (*)

2.2.2. Oxygen sensor: yes/no (*)

2.2.2.1. Make(s): .....

2.2.2.2. Type: .....

2.2.2.3. Location: .....

2.2.3. Air injection: yes/no (*)

2.2.3.1. Type (pulse air, air pump, etc.): .....

2.2.4. EGR: yes/no (*)

2.2.4.1. Characteristics (cooled/uncooled, high pressure/low pressure, etc.): .....

2.2.5. Particulate trap: yes/no (*)

2.2.5.1. Dimensions and capacity of the particulate trap: .....

2.2.5.2. Type and design of the particulate trap: .....

2.2.5.3. Location (place(s) and maximum/minimum distance(s) from engine): .....

2.2.5.4. Method or system of regeneration, description and/or drawing: .....

2.2.5.5. Normal operating temperature (K) and pressure (kPa) range: .....

2.2.6. Other systems: yes/no (*)

2.2.6.1. Description and operation: .....

(*) Strike out what does not apply.'

(b) instead of section 2 of Appendix 3 thereto, there shall be substituted the following:

‘2. MEASURES TAKEN AGAINST AIR POLLUTION

2.1. Device for recycling crankcase gases: yes/no (*) .....

2.2. Additional anti-pollution devices (if any, and if not covered by another heading)

2.2.1. Catalytic converter: yes/no (*)

2.2.1.1. Make(s): .....

2.2.1.2. Type(s): .....

2.2.1.3. Number of catalytic converters and elements .....

2.2.1.4. Dimensions- and volume of the catalytic converter(s): .....

2.2.1.5. Type of catalytic action: .....

2.2.1.6. Total charge of precious metals: .....

2.2.1.7. Relative concentration: .....

2.2.1.8. Substrate (structure and material): .....

2.2.1.9. Cell density: .....

2.2.1.10. Type of casing for the catalytic converter(s): .....

2.2.1.11. Location of the catalytic converter(s) (place(s) and maximum/minimum distance(s) from engine): .....

2.2.1.12. Normal operating range (K) .....

2.2.1.13. Consumable reagent (where appropriate): .....

2.2.1.13.1. Type and concentration of reagent needed for catalytic action: .....

2.2.1.13.2. Normal operational temperature range of reagent: .....

2.2.1.13.3. International standard (where appropriate): .....

2.2.1.14. NO_x sensor: yes/no (*)

2.2.2. Oxygen sensor: yes/no (*)

2.2.2.1. Make(s): .....

2.2.2.2. Type: .....

2.2.2.3. Location: .....

2.2.3. Air injection: yes/no (*)

2.2.3.1. Type (pulse air, air pump, etc.): .....

2.2.4. EGR: yes/no (*)

2.2.4.1. Characteristics (cooled/uncooled, high pressure/low pressure, etc.): .....

2.2.5. Particulate trap: yes/no (*)

2.2.5.1. Dimensions and capacity of the particulate trap: .....

2.2.5.2. Type and design of the particulate trap: .....

2.2.5.3. Location (place(s) and maximum/minimum distance(s) from engine): .....

2.2.5.4. Method or system of regeneration, description and/or drawing: .....

2.2.5.5. Normal operating temperature (K) and pressure (kPa) range: .....

2.2.6. Other systems: yes/no (*)

2.2.6.1. Description and operation: .....

_____

(*) Strike out what does not apply.’

5. Annex III to the principal regulations shall be amended as follows:

Amends Annex III to the principal regulations.

(a) instead of section 1.1 of Annex III thereto, there shall be substituted the following:

'1.1. This Annex describes the method of determining emissions of gaseous and particulate pollutants from the engine to be tested.

The following test cycles shall apply:

— the NRSC (non-road steady cycle) appropriate for the equipment specification which shall be used for the measurement of the emissions of carbon monoxide, hydrocarbons, oxides of nitrogen and particulates for stages I, II, IIIA, IIIB and IV of engines described in points (i) and (ii) of section 1.A of Annex I, and

— the NRTC (non-road transient cycle) which shall be used for the measurement of the emissions of carbon monoxide, hydrocarbons, oxides of nitrogen and particulates for stages IIIB and IV of engines described in point (i) of section 1.A of Annex I,

— for engines intended to be used in inland waterway vessels the ISO test procedure as specified by ISO 8178-4:2002 and IMO ([1]) MARPOL ([2]) 73/78, Annex VI (NO_x Code) shall be used,

— for engines intended for propulsion of railcars an NRSC shall be used for the measurement of gaseous and particulate pollutants for stage IIIA and for stage IIIB,

— for engines intended for propulsion of locomotives an NRSC shall be used for the measurement of gaseous and particulate pollutants for stage IIIA and for stage IIIB.

([1]) IMO: International Maritime Organisation.
([2]) MARPOL: International Convention for the Prevention of Pollution from Ships.'

(b) instead of section 1.3.2 of Annex III thereto, there shall be substituted the following:

'1.3.2. *NRTC test*

The prescribed transient test cycle, based closely on the operating conditions of diesel engines installed in non-road machinery, is run twice:

— the first time (cold start) after the engine has soaked to room temperature and the engine coolant and oil temperatures, after treatment systems and all auxiliary engine control devices are stabilised between 20 and 30 °C,

— the second time (hot start) after a twenty-minute hot soak that commences immediately after the completion of the cold start cycle.

During this test sequence the above pollutants shall be examined. The test sequence consists of a cold start cycle following natural or forced cool-down of the engine, a hot soak period and a hot start cycle, resulting in a composite emissions calculation. Using the engine torque and speed feedback signals of the engine dynamometer, the power shall be integrated with respect to the time of the cycle, resulting in the work produced by the engine over the cycle. The concentrations of the gaseous components shall be determined over the cycle, either in the raw exhaust gas by integration of the analyser signal in accordance with Appendix 3 to this Annex, or in the diluted exhaust gas of a CVS full-flow dilution system by integration or by bag sampling in accordance with Appendix 3 to this Annex. For particulates, a proportional sample shall be collected from the diluted exhaust gas on a specified filter by either partial flow dilution or full-flow dilution. Depending on the method used, the diluted or undiluted exhaust gas flow rate shall be determined over the cycle to calculate the mass emission values of the pollutants. The mass emission values shall be related to the engine work to give the grams of each pollutant emitted per kilowatt-hour.

(c) instead of section 3.7.1 of Annex III thereto, there shall be substituted the following:

'3.7.1. Equipment specification according to section 1.A of Annex I:

3.7.1.1. Specification A

For engines covered by points (i) and (iv) of section 1.A of Annex I, the following 8-mode cycle ([1]) shall be followed in dynamometer operation on the test engine:

Mode No	Engine speed (r/min)	Load (%)	Weighting factor
1	Rated or reference (*)	100	0,15
2	Rated or reference (*)	75	0,15
3	Rated or reference (*)	50	0,15
4	Rated or reference (*)	10	0,10
5	Intermediate	100	0,10
6	Intermediate	75	0,10
7	Intermediate	50	0,10
8	Idle	—	0,15

(*) Reference speed is defined in section 4.3.1 of Annex III.

3.7.1.2. Specification B

For engines covered by point (ii) of section 1.A of Annex I, the following 5-mode cycle ([2]) shall be followed in dynamometer operation on the test engine:

Mode No	Engine speed (r/min)	Load (%)	Weighting factor
1	Rated	100	0,05
2	Rated	75	0,25
3	Rated	50	0,30
4	Rated	25	0,30
5	Rated	10	0,10

The load figures are percentage values of the torque corresponding to the prime power rating defined as the maximum power available during a variable power sequence, which may be run for an unlimited number of hours per year, between stated maintenance intervals and under the stated ambient conditions, the maintenance being carried out as prescribed by the manufacturer.

3.7.1.3. Specification C

For propulsion engines ([3]) intended to be used in inland waterway vessels the ISO test procedure as specified by ISO 8178-4:2002 and IMO MARPOL 73/78, Annex VI (NO_x Code) shall be used.

Propulsion engines that operate on a fixed-pitch propeller curve shall be tested on a dynamometer using the following 4-mode steady-state cycle ([4]) developed to represent in-use operation of commercial marine diesel engines.

Mode No	Engine speed (r/min)	Load (%)	Weighting factor
1	100 % (Rated)	100	0,20
2	91 %	75	0,50
3	80 %	50	0,15
4	63 %	25	0,15

Fixed speed inland waterway propulsion engines with variable pitch or electrically coupled propellers shall be tested on a dynamometer using the following 4-mode steady-state cycle ([5]) characterised by the same load and weighting factors as the above cycle, but with engine operated in each mode at rated speed:

Mode No	Engine speed (r/min)	Load (%)	Weighting factor
1	Rated	100	0,20
2	Rated	75	0,50
3	Rated	50	0,15
4	Rated	25	0,15

3.7.1.4. Specification D

For engines covered by point (v) of section 1.A of Annex I, the following 3-mode cycle ([6]) shall be followed in dynamometer operation on the test engine:

Mode No	Engine speed (r/min)	Load (%)	Weighting factor
1	Rated	100	0,25
2	Intermediate	50	0,15
3	Idle	—	0,60

([1]) Identical with C1 cycle as described in paragraph 8.3.1.1 of ISO 8178-4:2007 standard (corrected version 2008-07-01).
([2]) Identical with D2 cycle as described in paragraph 8.4.1 of the ISO 8178-4: 2002(E) standard.
([3]) Constant-speed auxiliary engines must be certified to the ISO D2 duty cycle, i.e. the 5-mode steady-state cycle specified in section 3.7.1.2, while variable-speed auxiliary engines must be certified to the ISO C1 duty cycle, i.e. the 8-mode steady-state cycle specified in section 3.7.1.1.
([4]) Identical with E3 cycle as described in Sections 8.5.1, 8.5.2 and 8.5.3 of the ISO 8178-4: 2002(E) standard. The four modes lie on an average propeller curve based on in-use measurements.
([5]) Identical with E2 cycle as described in Sections 8.5.1, 8.5.2 and 8.5.3 of the ISO 8178-4: 2002(E) standard.
([6]) Identical with F cycle of ISO 8178-4: 2002(E) standard.'

(d) instead of section 4.3.1 of Annex III thereto, there shall be substituted the following:

'4.3.1. *Reference speed*

The reference speed (n_{ref}) corresponds to the 100 % normalised speed values specified in the engine dynamometer schedule of Appendix 4 of Annex III. The actual engine cycle resulting from denormalisation to the reference speed depends largely on selection of the proper reference speed. The reference speed shall be determined by the following formula:

$$n_{ref} = \text{low speed} + 0{,}95 \times (\text{high speed} - \text{low speed})$$

(the high speed is the highest engine speed where 70 % of the rated power is delivered, while the low speed is the lowest engine speed where 50 % of the rated power is delivered).

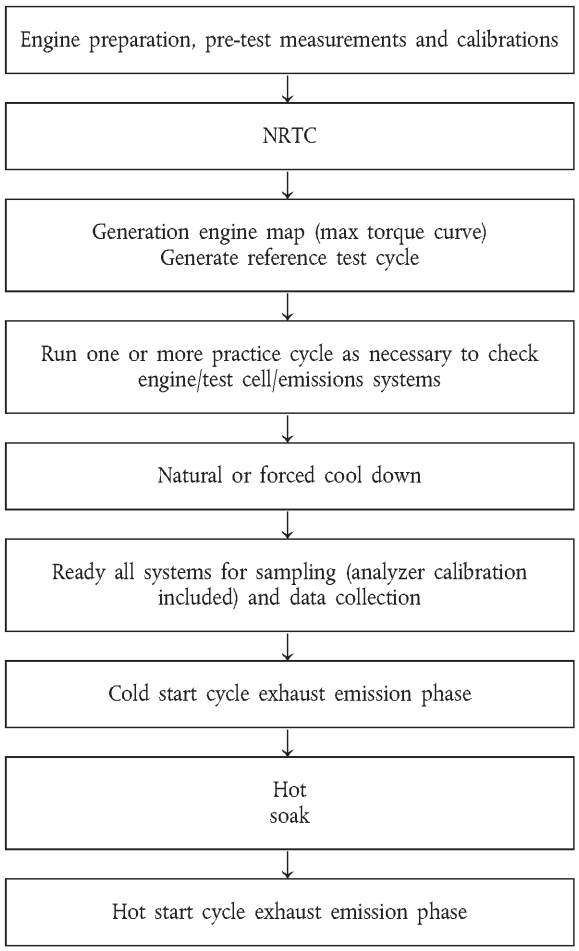
If the measured reference speed is within +/– 3 % of the reference speed as declared by the manufacturer, the declared reference speed may be used for the emissions test. If the tolerance is exceeded, the measured reference speed shall be used for the emissions test ([1]).

([1]) This is consistent with the ISO 8178-11:2006 standard.'

(e) instead of section 4.5 of Annex III thereto, there shall be substituted the following:

'4.5. **Emissions test run**

The following flow chart outlines the test sequence:



One or more practice cycles may be run as necessary to check engine, test cell and emissions systems before the measurement cycle.

4.5.1. *Preparation of the sampling filters*

At least one hour before the test, each filter shall be placed in a petri dish, which is protected against dust contamination and allows air exchange, and placed in a weighing chamber for stabilisation. At the end of the stabilisation period, each filter shall be weighed and the weight shall be recorded. The filter shall then be stored in a closed petri dish or sealed filter holder until needed for testing. The filter shall be used within eight hours of its removal from the weighing chamber. The tare weight shall be recorded.

4.5.2. *Installation of the measuring equipment*

The instrumentation and sample probes shall be installed as required. The tailpipe shall be connected to the full-flow dilution system, if used.

4.5.3. *Starting the dilution system*

The dilution system shall be started. The total diluted exhaust gas flow of a full-flow dilution system or the diluted exhaust gas flow through a partial flow dilution system shall be set to eliminate water condensation in the system, and to obtain a filter face temperature between 315 K (42 °C) and 325 K (52 °C).

4.5.4. *Starting the particulate sampling system*

The particulate sampling system shall be started and run on by-pass. The particulate background level of the dilution air may be determined by sampling the dilution air prior to entrance of the exhaust into the dilution tunnel. It is preferred that background particulate sample be collected during the transient cycle if another PM sampling system is available. Otherwise, the PM sampling system used to collect transient cycle PM can be used. If filtered dilution air is used, one measurement may be done prior to or after the test. If the dilution air is not filtered, measurements should be carried out prior to the beginning and after the end of the cycle and the values averaged.

4.5.5. *Checking the analysers*

The emission analysers shall be set at zero and spanned. If sample bags are used, they shall be evacuated.

4.5.6. *Cool-down requirements*

A natural or forced cool-down procedure may be applied. For forced cool-down, good engineering judgement shall be used to set up systems to send cooling air across the engine, to send cool oil through the engine lubrication system, to remove heat from the coolant through the engine cooling system, and to remove heat from an exhaust after-treatment system. In the case of a forced after-treatment cool down, cooling air shall not be applied until the after-treatment system has cooled below its catalytic activation temperature. Any cooling procedure that results in unrepresentative emissions is not permitted.

The cold start cycle exhaust emission test may begin after a cool-down only when the engine oil, coolant and after-treatment temperatures are stabilised between 20 °C and 30 °C for a minimum of 15 minutes.

4.5.7. *Cycle run*

4.5.7.1. Cold start cycle

The test sequence shall commence with the cold start cycle at the completion of the cool-down when all the requirements specified in section 4.5.6 are met.

The engine shall be started according to the starting procedure recommended by the manufacturer in the owner's manual, using either a production starter motor or the dynamometer.

As soon as it is determined that the engine is started, start a "free idle" timer. Allow the engine to idle freely with no-load for 23 ± 1 s. Begin the transient engine cycle such that the first non-idle record of the cycle occurs at 23 ± 1 s. The free idle time is included in the 23 ± 1 s.

The test shall be performed according to the reference cycle as set out in Annex III, Appendix 4. Engine speed and torque command set points shall be issued at 5 Hz (10 Hz recommended) or greater. The set points shall be calculated by linear interpolation between the 1 Hz set points of the reference cycle. Feedback engine speed and torque shall be recorded at least once every second during the test cycle, and the signals may be electronically filtered.

4.5.7.2. Analyser response

At the start of the engine the measuring equipment shall be started, simultaneously:

— start collecting or analysing dilution air, if a full flow dilution system is used,

— start collecting or analysing raw or diluted exhaust gas, depending on the method used,

— start measuring the amount of diluted exhaust gas and the required temperatures and pressures,

— start recording the exhaust gas mass flow rate, if raw exhaust gas analysis is used,

— start recording the feedback data of speed and torque of the dynamometer.

If raw exhaust measurement is used, the emission concentrations (HC, CO and NO_x) and the exhaust gas mass flow rate shall be measured continuously and stored with at least 2 Hz on a computer system. All other data may be recorded with a sample rate of at least 1 Hz. For analogue analysers the response shall be recorded, and the calibration data may be applied online or offline during the data evaluation.

If a full flow dilution system is used, HC and NO_x shall be measured continuously in the dilution tunnel with a frequency of at least 2 Hz. The average concentrations shall be determined by integrating the analyser signals over the test cycle. The system response time shall be no greater than 20 s, and shall be coordinated with CVS flow fluctuations and sampling time/test cycle offsets, if necessary. CO and CO_2 shall be determined by integration or by analysing the concentrations in the sample bag collected over the cycle. The concentrations of the gaseous pollutants in the dilution air shall be determined by integration or by collection in the background bag. All other parameters that need to be measured shall be recorded with a minimum of one measurement per second (1 Hz).

4.5.7.3. Particulate sampling

At the start of the engine the particulate sampling system shall be switched from by-pass to collecting particulates.

If a partial flow dilution system is used, the sample pump(s) shall be adjusted so that the flow rate through the particulate sample probe or transfer tube is maintained proportional to the exhaust mass flow rate.

If a full flow dilution system is used, the sample pump(s) shall be adjusted so that the flow rate through the particulate sample probe or transfer tube is maintained at a value within ± 5 % of the set flow rate. If flow compensation (i.e. proportional control of sample flow) is used, it must be demonstrated that the ratio of main tunnel flow to particulate sample flow does not change by more than ± 5 % of its set value (except for the first 10 seconds of sampling).

NOTE: For double dilution operation, sample flow is the net difference between the flow rate through the sample filters and the secondary dilution airflow rate.

The average temperature and pressure at the gas meter(s) or flow instrumentation inlet shall be recorded. If the set flow rate cannot be maintained over the complete cycle (within ± 5 %) because of high particulate loading on the filter, the test shall be voided. The test shall be rerun using a lower flow rate and/or a larger diameter filter.

4.5.7.4. Engine stalling during the cold start test cycle

If the engine stalls anywhere during the cold start test cycle, the engine shall be preconditioned, then the cool-down procedure repeated; finally the engine shall be restarted, and the test repeated. If a malfunction occurs in any of the required test equipment during the test cycle, the test shall be voided.

4.5.7.5. Operations after cold start cycle

At the completion of the cold start cycle of the test, the measurement of the exhaust gas mass flow rate, the diluted exhaust gas volume, the gas flow into the collecting bags and the particulate sample pump shall be stopped. For an integrating analyser system, sampling shall continue until system response times have elapsed.

The concentrations of the collecting bags, if used, shall be analysed as soon as possible and in any case not later than 20 minutes after the end of the test cycle.

After the emission test, a zero gas and the same span gas shall be used for re-checking the analysers. The test will be considered acceptable if the difference between the pre-test and post-test results is less than 2 % of the span gas value.

The particulate filters shall be returned to the weighing chamber no later than one hour after completion of the test. They shall be conditioned in a petri dish, which is protected against dust contamination and allows air exchange, for at least one hour, and then weighed. The gross weight of the filters shall be recorded.

4.5.7.6. Hot soak

Immediately after the engine is turned off, the engine cooling fan(s) shall be turned off if used, as well as the CVS blower (or disconnect the exhaust system from the CVS), if used.

Allow the engine to soak for 20 ± 1 minutes. Prepare the engine and dynamometer for the hot start test. Connect evacuated sample collection bags to the dilute exhaust and dilution air sample collection systems. Start the CVS (if used or not already on) or connect the exhaust system to the CVS (if disconnected). Start the sample pumps (except the particulate sample pump(s), the engine cooling fan(s) and the data collection system.

The heat exchanger of the constant volume sampler (if used) and the heated components of any continuous sampling system(s) (if applicable) shall be preheated to their designated operating temperatures before the test begins.

Adjust the sample flow rates to the desired flow rate and set the CVS gas flow measuring devices to zero. Carefully install a clean particulate filter in each of the filter holders and install assembled filter holders in the sample flow line.

4.5.7.7. Hot start cycle

As soon as it is determined that the engine is started, start a “free idle” timer. Allow the engine to idle freely with no-load for 23 ± 1 s. Begin the transient engine cycle such that the first non-idle record of the cycle occurs at 23 ± 1 s. The free idle time is included in the 23 ± 1 s.

The test shall be performed according to the reference cycle as set out in Appendix 4 to Annex III. Engine speed and torque command set points shall be issued at 5 Hz (10 Hz recommended) or greater. The set points shall be calculated by linear interpolation between the 1 Hz set points of the reference cycle. Feedback engine speed and torque shall be recorded at least once every second during the test cycle, and the signals may be electronically filtered.

The procedure described in previous sections 4.5.7.2 and 4.5.7.3 shall then be repeated.

4.5.7.8. Engine stalling during the hot start cycle

If the engine stalls anywhere during the hot start cycle, the engine may be shut off and re-soaked for 20 minutes. The hot start cycle may then be rerun. Only one hot re-soak and hot start cycle restart is permitted.

4.5.7.9. Operations after hot start cycle

At the completion of the hot start cycle, the measurement of the exhaust gas mass flow rate, the diluted exhaust gas volume, the gas flow into the collecting bags and the particulate sample pump shall be stopped. For an integrating analyser system, sampling shall continue until system response times have elapsed.

The concentrations of the collecting bags, if used, shall be analysed as soon as possible and in any case not later than 20 minutes after the end of the test cycle.

After the emission test, a zero gas and the same span gas shall be used for re-checking the analysers. The test will be considered acceptable if the difference between the pre-test and post-test results is less than 2 % of the span gas value.

The particulate filters shall be returned to the weighing chamber no later than one hour after completion of the test. They shall be conditioned in a petri dish, which is protected against dust contamination and allows air exchange, for at least one hour, and then weighed. The gross weight of the filters shall be recorded.’

(f) instead of section 2.1.2.4 of Appendix 3 to Annex III thereto, there shall be substituted the following:

'2.1.2.4. Calculation of the specific emissions

The specific emissions (g/kWh) shall be calculated for each individual component in the following way:

$$\text{Individual gas} = \frac{(1/10)M_{gas,cold} + (9/10)M_{gas,hot}}{(1/10)W_{act,cold} + (9/10)W_{act,hot}}$$

where:

$M_{gas,cold}$ = total mass of gaseous pollutant over the cold start cycle (g)

$M_{gas,hot}$ = total mass of gaseous pollutant over the hot start cycle (g)

$W_{act,cold}$ = actual cycle work over the cold start cycle as determined in Annex III section 4.6.2 (kWh)

$W_{act,hot}$ = actual cycle work over the hot start cycle as determined in Annex III section 4.6.2 (kWh)'

(g) instead of section 2.1.3.1 of Appendix 3 to Annex III thereto, there shall be substituted the following:

'2.1.3.1. Calculation of mass emission

The particulate masses $M_{PT,cold}$ and $M_{PT,hot}$ (g/test) shall be calculated by either of the following methods:

(a) $M_{PT} = \frac{M_f}{M_{SAM}} \times \frac{M_{EDFW}}{1\ 000}$

where

M_{PT} = $M_{PT,cold}$ for the cold start cycle

M_{PT} = $M_{PT,hot}$ for the hot start cycle

M_f = particulate mass sampled over the cycle (mg)

M_{EDFW} = mass of equivalent diluted exhaust gas over the cycle (kg)

M_{SAM} = mass of diluted exhaust gas passing the particulate collection filters (kg)

The total mass of equivalent diluted exhaust gas mass over the cycle shall be determined as follows:

$$M_{EDFW} = \sum_{i=1}^{1=n} G_{EDFW,i} \times \frac{1}{f}$$

$$G_{EDFW,i} = G_{EXHW,i} \times q_i$$

$$q_i = \frac{G_{TOTW,i}}{(G_{TOTW,i} - G_{DILW,i})}$$

where

$G_{EDFW,i}$ = instantaneous equivalent diluted exhaust mass flow rate (kg/s)

$G_{EXHW,i}$ = instantaneous exhaust mass flow rate (kg/s)

q_i = instantaneous dilution ratio

$G_{TOTW,i}$ = instantaneous diluted exhaust mass flow rate through dilution tunnel (kg/s)

$G_{DILW,i}$ = instantaneous dilution air mass flow rate (kg/s)

f = data sampling rate (Hz)

n = number of measurements

(b) $M_{PT} = \frac{M_f}{r_s \times 1\,000}$

where

M_{PT} = $M_{PT,cold}$ for the cold start cycle

M_{PT} = $M_{PT,hot}$ for the hot start cycle

M_f = particulate mass sampled over the cycle (mg)

r_s = average sample ratio over the test cycle

where

$$r_s = \frac{M_{SE}}{M_{EXHW}} \times \frac{M_{SAM}}{M_{TOTW}}$$

M_{SE} = sampled exhaust mass over the cycle (kg)

M_{EXHW} = total exhaust mass flow over the cycle (kg)

M_{SAM} = mass of diluted exhaust gas passing the particulate collection filters (kg)

M_{TOTW} = mass of diluted exhaust gas passing the dilution tunnel (kg)

NOTE: In case of the total sampling type system, M_{SAM} and M_{TOTW} are identical'

(h) instead of section 2.1.3.3 of Appendix 3 to Annex III thereto, there shall be substituted the following:

'2.1.3.3. Calculation of the specific emissions

The specific emissions (g/kWh) shall be calculated for in the following way:

$$PT = \frac{(1/10)K_{p,cold} \times M_{PT,cold} + (9/10)K_{p,hot} \times M_{PT,hot}}{(1/10)W_{act,cold} + (9/10)W_{act,hot}}$$

where

$M_{PT,cold}$ = particulate mass over the cold start cycle (g/test)

$M_{PT,hot}$ = particulate mass over the hot start cycle (g/test)

$K_{p,\ cold}$ = humidity correction factor for particulate over the cold start cycle

$K_{p,\ hot}$ = humidity correction factor for particulate over the hot start cycle

$W_{act,\ cold}$ = actual cycle work over the cold start cycle as determined in section 4.6.2. of Annex III, (kWh)

$W_{act,\ hot}$ = actual cycle work over the hot start cycle as determined in section 4.6.2. of Annex III, (kWh)'

(i) instead of section 2.2.4 of Appendix 3 to Annex III thereto, there shall be substituted the following:

'2.2.4. *Calculation of the specific emissions*

The specific emissions (g/kWh) shall be calculated for each individual component in the following way:

$$\text{Individual gas} = \frac{(1/10)M_{\text{gas,cold}} + (9/10)M_{gas,hot}}{(1/10)W_{act,cold} + (9/10)W_{act,hot}}$$

where

$M_{gas,cold}$ = total mass of gaseous pollutant over the cold start cycle (g)

$M_{gas,hot}$ = total mass of gaseous pollutant over the hot start cycle (g)

$W_{act,cold}$ = actual cycle work over the cold start cycle as determined in section 4.6.2. of Annex III (kWh)

$W_{act,hot}$ = actual cycle work over the hot start cycle as determined in section 4.6.2. of Annex III. (kWh)'

(j) instead of section 2.2.5.1 of Appendix 3 to Annex III thereto, there shall be substituted the following:

'2.2.5.1. Calculation of the mass flow

The particulate masses $M_{PT,cold}$ and $M_{PT,hot}$ (g/test) shall be calculated as follows:

$$M_{PT} = \frac{M_f}{M_{SAM}} \times \frac{M_{TOTW}}{1\ 000}$$

where

M_{PT} = $M_{PT,cold}$ for the cold start cycle

M_{PT} = $M_{PT,hot}$ for the hot start cycle

M_f = particulate mass sampled over the cycle (mg)

M_{TOTW} = total mass of diluted exhaust gas over the cycle as determined in section 2.2.1. (kg)

M_{SAM} = mass of diluted exhaust gas taken from the dilution tunnel for collecting particulates (kg)

and,

M_f = $M_{f,p}$ + $M_{f,b}$, if weighed separately (mg)

$M_{f,p}$ = particulate mass collected on the primary filter (mg)

$M_{f,b}$ = particulate mass collected on the back-up filter (mg)

If a double dilution system is used, the mass of the secondary dilution air shall be subtracted from the total mass of the double diluted exhaust gas sampled through the particulate filters.

$$M_{SAM} = M_{TOT} - M_{SEC}$$

where,

M_{TOT} = mass of double diluted exhaust gas through particulate filter (kg)

M_{SEC} = mass of secondary dilution air (kg)

If the particulate background level of the dilution air is determined in accordance with section 4.4.4 of Annex III, the particulate mass may be background corrected. In this case, the particulate masses $M_{PT,cold}$ and $M_{PT,hot}$ (g/test) shall be calculated as follows:

$$M_{PT} = \left[\frac{M_f}{M_{SAM}} - \left(\frac{M_d}{M_{DIL}} \times \left(1 - \frac{1}{DF}\right)\right)\right] \times \frac{M_{TOTW}}{1\,000}$$

where

M_{PT} = $M_{PT,cold}$ for the cold start cycle

M_{PT} = $M_{PT,hot}$ for the hot start cycle

M_f, M_{SAM}, M_{TOTW} = see above

M_{DIL} = mass of primary dilution air sampled by background particulate sampler (kg)

M_d = mass of the collected background particulates of the primary dilution air (mg)

DF = dilution factor as determined in section 2.2.3.1.1'

(k) instead of section 2.2.5.3 of Appendix 3 to Annex III thereto, there shall be substituted the following:

'2.2.5.3. Calculation of the specific emissions

The specific emissions (g/kWh) shall be calculated for in the following way:

$$PT = \frac{(1/10)K_{p,cold} \times M_{PT,cold} + (9/10)K_{p,hot} \times M_{PT,hot}}{(1/10)W_{act,cold} + (9/10)W_{act,hot}}$$

where

$M_{PT,cold}$ = particulate mass over the cold start cycle of NRTC, (g/test)

$M_{PT,hot}$ = particulate mass over the hot start cycle of NRTC, (g/test)

$K_{p,\ cold}$ = humidity correction factor for particulate over the cold start cycle

$K_{p,\ hot}$ = humidity correction factor for particulate over the hot start cycle

$W_{act,\ cold}$ = actual cycle work over the cold start cycle as determined in section 4.6.2. of Annex III, (kWh)

$W_{act,\ hot}$ = actual cycle work over the hot start cycle as determined in section 4.6.2 of Annex III, (kWh)'

Amends Annex V to the principal regulations

6. For the second row of the table in Annex V to the principal regulations titled ' NON-ROAD MOBILE MACHINERY REFERENCE FUEL FOR CI ENGINES TYPE APPROVED TO MEET STAGE IIIB AND IV LIMIT VALUES' there shall be substituted the following:

'Density at 15 °C	kg/m^3	833	865	EN-ISO 3675'

Amends Annex XIII to the principal regulations.

7. Annex XIII to the principal regulations shall be amended as follows:

(a) instead of section 1.5 of Annex XIII thereto, there shall be substituted the following:

'1.5. The OEM shall provide the approval authority with any information connected with the implementation of the flexibility scheme that the approval authority may request as necessary for the decision.'

(b) instead of section 1.6 of Annex XIII thereto, there shall be substituted the following:

'1.6. The OEM shall provide any requesting type approval authority in the Member States, with any information that the type approval authority requires in order to confirm that any engine claimed to be, or labelled as being, placed on the market under a flexibility scheme is properly so claimed or labelled.'

(c) section 1.7 of Annex XIII thereto shall be deleted.

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