الهيئة السعودية للمواصفات والمقاييس والجودة

Saudi Standards, Metrology and Quality Org. (SASO)

SASO / DS / 33916

مركبات الطرق – الحدود المسموح بها لانبعاثات الملوثات الغازية والجسيمية إلى البيئة لمحركات مركبات الخدمة الثقيلة

Road vehicles — Allowable limits of gaseous and particulate pollutants emitted into the atmosphere from heavy-duty vehicle engines

هذه الوثيقة مشروع مواصفة قياسية سعودية تم توزيعها لإبداء الرأي والملحوظات بشأنها، لذلك فإنها عرضة للتغيير والتبديل، ولا يجوز الرجوع إليها كمواصفة قياسية سعودية إلا بعد اعتمادها من الهيئة.

This document is a draft Saudi Standard circulated for comments. It is, therefore, subject to alteration and modification and may not be referred to as a Saudi Standard until approved by SASO.

ICS: 13.040.50

SASO XXXX:2026

مركبات الطرق – الحدود المسموح بها لانبعاثات الملوثات الغازية والجسيمية إلى البيئة لمحركات مركبات الخدمة الثقيلة

Road vehicles - Allowable limits of gaseous and particulate pollutants emitted into the atmosphere from heavy-duty vehicle engines

Date of SASO Board of Directors' Approval:
Date of Publication in the Official Gazette:

مقدمة

قامت الهيئة السعودية للمواصفات والمقاييس والجودة بإعداد المواصفة القياسية السعودية رقم SASO XXXX:2026 " مركبات الطرق – الحدود المسموح بها لانبعاثات الملوثات الغازية والجسيمية إلى البيئة لمحركات مركبات الخدمة الثقيلة " بعد استعراض المواصفات القياسية العربية والاجنبية والدولية والمؤلفات المرجعية.

Foreword

Saudi Standards, Metrology and Quality Organization (SASO) has updated the Saudi Standard No. SASO XXXX:2026 " Road vehicles - Allowable limits of gaseous and particulate pollutants emitted into the atmosphere from heavy-duty vehicle engines " based on relevant ADMO, International and National foreign Standards and references.

Table of Contents

Abbreviations

AECS	Auxiliary Emission Control Strategy
BECS	Base Emission Control Strategy
B2	Euro V Row B2 (2008)
CO	Carbon Monoxide
DPF	Diesel Particulate Filter
DTCs	Diagnostic Trouble Codes
ECS	Emission Control Strategy
EECU	Engine Electronic Control Unit
EGR	Exhaust Gas Recirculation
ELR	European Load Response Test
ESC	European Steady-State Cycle
ETC	European Transient Cycle
Euro V	European Emission Standard Euro V
g/kWh	Grams per Kilowatt-Hour
HC	Hydrocarbons
MI	Malfunction Indicator
nhi	High Engine Speed
NMHC	Non-Methane Hydrocarbons
NOx	Oxides of Nitrogen
nlo	Low Engine Speed
OBD	On-Board Diagnostics
PM	Particulate Matter
PT	Particulate Pollutants
RM	Reference Mass
SCR	Selective Catalytic Reduction

THC	Total Hydrocarbons
UNECE	United Nations Economic Commission for Europe

1. Scope

This Standard specifies the technical requirements, measurement and test methods for exhaust emissions, and the maximum permissible limits for gaseous and particulate pollutants emitted into the environment from engines of heavy-duty vehicles equipped with compression-ignition (CI) internal combustion engines operating on diesel fuel.

This standard applies to vehicles of the passenger transport categories (M1) and (M2), and goods transport vehicles (N1) and (N2) with a reference mass exceeding 2,610 kg, as well as all heavy-duty service vehicles of categories (M3) and (N3), in accordance with the technical provisions set out in **UNECE Regulation No. 49 Revision 5**, in accordance with the technical requirements of the **Euro 5** level.

2. Complementary References

2.1 **UNECE Regulation No. 49 Revision 5:** "Uniform provisions concerning 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".

2.2 **SASO 844** "Clean Diesel Fuel".

2.3 **ECE/TRANS/WP.29/78/Revision 6** "Consolidated Resolution on the Construction of Vehicles".

3. Definitions

3.1 **Clean Diesel Fuel:** Diesel fuel with a sulfur content not exceeding 10 parts per million, in accordance with the Saudi clean fuel standard specifications referred to in complementary reference 2.2.

3.2 **Reference Diesel Fuel:** The reference diesel fuel with characteristics as described in Annex 5 of complementary reference 2.1.

3.3 **Reagent:** means any medium that is stored on-board the vehicle in a tank and provided to the exhaust aftertreatment system (if required) upon request of the emission control system.

3.4 **Engine System**: means the engine, the emission control system and the communication interface (hardware and messages) between the engine system electronic control unit(s) (EECU) and any other powertrain or vehicle control unit.

3.5 **Engine Family**: means a manufacturer's grouping of engine systems which, through their design as defined in paragraph 7. of this standard, have similar exhaust emission characteristics; all members of the family shall comply with the applicable emission limit values.

3.6 **Engine Operating Speed Range**: means the engine speed range, most frequently used during engine field operation, which lies between the low and high speeds, as set out in Appendix 1 to Annex 4A of complementary reference 2.1.

3.6.1 **Low Speed (n_{lo})**: means the lowest engine speed where 50 per cent of the declared maximum power occurs.

3.6.2 **High Speed (n_{hi})**: means the highest engine speed where 70 per cent of the declared maximum power occurs.

3.7 **Engine Speeds A, B and C**: means the test speeds within the engine operating speed range to be used for the ESC test and the ELR test, as set out in Appendix 1 to Annex 4A of complementary reference 2.1.

3.8 **Engine Setting**: means a specific engine/vehicle configuration that includes the emission control strategy (ECS), one single engine performance rating (the approved full-load curve) and, if used, one set of torque limiters.

3.9 **Engine Type**: means a category of engines which do not differ in such essential respects as engine characteristics as described in Annex 1 of complementary reference 2.1.

3.10 **Engine-Aftertreatment System Family**: means, for testing over a service accumulation schedule to establish deterioration factors according to Annex 7 of complementary reference 2.1 and for checking the conformity of in-service vehicles/engines according to Annex 8 of complementary reference 2.1, a manufacturer’s grouping of engines that comply with the definition of engine family, but which are further grouped into engines utilising a similar exhaust aftertreatment system.

3.11 **Net Power**: means the power in kW obtained on the test bench at the end of the crankshaft, or its equivalent, measured in accordance with the method of measuring power as set out in Regulation No. 85.

3.12 **Rated Speed**: means the maximum full load speed allowed by the governor as specified by the manufacturer in his sales and service literature, or, if such a governor is not present, the speed at which the maximum power is obtained from the engine, as specified by the manufacturer in his sales and service literature.

3.13 **Test Cycle**: means a sequence of test points each with a defined speed and torque to be followed by the engine under steady state (ESC test) or transient operating conditions (ETC, ELR tests).

3.14 **ESC Test**: means a test cycle consisting of 13 steady state modes to be applied in accordance with paragraph 5.2 of complementary reference 2.1.

3.15 **ETC Test**: means a test cycle consisting of 1,800 second-by-second transient modes to be applied in accordance with paragraph 5.2 of complementary reference 2.1.

3.16 **ELR Test**: means a test cycle consisting of a sequence of load steps at constant engine speeds to be applied in accordance with paragraph 5.2 of complementary reference 2.1.

3.17 **Gaseous Pollutants**: means carbon monoxide, hydrocarbons (assuming a ratio of $CH_{1.85}$ for diesel, $CH_{2.525}$ for LPG and $CH_{2.93}$ for NG (NMHC) and an assumed molecule $CH_3O_{0.5}$ for ethanol-fuelled diesel engines), methane (assuming a ratio of CH_4 for NG) and oxides of nitrogen, the last-named being expressed in nitrogen dioxide (NO_2) equivalent.

3.18 **Particulate Pollutants**: means any material collected on a specified filter medium after diluting the exhaust with clean filtered air so that the temperature does not exceed 325 K (52 °C).

3.19 **Smoke**: means particles suspended in the exhaust stream of a diesel engine which absorb, reflect, or refract light.

3.20 **Opacimeter**: means an instrument designed to measure the opacity of smoke particles by means of the light extinction principle.

3.21 **Exhaust Aftertreatment System**: means a catalyst (oxidation or 3-way), particulate filter, deNOx system, combined deNOx-particulate filter or any other emission-reducing device that is installed downstream of the engine. This definition excludes exhaust gas recirculation, which, where fitted, is considered an integral part of the engine system.

3.22 **Particulate Aftertreatment Device**: means an exhaust aftertreatment system designed to reduce emissions of particulate pollutants (PT) through a mechanical, aerodynamic, diffusional or inertial separation.

3.23 **deNOx System**: means an exhaust aftertreatment system designed to reduce emissions of oxides of nitrogen (NOx) (e.g. there are presently passive and active lean NOx catalysts, NOx adsorbers and selective catalytic reduction (SCR) systems).

3.24 **Combined deNOx-Particulate Filter**: means an exhaust aftertreatment system designed to concurrently reduce emissions of oxides of nitrogen (NOx) and particulate pollutants (PT).

3.25 **Emission Control System**: means the exhaust aftertreatment system, the electronic management controller(s) of the engine system and any emission-related component of the engine system in the exhaust which supplies an input to or receives an output from this(these) controller(s), and when applicable the communication interface (hardware and messages) between the engine system electronic control unit(s) (EECU) and any other power train or vehicle control unit with respect to emissions management.

3.26 **Emission Control Monitoring System**: means the system that ensures correct operation of the NOx control measures implemented in the engine system according to the requirements of paragraph 5.5 of complementary reference 2.1.

3.27 **Emission Default Mode**: means an AECS activated in the case of a malfunction of the ECS detected by the OBD system that results in the malfunction indicator (MI) being activated and that does not require an input from the failed component or system.

3.28 **Emissions-Related Defect**: means a deficiency or deviation from normal production tolerances in design, materials or workmanship in a device, system or assembly that affects any parameter, specification or component belonging to the emission control system. A missing component may be considered to be an "emissions-related defect".

3.29 **Periodic Regeneration**: means the regeneration process of an emission control device that occurs periodically in less than 100 hours of normal engine operation. During cycles where regeneration occurs, emission standards can be exceeded.

3.30 **OBD**: means an on-board diagnostic system for emission control, which has the capability of detecting the occurrence of a malfunction and of identifying the likely area of malfunction by means of fault codes stored in computer memory. In accordance with Annex 9A of complementary reference 2.1, the OBD system in this Standard is defined in two stages with different monitoring scope, requirements, fault thresholds and reporting requirements, namely Stage I and Stage II.

3.31 **Major Functional Failure**: means a permanent or temporary malfunction of any exhaust aftertreatment system that is expected to result in an immediate or delayed increase of the gaseous or particulate emissions of the engine system and which cannot be properly estimated by the OBD system.

3.32 **Malfunction**:

(a) Any deterioration or failure, including electrical failures, of the emission control system, that would result in emissions exceeding the OBD threshold limits or, when applicable, in failing to reach the range of functional performance of the exhaust aftertreatment system where the emission of any regulated pollutant would exceed the OBD threshold limits;

(b) Any case where the OBD system is not able to fulfil the monitoring requirements of this standard.

A manufacturer may nevertheless consider a deterioration or failure that would result in emissions not exceeding the OBD threshold limits as a malfunction.

3.33 **Malfunction Indicator (MI)**: means a visual indicator that clearly informs the driver of the vehicle in the event of a malfunction in the sense of this standard.

3.34 **Unladen Mass**: means the mass of the vehicle in running order without the uniform mass of the driver of 75 kg, passenger or load, but with the fuel tank 90 per cent full and the usual set of tools and spare wheel on board, where applicable.

3.35 **Reference Mass (RM)**: means the "unladen mass" of the vehicle increased by a uniform figure of 100 kg for test according to Annexes 4A and 8 of Regulation No. 83.

3.36 Any other definitions not specified herein shall be directly referred to section (2) of complementary reference 2.1.

4. Classification of Vehicles and Categories

4.1 Classification of vehicles by category

Vehicles covered by this Standard shall be classified in accordance with the vehicle categories set out in ECE/TRANS/WP.29/78/Revision 6 "Consolidated Resolution on the Construction of Vehicles", considering the scope of application specified in Clause (1), as follows:

4.1.1 Category M1: Vehicles used for the carriage of passengers and comprising no more than eight seats in addition to the driver's seat.

4.1.2 Category M2: Vehicles used for the carriage of passengers, comprising more than eight seats in addition to the driver's seat, and having a maximum mass not exceeding 5 tonnes.

4.1.3 Category N1: Vehicles used for the carriage of goods and having a maximum mass not exceeding 3.5 tonnes.

4.1.4 Category N2: Vehicles used for the carriage of goods and having a maximum mass exceeding 3.5 tonnes but not exceeding 12 tonnes.

4.1.5 Category M3: Vehicles used for the carriage of passengers, comprising more than eight seats in addition to the driver's seat, and having a maximum mass exceeding 5 tonnes.

4.1.6 Category N3 (Goods Vehicles): Vehicles used for the carriage of goods and having a maximum mass exceeding 12 tonnes.

5. General Requirements and Provisions

5.1 Emission control equipment

5.1.1 The components liable to affect, where appropriate, the emission of gaseous and particulate pollutants from diesel and gas engines shall be so designed, constructed,

assembled and installed as to enable the engine, in normal use, to comply with the provisions of this standard.

5.1.2 The use of a defeat strategy is forbidden.

5.2 Emission control strategy

5.2.1 Any element of design and Emission Control Strategy (ECS) liable to affect the emission of gaseous and particulate pollutants from diesel engines and the emission of gaseous pollutants from gas engines shall be so designed, constructed, assembled and installed as to enable the engine, in normal use, to comply with the provisions of this standard. ECS consists of the base Emission Control Strategy (BECS) and usually one or more auxiliary Emission Control Strategies (AECS).

5.3 Requirements for base emission control strategy

5.3.1 The Base Emission Control Strategy (BECS) shall be so designed as to enable the engine, in normal use, to comply with the provisions of this standard. Normal use is not restricted to the conditions of use as specified in paragraph 5.4.4.

5.4 Requirements for auxiliary emission control strategy

5.4.1 An Auxiliary Emission Control Strategy (AECS) may be installed to an engine or on a vehicle provided that the AECS:

(a) Operates only outside the conditions of use specified in paragraph 5.4.4 for the purposes defined in paragraph 5.4.5 or,

(b) Is activated only exceptionally within the conditions of use specified in paragraph 5.4.4 for the purposes defined in paragraph 5.4.6 and not longer than is needed for these purposes.

5.4.2 An auxiliary emission control strategy (AECS) that operates within the conditions of use specified in paragraph 5.4.4 and which results in the use of a different or modified emission control strategy (ECS) to that normally employed during the applicable emission test cycles will be permitted if, in complying with the requirements of paragraph 5.1.7. of complementary reference 2.1, it is fully demonstrated that the measure does not permanently reduce the effectiveness of the emission control system. In all other cases, such strategy shall be considered to be a defeat strategy.

5.4.3 An auxiliary emission control strategy (AECS) that operates outside the conditions of use specified in paragraph 5.4.4 will be permitted if, in complying with the requirements of paragraph 5.1.7. of complementary reference 2.1, it is fully demonstrated that the measure is the minimum strategy necessary for the purposes of paragraph 5.4.6 with respect to environmental protection and other technical aspects. In all other cases, such a strategy shall be considered to be a defeat strategy.

5.4.4 As provided for in paragraph 5.4.1, the following conditions of use apply under steady state and transient engine operations:

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

(b) An ambient temperature within the range 275 K to 303 K (2 °C to 30 °C)4, 5 and;

(c) Engine coolant temperature within the range 343 K to 373 K (70 °C to 100 °C).

5.4.5 An auxiliary emission control strategy (AECS) may be installed to an engine, or on a vehicle, provided that the operation of the AECS is included in the applicable approval test and is activated according to paragraph 5.4.6.

5.4.6 The AECS is activated:

(a) Only by on-board signals for the purpose of protecting the engine system (including air-handling device protection) and/or vehicle from damage, or;

(b) For purposes such as operational safety, emission default modes and limp-home strategies, or;

(c) For such purposes as excessive emissions prevention, cold start or warming-up, or;

(d) If it is used to trade-off the control of one regulated pollutant under specific ambient or operating conditions in order to maintain control of all other regulated pollutants within the emission limit values that are appropriate for the engine in question. The overall effects of such an AECS is to compensate for naturally occurring phenomena and do so in a manner that provides acceptable control of all emission constituents.

5.5 Requirements for torque limiters

5.5.1 A torque limiter will be permitted if it complies with the requirements of paragraph 5.5.2 or 5.9.5. In all other cases, a torque limiter shall be considered to be a defeat strategy.

5.5.2 A torque limiter may be installed to an engine, or on a vehicle, provided that:

(a) The torque limiter is activated only by on-board signals for the purpose of protecting the powertrain or vehicle construction from damage and/or for the purpose of vehicle safety, or for power take-off activation when the vehicle is stationary, or for measures to ensure the correct functioning of the deNOx system, and;

(b) The torque limiter is active only temporarily, and;

(c) The torque limiter does not modify the emission control strategy (ECS), and;

(d) In case of power take-off or powertrain protection the torque is limited to a constant value, independent from the engine speed, while never exceeding the full-load torque, and;

(e) Is activated in the same manner to limit the performance of a vehicle in order to encourage the driver to take the necessary measures in order to ensure the correct functioning of NOx control measures within the engine system.

5.6 Provisions for electronic system security

5.6.1 Any vehicle with an Emission Control Unit shall include features to deter modification, except as authorized by the manufacturer. The manufacturer shall authorize modifications if these modifications are necessary for the diagnosis, servicing, inspection, retrofitting or repair of the vehicle. Any reprogrammable computer codes or operating parameters shall be resistant to tampering and afford a level of protection at least as good as the provisions in ISO 15031-7 (SAE J2186) provided that the security exchange is conducted using the protocols and diagnostic connector as prescribed in paragraph 6. of Annex 9A of complementary reference 2.1. Any removable calibration memory chips shall be plotted, encased in a sealed container or protected by electronic algorithms and shall not be changeable without the use of specialised tools and procedures.

5.6.2 Computer-coded engine operating parameters shall not be changeable without the use of specialised tools and procedures (e.g. soldered or potted computer components or sealed (or soldered) computer enclosures).

5.6.3 Manufacturers shall take adequate steps to protect the maximum fuel delivery setting from tampering while a vehicle is in-service.

5.7 Durability and deterioration factors

5.7.1 The manufacturer shall demonstrate that a compression-ignition engine approved by reference to the emission limits set out in row B2 of the tables in Section 7 of this standard, will comply with those emission limits for a useful life of:

5.7.1.1 100,000 km or five years, whichever is the sooner, in the case of engines to be fitted to vehicles of category N1, M1 > 3.5 tons and M2;

5.7.1.2 200,000 km or six years, whichever is the sooner, in the case of engines to be fitted to vehicles of category N2, N3 with a maximum technically permissible mass not exceeding 16 tonnes and M3 Class I, Class II and Class A, and Class B with a maximum technically permissible mass not exceeding 7.5 tonnes;

5.7.1.3 500,000 km or seven years, whichever is the sooner, in the case of engines to be fitted to vehicles of category N3 with a maximum technically permissible mass exceeding 16 tonnes and M3, Class III and Class B with a maximum technically permissible mass exceeding 7.5 tonnes.

5.7.2 For the purposes of this standard, the manufacturer shall determine deterioration factors that will be used to demonstrate that the gaseous and particulate emissions of an engine family or engine-aftertreatment system family remain in conformity with the appropriate emission limits specified in the tables in Section 7 over the appropriate durability period laid down in paragraph 5.7.1.

5.7.3 The procedures for demonstrating the compliance of an engine or engine aftertreatment system family with the relevant emission limits over the appropriate durability period are given in Annex 7 of complementary reference 2.1.

5.8 On-board diagnostic (OBD) system

5.8.1 A compression-ignition engine shall be fitted with an on-board diagnostic (OBD) system that signals the presence of a fault to the driver if the OBD threshold limits set out in Table 3 of Section 7 of this standard are exceeded. The OBD system for emission control shall be in accordance with the requirements of Annex 9A of complementary reference 2.1.

5.8.2 The OBD system shall also include an interface between the Engine Electronic Control Unit (EECU) and any other engine or vehicle electrical or electronic systems that provide an input to or receive an output from the EECU and which affect the correct functioning of the emission control system, such as the interface between the EECU and a transmission electronic control unit.

5.8.3 In the case of exhaust after-treatment systems, the OBD system may monitor for major functional failure of any of the following:

(a) A catalyst, where fitted as a separate unit, whether or not it is part of a deNOx system or a diesel particulate filter;

(b) A deNOx system, where fitted;

(c) A diesel particulate filter, where fitted;

(d) A combined deNOx-diesel particulate filter system.

5.8.4 Full and uniform access to OBD information shall be provided for the purposes of testing, diagnosis, servicing and repair in keeping with the relevant provisions of ECE Regulation No. 83 and provisions regarding replacement components ensuring compatibility with OBD systems.

5.9 Requirements to ensure correct operation of NOx control measures

5.9.1 General

5.9.1.1 This paragraph is applicable to compression-ignition engine systems irrespective of the technology used to comply with the emission limit values provided in the tables in paragraph 5.2.1.

5.9.1.2 Any engine system covered by this paragraph shall be designed, constructed and installed so as to be capable of meeting these requirements over the useful life of the engine.

5.9.1.3 Subject to requirements set out in paragraph 5.1, any engine system covered by paragraph 5 shall retain its emission control function during all conditions regularly pertaining in the territory of the Contracting Parties, especially at low ambient temperatures.

5.9.1.4 For engine systems requiring a reagent, each separate reagent tank installed on a vehicle shall include means for taking a sample of any fluid inside the tank. The sampling point shall be easily accessible without theuse of any specialised tool or device.

5.9.2 Maintenance requirements

5.9.2.1 The manufacturer shall furnish or cause to be furnished to all owners of new heavy-duty vehicles or new heavy-duty engines written instructions that shall state that if the vehicle emission control system is not functioning correctly, the driver shall be informed of a problem by the malfunction indicator (MI) and the engine shall consequentially operate with a reduced performance.

5.9.2.2 The instructions will indicate requirements for the proper use and maintenance of vehicles, including where relevant the use of consumable reagents.

5.9.2.3 The instructions shall be written in clear and non-technical language and in the language of the country in which a new heavy-duty vehicle or new heavy-duty engine is sold or registered.

5.9.2.4 The instructions shall specify if consumable reagents have to be refilled by the vehicle operator between normal maintenance intervals and shall indicate a likely rate of reagent consumption according to the type of new heavy-duty vehicle.

5.9.3 Engine system NOx control

5.9.3.1 Incorrect operation of the engine system with respect to NOx emissions control (for example due to lack of any required reagent, incorrect EGR flow or deactivation of

EGR) shall be determined through monitoring of the NOx level by sensors positioned in the exhaust stream.

5.9.3.2 Any deviation in NOx level more than 1.5 g/kWh above the applicable limit value given in Tables 1 and 2 in Sections 7.1 and 7.2, shall result in the driver being informed by activation of the MI as referred to in paragraph 3.6.5 of Annex 9A of complementary reference 2.1.

5.9.3.3 In addition, a non-erasable fault code identifying the reason why NOx exceeds the levels specified in paragraph 5.9.3.2 shall be stored in accordance with Annex 9A of complementary reference 2.1 for at least 400 days or 9,600 hours of engine operation. The reasons for the NOx exceedance shall, at a minimum, and where applicable, be identified in the cases of empty reagent tank, interruption of reagent dosing activity, insufficient reagent quality, too low reagent consumption, incorrect EGR flow or deactivation of the EGR. In all other cases, the manufacturer is permitted to refer to a non-erasable fault code "high NOx - root cause unknown".

5.9.3.4 If the NOx level exceeds the OBD threshold limit values given in Table 3 of Section 7.3, a torque limiter shall reduce the performance of the engine according to the requirements of paragraph 5.9.5 in a manner that is clearly perceived by the driver of the vehicle. When the torque limiter is activated, the driver shall continue to be alerted according to the requirements of paragraph 5.9.3.2 and a non-erasable fault code shall be stored in accordance with paragraph 5.9.3.3.

5.9.4 Reagent control

5.9.4.1 For vehicles that require the use of a reagent to fulfil the requirements of this paragraph, the driver shall be informed of the level of reagent in the on vehicle reagent storage tank through a specific mechanical or electronic indication on the vehicle's dashboard. This shall include a warning when the level of reagent goes:

(a) Below 10 per cent of the tank or a higher percentage at the choice of the manufacturer, or;

(b) Below the level corresponding to the driving distance possible with the fuel reserve level specified by the manufacturer.

The reagent indicator shall be placed in close proximity to the fuel level indicator.

5.9.4.2 The driver shall be informed, according to the requirements of Annex 9A of complementary reference 2.1, if the reagent tank becomes empty.

5.9.4.3 As soon as the reagent tank becomes empty, the requirements of paragraph 5.9.5 shall apply in addition to the requirements of paragraph 5.9.4.2.

5.9.4.4 A manufacturer may choose to comply with the paragraphs 5.9.4.5 to 5.9.4.11 as an alternative to complying with the requirements of paragraph 5.9.3.

5.9.4.5 Engine systems shall include a means of determining that a fluid corresponding to the reagent characteristics declared by the manufacturer and recorded in Annex 1 of complementary reference 2.1 is present on the vehicle.

5.9.4.6 If the fluid in the reagent tank does not correspond to the minimum requirements declared by the manufacturer as recorded in Annex 1 of complementary reference 2.1, the additional requirements of paragraph 5.9.4.12 shall apply.

5.9.4.7 Engine systems shall include a means for determining reagent consumption and providing off-board access to consumption information.

5.9.4.8 Average reagent consumption and average demanded reagent consumption by the engine system either over the previous complete 48-hour period of engine operation or the period needed for a demanded reagent consumption of at least 15 litres, whichever is longer, shall be available via the serial port of the standard diagnostic connector as referred to in Annex 9A of complementary reference 2.1.

5.9.4.9 In order to monitor reagent consumption, at least the following parameters within the engine shall be monitored:

(a) Level of reagent in on-vehicle storage tank;

(b) Flow of reagent or injection of reagent as close as technically possible to the point of injection into an exhaust aftertreatment system.

5.9.4.10 Any deviation more than 50 per cent in average reagent consumption and average demanded reagent consumption by the engine system over the period defined in paragraph 5.9.4.8 shall result in application of the measures laid down in paragraph 5.9.4.12.

5.9.4.11 In the case of interruption in reagent dosing activity the measures laid down in paragraph 5.9.4.12 shall apply. This is not required where such interruption is demanded by the engine ECU because engine operating conditions are such that the engine's emission performance does not require reagent dosing, provided that the manufacturer has clearly informed the Approval Authority when such operating conditions apply.

5.9.4.12 Any failure detected with respect to paragraphs 5.9.4.6, 5.9.4.10 or 5.9.4.11 shall trigger the same consequences in the same order as those referred to in paragraphs 5.9.3.2, 5.9.3.3 or 5.9.3.4.

5.9.5 Measures to discourage tampering of exhaust aftertreatment systems

5.9.5.1 Any engine system covered by this paragraph shall include a torque limiterthat will alert the driver that the engine system is operating incorrectly, or the vehicle is being operated in an incorrect manner and thereby encourage the prompt rectification of any fault(s).

5.9.5.2 The torque limiter shall be activated when the vehicle becomes stationary for the first time after the conditions of either paragraph 5.9.3.4, 5.9.4.3, 5.9.4.6, 5.9.4.10 or 5.9.4.11 have occurred.

5.9.5.3 Where the torque limiter comes into effect, the engine torque shall not, in any case, exceed a constant value of:

(a) 60 per cent of the engine maximum torque for vehicles of category N3 > 16 tons, M1 > 7.5 tons, M3/III and M3/B > 7.5 tons;

(b) 75 per cent of the engine maximum torque for vehicles of category N1, N2, N3 ≤ 16 tons, 3.5 < M1 ≤ 7.5 tons, M2, M3/I, M3/II, M3/A and M3/B ≤ 7.5 tons.

5.9.5.4 Detailed written information fully describing the functional operation characteristics of the emission control monitoring system and the torque limiter shall be specified according to the documentation requirements of paragraph 5.1.7.1.(b) of complementary reference 2.1. Specifically, the manufacturer shall provide information on the algorithms used by the ECU for relating the NOx concentration to the specific NOx emission (in g/kWh) on the ETC in accordance with paragraph 5.9.6.5.

5.9.5.5 The torque limiter shall be deactivated when the engine speed is at idle if the conditions for its activation have ceased to exist. The torque limiter shall not be automatically deactivated without the reason for its activation being remedied.

5.9.5.6 Deactivation of the torque limiter shall not be feasible by means of a switch or a maintenance tool.

5.9.5.7 The torque limiter shall not apply to engines or vehicles for use by the armed services, by rescue services and by fire-services and ambulances. Permanent deactivation shall only be done by the engine or vehicle manufacturer, and a special engine type within the engine family shall be designated for proper identification.

5.9.6 Operating conditions of the emission control monitoring system

5.9.6.1 The emission control monitoring system shall be operational,

(a) At all ambient temperatures between 266 K and 308 K (-7 °C and 35 °C);

(b) At all altitudes below 1,600 m;

(c) At engine coolant temperatures above 343 K (70 °C).

This paragraph does not apply in the case of monitoring for reagent level in the storage tank where monitoring shall be conducted under all conditions of use.

5.9.6.2 The emission control monitoring system may be deactivated when a limphome strategy is active and which results in a torque reduction greater than the levels indicated in paragraph 5.9.5.3 for the appropriate vehicle category.

5.9.6.3 If an emission default mode is active, the emission control monitoring system shall remain operational and comply with the provisions of paragraph 5.9.

5.9.6.4 The incorrect operation of NOx control measures shall be detected within four OBD test cycles as referred to in the definition given in paragraph 6.1 of the Appendix to Annex 9A of complementary reference 2.1.

5.9.6.5 Algorithms used by the ECU for relating the actual NOx concentration to the specific NOx emission (in g/kWh) on the ETC shall not be considered to be a defeat strategy.

5.9.6.6 If an AECS that has been approved by the Approval Authority in accordance with paragraph 5.4 becomes operational, any increase in NOx due to the operation of the

AECS may be applied to the appropriate NOx level referred to in paragraph 5.9.3.2. In all such cases, the influence of the AECS on the NOx threshold shall be described in accordance with paragraph 5.9.5.4.

5.9.7 Failure of the emission control monitoring system

5.9.7.1 The emission control monitoring system shall be monitored for electrical failures and for removal or deactivation of any sensor that prevents it from diagnosing an emission increase as required by paragraphs 5.9.3.2 and 5.9.3.4. Examples of sensors that affect the diagnostic capability are those directly measuring NOx concentration, urea quality sensors, and sensors used for monitoring reagent dosing activity, reagent level, reagent consumption or EGR rate.

5.9.7.2 If a failure of the emission control monitoring system is confirmed, the driver shall be immediately alerted by the activation of the warning signal according to Annex 9A of complementary reference 2.1.

5.9.7.3 The torque limiter shall be activated in accordance with paragraph 5.9.5 if the failure is not remedied within a period of 50 hours of engine operation. This period shall be reduced to 36 hours from the dates specified in paragraphs 13.2.3. and 13.3.3 of complementary reference 2.1.

5.9.7.4 When the emission control monitoring system has determined that the failure has ceased to exist, the fault code(s) associated with that failure may be cleared from the system memory, except in the cases referred to in paragraph 5.9.7.5, and the torque limiter, if applicable, shall be deactivated according to paragraph 5.9.5.5.

Fault code(s) associated with a failure of the emission control monitoring system shall not be capable of being cleared from the system memory by any scan tool.

5.9.7.5 In the case of the removal or deactivation of elements of the emission control monitoring system, in accordance with paragraph 5.9.7.1, a non-erasable fault code shall be stored in accordance with Annex 9A of complementary reference 2.1 for a minimum of 400 days or 9,600 hours of engine operation.

5.9.8 Demonstration of the emission control monitoring system

5.9.8.1 The requirements for demonstrating compliance of the emission control monitoring system shall be applied in accordance with the provisions of Section 5 and Annex 9A of complementary reference 2.1.

6. Measurements and tests

6.1 Determination of Gaseous, Particulate, and Smoke Pollutant Emissions

6.1.1 The emissions of gaseous, particulate, and smoke pollutants from engines covered by this specification are determined using the European Steady-State Cycle (ESC) test, the European Load Response (ELR) test, and the European Transient Cycle (ETC) test.

6.1.2 The procedures for the European Steady-State Cycle (ESC) and European Load Response (ELR) tests are described in Annex 4A Appendix 1 of complementary reference 2.1, and the procedures for the European Transient Cycle (ETC) test are described in Annex 4A Appendices 2 and 3 of complementary reference 2.1.

6.1.3 Emissions of gaseous and particulate pollutants, where applicable, and smoke, where applicable, from the engine submitted for testing are measured using the measurement methods described in Annex 4A Appendix 4 of complementary reference 2.1.

6.1.4 Annex 4A Appendix 7 of complementary reference 2.1 describes the recommended analysis systems for gaseous pollutants, the recommended particulate sampling systems, and the recommended smoke measurement system.

6.2 Hydrocarbon measurement for diesel fuelled engines

6.2.1 A manufacturer may choose to measure the mass of total hydrocarbons (THC) on the ETC test instead of measuring the mass of non-methane hydrocarbons. In this case, the limit for the mass of total hydrocarbons is the same as shown in Table 2 of Section 7 for the mass of non-methane hydrocarbons.

6.3 Specific requirements for diesel engines

6.3.1 The specific mass of the NOx measured at the random check points within the control area of the ESC test shall not exceed by more than 10 per cent the values interpolated from the adjacent test modes (reference Annex 4A, Appendix 1, paragraphs 5.6.2 and 5.6.3 of complementary reference 2.1).

6.3.2 The smoke value on the random test speed of the ELR shall not exceed the highest smoke value of the two adjacent test speeds by more than 20 per cent, or by more than 5 per cent of the limit value, whichever is greater.

6.4 General provisions for measurement and testing

6.4.1 Measurements of gaseous, particulate and smoke pollutant emissions from engines covered by this standard shall be carried out in accordance with the methods and procedures of testing set forth in Annex 4A of complementary reference 2.1, including the conditions for conducting the test, sampling procedures, measurement systems and methods for calculating emissions.

7. Maximum allowable limits for pollutants

The maximum allowable emission limits for gaseous and particulate pollutants, as set forth in this section, apply to the engines of heavy-duty vehicles covered by this standard. These limits are based on the values specified in the emission limit tables in paragraph 5.2.1 of complementary reference 2.1, in accordance with **Euro V - Level B2 (2008)**.

All values in this section are expressed in grams per kilowatt-hour (g/kWh), except for smoke density (m^{-1}), and represent the maximum exhaust emission limits resulting from ESC and ETC tests, as well as the smoke limits resulting from the ELR test.

7.1 Maximum allowable pollutant limits during ESC and ELR tests

Table 1: Maximum exhaust emission limits during ESC and ELR tests.

Row	Mass of (CO) g/kWh	Mass of (HC) g/kWh	Mass of (NOx) g/kWh	Mass of (PT) g/kWh	Smoke m^{-1}
B2 (2008)	1.5	0.46	2.0	0.02	0.5

7.2 Maximum allowable pollutant limits during ETC test

Table 2: Maximum exhaust emission limits during ETC test.

Row	Mass of (CO) g/kWh	Mass of (NMHC) g/kWh	Mass of (NOx) g/kWh	Mass of (PT) g/kWh
B2 (2008)	**4.0**	**0.55**	**2.0**	**0.03**

7.3 On-Board Diagnostic System (OBD) Threshold Limits

Table 3: On-Board Diagnostic (OBD) Threshold Limits.

Row	Mass of (NOx) g/kWh	Mass of (PT) g/kWh
B2 (2008)	**7.0**	**0.1**

8. References

- (UNECE Regulation No. 49 – Revision 5): Uniform provisions concerning 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.