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Road vehicles — Engine families for certification of heavy-duty vehicles — Exhaust emissions

Véhicules routiers — Familles de moteurs pour homologation des véhicules lourds — Émissions de gaz d'échappement

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 16185 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 5, *Engine tests*.

Introduction

This International Standard aims to define the criteria making it possible to group engines of road vehicles in order to reduce the number of type approval tests.

This concept already exists in certain regulations (United Nations, United States of America, European Union). ISO 8178-7 deals with this subject within the broader framework of those engines designed originally for non-road applications.

ISO was requested within the framework of the United Nations[1)] to work on an International Standard that would adapt these concepts to heavy-duty road vehicles. This work is considered as a step towards a world-wide heavy-duty certification (WHDC) procedure.

In the case of regulations based on emission tests, the family concept as described in this International Standard makes it possible to minimize the number of these tests (some of them may be very long) by carrying them out only on a parent engine.

1) UN/ECE/GRPE: United Nations/Economic Commission for Europe/Group of Rapporteurs on Pollution and Energy.

Road vehicles — Engine families for certification of heavy-duty vehicles — Exhaust emissions

1 Scope

This International Standard is applicable to heavy-duty road vehicle engines subject to regulations as regards their exhaust emissions at the time of their certification. Mopeds, motorcycles, passenger cars and non-road vehicles are not within its scope.

This International Standard defines the criteria making it possible to group those engines of the same manufacturer having, by design, similar regulated exhaust emission characteristics (gaseous and particulate pollutants, as well as smoke) within a family or families.

It defines the parameters necessitating the carrying out of different groupings, leaving open to the manufacturer the latitude to carry out groupings of lower size.

This International Standard defines the procedure for selecting from within each engine family the parent engine, the specific characteristics of which will probably make it more difficult to produce a low level of exhaust emissions.

2 Normative reference

The following normative document contains provisions which, through reference in this text, constitutes provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent edition of the normative document indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 8178-7:1996, *Reciprocating internal combustion engines — Exhaust emission measurements — Part 7: Engine family determination.*

3 Terms and definitions

For the purposes of this International Standard, the following terms and definitions apply.

3.1
engine family
manufacturer's grouping of engines which, through their design, have similar exhaust-emission characteristics (gaseous and particulate pollutants, smoke)

3.2
parent engine
engine selected from an engine family considered from its design to have comparatively high exhaust-emission characteristics, while being representative of that family

3.3
member of a family
any engine in an engine family that is not a parent engine

3.4
after-treatment system
device fitted to an engine's exhaust line designed to reduce the level of the gaseous or particulate exhaust emissions, or both

NOTE Catalytic converters (oxidation catalysts; DeNOx catalysts) and particulate traps are typically considered to be after-treatment devices, whereas devices such as exhaust gas recirculation systems (EGR) are not considered to be after-treatment devices but integral parts of the engine.

3.4.1
controlled after-treatment system
after-treatment system whose operation is controlled by external information or by influences external to the device such as additives or heat

EXAMPLE DeNOx systems with selective reduction of NOx.

3.4.2
non-controlled after-treatment system
after-treatment system whose operation depends on the presence of exhaust-emission components in the exhaust gas and conditions such as temperature

EXAMPLE Oxidation catalysts.

4 Parameters defining the engine family

4.1 General

An engine family is characterized by design parameters. These shall be common to all the engines within the family. The engine manufacturer may decide which engines of its design belong to an engine family, as long as they respect the membership criteria listed in this clause.

As regards to the certification of engines, considering their exhaust emission of pollutants, in order that engines may be considered to belong to the same engine family, the engines shall comply with the same regulatory requirements as those for exhaust emissions and shall meet the same emission limit values over their useful life (if defined). The list of basic parameters given in 4.3 shall be common.

4.2 Special cases

a) In some cases there may be interaction between parameters. This shall be taken into consideration to ensure that only engines with similar exhaust emission characteristics are included in the same engine family.

   EXAMPLE The number of cylinders can become a significant parameter on certain engines because of the fuel supply or their intake system, while with other designs, the characteristics of the exhaust emissions are independent of the number of cylinders or their configuration.

   These cases shall be identified by the manufacturer and notified to the authorities.

b) In the case of devices or features which are not listed in this clause and which may have a strong influence on the level of emissions, this equipment shall be identified by the manufacturer, on the basis of good engineering practice, and notified to the authorities.

   It shall be then taken into account as a criterion for belonging to an engine family.

c) In addition to the following required parameters, the manufacturer may introduce additional criteria allowing the definition of families of more restricted size. These parameters are not necessarily parameters having an influence on the level of emissions.

EXAMPLE The type of vehicle or the place where this vehicle is put into commerce may be criteria retained by the manufacturer.

4.3 Parameters

4.3.1 Combustion cycle

— 2 stroke cycle

— 4 stroke cycle

— Rotary engine

— Others

4.3.2 Configuration of the cylinders[2)]

4.3.2.1 Position of the cylinders in the block

— V

— In line

— Radial

— Others (F, W, etc.)

4.3.2.2 Relative position of the cylinders

Engines with the same block may belong to the same family as long as their bore centre-to-centre dimensions are the same.

4.3.3 Main cooling medium

— Air

— Water

— Oil

NOTE If cooling is ensured in a way that combines more than one fluid, the selective parameter for defining the engine family is the fluid considered as having the largest influence on the exhaust emissions of the engine.

4.3.4 Individual cylinder displacement

4.3.4.1 Engines with a unit cylinder displacement $\geqslant$ 0,75 dm^3

In order for engines with a unit cylinder displacement $\geqslant$ 0,75 dm^3 to be considered to belong to the same engine family, the spread of their individual cylinder displacements shall not exceed 15 % of the largest individual cylinder displacement within the family.

2) The inclination of the engine is not a membership parameter.

4.3.4.2 Engines with a unit cylinder displacement < 0,75 dm^3

In order for engines with a unit cylinder displacement < 0,75 dm^3 to be considered to belong to the same engine family, the spread of their individual cylinder displacements shall not exceed 30 % of the largest individual cylinder displacement within the family.

4.3.4.3 Engines of other unit cylinder displacement limits

Engines with an individual cylinder displacement that exceeds the limits defined in 4.3.4.1 and 4.3.4.2 may be considered as belonging to that family with the agreement of the parties involved. This agreement should be based on technical elements (calculations, simulations, experimental results etc.) showing that this excess does not have a significant influence on the exhaust emissions.

4.3.5 Method of air aspiration

— Naturally aspirated

— Pressure charged

— Pressure charged with charge air cooler

4.3.6 **Fuel** (for which the engine is designed)

— Diesel fuel

— Gasoline

— Gaseous fuel

  — Natural gas (NG)

  — Liquefied petroleum gas (LPG)

  — Hydrogen

  — Dimethylether (DME)

  — Others

— Alcohols

— Others

If an engine is designed for a given fuel, but used without basic design modifications with another fuel, the necessity for two different families may vary according to the regulation itself. However, if not specified, any decision should be based on technical elements.

EXAMPLE It is possible in some cases to consider a gas engine fuelled with gasoline during warm up as belonging to the same engine family as a pure gas engine.

4.3.7 Combustion chamber type

— Open chamber

— Divided chamber

— Other types

4.3.8 Ignition type

— Spark ignition

— Compression ignition

4.3.9 Valves and porting

— Configuration

— Number of valves per cylinder

4.3.10 Fuel supply type

— Liquid fuel supply type

  — Pump and (high-pressure) line and injector

  — In-line or distributor pump

  — Unit pump or unit injector

  — Common rail

  — Carburettor(s)

  — Others

— Gas fuel supply type

  — Gaseous

  — Liquid

  — Mixing units

  — Others

— other types of fuel supply

4.3.11 Miscellaneous devices

— Exhaust gases recirculation (EGR) devices

— Water-injection devices

— Air-injection devices

— Other devices

NOTE The influence of the listed devices on exhaust gas emissions depends largely on the specific layout and adapted control strategy. The decision as to whether an engine with these devices can be considered as a part of the family can be left to the manufacturer. If necessary, the manufacturer will give the technical elements for the decision (e.g. calculations, simulations, experimental results).

4.3.12 Electronic control strategy of engines

The presence or absence of an electronic control unit (ECU) on the engine is regarded as a basic parameter of the family.

In the case of electronically controlled engines, the manufacturer shall present the technical elements explaining the grouping of these engines in the same family, i.e. the reasons why these engines can be expected to satisfy the same emission requirements.

These elements can be calculations, simulations, estimations, descriptions of injection parameters, experimental results, etc.

Examples of controlled features are:

— timing,

— injection pressure,

— multiple injection,

— boost pressure,

— VGT, and

— EGR.

4.3.13 After-treatment systems

The function and combination of the following devices are regarded as membership criteria for an engine-family:

— oxidation catalysts;

— 3-way catalysts (λ 1 engines);

— DeNOx systems with a selective reduction of NOx (addition of a reducing agent)

— other DeNOx systems;

— particulate traps with passive regeneration;

— particulate traps with active regeneration;

— other particulate traps;

— other devices.

When an engine not equipped with an after-treatment system is certified, whether as a parent engine or as a member of an engine family, this engine, once equipped with a non-controlled after-treatment system, is included in the same engine family if it does not require different fuel characteristics (e.g. most of the oxidation catalysts).

On the contrary, if it requires specific fuel characteristics (e.g. particulate traps requiring special additives in the fuel to ensure the regeneration process), the decision to include it in the family should be based on technical elements provided by the manufacturer. These elements should indicate that the expected emission level of the equipped engine satisfies the same limit as the non-equipped engine.

When an engine equipped with an after-treatment system is certified, whether as a parent engine or as a member of an engine family whose parent engine is equipped with the same after-treatment system, this engine not equipped with the said after-treatment system cannot be added to the same family.

NOTE Systems of the same type with similar efficiency are considered as generally not discriminating within a family (typically, a supplier difference is generally not regarded as a discriminating criterion).

5 Choice of the parent engine

5.1 Compression ignition engines

The parent engine of the family shall be selected using the primary criterion of the highest fuel delivery per stroke at the declared maximum torque speed. In the event that two or more engines share this primary criterion, the parent engine shall be selected using the secondary criterion of highest fuel delivery per stroke at rated speed.

5.2 Spark-ignition engines

The parent engine of the family shall be selected using the primary criterion of the largest displacement. In the event that two or more engines share this primary criterion, the parent engine shall be selected using the secondary criterion in the following order of priority:

a) the highest fuel delivery per stroke at the speed of declared rated power;

b) the most advanced spark timing;

c) the lowest EGR rate.

5.3 Remarks on the choice of the parent engine

Under certain circumstances, the involved parties may conclude that the worst case emission rate of the family can best be characterized by testing a second engine. Thus, they may select an additional engine for test based upon features which indicate that it may have the highest emission level of the engines within that family. In this case, the involved parties have the appropriate information to determine the engine within the family likely to have the highest emission level; this engine may be directly selected for testing without a prior test of any engine selected according to 5.1 and 5.2.

If engines within the family incorporate other variable features which may be considered to affect exhaust emissions, these features shall also be identified and taken into account in the selection of the parent engine.

If engines within the family meet the same emission limit values over different useful lives, this shall be taken into account in the selection of the parent engine.

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