BS ISO 8178-7:2015

BSI Standards Publication

Reciprocating internal combustion engines — Exhaust emission measurement

Part 7: Engine family determination

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National foreword

This British Standard is the UK implementation of ISO 8178-7:2015. It supersedes BS ISO 8178-7:1996 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee MCE/14/-/3, RIC engines - Emissions.

A list of organizations represented on this committee can be obtained on request to its secretary.

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Second edition
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Reciprocating internal combustion engines — Exhaust emission measurement —

Part 7: Engine family determination

Moteurs alternatifs à combustion interne — Mesurage des émissions de gaz d'échappement —

Partie 7: Détermination des familles de moteurs

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 70, *Internal combustion engines*, Subcommittee SC 8, *Exhaust gas emission measurement*.

This second edition cancels and replaces the first edition (ISO 8178-7:1996), which has been technically revised.

ISO 8178 consists of the following parts, under the general title *Reciprocating internal combustion engines — Exhaust emission measurement*:

— *Part 1: Test-bed measurement of gaseous and particulate emissions*

— *Part 2: Measurement of gaseous and particulate exhaust emissions under field conditions*

— *Part 3: Definitions and methods of measurement of exhaust gas smoke under steady-state conditions*

— *Part 4: Steady-state test cycles for different engine applications*

— *Part 5: Test fuels*

— *Part 6: Report of measuring results and test*

— *Part 7: Engine family determination*

— *Part 8: Engine group determination*

— *Part 9: Test cycles and test procedures for test bed measurement of exhaust gas smoke emissions from compression ignition engines operating under transient conditions*

— *Part 10: Test cycles and test procedures for field measurement of exhaust gas smoke emissions from compression ignition engines operating under transient conditions*

Introduction

Unlike engines for on-road applications, engines for non-road use are made in a much wider range of power output and configuration and are used in a great number of different applications.

The objective of ISO 8178 is to rationalize the test methods for non-road engines in order to simplify and make more cost-effective drafting of legislation, development of engine specifications, and certification of engines to control gaseous and particulate emissions.

In order to achieve the objectives, ISO 8178 embraces four concepts as follows:

a) grouping of engine applications in order to reduce the number of test cycles as defined in ISO 8178-4;

b) use of observed brake power as defined in ISO 8178-4 as the basis for the expression of specific emission levels;

c) incorporation of "engine family" concept, in which engines with similar emission characteristics and design can be represented by an engine within the family;

d) incorporation of "engine group" concept, which addresses the modification and adjustment of engines (see ISO 8178-8).

In this part of ISO 8178, the engine family concept is elaborated.

The engine family concept provides the possibility of reducing the number of engines to be submitted for type approval testing, while providing safeguards for the parties involved that all engines within the family will comply with the approval requirements.

INTERNATIONAL STANDARD ISO 8178-7:2015(E)

Reciprocating internal combustion engines — Exhaust emission measurement —

Part 7: Engine family determination

1 Scope

This part of ISO 8178 specifies the parameters to be applied for the determination of which engine specifications may be included in an engine family and for the selection of the parent engine of the family.

This part of ISO 8178 is applicable to reciprocating internal combustion engines for land, rail traction, and marine use, excluding engines for motor vehicles primarily designed for on-road operation. It may be applied to engines for power production and/or propulsion, e.g. agricultural equipment, road construction and earth moving machines, industrial trucks, generating sets, etc.

2 Terms and definitions

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

2.1
engine family
manufacturer's grouping of engines, which through their design are expected to have similar exhaust emission characteristics where members of the family shall comply with the applicable emission limit values

2.2
parent engine
engine selected from an engine family, in such a way that it will incorporate those features which will adversely affect the levels of the relevant exhaust components

Note 1 to entry: Such an engine would be expected to be a comparatively high-emitting engine.

3 Engine family selection

3.1 General

The engine family shall be selected based on the following principles.

An engine family is characterized by design parameters. These shall be common to all engines within the family. The engine manufacturer may decide which engines belong to an engine family, as long as the membership criteria listed in Clause 4 are respected. The engine family shall be agreed upon by the parties involved. The manufacturer shall provide the appropriate information relating to the emission levels of the members of the engine family.

The manufacturer shall provide a list of engines and their specifications, which is considered to be within a family and on the basis of tests and technical considerations agreed with the parties involved, on which engine(s) should be selected for testing and which will likely give high emissions.

The selection procedure for the choice of the parent engine is described in Clause 5.

The parties involved should have the possibility of selecting a different engine, either for approval or production conformity testing, in order to have confidence that the complete family of engines complies with the emissions requirements.

3.2 Special cases

In some cases, there can be interaction between parameters. This shall be taken into consideration to ensure that only engines with similar exhaust emission characteristics are included within the same engine family; e.g. the number of cylinders can become a relevant parameter on some engines due to the aspiration or fuel system used, but with other designs, exhaust emission characteristics will be independent of the number of cylinders or configuration. These cases shall be identified by the manufacturer and notified to the parties involved. It shall then be taken into account as a criterion for creating a new engine family.

In case of devices or features, which are not listed in Clause 4 and which have a strong influence on the level of emissions, these devices or features shall be identified by the manufacturer on the basis of good engineering practice and shall be notified to the parties involved. It shall then be taken into account as a criterion for creating a new engine family.

In addition to the parameters listed in Clause 4, the manufacturer may introduce additional criteria allowing the definition of families of more restricted size. These parameters are not necessarily parameters that have an influence on the level of emissions.

4 Parameters defining the engine family

The engine manufacturer is responsible for defining those engines from his range which are to be included in a family. In order that engines be considered to belong to the same engine family, the following list of basic characteristics (but not specifications) shall be common.

a) combustion cycle
   1) two-stroke
   2) four-stroke
   3) rotary engine
   4) others

b) main cooling medium
   1) air
   2) water
   3) oil

c) individual cylinder displacement
   1) for engines with a unit cylinder displacement of ≥0,75 dm^3, within 85 % and 100 % of the largest displacement within the engine family
   2) for engines with a unit cylinder displacement of <0,75 dm^3, within 70 % and 100 % of the largest displacement within the engine family
   3) a greater deviation may be used if agreed between the parties involved

d) number of cylinders (applicable to spark ignition engines only)

e) cylinder configuration
    1) position of the cylinders in the block
        i) V
        ii) in-line
        iii) radial
        iv) others (F, W, etc.)
    2) relative position of the cylinders
        i) engines with the same block may belong to the same family as long as their bore centre-to-centre dimensions are the same.

f) method of air aspiration
    1) naturally aspirated
    2) pressure charged
    3) pressure charged with charge cooler

g) fuel type
    1) diesel
    2) petrol
    3) natural gas (CNG, LNG)
    4) liquefied petroleum gas (LPG)
    5) methanol
    6) ethanol
    7) other fuels

h) combustion chamber type
    1) open chamber
    2) divided chamber
    3) other types

i) valve and porting
    1) configuration
    2) number of valves per cylinder

j) fuel supply type
    1) fuel only
        i) pump-line-injector
        ii) in-line pump
        iii) distributor pump
        iv) unit pump

v) unit injector

vi) common rail

vii) gas valve

viii) throttle body injection

2) fuel and air

3) carburettor

k) miscellaneous features

1) exhaust gas recirculation (EGR)

2) water emulsion or injection

3) air injection

4) dual fuel

5) ignition type

i) compression

ii) spark

iii) glow plug

l) electronic control strategy

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, description of injection parameters, experimental results, etc.

The electronic governing of engine speed does not need to be in a different family from those with mechanical governing. The need to separate electronic engines from mechanical engines should only apply to control characteristics, such as timing, injection pressure, multiple injections, rate shape, boost pressure, VGT, EGR, etc.

m) exhaust after-treatment systems

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

1) oxidation catalyst;

2) three-way catalyst;

3) DeNOx system with selective reduction of NOx (addition of reducing agent);

4) other DeNOx systems;

5) particulate trap with passive regeneration;

6) particulate trap with active regeneration;

7) other particulate traps;

8) other devices.

When an engine has been approved without after-treatment system, whether as parent engine or as member of the family, then this engine, when equipped with an oxidation catalyst, may be included in the same engine family, if it does not require different fuel characteristics.

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 same family shall be based on technical elements provided by the manufacturer. These elements shall indicate that the expected emission level of the equipped engine complies with the same limit value as the non-equipped engine.

When an engine has been approved with an after-treatment system, whether as parent engine or as member of a family, whose parent engine is equipped with the same after-treatment system, then this engine, when equipped without after-treatment system, shall not be added to the same engine family.

5 Choice of the parent engine

Once the engine family has been agreed by the parties involved, the parent engine of the family shall be selected by using one of the methods described 5.1 to 5.3. The method selected should be agreed between the parties involved.

The methods described in 5.1 and 5.2 are more simple to administer, but might not result in the selection of an engine with emissions as high as the alternative method described in 5.3.

The parties involved may conclude that the worst-case emission of the family can best be characterized by testing additional engines. In this case, the engine manufacturer shall submit the appropriate information to determine the engines within the family likely to have the highest emissions level by taking into account the features listed in 5.3.

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 Positive 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 Alternative method

This method is based upon selecting an engine which incorporates engine features and characteristics which, from experience, are known to make the achievement of low emissions more difficult. This method requires detailed knowledge of the engine within the family, but is typically accurate in selecting a high-emitting engine.

The selection of the parent engine of the family in terms of exhaust emission control may be made on the basis that the engine incorporating those features which are most disadvantageous in terms of specific exhaust emissions (expressed in grams per kilowatt hour) should be chosen. The following features

may be regarded as being disadvantageous, but the choice shall take into account the combination of basic characteristics in the engine specification.

a) engine whose injection control or ignition timing control is not dependent on speed;

b) engine whose injection control or ignition timing control is not dependent on load;

c) engine with the lowest maximum injection pressure;

d) engine with the highest charge air temperature at the inlet to the cylinder;

e) engine with the lowest charge air pressure at the inlet to the cylinder;

f) engine with the least number of cylinders;

g) engine with the lowest rated power at rated speed;

h) engine with the lowest rated speed;

i) engine with the lowest low idle speed;

j) engine with the least number of fuel injection points.

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

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