INTERNATIONAL STANDARD

ISO 8178-6

First edition
2000-11-01

Reciprocating internal combustion engines — Exhaust emission measurement —

Part 6: Report of measuring results and test

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

Partie 6: Rapport de mesure et d'essai

Reference number
ISO 8178-6:2000(E)

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 7494 09 47
E-mail copyright@iso.ch
Web www.iso.ch

Printed in Switzerland

Contents

Page

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 part of ISO 8178 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 8178-6 was prepared by Technical Committee ISO/TC 70, *Internal combustion engines*, Subcommittee SC 8, *Exhaust gas emission measurement*.

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 exhaust emissions*

— *Part 2: Measurement of gaseous and particulate exhaust emissions at site*

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

— *Part 4: 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 transitory conditions*

Annex A forms a normative part of this part of ISO 8178.

Introduction

Results of an emissions test shall be presented clearly and should include all information pertinent to the derivation of the emission test results. An accuracy or uncertainty analysis relevant to the test system used and engine being evaluated should be made by the laboratory. A record shall be made of the measurement equipment being used, the ambient conditions, the engine performance and the fuel used. Recommendations for the data to be recorded are given regardless to the type of fuel being used.

The data format recommended in this part of ISO 8178 is intended to be used by individuals measuring emissions using ISO 8178-1, ISO 8178-2, ISO 8178-9 or ISO 8178-10, but is not intended to contradict or replace existing data formats which may be required by some regulatory bodies.

As expressed in ISO 8178-1 and ISO 8178-2, the emission results shall be stated in either "g/kWh" (preferred) or in "g/m^3". It should be noted that some regulators require the results to be expressed in unique measurement units; this should be determined prior to testing.

Reciprocating internal combustion engines — Exhaust emission measurement —

Part 6: Report of measuring results and test

1 Scope

This part of ISO 8178 specifies as a standard data format for reporting the measurement results of exhaust emissions from RIC engines for mobile, transportable and stationary use, excluding engines for motor vehicles primarily designed for road use. This part of ISO 8178 may be applied to engines used e.g. earth-moving machines, generating sets and for other applications. This part of ISO 8178 applies to measurement in the laboratory and at site.

For engines used in machinery covered by additional requirements, (e.g. occupational health and safety regulations, dust regulations for powerplants) additional test conditions and special evaluation methods may apply.

NOTE Since the standard report format defined in this part of ISO 8178 is intended to be applicable to all types of internal combustion engine, in certain cases some items are not necessary for specific engines and/or tests, especially when measuring at site. On the other hand, some additional items might be necessary according to test purposes. Deletion and addition of items to be reported should be based on agreement between the parties involved.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 8178. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO 8178 are encouraged to investigate the possibility of applying the most recent editions of the normative documents 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 8178-1:1996, *Reciprocating internal combustion engines — Exhaust emission measurement — Part 1: Test bed measurement of gaseous and particulate exhaust emissions.*

ISO 8178-2:1996, *Reciprocating internal combustion engines — Exhaust emission measurement — Part 2: Measurement of gaseous and particulate exhaust emissions at site*.

ISO 8178-3:1994, *Reciprocating internal combustion engines — Exhaust emission measurement — Part 3: Definitions and methods of measurement of exhaust gas smoke under steady-state conditions*.

ISO 8178-4:1996, *Reciprocating internal combustion engines — Exhaust emission measurement — Part 4: Test cycles for different engine applications*.

ISO 8178-5:1997, *Reciprocating internal combustion engines — Exhaust emission measurement — Part 5: Test fuels*.

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

ISO 8178-8:1996, *Reciprocating internal combustion engines — Exhaust emission measurement — Part 8: Engine group determination*.

ISO 8178-9:2000, *Reciprocating internal combustion engines — Exhaust emission measurement — Part 9: Test cycles and test procedures for test bed measurement of exhaust gas smoke emissions from compression ignition engines operating under transient conditions*.

ISO 8178-10:—[1)], *Reciprocating internal combustion engines — Exhaust emission measurement — Part 10: Test cycles and test procedures for field measurement of exhaust gas smoke emissions from compression ignition engines operating under transitory conditions*.

3 Terms and definitions

For the purposes of this part of ISO 8178, the terms and definitions given in ISO 8178-1, ISO 8178-2, ISO 8178-3, ISO 8178-4, ISO 8178-5, ISO 8178-7, ISO 8178-8, ISO 8178-9 and ISO 8178-10 apply.

4 Symbols and abbreviated terms

4.1 General symbols

See Table 1. For the EEC-UNO regulation equivalents of the symbols listed in Table 1 see ISO 8178-1.

Table 1 —General symbols

Symbol	Term	Unit
D	Dilution factor	1
F_h	Fuel specific factor used for the calculations of wet concentrations from dry concentrations	1
p_{Rv}	Reid vapour pressure	kPa
q^*_{mdx}	Equivalent diluted exhaust gas mass flow rate on wet basis	kg/h
q_{mdx}	Diluted exhaust gas mass flow rate on wet basis	kg/h
S_L	Lug smoke value	m^{-1}
S_P	Peak smoke value	m^{-1}
S_S	Steady state smoke value	m^{-1}
q^*_{Vdx}	Equivalent diluted exhaust gas volume flow rate on wet basis	m^3/h
q_{Vdx}	Diluted exhaust gas volume flow rate on wet basis	m^3/h
W_f	Weighting factor	1
W_{fe}	Effective weighting factor	1

1) To be published.

4.2 Symbols and abbreviations for the chemical components

CO	Carbon monoxide
CO_2	Carbon dioxide
HC	Hydrocarbons
NO_x	Oxides of nitrogen
O_2	Oxygen
PT	Particulates
SO_2	Sulfur dioxide

4.3 Abbreviations

CCAI	Calculated carbon aromaticity index
CFPP	Cold filter plugging point
CFV	Critical flow venturi
CNG	Compressed natural gas
CVS	Constant volume sampling
DPT	Differential pressure transducer
EGA	Exhaust gas analyser
EOPL	Effective optical path length
FBP	Final boiling point
IBP	Initial boiling point
LHV	Lower heating value
LPG	Liquefied petroleum gas
MON	Motor octane number
PDP	Positive displacement pump
RME	Rapeseed methyl ester
RON	Research octane number

5 Emissions test report

5.1 Introduction

The recommended test report consists of eleven data sheets (see annex A) that contain all the information pertinent to a test run in a very compact way. The test report is a single document that can be filed easily for later review of the test results by authorities, customers and engine manufacturers. It incorporates the final test results and the information needed to trace the final results to the values originally measured, as well as the information on the test engine, the test cell equipment and the test fuel. The report format is applicable to all test cycles and fuels.

5.2 General information

Table A.1 includes the information essential for engine approval, such as engine identification, engine application, test cycle and test identification. The emission test results may be listed for five different test cycles, if applicable. The gaseous and particulate emissions shall be expressed in grams per kilowatt hour whenever possible. Other units shall be indicated if used according to the provisions laid down in the scope. The smoke test results shall be listed for the smoke cycle applicable to the indicated application. The smoke values shall be expressed per metre whenever possible. Exceptions are only allowed if regulators require other units.

5.3 Engine information

Table A.2 contains the basic features of the engine under test. This information is sufficient to build up an engine with the same emission behaviour for confirmatory testing. If more information is demanded by authorities or customers, this may be appended to the test report. Table A.3 and Table A.4 contain other information to identify the features of the engine family and group respectively. These features are derived from ISO 8178-7 for engine family and ISO 8178-8 for engine group. If the engine family or group concept does not apply for the engine under test, Table A.3 or Table A.4 does not have to be submitted.

5.4 Ambient and engine test data

Table A.5 includes in the upper part the relevant ambient data, in the lower part the relevant engine data required to be recorded in ISO 8178-1. In most cases, mechanical shaft power will be used for the calculation of the final results. If other kinds of power are used, e.g. electrical, thermal or total power, this shall be indicated. Fuel flow, air flow and exhaust flow may be expressed as volume or mass flow rates, and the unit used shall be filled in. The measurement values shall be recorded for each mode individually (up to a maximum of 11), and the cycle value shall be calculated for the power and recorded in the column "$\Sigma(C) \times W_{fe}$" where (C) stands for the component under consideration. The number of modes shall be used in accordance with ISO 8178-4.

5.5 Gaseous emissions data

Table A.6 contains in the upper part the originally measured (or calculated for SO_2) concentrations of the gaseous emissions either in the raw or dilute exhaust gas for each individual mode. The number of modes shall be used in accordance with clause 8 of ISO 8178-4:1996. The way of measurement (wet or dry) shall be indicated in the second column. In the case of dilute measurement the (average) background concentrations shall be reported in column B. The second block contains some correction or calculation factors whose values shall be recorded only if applicable. The third block contains the mode and average cycle ($\Sigma(C) \times W_{fe}$) mass flow rates corrected for humidity (NO_x only) and to wet conditions where (C) stands for the component under consideration. The mass flow rates are the basis for the calculation of the other units like grams per kilowatt hour or grams per cubic metre.

5.6 Particulate emissions data

Table A.7 contains in the upper three blocks the measurement values required for the calculation of particulates for each individual mode. If the single filter method is used, the corresponding values shall be filled in under column "sum" (Σ). The number of modes shall be used in accordance with clause 8 of ISO 8178-4:1996. Use of a partial or full flow dilution system shall be indicated. For the dilution tunnel flow rate, the equivalent diluted exhaust gas flow rate on wet basis (q^*_{mdx} or q^*_{Vdx}) or diluted exhaust gas flow rate on wet basis (q_{mdx} or q_{Vdx}) shall be reported

depending on the system used. Some values (e.g. dilution ratio) are not required for certain systems. The particulate mass corresponds to the sum of the masses of both filters, including if weighed separately. If the particulate mass is corrected for background, the "b" shall be circled. The mass flow shall be reported as uncorrected and corrected for humidity for each individual mode and for the average cycle value ($\Sigma(C) \times W_{fe}$) where (C) stands for the component under consideration. Reporting of the smoke values during the emissions test cycle is optional. The unit of the smoke measurement value depends upon the system used. For the calculation of the soot concentration from the smoke value, the correlation function used shall be reported.

5.7 Smoke test data

Table A.8 contains the measurement values of the smoke cycles. The ambient data shall be reported for each test run to determine if the smoke values are to be corrected. If applicable, ambient density correction shall be applied, but the uncorrected smoke values shall also be reported. The mean values and the maximum difference between the test runs shall be reported whenever required according to Table A.8. Since different smoke cycles apply to different engine applications, the smoke values shall be reported in the appropriate lines. For the loaded transient test (C1 applications), the smoke values S_{P3}, S_{P6} and S_{P9} shall be reported under the columns run 1, run 2 and run 3 respectively.

5.8 Test cell information

Tables A.9 and A.10 contain information on the test cell and the measurement equipment. Not all of the information is required in ISO 8178-1 and ISO 8178-2, but filling in all applicable data is useful for confirmatory testing and interlaboratory comparisons. For the analysers, all measuring ranges used shall be reported, and the deviation shall be the maximum value found. The calibration curves, converter check results, hydrocarbon response factors and interference results shall be appended to the report. The values of the different pressure transducers, temperature sensors, and humidity sensors shall be reported in Table A.10. The type of dilution system shall be e.g. PDP, CFV, isokinetic, twin venturi or EGA, etc. The weighing chamber conditions may be reported as average values or as the range over the cycle.

5.9 Fuel characteristics

Table A.11 contains all fuel properties listed in ISO 8178-5. The fuel type shall be indicated, and the values required for the respective fuel shall be reported. In order to facilitate the use of this sheet, properties of different fuels with similar attributes (e.g. burning quality: cetane No. for diesel, RON for petrol) are combined in blocks.