
Reciprocating internal combustion engines - Exhaust emission measurement - Part 1: Test-bed measurement of gaseous and particulate exhaust emissions (ISO 8178-1:1996)

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Moteurs alternatifs a combustion interne - Mesurage des émissions de gaz d'échappement - Partie 1: Mesurage des émissions de gaz et de particules au banc d'essai (ISO 8178-1:1996)

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Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CEN member.

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European Committee for Standardization
Comité Européen de Normalisation
Europäisches Komitee für Normung

Central Secretariat: rue de Stassart, 36 B-1050 Brussels

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EN ISO 8178-1:1996

Foreword

The text of the International Standard ISO 8178-1:1996 has been prepared by Technical Committee ISO/TC 70 "Internal combustion engines" in collaboration with Technical Committee CEN/TC 270 "Internal combustion engines", the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by February 1997, and conflicting national standards shall be withdrawn at the latest by February 1997.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

Endorsement notice

The text of the International Standard ISO 8178-1:1996 was approved by CEN as a European Standard without any modification.

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Annex ZA (normative)
Normative references to international publications
with their relevant European publications

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN</u>	<u>Year</u>
ISO 5167-1	1991	Measurement of fluid flow by means of pressure differential devices - Part 1: Orifice plates, nozzles and Venturi tubes inserted in circular cross-section conduits	EN ISO 5167-1	1995

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ISO
8178-1

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**Reciprocating internal combustion
engines — Exhaust emission
measurement —**

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Part 1:

Test-bed measurement of gaseous and
particulate exhaust emissions

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

Partie 1: Mesurage des émissions de gaz et de particules au banc d'essai



Reference number
ISO 8178-1:1996(E)

ISO 8178-1:1996(E)

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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.

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.

International Standard ISO 8178-1 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: *Test report*
- Part 7: *Engine family determination*
- Part 8: *Engine group determination*
- Part 9: *Test bed measurement of exhaust gas smoke emissions from engines used in non-road mobile machinery*

Annexes A, B, C and D form an integral part of this part of ISO 8178. Annexes E and F are for information only.

Reciprocating internal combustion engines — Exhaust emission measurement —

Part 1:

Test-bed measurement of gaseous and particulate exhaust emissions

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1 Scope

This part of ISO 8178 specifies the measurement and evaluation methods for gaseous and particulate exhaust emission from reciprocating internal combustion engines (RIC engines) under steady-state conditions on a test bed, necessary for determining one weighted value for each exhaust gas pollutant. Various combinations of engine load and speed reflect different engine applications (see ISO 8178-4).

This part of ISO 8178 is applicable to 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. in earth-moving machines, generating sets and for other applications.

In limited instances, the engine can be tested on the test bed in accordance with ISO 8178-2, the field test document. This can only occur with the agreement of the parties involved. It should be recognized that data obtained under these circumstances may not agree completely with previous or future data obtained under the auspices of this part of ISO 8178. Therefore, it is recommended that this option be exercised only with engines built in very limited quantities such as very large marine or generating set engines.

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

Where it is not possible to use a test bed or where information is required on the actual emissions produced by an in-service engine, the site test procedures and calibration methods specified in ISO 8178-2 are appropriate.

NOTE 1 This part of ISO 8178 is intended for use as a measurement procedure to determine the gaseous and particulate emission levels of RIC engines for non-automotive use. Its purpose is to provide a map of an engine's emission characteristics which, through use of the proper weighting factors, can be used as an indication of that engine's emission levels under various applications. The emission results are expressed in units of grams per kilowatt hour and represent the mass rate of emissions per unit of work accomplished.

Although this part of ISO 8178 is designed for non-automotive engines, it shares many principles with particulate and gaseous emission measurements that have been in use for many years for on-road engines. One test procedure that shares many of these principles is the full dilution method currently specified for certification of 1985

and later heavy duty truck engines in the USA. Another is the procedure for direct measurement of the gaseous emissions in the undiluted exhaust gas, as currently specified for the certification of heavy duty truck engines in Japan and Europe.

Many of the procedures described below are detailed accounts of laboratory methods, since determining an emissions value requires performing a complex set of individual measurements, rather than obtaining a single measured value. Thus, the results obtained depend as much on the process of performing the measurements as they depend on the engine and test method.

Evaluating emissions from off-road engines is more complicated than the same task for on-road engines due to the diversity of off-road applications. For example, on-road applications primarily consist of moving a load from one point to another on a paved roadway. The constraints of the paved roadways, maximum acceptable pavement loads and maximum allowable grades of fuel, narrow the scope of on-road vehicle and engine sizes. Off-road engines and vehicles include a wider range of size, including the engines that power the equipment. Many of the engines are large enough to preclude the application of test equipment and methods that were acceptable for on-road purposes. In cases where the application of dynamometers is not possible the tests shall be made at site or under appropriate conditions.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 8178. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 8178 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 3046-3:1989, *Reciprocating internal combustion engines — Performance — Part 3: Test measurements.*

ISO 5167-1:1991, *Measurement of fluid flow by means of pressure differential devices — Part 1: Orifice plates, nozzles and Venturi tubes inserted in circular cross-section conduits running full.*

ISO 5725-2:1994, *Accuracy (trueness and precision) of measurement methods and results — Part 2: Basic method for the determination of repeatability and reproducibility of a standard measurement method.*

ISO 8178-2:—¹⁾, *Reciprocating internal combustion engines — Exhaust emission measurement — Part 2: Measurement of gaseous and particulate exhaust emissions at site.*

ISO 8178-4:—¹⁾, *Reciprocating internal combustion engines — Exhaust emission measurement — Part 4: Test cycles for different engine applications.*

ISO 8178-5:—¹⁾, *Reciprocating internal combustion engines — Exhaust emission measurement — Part 5: Test fuels.*

ISO 8178-6:—¹⁾, *Reciprocating internal combustion engines — Exhaust emission measurement — Part 6: Test report.*

SAE J 1151:1988, *Methane measurement using gas chromatography.*

SAE J 1936:1989, *Chemical methods for the measurement of nonregulated diesel emissions.*

1) To be published.

3 Definitions

For the purposes of this part of ISO 8178, the following definitions apply.

3.1 particulates: Any material collected on a specified filter medium after diluting exhaust gases with clean, filtered air at a temperature of less than or equal to 325 K (52 °C), as measured at a point immediately upstream of the primary filter; this is primarily carbon, condensed hydrocarbons and sulfates, and associated water.

NOTE 2 Particulates defined in this part of ISO 8178 are substantially different in composition and weight from particulates or dust sampled directly from the undiluted exhaust gas using a hot filter method (e.g. ISO 9096). Particulates measurement as described in this part of ISO 8178 is conclusively proven to be effective for fuel sulfur levels up to 0,8 %.

3.2 partial flow dilution method: The process of separating a part of the raw exhaust gases from the total exhaust flow, then mixing with an appropriate amount of dilution air prior to passing through the particulate sampling filter (see 16.1.1, figures 10 to 18).

3.3 full flow dilution method: The process of mixing dilution air with the total exhaust flow prior to separating a fraction of the diluted exhaust stream for analysis.

NOTE 3 It is common in many full-flow dilution systems to dilute this fraction of pre-diluted exhaust gases a second time to obtain appropriate sample temperatures at the particulate filter (see 16.1.2, figure 19).

3.4 isokinetic sampling: The process of controlling the flow of the exhaust sample by maintaining the mean sample velocity at the probe equal to the exhaust stream mean velocity.

3.5 non-isokinetic sampling: The process of controlling the flow of the exhaust sample independent of the exhaust stream velocity.

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3.6 multiple filter method: The process of using one pair of filters for each of the individual test cycle modes; the modal weighting factors are accounted for after sampling during the data evaluation phase of the test.

3.7 single filter method: The process of using one pair of filters for all test cycle modes. Modal weighting factors must be accounted for during the particulate sampling phase of the test cycle by adjusting sample flow rate and/or sampling time.

NOTE 4 This method dictates that particular attention be given to sampling duration and flow rates.

3.8 specific emissions: Emissions expressed on the basis of brake power as defined in 3.9.

NOTE 5 For many engine types within the scope of this part of ISO 8178 the auxiliaries which will be fitted to the engine in service are not known at the time of manufacture or certification.

When it is not appropriate to test the engine in the conditions as defined in annex B, e.g., if the engine and transmission form a single integral unit, the engine can only be tested with other auxiliaries fitted. In this case the dynamometer settings should be determined in accordance with 5.3 and 11.5. The auxiliary losses should not exceed 5 % of the maximum observed power. Losses exceeding 5 % must be approved, prior to the test, by the parties involved.

3.9 brake power: The observed power measured at the crankshaft or its equivalent, the engine being equipped only with the standard auxiliaries necessary for its operation on the test bed (see 5.3 and annex B).

3.10 auxiliaries: The equipment and devices listed in annex B.