

This is a preview of "ISO 8178-4:2017". [Click here to purchase the full version from the ANSI store.](#)

Third edition
2017-04

Reciprocating internal combustion engines — Exhaust emission measurement —

Part 4: Steady-state and transient test cycles for different engine applications

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

Partie 4: Cycles d'essai en régime permanent pour différentes applications des moteurs



Reference number
ISO 8178-4:2017(E)

© ISO 2017

This is a preview of "ISO 8178-4:2017". [Click here to purchase the full version from the ANSI store.](#)



COPYRIGHT PROTECTED DOCUMENT

© ISO 2017, Published in Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
Ch. de Blandonnet 8 • CP 401
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
copyright@iso.org
www.iso.org

This is a preview of "ISO 8178-4:2017". Click here to purchase the full version from the ANSI store.

Contents

	Page
Foreword	vi
Introduction	vii
1 Scope	1
2 Normative references	1
3 Terms and definitions	1
4 Symbols and abbreviated terms	11
4.1 Quantities and units — Numbers.....	11
4.2 General symbols.....	12
4.3 Symbols and abbreviated terms for fuel composition.....	14
4.4 Symbols and abbreviated terms for chemical components.....	15
4.5 Abbreviated terms.....	16
5 Test conditions	17
5.1 Engine test conditions.....	17
5.1.1 Laboratory test conditions.....	17
5.1.2 Test validity.....	17
5.2 Engine power.....	17
5.2.1 Auxiliaries to be fitted.....	18
5.2.2 Auxiliaries to be removed.....	18
5.2.3 Determination of auxiliary power.....	18
5.2.4 Engine cycle work.....	18
5.3 Engine intake air.....	18
5.3.1 Introduction.....	18
5.3.2 Intake air restriction.....	19
5.3.3 Engines with charge air cooling.....	19
5.4 Engine exhaust system.....	19
5.4.1 Introduction.....	19
5.4.2 Exhaust restriction.....	19
5.4.3 Engine with exhaust after-treatment system.....	20
5.5 Specific test conditions.....	20
5.5.1 Engine with exhaust after-treatment system.....	20
5.5.2 Crankcase emissions.....	24
5.6 Cooling system.....	24
5.7 Lubricating oil.....	24
6 Test fuels	24
7 Test cycles	25
7.1 Introduction.....	25
7.2 Test speeds.....	25
7.2.1 Maximum test speed (MTS).....	25
7.2.2 Rated speed.....	27
7.2.3 Intermediate speed.....	27
7.2.4 Idle speed.....	27
7.2.5 Test speed for constant speed engines.....	28
7.3 Torque and power.....	28
7.3.1 Torque.....	28
7.3.2 Power.....	29
7.4 Engine mapping.....	30
7.4.1 Engine mapping for transient cycles.....	31
7.4.2 Engine mapping for variable speed steady-state cycles.....	31
7.4.3 Engine mapping for constant-speed engines.....	32
7.5 Steady-state test cycles.....	33
7.5.1 Discrete mode test cycles.....	33
7.5.2 Ramped modal test cycles.....	34

This is a preview of "ISO 8178-4:2017". [Click here to purchase the full version from the ANSI store.](#)

7.5.3	Cycle types and applicability.....	35
7.6	Transient cycles.....	39
7.6.1	Introduction.....	39
7.6.2	Non-road transient cycle (NRTC).....	39
7.6.3	Large spark-ignition non-road transient cycle.....	39
7.7	Test cycle generation.....	40
7.7.1	Generation of steady-state discrete-mode or RMC test cycles.....	40
7.7.2	Generation of NRTC and LSI-NRTC.....	41
8	Test run.....	43
8.1	General test sequence.....	43
8.2	Instrument validation for test.....	45
8.2.1	Validation of proportional flow control for batch sampling and minimum dilution ratio for PM batch sampling.....	45
8.2.2	Gas analyser range validation, drift validation and drift correction.....	46
8.2.3	PM sampling media (e.g. filters) preconditioning and tare weighing.....	46
8.3	Sample system decontamination and preconditioning.....	48
8.3.1	Verification of HC contamination.....	49
8.4	Pre-test procedures.....	50
8.4.1	Preparation of the sampling filters.....	50
8.4.2	Preconditioning.....	50
8.4.3	Engine cool down (NRTC).....	51
8.4.4	Preparation of measurement equipment for sampling.....	51
8.4.5	Calibration of gas analysers.....	52
8.4.6	Adjustment of the dilution system.....	52
8.5	Engine starting and restarting.....	52
8.5.1	Engine start.....	52
8.5.2	Engine stalling.....	52
8.6	Test cycle running procedure.....	53
8.6.1	Test sequence for discrete steady-state test cycles.....	53
8.6.2	Ramped modal test cycles.....	54
8.6.3	Transient test cycle (NRTC and LSI-NRTC).....	55
8.7	Post-test procedures.....	58
8.7.1	Verification of proportional sampling.....	58
8.7.2	Post-test PM conditioning and weighing.....	58
8.7.3	Analysis of gaseous batch sampling.....	59
8.7.4	Drift verification.....	60
9	Data evaluation and calculation.....	60
9.1	Gaseous emissions.....	60
9.1.1	General.....	60
9.1.2	Sampling for gaseous emissions.....	60
9.1.3	Data evaluation.....	62
9.1.4	Calculation of mass emission.....	62
9.1.5	Dry/wet correction.....	68
9.1.6	NO _x correction for humidity and temperature.....	72
9.1.7	Cycle work and specific emissions.....	72
9.1.8	NH ₃ data evaluation.....	74
9.2	Particulate mass emission.....	74
9.2.1	General.....	74
9.2.2	Particulate sampling.....	75
9.2.3	Data evaluation.....	75
9.2.4	Calculation of mass emission.....	75
9.2.5	Effective weighting factor (steady-state discrete cycles only).....	80
9.3	Adjustment for emission controls that are regenerated on an infrequent (periodic) basis.....	81
9.4	Particle number emission.....	81
9.4.1	Time alignment.....	81

This is a preview of "ISO 8178-4:2017". [Click here to purchase the full version from the ANSI store.](#)

9.4.2	Determination of particle numbers for transient and ramped modal cycles (RMC) with a partial flow dilution or raw gas sampling system.....	81
9.4.3	Determination of particle numbers for transient and ramped modal cycles (RMC) with a full flow dilution system.....	82
9.4.4	Determination of particle numbers for discrete-mode cycles with a partial flow dilution system.....	82
9.4.5	Determination of particle numbers for discrete-mode cycles with a full flow dilution system.....	83
9.4.6	Test result.....	84
9.4.7	Determination of particle number background.....	85
9.5	Specific requirements for dual-fuel engines.....	86
9.5.1	Emission test procedure requirements for dual-fuel engines.....	86
9.5.2	Determination of molar component ratios and u_{gas} values for dual-fuel engines.....	89
10	Engine control area.....	91
10.1	General remarks.....	91
10.2	Control area for engines tested to cycles C1, C2, E1 and H.....	91
10.3	Control area for engines tested to cycles D1, D2, E2, G1, G2 and G3.....	94
10.4	Control area for engines tested to test cycle I.....	94
10.5	Control area for engines tested to E3 and E5 test cycle.....	95
10.5.1	Control area for CI marine engines.....	95
10.5.2	Control area for engines tested to the E4 test cycle.....	97
10.5.3	Control area for engines tested to the F cycle.....	98
	Annex A (normative) Steady-state discrete-mode test-cycles.....	100
	Annex B (normative) Steady-state ramped modal test cycles (RMCs).....	105
	Annex C (normative) Transient test cycles.....	111
	Annex D (informative) Calculation of the exhaust gas mass flow and/or of the combustion air mass flow.....	169
	Annex E (informative) Example programme for calculation of exhaust mass flows.....	189
	Annex F (informative) Example of calculation procedure (raw/partial flow).....	191
	Annex G (normative) Installation requirements for equipment and auxiliaries.....	194
	Annex H (normative) Molar based emission calculations.....	196
	Bibliography.....	236

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.

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).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

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 World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

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

This third edition cancels and replaces the second edition (ISO 8178-4:2007) which has been technically revised.

A list of all the parts in the ISO 8178- series, can be found on the ISO website.

This is a preview of "ISO 8178-4:2017". [Click here to purchase the full version from the ANSI store.](#)

Introduction

In comparison with 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 this document is to rationalize the test procedures for non-road engines in order to simplify and make more cost effective the drafting of legislation, the development of engine specifications and the certification of engines to control gaseous and particulate emissions.

This document embraces three concepts in order to achieve the objectives.

The first principle is to group applications with similar engine operating characteristics in order to reduce the number of test cycles to a minimum, but ensure that the test cycles are representative of actual engine operation.

The second principle is to express the emissions results on the basis of brake power as defined in ISO 8178-1. This ensures that alternative engine applications do not result in a multiplicity of tests.

The third principle is the incorporation of an engine family concept in which engines with similar emission characteristics and of similar design may be represented by the highest emitting engine within the group.