

**VÄIKELAEVAD. KOLBSISEPÕLEMISMOOTORITE  
HEITMETE MÕÕTMINE. GAASINA JA TAHKETE  
OSAKESTENA EMITEERUVATE HEITMETE MÕÕTMINE  
KATSESTENDIL**

**Small craft - Reciprocating internal combustion engines  
exhaust emission measurement - Test-bed  
measurement of gaseous and particulate exhaust  
emissions (ISO 18854:2015)**

**EESTI STANDARDI EESSÕNA****NATIONAL FOREWORD**

See Eesti standard EVS-EN ISO 18854:2015 sisaldab Euroopa standardi EN ISO 18854:2015 ingliskeelset teksti.	This Estonian standard EVS-EN ISO 18854:2015 consists of the English text of the European standard EN ISO 18854:2015.
Standard on jõustunud sellekohase teate avaldamisega EVS Teatajas.	This standard has been endorsed with a notification published in the official bulletin of the Estonian Centre for Standardisation.
Euroopa standardimisorganisatsioonid on teinud Euroopa standardi rahvuslikele liikmetele kättesaadavaks 22.04.2015.	Date of Availability of the European standard is 22.04.2015.
Standard on kättesaadav Eesti Standardikeskusest.	The standard is available from the Estonian Centre for Standardisation.

Tagasisidet standardi sisu kohta on võimalik edastada, kasutades EVS-i veebilehel asuvat tagasiside vormi või saates e-kirja meiliaadressile [standardiosakond@evs.ee](mailto:standardiosakond@evs.ee).

ICS 47.020.20, 47.080

**Standardite reprodutseerimise ja levitamise õigus kuulub Eesti Standardikeskusele**

Andmete paljundamine, taastekitamine, kopeerimine, salvestamine elektroonsesse süsteemi või edastamine ükskõik millises vormis või millisel teel ilma Eesti Standardikeskuse kirjaliku loata on keelatud.

Kui Teil on küsimusi standardite autorikaitse kohta, võtke palun ühendust Eesti Standardikeskusega:  
Aru 10, 10317 Tallinn, Eesti; koduleht [www.evs.ee](http://www.evs.ee); telefon 605 5050; e-post [info@evs.ee](mailto:info@evs.ee)

**The right to reproduce and distribute standards belongs to the Estonian Centre for Standardisation**

No part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying, without a written permission from the Estonian Centre for Standardisation.

If you have any questions about copyright, please contact Estonian Centre for Standardisation:

Aru 10, 10317 Tallinn, Estonia; homepage [www.evs.ee](http://www.evs.ee); phone +372 605 5050; e-mail [info@evs.ee](mailto:info@evs.ee)

---

ICS 47.020.20; 47.080

English Version

**Small craft - Reciprocating internal combustion engines exhaust  
emission measurement - Test-bed measurement of gaseous and  
particulate exhaust emissions (ISO 18854:2015)**

Petits navires - Moteurs alternatifs à combustion interne  
mesurage des émissions de gaz d'échappement -  
Mesurage des émissions de gaz et de particules au banc  
(ISO 18854:2015)

Kleine Wasserfahrzeuge - Messung der Emission von  
Hubkolben-Verbrennungsmotoren - Prüfstandsmessung der  
gasförmigen Emission und der Partikelemission (ISO  
18854:2015)

This European Standard was approved by CEN on 19 March 2015.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and United Kingdom.



EUROPEAN COMMITTEE FOR STANDARDIZATION  
COMITÉ EUROPÉEN DE NORMALISATION  
EUROPÄISCHES KOMITEE FÜR NORMUNG

**CEN-CENELEC Management Centre: Avenue Marnix 17, B-1000 Brussels**

## Foreword

This document (EN ISO 18854:2015) has been prepared by Technical Committee ISO/TC 188 "Small craft".

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 October 2015, and conflicting national standards shall be withdrawn at the latest by October 2015.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

According to the CEN-CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

### Endorsement notice

The text of ISO 18854:2015 has been approved by CEN as EN ISO 18854:2015 without any modification.

# Contents

	Page
<b>Foreword</b> .....	<b>vii</b>
<b>Introduction</b> .....	<b>viii</b>
<b>1 Scope</b> .....	<b>1</b>
<b>2 Normative references</b> .....	<b>1</b>
<b>3 Terms and definitions</b> .....	<b>1</b>
<b>4 Symbols and abbreviations</b> .....	<b>3</b>
4.1 General symbols.....	3
4.2 Symbols for fuel composition.....	5
4.3 Symbols and abbreviations for the chemical components.....	5
4.4 Abbreviations.....	6
<b>5 Test conditions</b> .....	<b>7</b>
5.1 Engine test conditions.....	7
5.1.1 Test condition parameter.....	7
5.1.2 Test validity.....	7
5.2 Engines with charge air cooling.....	7
5.3 Power.....	8
5.4 Specific test conditions.....	8
5.4.1 Engine air inlet system.....	8
5.4.2 Engine exhaust system.....	8
5.4.3 Cooling system.....	8
5.4.4 Lubricating oil.....	9
5.4.5 Adjustable carburettors.....	9
5.4.6 Crankcase breather.....	9
<b>6 Test fuels</b> .....	<b>9</b>
<b>7 Application of the engine family concept and choice of parent engine</b> .....	<b>9</b>
<b>8 Measurement equipment and data to be measured</b> .....	<b>10</b>
8.1 General.....	10
8.2 Dynamometer specification.....	10
8.3 Exhaust gas flow.....	10
8.3.1 General.....	10
8.3.2 Direct measurement method.....	10
8.3.3 Air and fuel measurement method.....	11
8.3.4 Fuel flow and carbon balance method.....	11
8.3.5 Tracer measurement method.....	11
8.3.6 Air flow and air-to-fuel ratio measurement method.....	12
8.3.7 Total dilute exhaust gas flow.....	13
8.4 Accuracy.....	13
8.5 Determination of the gaseous components.....	14
8.5.1 General analyser specifications.....	14
8.5.2 Gas drying.....	15
8.5.3 Analysers.....	15
8.5.4 Sampling for gaseous emissions.....	17
8.6 Particulate determination.....	18
8.6.1 General.....	18
8.6.2 Particulate sampling filters.....	19
8.6.3 Weighing chamber and analytical balance specifications.....	20

<b>9</b>	<b>Calibration of the analytical instruments</b>	<b>20</b>
9.1	General requirements	20
9.2	Calibration gases	21
9.2.1	General	21
9.2.2	Pure gas	21
9.2.3	Calibration and span gases	21
9.2.4	Use of gas dividers	21
9.2.5	Oxygen interference gases	22
9.3	Operating procedure for analysers and sampling system	22
9.4	Leakage test	22
9.5	Calibration procedure	22
9.5.1	Instrument assembly	22
9.5.2	Warm-up time	22
9.5.3	NDIR and HFID analyser	22
9.5.4	GC and HPCL	23
9.5.5	Establishment of the calibration curve	23
9.5.6	Alternative calibration methods	23
9.5.7	Verification of the calibration	23
9.6	Calibration of tracer gas analyser for exhaust flow measurement	23
9.7	Efficiency test of the NO <sub>x</sub> converter	24
9.7.1	General	24
9.7.2	Test setup	24
9.7.3	Calibration	24
9.7.4	Calculation	25
9.7.5	Adding of oxygen	25
9.7.6	Activation of the ozonator	25
9.7.7	NO <sub>x</sub> mode	25
9.7.8	Deactivation of the ozonator	25
9.7.9	NO mode	25
9.7.10	Test interval	25
9.7.11	Efficiency requirement	25
9.8	Adjustment of the FID	26
9.8.1	Optimization of the detector response	26
9.8.2	Hydrocarbon response factors	26
9.8.3	Oxygen interference check	26
9.8.4	Efficiency of the Non-Methane Cutter (NMC)	27
9.8.5	Methanol response factor	28
9.9	Interference effects with CO, CO <sub>2</sub> , NO <sub>x</sub> , O <sub>2</sub> , NH <sub>3</sub> , and N <sub>2</sub> O analysers	28
9.9.1	General	28
9.9.2	CO analyser interference check	29
9.9.3	NO <sub>x</sub> analyser quench checks	29
9.9.4	O <sub>2</sub> analyser interference	30
9.9.5	Cross-interference check compensation for NH <sub>3</sub> and N <sub>2</sub> O measurement channels using IR and UV measurement techniques	31
9.10	Calibration intervals	33
<b>10</b>	<b>Calibration of the particulate measuring system</b>	<b>33</b>
10.1	General	33
10.2	Calibration procedure	33
10.2.1	Flow measurement	33
10.2.2	Exhaust gas analysers	33
10.2.3	Carbon flow check	33
10.3	Checking the partial-flow conditions	33
10.4	Calibration intervals	33

<b>11</b>	<b>Calibration of the CVS full-flow dilution system</b>	<b>34</b>
11.1	General	34
11.2	Calibration of the Positive Displacement Pump (PDP)	34
11.2.1	General	34
11.2.2	Data analysis	34
11.3	Calibration of the Critical-Flow Venturi (CFV)	35
11.3.1	General	35
11.3.2	Data analysis	35
11.4	Calibration of the Subsonic Venturi (SSV)	36
11.4.1	General	36
11.4.2	Data analysis	36
11.5	Total system verification	37
11.5.1	General	37
11.5.2	Metering with a critical flow orifice	37
11.5.3	Metering by means of a gravimetric technique	37
<b>12</b>	<b>Test cycles (running conditions)</b>	<b>38</b>
12.1	Requirements	38
12.2	Test cycles	38
12.2.1	Applications	38
12.2.2	Test modes and weighting factors	39
12.2.3	Performing the test	40
<b>13</b>	<b>Test run</b>	<b>40</b>
13.1	Preparation of the sampling filters	40
13.2	Installation of the measuring equipment	40
13.3	Starting the dilution system and the engine	40
13.4	Adjustment of the dilution ratio	40
13.5	Determination of test points	41
13.6	Checking of the analysers	41
13.7	Test cycles	41
13.7.1	Test sequence	41
13.7.2	Analyser response	42
13.7.3	Particulate sampling	42
13.7.4	Engine conditions	42
13.8	Re-checking the analysers	42
13.9	Test report	42
<b>14</b>	<b>Data evaluation for gaseous and particulate emissions</b>	<b>42</b>
14.1	Gaseous emissions	42
14.2	Particulate emissions	43
<b>15</b>	<b>Calculation of the gaseous emissions</b>	<b>43</b>
15.1	General	43
15.2	Determination of the exhaust gas flow	44
15.3	Dry/wet correction	44
15.4	NO <sub>x</sub> correction for humidity and temperature	46
15.5	Calculation of the emission mass flow rates	47
15.5.1	Raw exhaust gas	47
15.5.2	Dilute exhaust gas	48
15.5.3	Determination of the NMHC concentration	50
15.6	Calculation of the specific emission	51

<b>16</b>	<b>Calculation of the particulate emission</b>	<b>51</b>
16.1	Particulate correction factor for humidity	51
16.2	Partial-flow dilution system	52
16.2.1	Isokinetic systems	52
16.2.2	Systems with measurement of CO <sub>2</sub> or NO <sub>x</sub> concentration	52
16.2.3	Systems with CO <sub>2</sub> measurement and carbon balance method	52
16.2.4	Systems with flow measurement	53
16.3	Full-flow dilution system	53
16.4	Calculation of the particulate mass flow rate	53
16.5	Calculation of the specific emissions	54
16.6	Effective weighting factor	54
<b>17</b>	<b>Determination of the gaseous emissions</b>	<b>55</b>
17.1	General	55
17.2	Main exhaust components CO, CO <sub>2</sub> , HC, NO <sub>x</sub> , O <sub>2</sub>	55
17.3	Ammonia analysis	60
17.4	Methane analysis	61
17.4.1	Gas chromatographic (GC) method ( <a href="#">Figure 6</a> )	61
17.4.2	Non-methane cutter (NMC) method ( <a href="#">Figure 7</a> )	63
17.5	Methanol analysis	64
17.6	Formaldehyde analysis	65
<b>18</b>	<b>Determination of the particulates</b>	<b>67</b>
18.1	General	67
18.2	Dilution system	67
18.2.1	Partial-flow dilution system ( <a href="#">Figures 10 to 18</a> )	67
18.2.2	Full-flow dilution system	79
18.3	Particulate sampling system	82
	<b>Bibliography</b>	<b>86</b>



## 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](http://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](http://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 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 188, *Small craft, SC 2, Engines and propulsion systems*.

## Introduction

This International Standard is intended for use as a measurement procedure to determine the gaseous and particulate emission levels of reciprocating internal combustion (RIC) engines for marine use in small craft. Its purpose is to provide a map of an engine's emissions 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 International Standard is designed for marine 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 process of mixing dilution air with the total exhaust flow prior to separating a fraction of the diluted exhaust stream for analysis (full-flow dilution method) as 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.

**NOTE** It is common in many full-flow dilution systems to dilute this fraction of pre-diluted exhaust a second time to obtain appropriate sample temperatures at the particulate filter (see [Figure 19](#)).

Many of the procedures described in this International Standard 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.

# Small craft — Reciprocating internal combustion engines exhaust emission measurement — Test-bed measurement of gaseous and particulate exhaust emissions

## 1 Scope

This International Standard specifies the measurement and evaluation methods for gaseous and particulate exhaust emissions from reciprocating internal combustion (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.

This International Standard is applicable to RIC marine engines intended to be installed in small craft up to 24 m length of hull.

## 2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 5725-1, *Accuracy (trueness and precision) of measurement methods and results — Part 1: General principles and definitions*

ISO 5725-2, *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 8178-1:2006, *Reciprocating internal combustion engines — Exhaust emission measurement — Part 1: Test-bed measurement of gaseous and particulate exhaust emissions*

ISO 8178-6:2000, *Reciprocating internal combustion engines — Exhaust emission measurement — Part 6: Report of measuring results and test*

ISO 8666, *Small craft — Principal data*

ISO 14396, *Reciprocating internal combustion engines — Determination and method for the measurement of engine power — Additional requirements for exhaust emission tests in accordance with ISO 8178*

ISO 15550:2002, *Internal combustion engines — Determination and method for the measurement of engine power — General requirements*

## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 8666 and the following apply.

### 3.1

#### **particulates**

material collected on a specified filter medium after diluting exhaust gases with clean, filtered air to a temperature greater than 315 K (42 °C) and less than or equal to 325 K (52 °C), as measured at a point immediately upstream of the primary filter

Note 1 to entry: Particulates consist primarily of carbon, condensed hydrocarbons, and sulfates and associated water.