

Heating boilers — Test code for heating boilers for atomizing oil burners

The European Standard EN 304:1992, with the incorporation of amendments A1:1998 and A2:2003, has the status of a British Standard

ICS 91.140.10

Cooperating organizations

The European Committee for Standardization (CEN), under whose supervision this European Standard was prepared, comprises the national standards organizations of the following countries:

Austria	Oesterreichisches Normungsinstitut
Belgium	Institut belge de normalisation
Denmark	Dansk Standardiseringsraad
Finland	Suomen Standardisoimisliitto, r.y.
France	Association française de normalisation
Germany	Deutsches Institut für Normung e.V.
Greece	Hellenic Organization for Standardization
Iceland	Technological Institute of Iceland
Ireland	National Standards Authority of Ireland
Italy	Ente Nazionale Italiano di Unificazione
Luxembourg	Inspection du Travail et des Mines
Netherlands	Nederlands Normalisatie-instituut
Norway	Norges Standardiseringsforbund
Portugal	Instituto Português da Qualidade
Spain	Asociación Española de Normalización y Certificación
Sweden	Standardiseringskommissionen i Sverige
Switzerland	Association suisse de normalisation
United Kingdom	British Standards Institution

This British Standard, having been prepared under the direction of the Refrigeration, Heating and Air Conditioning Standards Policy Committee, was published under the authority of the Standards Board and comes into effect on 15 December 1992

© BSI 2006

Amendments issued since publication

Amd. No.	Date	Comments
10183	February 1999	See national foreword
16418	30 June 2006	See national foreword

The following BSI references relate to the work on this British Standard:

Committee reference RHE/10
Draft for comment 90/73172 DC

ISBN 0 580 21370 6

Contents

	Page
Cooperating organizations	Inside front cover
National foreword	ii
Foreword	2
Foreword to amendment A1	2
Text of EN 304	5
National annex NA (informative) Committees responsible	Inside back cover
National annex NB (informative) Cross-references	Inside back cover

National foreword

This British Standard has been prepared under the direction of the Refrigeration, heating and air conditioning Standards Policy Committee and is the English language version of EN 304:1992, *Heating boilers — Test code for heating boilers for atomizing oil burners*, including amendments A1:1998 and A2:2003, published by the European Committee for Standardization (CEN).

The start and finish of text introduced or altered by amendment is indicated in the text by tags **A1** **A1**. Tags indicating changes to CEN text carry the number of the CEN amendment. For example, text altered by CEN amendment A1 is indicated by **A1** **A1**.

EN 304 was produced as a result of international discussion in which the United Kingdom took an active part.

Please note that the United Kingdom voted against amendment A1 on the grounds that in **5.8.1.1** the indirect method states a mean temperature of $(50 \pm 1) ^\circ\text{C}$. This does not legally conform to the Boiler Efficiency Directive, which specifies a mean temperature of not less than $50 ^\circ\text{C}$. Therefore boilers tested to this standard may not necessarily conform to the Boiler Equipment Directive.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, the EN title page, pages 2 to 37 and a back cover.

The BSI copyright notice displayed in this document indicates when the document was last issued.

Heating boilers — Test code for heating boilers for atomizing oil burners

Chaudières de chauffage — Règles d'essai
pour les chaudières avec brûleurs fioul à
pulvérisation

Heizkessel — Prüfregelein für Heizkessel mit
Ölzerstäubungsbrennern

This European Standard was approved by CEN on 1992-09-18; amendment A1 was approved by CEN on 1998-06-06. 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 Central Secretariat 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 Central Secretariat has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

CEN

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

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

Foreword

This European Standard was drawn up by the Technical Committee CEN/TC 57, Central heating boilers, of which the Secretariat is held by DIN.

The following structure is intended for the standards for heating boilers prepared by CEN/TC 57:

EN 303-1, *Heating boilers — Heating boilers with forced draught burners — Part 1: Terminology, general requirements, testing and marking.*

EN 303-2, *Heating boilers — Heating boilers with forced draught burners — Part 2: Special requirements for boilers with atomizing oil burners.*

EN 303-2, *Heating boilers — Heating boilers with forced draught burners up to a heat output of 70 kW and an operating pressure of max. 3 bar — Terminology, special requirements, testing and marking (standard in preparation).*

EN 304, *Heating boilers — Test code for heating boilers for atomizing oil burners.*

This European Standard shall be given the status of national standard, either by publication of an identical text or by endorsement, at the latest by March 1993, and conflicting national standards shall be withdrawn at the latest by March 1993.

The standard was approved and in accordance with the CEN/CENELEC Internal Regulations, 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, United Kingdom.

Foreword to amendment A1

This amendment EN 304:1992/A1:1998 to EN 304:1992 has been prepared by Technical Committee CEN/TC 57, Central heating boilers, the Secretariat of which is held by DIN.

This amendment to the European Standard EN 304:1992 shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by December 1998, and conflicting national standards shall be withdrawn at the latest by December 1998.

For relationship with EU Directive(s), see informative Annex ZA, which is an integral part of this standard.

The following structure is intended for the standards for heating boilers:

prEN 303-1, *Heating boilers — Part 1: Heating boilers with forced draught burners — Terminology, general requirements, testing and marking.*

prEN 303-2, *Heating boilers — Part 2: Heating boilers with forced draught burners — Special requirements for boilers with atomizing oil burners.*

prEN 303-3, *Heating boilers — Part 3: Gas-fired central heating boilers — Assembly comprising a boiler body and a forced draught burner.*

prEN 303-4, *Heating boilers — Part 4: Heating boilers with forced draught burners — Special requirements for boilers with forced draught oil burners with outputs up to 70 kW and a maximum operating pressure of 3 bar — Terminology, special requirements, testing and marking.*

prEN 303-5, *Heating boilers — Part 5: Heating boilers for solid fuels, hand and automatically fired, with a nominal heat output of up to 300 kW — Terminology, requirements, testing and marking.*

EN 304, *Heating boilers — Test code for heating boilers for atomizing oil burners.*

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

Foreword to amendment A2

This document (EN 304:1992/A2:2003) has been prepared by Technical Committee CEN/TC 57 “Central heating boilers”, the secretariat of which is held by DIN.

This Amendment to the European Standard EN 304:1992 shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by March 2004, and conflicting national standards shall be withdrawn at the latest by March 2004.

This Amendment to the European Standard EN 304:1992 specifies the additionally required heating-related tests and the deviating boundary conditions for low-temperature central-heating boilers. Its purpose is to complete, amend or shorten EN 304:1992. This does not affect the main standard.

WARNING : other requirements and other EU Directives may be applicable to the products falling within the scope of this European Standard.

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

Contents

		Page
Foreword		
1 Scope	5	
2 Normative references	5	
3 Principles of tests	5	
4 Measuring instruments and methods	5	
5 Tests	7	
5.1 Determination of the heat output and the efficiency of the boiler	7	
5.2 Determination of the rated heat output	7	
5.3 Determination of the boiler efficiency (direct method)	7	
5.4 Test operation	8	
5.5 Calculation	8	
5.6 Determination of the waterside resistance	9	
5.7 Determination of the standby loss	9	
5.8 Useful efficiency at part load	10	
5.9 Surface temperature	13	
5.10 Floor temperatures	13	
5.11 Emission values of NO _x and CO	16	
6 Test report and other documents	16	
Annex A (normative) Measurements	20	
Annex B (informative) Applicable symbols and units	31	
Annex C (informative) Performance tests	32	
Annex D (informative) Criteria for the adaption of atomizing oil burners to heating boilers for liquid fuels	33	
Annex E (informative) Hints for setting up and evaluation of the test rig	35	
Annex F (informative) Determination of the heat losses from the test rig and the heat contributions of the circulating pump of the test rig	35	
Annex G (informative) Determination of the time t_1	35	
Annex ZA (informative) Clauses of this European Standard addressing essential requirements or other provisions of EU Directives	36	
Figure 1 — Measuring installation to determine the amount of fuel	6	
Figure 2 — Flue gas section	14	
Figure 3 — Test configuration for the determination of base temperatures	15	
Figure 4 — Configuration of a thermocouple for measuring the surface temperatures of the test base		15
Figure 5 — Relation of temperature to time for a boiler equipped with a pumped hot water cylinder		16
Figure 6 — Test rig with short-circuit section and three possible arrangements for cold water supply		17
Figure 7 — Test rig with heat exchanger		18
Figure 8 — Test installation to determine the heat emissions of the boiler when the burner is off and the thermal capacity of the boiler		19
Figure A.1 — Test rig with heat exchanger		22
Figure A.2 — Test rig with short-circuit section and three possible arrangements for cold water supply		23
Figure A.3 — Mean specific heat capacities for dry combustion products and water vapour at flue gas temperatures up to and including 500 °C		26
Figure A.4 — Total heat transmission figure α by radiation and free convection to the horizontal and vertical surfaces at an ambient temperature $t_L = 20$ °C as a function of the mean surface temperature t_m		28
Figure A.5 — Test rig for determination of the waterside resistance (transparent flexible tubes for connections to differential pressure gauge)		28
Figure D.1 — Minimum dimensions of the combustion chamber		34
Figure D.2		34
Table 1 — Symbols and quantities needed to calculate the efficiency at part load		13
Table 2 — Calculation of part-load efficiency		13
Table A.1		21

1 Scope

The test code applies to the tests of the thermal performance of oil-fired heating boilers (hereafter called “boilers”) and combined boilers and water heaters. The requirements are laid down in EN 303-1 and EN 303-2.

This standard includes the requirements and recommendations for carrying out and evaluating the procedure for testing boilers and also the details of the technical conditions under which the tests shall be carried out.

2 Normative references

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.

EN 267:1991, *Atomizing oil burners of monobloc type; testing*.

EN 303-1:1992, *Heating boilers; Heating boilers with forced draught burners — Part 1: Terminology, general requirements, testing and marking*.

EN 303-2:1992, *Heating boilers; Heating boilers with forced draught burners — Part 2: Special requirements for boilers with atomizing oil burners*.

3 Principles of tests

3.1 Choice of boiler to be tested and its accessories

The parts and accessories used should be those supplied as standard by the manufacturer or those recommended by him.

For the rest an atomizing oil burner shall be used which complies with EN 267 and which is suitable for the boiler (dimensions of the combustion chamber, pressure conditions, etc.).

3.2 Condition of the boiler

The condition and the equipment of the boiler to be tested shall conform to the normal supply specification. The use of additional thermal insulation to parts in contact with water, products of combustion and fire is not permitted.

When determining the thermal output of a boiler fitted with a water heater (either storage or instantaneous), no sanitary hot water shall be drawn off during the test. The thermal output shall be determined from the heating circuit only.

4 Measuring instruments and methods

Only such measuring instruments shall be used which meet the requirements noted in the following clauses. The use of recording instruments, which show the progress of the test in detail, is recommended, especially for measuring the water temperatures at the flow and return connections to the boiler, the draught at the outlet from the boiler, and the temperature and composition of the products of combustion.

Regarding admissible errors, the measuring instruments shall be chosen in such a way that the efficiency can be determined to an accuracy of $\pm 2\%$. The tolerances for test equipment are given in Annex A.

4.1 Fuel

The tests shall be carried out using commercially available heating gas oil or kerosene as selected by the boiler manufacturer.

The viscosity of the gas oil shall be $5,5 \pm 0,5 \text{ mm}^2/\text{s}$ at 20°C in accordance with EN 267.

The viscosity of kerosene shall be $1,3 \text{ mm}^2/\text{s}$ to $2,9 \text{ mm}^2/\text{s}$ at 20°C .

4.1.1 Quantities

The fuel quantities are either weighed or measured volumetrically (see Figure 1).

4.1.2 Determination of the calorific values for oil fuels

4.1.2.1 Heating gas oil

a) If the calorific value is not determined calorimetrically and in the absence of a complete analysis, the value for fuel oil can, with sufficient accuracy, be assumed as follows:

$$H_U = 42,689 \text{ MJ/kg}$$

where

carbon content	$c = 0,86 \text{ kg/kg};$
hydrogen content	$h = 0,136 \text{ kg/kg};$
sulfur content	$s = 0,003 \text{ kg/kg};$
density at 15 °C:	$0,85 \text{ kg/dm}^3.$

b) If the density and sulfur content is known (e.g. by analysis) the calorific value can be calculated as follows:

$$H_U = 52,92 - (11,93 \cdot \rho_{15}) - (0,3 \cdot s) \text{ in MJ/kg}$$

where

ρ_{15} = density of the heating gas oil at 15 °C in kg/dm³;
 s = sulfur content in kg/kg.

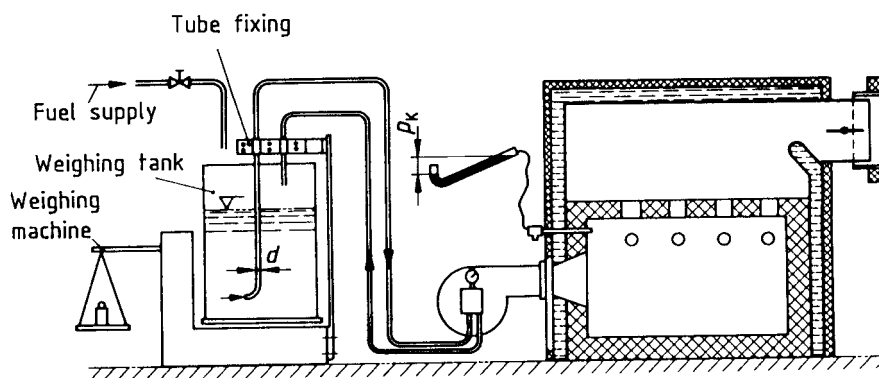


Figure 1 — Measuring installation to determine the amount of fuel

4.1.2.2 Kerosene

a) If the calorific value is not determined calorimetrically and in the absence of a complete analysis, the value for kerosene can with sufficient accuracy be assumed as follows:

$$H_U = 43,300 \text{ MJ/kg}$$

where

carbon content	$c = 0,85 \text{ kg/kg};$
hydrogen content	$h = 0,141 \text{ kg/kg};$
sulfur content	$s = 0,004 \text{ kg/kg};$
density at 15 °C:	$0,79 \text{ kg/dm}^3.$

b) If the density and sulfur content is known (e.g. by analysis) the calorific value can be calculated in accordance with 4.1.2.1b).

4.1.3 Combustion parameters

The necessary combustion parameters can be calculated from the analysis of the fuel (see A.4).

4.2 Determination of the composition of the products of combustion

In order to minimize the errors of measurement, the instruments shall be installed in a zone of as constant temperature as possible and shall be in operation some time before the commencement of the tests. (See A.5.)

5 Tests

5.1 Determination of the heat output and the efficiency of the boiler

5.1.1 Method for the measurement of the heat output

The amount of useful heat transmitted to the heat carrier (water) is measured. It can be determined directly in the boiler circuit or indirectly by means of a heat exchanger.

5.1.1.1 Measurement of heat output in the boiler circuit

The useful heat output transmitted to the water is determined either by measuring the mass flow of cold water entering the boiler circuit and the rise of temperature to the outlet temperature, or by measuring the mass flow of the water circulating in the boiler circuit and its temperature rise.

5.1.1.2 Measurement of heat output by means of a heat exchanger

The heat produced by the boiler is transferred to the cooling water by means of a heat exchanger. The heat received by the latter is calculated from the throughput and the temperature rise of the cooling water. The heat losses from the well-insulated connections between the boiler and the heat exchanger and those of the heat exchanger itself, are determined either by preliminary tests or by calculation.

The heat output of the boiler is the sum of the two amounts of heat.

5.2 Determination of the rated heat output

The tests for the determination of the rated output shall be carried out at a firing rate such that the output is at least 100 %, but does not exceed 105 % of the rated value, and the requirements concerning the rated heat output shall be met. If one of the requirements is not met during the tests, a second test shall be carried out at 95 % to 100 % of the rated output of the boiler. The actual value for the rated heat output shall be determined by linear interpolation between the two test results.

The determination of the rated heat output shall be carried out with a mean flow temperature of between 80 °C and 90 °C, and the mean temperature difference between flow and return shall be between 10 K and 25 K.

A temperature rise of:

$$\frac{t_V + t_R}{2} - t_L \geq 50,0 \text{ K}$$

shall be maintained.

5.3 Determination of the boiler efficiency (direct method)

The efficiency is determined on the basis of the net calorific value H_U .

The direct method is to be used. The indirect method allows an additional check of test accuracy of the test rig to be made by means of a heat balance. From this the values of other losses will also be determined.

5.4 Test operation

5.4.1 Basic details

The boiler and the burner shall be operated in accordance with the manufacturer's instructions throughout the tests.

The minimum ambient temperature shall be ≥ 15 °C.

The settings of the combustion equipment shall not be manually adjusted during the test, and no change shall be made to the water flow.

The temperature, pressure and composition of the products of combustion shall be measured at intervals of not more than once per minute or continuously and shall be recorded simultaneously on recording instruments. The time intervals shall be selected so that any variations of measured values are detected with sufficient accuracy.

The temperatures t_V and t_R shall not differ by more than $0,5 \text{ (K/h)} \times \text{test period (h)}$ at the beginning and the end of the test.

During the test for efficiency determination the burner heat input shall remain constant and shall not be interrupted by the thermostat or the safety temperature limiter.

5.4.2 Draught adjustment

5.4.2.1 Boilers operating under negative pressure

For boilers operating under negative pressure the draught at the boiler outlet shall be adjusted so that there is a negative pressure in the combustion chamber. The draught shall be measured.

5.4.2.2 Boilers operating under positive pressure

In positive pressure boilers the pressure shall be set at the boiler outlet to approximately 0 mbar. The pressure difference between combustion chamber and boiler outlet shall be measured.

5.4.3 Establishment of steady state conditions

It is recommended that the boiler be operated for about 1 h before the commencement of the performance and efficiency test at the output intended for the test.

The steady state condition is regarded as reached when the water temperature does not vary by more than $\pm 0,5 \text{ K/h}$.

5.4.4 Test period

For the rated heat minimum output test, the test period shall be at least 60 min. Intermediate results shall be taken every 30 min. If the efficiency results deviate by more than 0,5 % points, the test shall be extended by periods of 30 min until this requirement is met.

5.4.5 Setting up the test rig

The test rig shall be set up in such a way that the test conditions laid down in A.6 are met, and the efficiency can be determined within a tolerance of ± 2 % points.

Other equivalent arrangements of rigs may be used.

5.5 Calculation

The calculations are to be based on the mean values of the individual readings recorded during the test period.

5.5.1 Boiler heat output

The necessary formulae relevant to the individual test methods are given in A.7.

5.5.2 The heat input

For these calculations, formulae in A.8 are to be used.

5.5.3 Boiler efficiency

5.5.3.1 Direct method

In the direct method the boiler efficiency is determined by:

$$\eta_K = \frac{Q}{Q_B} \quad (1)$$

5.5.3.2 Indirect method (only to be used for checking purposes, see A.9)

In the indirect method the boiler efficiency is given by:

$$\eta_K = 1 - q_A - q_U - q_S \quad (2)$$

where

q_A is the loss through sensible heat of the products of combustion (values relative to the heat input);

q_U is the loss through incomplete combustion (values relative to the heat input);

q_S is the loss through radiation, convection and conduction (values relative to the heat input).

5.6 Determination of the waterside resistance

The waterside resistance (measured in mbar) shall be determined for the flow which is equivalent to the rated output of the boiler at a temperature difference at $\Delta t = 10$ K and 20 K between the flow and return.

5.7 Determination of the standby loss

5.7.1 General

No useful heat shall be extracted for heating or hot water.

5.7.2 Test arrangement and measurement (see A.11)

The boiler shall remain as set up for the determination of Q and η_K . The short-circuit section remains connected. For boilers producing hot water, the hot and cold water feed pipes remain connected, the cylinder is kept full.

The circulation in the short-circuit section is interrupted during the “off” period of the burner.

5.7.3 Standby heat loss

The thermostat shall be set in such a way that the mean temperature at the sensor exceeds the ambient temperature by 50 ± 3 K during the operation of the burner when no transmission of useful heat takes place. If the mean temperature difference deviates from the prescribed temperature by more than 3 K the test shall be repeated after the thermostat has been adjusted.

The boiler temperature and the air temperature at mid-height of the boiler shall be measured by automatic instruments.

A negative pressure of between $-0,05$ mbar and $-0,07$ mbar shall be maintained at the measuring section when the burner is not firing during the whole test period.

The electrical energy used during the test shall be measured and included in the test report.

5.7.3.1 Calculation

The calculation is in accordance with A.11.2.

5.7.3.2 Standby heat loss from boilers with and without water heaters

After heating the boiler up, the test begins at a burner start. The test ends at a subsequent burner start (a period commences at a burner start and ends at the next burner start).

The standby heat loss shall be calculated from the measured fuel consumption during the test periods, always using complete periods.

The standby loss shall be calculated from the beginning of the test at the end of each test period.