

Specification for

Performance requirements for domestic flued oil burning appliances (including test procedures)

UDC 697.241:697.244:696.48 – 63:644.06 – 63

NO COPYING WITHOUT BSI PERMISSION EXCEPT AS PERMITTED BY COPYRIGHT LAW



Document Sharing Hub

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Refrigeration, Heating and Air Conditioning Standards Committee (RHE/-) to Technical Committee RHE/13 upon which the following bodies were represented:

- Associated Offices Technical Committee
- Association of Shell Boilermakers
- British Combustion Equipment Manufacturers' Association
- British Tar Industry Association
- Chartered Institution of Building Services
- Chief and Assistant Chief Fire Officers Association
- Department of the Environment (Property Services Agency)
- Dobeta Limited
- Electricity Supply Industry in England and Wales
- Energy Industries Council
- Engineering Equipment and Materials Users' Association
- Fire Officers Committee
- Engineering Industries Association
- Greater London Council
- Health and Safety Executive
- Institute of Energy
- Institution of Fire Engineers
- Process Plant Association
- Water-tube Boilermakers' Association
- Coopted member

This British Standard, having been prepared under the direction of the Refrigeration, Heating and Air Conditioning Standards Committee, was published under the authority of the Board of BSI and comes into effect on 29 February 1984

© BSI 02-2000

The following BSI references relate to the work on this standard:
Committee reference RHE/13
Draft for comment 81/70120 DC

ISBN 0 580 13534 9

Amendments issued since publication

Amd. No.	Date of issue	Comments

Contents

	Page
Committees responsible	Inside front cover
Foreword	iv
Section 1. General	
1.1 Scope	1
1.2 Definitions	1
1.3 Marking	2
1.4 Test fuels	2
1.5 Classification of heating appliances	3
Section 2. Performance requirements	
2.0 General	4
2.1 Class 1: appliances employing natural draught vaporizing burners	4
2.2 Class 2: appliances employing high/low forced draught vaporizing burners	7
2.3 Class 3: appliances employing on/off forced draught vaporizing burners	11
2.4 Class 4: appliances employing rotary vaporizing burners	15
2.5 Class 5: appliances employing on/off pressure jet burners	18
Section 3. Test procedures	
3.1 Test procedure 1: primary screening	22
3.2 Test procedure 2: efficiency of boilers	26
3.3 Test procedure 3: overall efficiency of indirect impelled convection air heaters	30
3.4 Test procedure 4: overall efficiency of direct impelled convection air heaters	32
3.5 Test procedure 5: efficiency of direct natural convection air heaters	34
3.6 Test procedure 6: sensitivity to flue conditions (appliances with integral draught diverter)	36
3.7 Test procedure 7: sensitivity to flue conditions (appliances without integral draught diverter)	37
3.8 Test procedure 8: response to load change (manually controlled appliances)	38
3.9 Test procedure 9: response to load change (semi-automatic appliances)	39
3.10 Test procedure 10: start and shut-down combustion performance	40
3.11 Test procedure 11: hearth and side panel temperatures	41
3.12 Test procedure 12: fuel flooding test	43
3.13 Test procedure 13: effects of voltage variation	44
3.14 Test procedure 14: electrical safety	46
3.15 Test procedure 15: boiler reliability and endurance: on/off appliances	48
3.16 Test procedure 16: boiler reliability and endurance: high/low appliances	50
3.17 Test procedure 17: reliability and endurance: manually controlled natural convection air heaters	51
3.18 Test procedure 18: reliability and endurance: automatic and semi-automatic air heaters	53
3.19 Test procedure 19: sensitivity to wind of an appliance designed to operate with its own integral flue arrangement	56

	Page
Section 4. Measurement methods	
4.1 Method 1: determination of smoke number and smoke index	58
4.2 Method 2: determination of flue gas composition	59
4.3 Method 3: determination of flue gas temperatures	59
4.4 Method 4: determination of flue draught	59
4.5 Method 5: degree of incomplete combustion, determination of combustible gas index	60
4.6 Method 6: determination of gas velocity by pitot tube	61
4.7 Method 7: determination of fuel flow rate	62
4.8 Method 8: determination of surface temperatures and effectiveness of guards	62
4.9 Method 9: determination of float control temperatures	64
4.10 Method 10: determination of exhaust gas heat (stack) losses	64
Appendix A Suggested forms for use by laboratory staff during a preliminary inspection of an appliance	65
Appendix B Suggested report forms	68
Appendix C Typical points for examination after endurance test	73
Figure 1 — Circuit example, class 3 and 4 appliances	74
Figure 2 — Circuit example, class 5 appliance with photo-electric cell	75
Figure 3 — Test rigs for hot water boilers operating below a temperature of 100 °C	76
Figure 4 — Thermometer pocket	77
Figure 5 — Water collecting method	78
Figure 6 — Resistance grid	79
Figure 7 — Air flow	80
Figure 8 — Test layout	81
Figure 9 — Air flow	82
Figure 10 — Orifice plate	82
Figure 11 — Sensitivity to flue conditions: flue duct system	83
Figure 12 — Sensitivity to flue conditions: flue duct system	84
Figure 13 — Standard test hearth	85
Figure 14 — Side panel temperature measuring boards	86
Figure 15 — Total of four boards assembled to measure boiler side panel temperatures	87
Figure 16 — Brick central test chamber	88
Figure 17 — Reliability and endurance test: water system	89
Figure 18 — Horizontal discharge, with integral flue arrangement	90
Figure 19 — Suction pyrometer	91
Figure 20 — Basic gas and signal circuits	92
Figure 21 — Appliance limits on a typical curve shape	93
Figure 22 — Use of pitot tube	94
Figure 23 — Fuel measurement system	95
Figure 24 — Contact thermocouple	96
Figure 25 — Test probe	97
Figure 26 — Determination of exhaust gas heat losses applicable to standard test fuels	98
Table 1 — Test fuel requirements	3
Table 2 — Summary of test procedures and measurement methods	22

	Page
Table 3 — Report for test procedure 13	46
Table 4 — Creepage distances and clearances	47
Table 5 — Report for test procedure 15	49
Table 6 — Report for test procedure 16	51
Table 7 — Programme of tests and adjustments for test procedure 17	53
Table 8 — Report for test procedure 17	53
Table 9 — Report for test procedure 18: automatic appliances	55
Table 10 — Report for test procedure 18: semi-automatic appliances	55
Publications referred to	Inside back cover

Foreword

This revision of this British Standard has been prepared under the direction of the Refrigeration, Heating and Air Conditioning Standards Committee. BS 4876 was first published in 1972 and has been amended twice, in 1976 (AMD 2147) and in 1978 (AMD 3175).

The only differences between this revision and BS 4876:1972 with amendments are as follows:

- a) test procedure 2 has been revised and is technically equivalent to DD 65-1;
- b) an explanatory clause has been inserted in section 2;
- c) minor editorial changes have been included.

The tests described in this standard are for investigating the safety, reliability and performance aspects of the appliances and are based on tests developed by DOBETA Limited.

For convenience, the appliances have been divided into appliance classes. Some tests are similar for all appliance classes, but other tests are particular to one class, especially tests for safety and reliability.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their 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 to iv, pages 1 to 98, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

Section 1. General

1.1 Scope

This British Standard specifies performance requirements for flued oil burning appliances, up to and including 44 kW capacity, used for hot water supply and for space heating purposes. Test procedures and measurement methods are also described.

NOTE The titles of the publications referred to in this standard are listed on the inside back cover.

1.2 Definitions

For the purposes of this British Standard, the following definitions apply.

1.2.1

performance requirements

the range of stipulated performance values (maximum and minimum) between which the tested value achieved by an appliance should lie (see section 2)

1.2.2

test procedure

the procedure to determine a particular overall aspect of an appliance's performance which usually involves several parameters, e.g. its thermal efficiency (see Table 2)

1.2.3

measurement method

the method for determining each parameter, e.g. draught; several methods are normally required for each test procedure (see Table 2)

1.2.4

declared output

the output specified by the manufacturer of the appliance

1.2.5

smoke index

the product of the average smoke number and the time in minutes during which the average smoke number exceeds 2 during transient operating conditions of the appliance, e.g. during start-up (see 4.1)

1.2.6

automatic appliance

an appliance whose burners are equipped with flame monitoring, control and regulating devices which function automatically, so that ignition of the flame, flame monitoring and the starting-up and shutting-down of the oil burner according to the controlled quantity, take place without the intervention of operating personnel

1.2.7

semi-automatic appliance

an appliance having burners in which each ignition process is initiated manually. On starting-up and during operation the oil burner is monitored and shut-down by flame detectors and, where these are present, by limiters. The burner output (oil throughput) is regulated during operation either automatically or manually

any appliance falling within this category for continuous operation, but fitted with automatically operated electrical ignition, is tested as a semi-automatic appliance, but in addition is subjected to start and shut-down tests as applied to automatic appliances

1.2.8

brick central chambers

a chamber with inlet and outlet apertures containing a flued air heater which distributes air by convection only and is sometimes fitted with a water-heating facility

1.2.9

integral draught diverter

a device for preventing conditions in a secondary flue from interfering with the combustion performance of an appliance

1.2.10

poor conductor

a conductor fabricated from material possessing a thermal conductivity not in excess of 0.3 W/(m K)

NOTE Requirements for conductivity are only specified for control knobs.

1.2.11 air heaters

1.2.11.1

indirect impelled convection air heater

an air heating flued appliance in which the products of combustion are primarily passed through a water heater. The air to be heated is forced by an integral fan to traverse a water/air heat exchanger

1.2.11.2

direct impelled convection air heater

an air heating flued appliance consisting of one or more heat exchangers with air circulating past these. The heated air movement is dependent on an integral power-driven fan

1.2.11.3

direct natural convection air heater

an air heating flued appliance consisting of one or more heat exchangers with air circulated past these by natural convection. The combustion gases do not come into contact with the air being heated

1.2.11.4

combined unit

any one of the air heaters defined in 1.2.11.1 to 1.2.11.3 incorporating a domestic hot water heating device

1.3 Marking

Each flued oil burning appliance complying with this standard shall be durably and clearly marked with:

- a) the manufacturer's name and type designation;
- b) the number of this British Standard, i.e. BS 4876¹⁾.

NOTE This standard specifies performance requirements of the appliance; additional marking in respect of constructional or other requirements may be required.

1.4 Test fuels

Test fuel 1, which is of the kerosine type, shall comply with Table 1. It shall be wholly derived from petroleum and be free of additives other than those employed to meet statutory requirements.

Test fuel 2, which is of the heating-oil type, shall comply with Table 1. It shall be wholly derived from petroleum and be free of additives other than those employed to meet statutory requirements and/or low-temperature fluidity requirements.

¹⁾ Marking BS 4876 on or in relation to a product is a claim by the manufacturer that the product has been manufactured in accordance with the requirements of the standard. The accuracy of such a claim is therefore solely the manufacturer's responsibility. Enquiries as to the availability of third party certification to support such claims should be addressed to the Director, Quality Assurance Division, BSI, Maylands Avenue, Hemel Hempstead, Herts HP2 4SW in the case of certification marks administered by BSI or to the appropriate authority for other certification marks.

1.5 Classification of heating appliances

The heating appliances (e.g. boilers, air heaters) are classified into five classes depending on the type of burner used, as follows:

- class 1 appliances employing natural draught vaporizing burners;
- class 2 appliances employing high/low forced draught vaporizing burners;
- class 3 appliances employing on/off forced draught vaporizing burners;
- class 4 appliances employing rotary vaporizing burners;
- class 5 appliances employing on/off pressure jet burners.

Table 1 — Test fuel requirements

Property	Minimum	Maximum	Test method	
			British Standard	Technically equivalent to
Test fuel 1				
Density at 15 °C (kg/L)	0.77	0.80	BS 4714	IP 160/68 (79)
Smoke point (mm)	20	25	BS 2000-57	IP 57
Flash point (°C)	38	—	BS 2000-170	IP 170
Copper strip corrosion	—	1	BS 2000-154	IP 154
Existent gum (mg/100 ml)	—	7	BS 4348	IP 131/77
Sulphur content (% <i>m/m</i>)	—	0.2	BS 2000-107	IP 107
Distillation (°C)			BS 2000-123	IP 123
45 % Recovery	—	200		
50 % Recovery	—	240		
75 % Recovery	200	—		
90 % Recovery	210	—		
Final boiling point		300		
Kinematic viscosity at 40 °C (cSt ^a)	1.1	1.4	BS 2000-71	IP 71
Test fuel 2				
Density at 15 °C (kg/L)	0.830	0.850	BS 4714	IP 160/68 (79)
Closed flash point (°C)	55	—	BS 2000-34	IP 34
Copper strip corrosion		1	BS 2000-154	IP 154
Sulphur content (% <i>m/m</i>)	0.4	0.5		IP 336/81 ^b
Ash content (% <i>m/m</i>)		0.01	BS 4450	IP 4/81
Carbon residue				
Ramsbottom on 10 % residue (% <i>m/m</i>)		0.2	BS 4451	IP 14/65
Low-temperature fluidity (cold filter plugging point) (°C)		– 9	BS 6188	IP 309/80
Water content (% <i>V/V</i>)		0.05	BS 4385	IP 74/77 (80)
Condition	Clear and bright		—	—
Distillation (°C)				
10 % Recovery	—	250	BS 200-123	IP 123
50 % Recovery	240	340		
85 % Recovery		350		
Final boiling point		380		
Kinematic viscosity at 40 °C (cSt ^a)	3.0	4.0	BS 2000-71	IP 71

^a 1 cSt = 1 mm²/s.
^b It is intended to publish an equivalent Part of BS 2000.

^a 1 cSt = 1 mm²/s.

^b It is intended to publish an equivalent Part of BS 2000.

2.0 General

The test results for the requirements specified for the appropriate appliance class shall be listed in an appliance report which shall consist of the test reports for each test procedure specified in **2.1, 2.2, 2.3, 2.4** or **2.5** and for each relevant measurement method as listed in Table 2.

2.1 Class 1: appliances employing natural draught vaporizing burners

^a 1 cm³/m³ = 1 p.p.m.

Applicable test procedures	Minimum limit	Maximum limit
3. Overall efficiency of indirect impelled convection air heaters		
Deviation from declared output (heat to air)		+ 8 % – 1 %
Heat to water efficiency (gross calorific value)	65 %	
4. Overall efficiency of direct impelled convection air heaters		
Deviation from declared outputs		+ 8 % – 1 %
Combined unit heat to water at low fire		1 kW
Overall efficiency (gross calorific value)	70 %	
5. Efficiency of direct natural convection air heaters		
Deviation from declared outputs		+ 8 % – 1 %
Combined unit heat to water at low fire		1 kW
Overall efficiency (gross calorific value)	70 %	
7. Sensitivity to flue conditions (appliances without integral draught diverter)		
Smoke number: excess draught high fire		3
low fire		3
reduced draught high fire		8
low fire		8
CO/CO ₂ ratio from 50 % nominal maximum fuel flow to any prescribed over firing condition		0.02
CO/CO ₂ ratio from any prescribed low fire setting to 50 % nominal maximum fuel flow		$\frac{0.02 \times 50 \% \text{ max. rated input}}{\text{test rated input}}$
Flue gas temperature		(to be reported)
Combustible gas index at low fire:		
a) Time above 50 cm ³ /m ³ equivalent hexane in air		60 s
b) Time of any peak above 250 cm ³ /m ³ equivalent hexane in air		15 s
Surface temperatures, accessible areas		120 °C
8. Response to load change (manually controlled appliances)		
Time to achieve stability, low to median		180 s
Time to achieve stability, median to high		120 s
Smoke index during transitional periods		20 s
Combustible gas index during transitional periods:		
a) Time above 50 cm ³ /m ³ equivalent hexane in air		60 s
b) Time of any peak above 250 cm ³ /m ³ equivalent hexane in air		15 s
9. Response to load change (semi-automatic appliances)		
Time to achieve stability, low to high		300 s (or controlled time whichever is the greater)
Smoke index during transitional period		20 s
Combustible gas index during transitional period:		
a) Time above 50 cm ³ /m ³ equivalent hexane in air		60 s
b) Time of any peak above 250 cm ³ /m ³ equivalent hexane in air		15 s
11. Hearth and side panel temperatures at ambient temperature of 27 °C (see 3.11.1)		100 °C
12. Fuel flooding test		
Trip level to nearest aperture	6.5 mm	

Applicable test procedures	Minimum limit	Maximum limit
14. Electrical safety		
Resistance between earthing terminal and components intended to be at earth potential		0.1 Ω
Resistance between line circuit and earthing terminal	1 M Ω	
Leakage current on heating elements		0.75 mA (or 0.75 mA/1 kW input whichever is the greater)
High voltage test	no arcing or tracking	
Protection against electric shock	shall pass finger test	
Distances and clearances between parts of different polarity	as in Table 4	
16. Boiler reliability and endurance: high/low appliances		
Smoke number		2
CO/CO ₂ ratio from 50 % nominal maximum fuel flow to any prescribed over firing condition		0.02
CO/CO ₂ ratio from any prescribed low fire setting to 50 % nominal maximum fuel flow		$\frac{0.02 \times 50 \% \text{ max. rated input}}{\text{test rated input}}$
Combustible gas index at low fire:		
a) Time above 50 cm ³ /m ³ equivalent hexane in air		60 s
b) Time of any peak above 250 cm ³ /m ³ equivalent hexane in air		15 s
17. Reliability and endurance: manually controlled natural heaters		
Smoke number		2
CO/CO ₂ ratio from 50 % nominal maximum fuel flow to any prescribed over firing condition		0.02
CO/CO ₂ ratio from any prescribed low fire setting to 50 % nominal maximum fuel flow		$\frac{0.02 \times 50 \% \text{ max. rated input}}{\text{test rated input}}$
Combustible gas index at low fire:		
a) Time above 50 cm ³ /m ³ equivalent hexane in air		60 s
b) Time of any peak above 250 cm ³ /m ³ equivalent hexane in air		15 s
Smoke index during transitional period		20
18. Reliability and endurance: automatic and semi-automatic air heaters		
Smoke number		2
CO/CO ₂ ratio from 50 % nominal maximum fuel flow to any prescribed over firing condition		0.02
CO/CO ₂ ratio from any prescribed low fire setting to 50 % nominal maximum fuel flow		$\frac{0.02 \times 50 \% \text{ max. rated input}}{\text{test rated input}}$
Combustible gas index at low fire:		
a) Time above 50 cm ³ /m ³ equivalent hexane in air		60 s
b) Time of any peak above 250 cm ³ /m ³ equivalent hexane in air		15 s
Smoke index during transitional period		20

2.2 Class 2: appliances employing high/low forced draught vaporizing burners

Applicable test procedures	Minimum limit	Maximum limit
1. Primary screening		
Smoke number, high fire		2
Smoke number, low fire		2
CO/CO ₂ ratio from 50 % nominal maximum fuel flow to any prescribed over firing condition		0.02
CO/CO ₂ ratio from any prescribed low fire setting to 50 % nominal maximum fuel flow		$\frac{0.02 \times 50 \% \text{ max. rated input}}{\text{test rated input}}$
Flue gas temp. at heat exchanger exit at ambient temperature of 16 °C (see 4.3)	150 °C	(to be reported)
Combustible gas index:		
a) Time above 50 cm ³ /m ³ equivalent hexane in air		60 s
b) Time of any peak above 250 cm ³ /m ³ equivalent hexane in air		15 s
For appliances with low level discharge of products of combustion:		
a) Time above 5 cm ³ /m ³ equivalent hexane in air		120 s
b) Time above 40 cm ³ /m ³ equivalent hexane in air		8 s
Surface temperatures at ambient temperature of 27 °C		
Float control (mid oil level)		38 °C
Accessible areas ^a		120 °C
Control knobs, handles:		
Poor conductor (see 1.2.10)		85 °C
Good conductor (see 1.2.10)		60 °C
Turn down ratio	4 : 1	
Attainable fuel flow rate above manufacturer's declared high fire setting		10 %
Ignition control timings	in accordance with BS 799	
2. Efficiency of boilers		
Deviation from declared output		+ 8 % – 1 %
Heat to water, low fire percentage of max. rating		10 %
NOTE Where an appliance		
a) is fitted with a limit control to shut off the burner in the event of an excessive water temperature rise,		
and		
b) has literature specifying that a minimum heat take-off is required at low fire by means of a radiator or towel rail for example,		
10 % of the maximum heat to water may be exceeded.		
Efficiency at high fire (gross calorific value)	75 %	
(net calorific value)	80 %	
Efficiency at 25 % firing time:		
(gross calorific value)	65 %	
(net calorific value)	69 %	
3. Overall efficiency of indirect impelled convection air heaters		
Deviation from declared output (heat to air)		+ 8 % – 1 %
Heat to water efficiency (gross calorific value)	65 %	
4. Overall efficiency of direct impelled convection air heaters		
Deviation from declared outputs		+ 8 % – 1 %
Combined unit heat to water at low fire		1 kW
Overall efficiency (gross calorific value)	70 %	

^a Includes terminals or guards for low level discharge appliances positioned less than 2 m from ground level.

Applicable test procedures	Minimum limit	Maximum limit
5. Efficiency of direct natural convection air heaters		
Deviation from declared outputs		+ 8 % – 1 %
Combined unit heat to water at low fire		1 kW
Overall efficiency (gross calorific value)	70 %	
6. Sensitivity to flue conditions (appliances with integral draught diverter) (change from normal running only)		
At high and low fire:		
Smoke index		20
CO/CO ₂ ratio from 50 % nominal maximum fuel flow to any prescribed over firing condition		0.02
CO/CO ₂ ratio from any prescribed low fire setting to 50 % nominal maximum fuel flow		$\frac{0.02 \times 50 \% \text{ max. rated input}}{\text{test rated input}}$
Combustible gas index:		
a) Time above 50 cm ³ /m ³ equivalent hexane in air		60 s
b) Time of any peak above 250 cm ³ /m ³ equivalent hexane in air		15 s
7. Sensitivity to flue conditions (appliances without integral draught diverter)		
Smoke number: excess draught high fire		3
low fire		3
reduced draught high fire		8
low fire		8
CO/CO ₂ ratio from 50 % nominal maximum fuel flow to any prescribed over firing condition		0.02
CO/CO ₂ ratio from any prescribed low fire setting to 50 % nominal maximum fuel flow		$\frac{0.02 \times 50 \% \text{ max. rated input}}{\text{test rated input}}$
Flue gas temperature		(to be reported)
Combustible gas index at low fire:		
a) Time above 50 cm ³ /m ³ equivalent hexane in air		60 s
b) Time of any peak above 250 cm ³ /m ³ equivalent hexane in air		15 s
Surface temperatures, accessible areas		120 °C
9. Response to load change (semi-automatic appliances)		
Time to achieve stability, low to high		300 s (or controlled time whichever is the greater)
Smoke index during transitional period		20
Combustible gas index during transitional period:		
a) Time above 50 cm ³ /m ³ equivalent hexane in air		60 s
b) Time of any peak above 250 cm ³ /m ³ equivalent hexane in air		15 s
For appliances with low level discharge of products of combustion:		
a) Time above 5 cm ³ /m ³ equivalent hexane in air		120 s
b) Time above 40 cm ³ /m ³ equivalent hexane in air		8 s
11. Hearth and side panel temperatures at ambient temperature of 27 °C (see 3.11.1)		100 °C
12. Fuel flooding test		
Trip level to nearest aperture	6.5 mm	

Applicable test procedures	Minimum limit	Maximum limit
13. Effects of voltage variation		
At both $\pm 10\%$ of nominal mains voltage:		
Smoke index		30
Combustible gas index:		
a) Time above $50 \text{ cm}^3/\text{m}^3$ equivalent hexane in air		60 s
b) Time of any peak above $250 \text{ cm}^3/\text{m}^3$ equivalent hexane in air		15 s
For appliances with low level discharge of products of combustion:		
a) Time above $5 \text{ cm}^3/\text{m}^3$ equivalent hexane in air		120 s
b) Time above $40 \text{ cm}^3/\text{m}^3$ equivalent hexane in air		8 s
CO/CO ₂ ratio from 50 % nominal maximum fuel flow to any prescribed over firing condition		0.02
CO/CO ₂ ratio from any prescribed low fire setting to 50 % nominal maximum fuel flow		$\frac{0.02 \times 50\% \text{ max. rated input}}{\text{test rated input}}$
At -15% of nominal mains voltage:		
Smoke index		40
CO/CO ₂ ratio from 50 % nominal maximum fuel flow to any prescribed over firing condition		0.02
CO/CO ₂ ratio from any prescribed low fire setting to 50 % nominal maximum fuel flow		$\frac{0.02 \times 50\% \text{ max. rated input}}{\text{test rated input}}$
Combustible hydrocarbon gas level:		
Equivalent hexane in air cm^3/m^3		800
14. Electrical safety		
Resistance between earthing terminal and components intended to be at earth potential		0.1 Ω
Resistance between line circuit and earthing terminal	1 M Ω	
Leakage current on heating elements		0.75 mA (or 0.75 mA/kW input whichever is the greater)
High voltage test	no arcing or tracking	
Protection against electric shock	shall pass finger test	
Distance and clearances between parts of different polarity	as in Table 4	
16. Boiler reliability and endurance: high/low appliances		
Smoke number		2
CO/CO ₂ ratio from 50 % nominal maximum fuel flow to any prescribed over firing condition		0.02
CO/CO ₂ ratio from any prescribed low fire setting to 50 % nominal maximum fuel flow		$\frac{0.02 \times 50\% \text{ max. rated input}}{\text{test rated input}}$
Combustible gas index at low fire:		
a) Time above $50 \text{ cm}^3/\text{m}^3$ equivalent hexane in air		60 s
b) Time of any peak above $250 \text{ cm}^3/\text{m}^3$ equivalent hexane in air		15 s
For appliances with low level discharge of products of combustion:		
a) Time above $5 \text{ cm}^3/\text{m}^3$ equivalent hexane in air		120 s
b) Time above $40 \text{ cm}^3/\text{m}^3$ equivalent hexane in air		8 s

Applicable test procedures	Minimum limit	Maximum limit
18. Reliability and endurance: automatic and semi-automatic air heaters		
Smoke number		2
CO/CO ₂ ratio from 50 % nominal maximum fuel flow to any prescribed over firing condition		0.02
CO/CO ₂ ratio from any prescribed low fire setting to 50 % nominal maximum fuel flow		$\frac{0.02 \times 50 \% \text{ max. rated input}}{\text{test rated input}}$
Combustible gas index at low fire:		
a) Time above 50 cm ³ /m ³ equivalent hexane in air		60 s
b) Time of any peak above 250 cm ³ /m ³ equivalent hexane in air		15 s
For appliances with low level discharge of products of combustion:		
a) Time above 5 cm ³ /m ³ equivalent hexane in air		120 s
b) Time above 40 cm ³ /m ³ equivalent hexane in air		8 s
Smoke index during transitional period		20
19. Sensitivity to wind of an appliance designed to operate with its own integral flue arrangement		
CO/CO ₂ ratio at high fire		0.02
CO/CO ₂ ratio from 50 % nominal maximum fuel flow to any prescribed over firing condition		0.02
CO/CO ₂ ratio from any prescribed low fire setting to 50 % nominal maximum fuel flow		$\frac{0.02 \times 50 \% \text{ max. rated input}}{\text{test rated input}}$
Smoke number during continuous operation at high and low fire		2
Smoke index during transition from low to high fire and vice versa		3
Combustible gas index at low and high fire and during transition from low to high fire and vice versa:		
a) Time above 5 cm ³ /m ³ equivalent hexane in air		120 s
b) Time above 40 cm ³ /m ³ equivalent hexane in air		8 s
Surface temperatures, accessible areas		120 °C

2.3 Class 3: appliances employing on/off forced draught vaporizing burners

Applicable test procedures	Minimum limit	Maximum limit
1. Primary screening		
Smoke number		2
CO/CO ₂ ratio		0.02
Flue gas temp. at heat exchanger exit at ambient temperature of 16 °C (see 4.3)	150 °C	(to be reported)
Combustible gas index:		
a) Time above 50 cm ³ /m ³ equivalent hexane in air		60 s
b) Time of any peak above 250 cm ³ /m ³ equivalent hexane in air		15 s
For appliances with low level discharge of products of combustion:		
a) Time above 5 cm ³ /m ³ equivalent hexane in air		120 s
b) Time above 40 cm ³ /m ³ equivalent hexane in air		8 s
Surface temperatures at ambient temperature of 27 °C		
Float control (mid oil level)		38 °C
Accessible areas ^a		120 °C
Control knobs, handles:		
Poor conductor (see 1.2.10)		85 °C
Good conductor (see 1.2.10)		60 °C
Attainable fuel flow rate above manufacturer's declared high fire setting		10 %
Ignition control timings	in accordance with BS 799	
2. Efficiency of boilers		
Deviation from declared output		+ 8 % – 1 %
Efficiency (gross calorific value)	75 %	
(net calorific value)	80 %	
Efficiency at 25 % firing time:		
(gross calorific value)	65 %	
(net calorific value)	69 %	
3. Overall efficiency of indirect impelled convection air heaters		
Deviation from declared output (heat to air)		+ 8 % – 1 %
Heat to water efficiency (gross calorific value)	65 %	
4. Overall efficiency of direct impelled convection air heaters		
Deviation from declared output (heat to air)		+ 8 % – 1 %
Overall efficiency (gross calorific value)	70 %	
6. Sensitivity to flue conditions (appliances with integral draught diverter)		
Cold start:		
Smoke index		30
CO/CO ₂ ratio		0.02
Combustible gas index:		
a) Time above 50 cm ³ /m ³ equivalent hexane in air		60 s
b) Time of any peak above 250 cm ³ /m ³ equivalent hexane in air		15 s
Change from normal running:		
CO/CO ₂ ratio		0.02
Combustible gas index:		
a) Time above 50 cm ³ /m ³ equivalent hexane in air		60 s
b) Time of any peak above 250 cm ³ /m ³ equivalent hexane in air		15 s

^a Includes terminals or guards for low level discharge appliances positioned less than 2 m from ground level

Applicable test procedures	Minimum limit	Maximum limit
7. Sensitivity to flue conditions (appliances without integral draught diverter)		
Smoke number: excess draught		3
reduced draught		8
CO/CO ₂ ratio		0.02
Flue gas temperature		(to be reported)
Combustible gas index:		
a) Time above 50 cm ³ /m ³ equivalent hexane in air		60 s
b) Time of any peak above 250 cm ³ /m ³ equivalent hexane in air		15 s
Surface temperatures, accessible areas		120 °C
10. Start and shut-down combustion performance		
Cold start:		
Smoke index		20
Combustible gas index:		
a) Time above 50 cm ³ /m ³ equivalent hexane in air		60 s
b) Time of any peak above 250 cm ³ /m ³ equivalent hexane in air		15 s
For appliances with low level discharge of products of combustion:		
a) Time above 5 cm ³ /m ³ equivalent hexane in air		120 s
b) Time above 40 cm ³ /m ³ equivalent hexane in air		8 s
Hot start:		
Smoke index		10
Combustible gas index:		
a) Time above 50 cm ³ /m ³ equivalent hexane in air		60 s
b) Time of any peak above 250 cm ³ /m ³ equivalent hexane in air		15 s
For appliances with low level discharge of products of combustion:		
a) Time above 5 cm ³ /m ³ equivalent hexane in air		120 s
b) Time above 40 cm ³ /m ³ equivalent hexane in air		8 s
Shut-down:		
Smoke index		10
Combustible gas index:		
a) Time above 50 cm ³ /m ³ equivalent hexane in air		60 s
b) Time of any peak above 250 cm ³ /m ³ equivalent hexane in air		15 s
For appliances with low level discharge of products of combustion:		
a) Time above 5 cm ³ /m ³ equivalent hexane in air		120 s
b) Time above 40 cm ³ /m ³ equivalent hexane in air		8 s
11. Hearth and side panel temperatures at ambient temperature of 27 °C (see 3.11.1)		
		100 °C
12. Fuel flooding test		
Trip level to nearest aperture	6.5 mm	
Attempt to fire in flooded condition	shall not fire	
At 10 % of normal control level, should burner ignite:		
Flue gas temperature		350 °C

Applicable test procedures	Minimum limit	Maximum limit
13. Effects of voltage variation		
At both $\pm 10\%$ of nominal mains voltage:		
Smoke index		30
CO/CO ₂ ratio		0.02
Combustible gas index:		
a) Time above 50 cm ³ /m ³ equivalent hexane in air		60 s
b) Time of any peak above 250 cm ³ /m ³ equivalent hexane in air		15 s
For appliances with low level discharge of products of combustion:		
a) Time above 5 cm ³ /m ³ equivalent hexane in air		120 s
b) Time above 40 cm ³ /m ³ equivalent hexane in air		8 s
At -15% of nominal mains voltage:		
Smoke index		40
CO/CO ₂ ratio		0.02
Combustible hydrocarbon gas level:		
Equivalent hexane in air cm ³ /m ³		800
14. Electrical safety		
Resistance between earthing terminal and components intended to be at earth potential		0.1 Ω
Resistance between line circuit and earthing terminal	1 M Ω	
Leakage current on heating elements		0.75 mA (or 0.75 mA/kW input whichever is the greater)
High voltage test	no arcing or tracking	
Protection against electric shock	shall pass finger test	
Distances and clearances between parts of different polarity	as in Table 4	
15. Boiler reliability and endurance: on/off appliances		
Smoke number		2
CO/CO ₂ ratio		0.02
Combustible gas index:		
a) Time above 50 cm ³ /m ³ equivalent hexane in air		60 s
b) Time of any peak above 250 cm ³ /m ³ equivalent hexane in air		15 s
For appliances with low level discharge of products of combustion:		
a) Time above 5 cm ³ /m ³ equivalent hexane in air		120 s
b) Time above 40 cm ³ /m ³ equivalent hexane in air		8 s
Smoke index		
Cold start		20
Hot start		10
Shut-down		10

Applicable test procedures	Minimum limit	Maximum limit
18. Reliability and endurance: automatic and semi-automatic air heaters (on/off operation)		
Smoke number		2
CO/CO ₂ ratio		0.02
Combustible gas index:		
a) Time above 50 cm ³ /m ³ equivalent hexane in air		60 s
b) Time of any peak above 250 cm ³ /m ³ equivalent hexane in air		15 s
For appliances with low level discharge of products of combustion:		
a) Time above 5 cm ³ /m ³ equivalent hexane in air		120 s
b) Time above 40 cm ³ /m ³ equivalent hexane in air		8 s
Smoke index		
Cold start		20
Hot start		10
Shut-down		10
19. Sensitivity to wind of an appliance designed to operate with its own integral flue arrangement		
CO/CO ₂ ratio		0.02
Smoke number during continuous burner operation		2
Smoke index during transient conditions		
Cold start		3
Hot start		3
Shut-down		3
Combustible gas index during continuous burner operation and transient conditions of cold and hot start and shut-down:		
a) Time above 5 cm ³ /m ³ equivalent hexane in air		120 s
b) Time of any peak above 40 cm ³ /m ³ equivalent hexane in air		8 s
Surface temperatures, accessible areas		120 °C

2.4 Class 4: appliances employing rotary vaporizing burners

Applicable test procedures	Minimum limit	Maximum limit
1. Primary screening		
Smoke number		2
CO/CO ₂ ratio		0.02
Flue gas temp. at heat exchanger exit at ambient temperature of 16 °C (see 4.3)	150 °C	(to be reported)
Combustible gas index:		
a) Time above 50 cm ³ /m ³ equivalent hexane in air		60 s
b) Time of any peak above 250 cm ³ /m ³ equivalent hexane in air		15 s
Surface temperatures at ambient temperature of 27 °C		
Float control (mid oil level)		38 °C
Accessible areas		120 °C
Control knobs, handles:		
Poor conductors (see 1.2.10)		85 °C
Good conductors (see 1.2.10)		60 °C
Attainable fuel flow rate above manufacturer's declared high fire setting		10 %
Ignition control timings	in accordance with BS 799	
2. Efficiency of boilers		
Deviation from declared output		+ 8 % – 1 %
Efficiency (gross calorific value)	75 %	
(net calorific value)	80 %	
Efficiency at 25 % firing time		
(gross calorific value)	65 %	
(net calorific value)	69 %	
3. Overall efficiency of indirect impelled convection air heaters		
Deviation from declared output (heat to air)		+ 8 % – 1 %
Heat to water efficiency (gross calorific value)	65 %	
4. Overall efficiency of direct impelled convection air heaters		
Deviation from declared output (heat to air)		+ 8 % – 1 %
Overall efficiency (gross calorific value)	70 %	
6. Sensitivity to flue conditions (appliances with integral draught diverter)		
Cold start:		
Smoke index		30
CO/CO ₂ ratio		0.02
Combustible gas index:		
a) Time above 50 cm ³ /m ³ equivalent hexane in air		60 s
b) Time of any peak above 250 cm ³ /m ³ equivalent hexane in air		15 s
Change from normal running:		
CO/CO ₂ ratio		0.02
Combustible gas index:		
a) Time above 50 cm ³ /m ³ equivalent hexane in air		60 s
b) Time of any peak above 250 cm ³ /m ³ equivalent hexane in air		15 s

Applicable test procedures	Minimum limit	Maximum limit
7. Sensitivity to flue conditions (appliances without integral draught diverter)		
CO/CO ₂ ratio		0.02
Flue gas temperature		(to be reported)
Combustible gas index:		
a) Time above 50 cm ³ /m ³ equivalent hexane in air		60 s
b) Time of any peak above 250 cm ³ /m ³ equivalent hexane in air		15 s
Surface temperatures, accessible areas		120 °C
Smoke number: excess draught		3
reduced draught		8
10. Start and shut-down combustion performance		
Cold start:		
Smoke index		20
Combustible gas index:		
a) Time above 50 cm ³ /m ³ equivalent hexane in air		60 s
b) Time of any peak above 250 cm ³ /m ³ equivalent hexane in air		15 s
Hot start:		
Smoke index		10
Combustible gas index:		
a) Time above 50 cm ³ /m ³ equivalent hexane in air		60 s
b) Time of any peak above 250 cm ³ /m ³ equivalent hexane in air		15 s
Shut-down:		
Smoke index		10
Combustible gas index:		
a) Time above 50 cm ³ /m ³ equivalent hexane in air		60 s
b) Time of any peak above 250 cm ³ /m ³ equivalent hexane in air		15 s
11. Hearth and side panel temperatures at ambient temperature of 27 °C (see 3.11.1)		100 °C
13. Effects of voltage variation		
At both ± 10 % of nominal mains voltage:		
Smoke index		30
CO/CO ₂ ratio		0.02
Combustible gas index:		
a) Time above 50 cm ³ /m ³ equivalent hexane in air		60 s
b) Time of any peak above 250 cm ³ /m ³ equivalent hexane in air		15 s
At – 15 % of nominal mains voltage:		
Smoke index		40
CO/CO ₂ ratio		0.02
Combustible hydrocarbon gas level		
Equivalent hexane in air cm ³ /m ³		800
At 10 % above nominal mains voltage, surface temp. of any pre-heating element within the combustion chamber		600 °C

Applicable test procedures	Minimum limit	Maximum limit
14. Electrical safety		
Resistance between earthing terminal and components intended to be at earth potential		0.1 Ω
Resistance between line circuit and earthing terminal	1 M Ω	
Leakage current on heating elements		0.75 mA (or 0.75 mA/kW input whichever is the greater)
High voltage test	no arcing or tracking	
Protection against electric shock	shall pass finger test	
Distances and clearances between parts of different polarity	as in Table 4	
15. Boiler reliability and endurance: on/off appliances		
CO/CO ₂ ratio		0.02
Combustible gas index:		
a) Time above 50 cm ³ /m ³ equivalent hexane in air		60 s
b) Time of any peak above 250 cm ³ /m ³ equivalent hexane in air		15 s
Smoke index		
Cold start		20
Hot start		10
Shut-down		10
18. Reliability and endurance: automatic and semi-automatic air heaters		
(on/off operation)		
CO/CO ₂ ratio		0.02
Combustible gas index:		
a) Time above 50 cm ³ /m ³ equivalent hexane in air		60 s
b) Time of any peak above 250 cm ³ /m ³ equivalent hexane in air		15 s
Smoke index		
Cold start		20
Hot start		10
Shut-down		10

2.5 Class 5: appliances employing on/off pressure jet burners

Applicable test procedures	Minimum limit	Maximum limit
1. Primary screening		
Smoke number		2
CO/CO ₂ ratio		0.02
Flue gas temp. at heat exchanger exit at ambient temperature 16 °C (see 4.3)	182 °C	(to be reported)
Combustible gas index:		
a) Time above 50 cm ³ /m ³ equivalent hexane in air		60 s
b) Time of any peak above 250 cm ³ /m ³ equivalent hexane in air		15 s
For appliances with low level discharge of products of combustion:		
a) Time above 5 cm ³ /m ³ equivalent hexane in air		120 s
b) Time above 40 cm ³ /m ³ equivalent hexane in air		8 s
Surface temperatures at ambient temperature of 27 °C		
Accessible areas ^a		120 °C
Control knobs, handles:		
Poor conductors (see 1.2.10)		85 °C
Good conductors (see 1.2.10)		60 °C
Ignition control timing:		
Failure to ignite:		
Time from oil admission circuit energized to lock-out		15 s
Flame failure during operation:		
Flame failure to ignition restoration ¹⁾		1 s
Flame failure to lock-out position		15 s
Fuel supply cut-off ²⁾		2 s
Time before automatic attempt to restart	60 s	
Lock-out to manual re-set		
¹⁾ Refers to ignition restoring controls }	Timings in accordance with BS 799	
²⁾ Refers to recycling controls }		
2. Efficiency of boilers		
Deviation from declared output		+ 8 % – 1 %
Efficiency (gross calorific value)	75 %	
(net calorific value)	80 %	
Efficiency at 25 % firing time		
(gross calorific value)	65 %	
(net calorific value)	69 %	
3. Overall efficiency of indirect impelled convection air heaters		
Deviation from declared output (heat to air)		+ 8 % – 1 %
Heat to water efficiency	65 %	
4. Overall efficiency of direct impelled convection air heaters		
Deviation from declared output (heat to air)		+ 8 % – 1 %
Overall efficiency	70 %	

^a Includes terminals or guards for low level discharge appliances positioned less than 2 m from ground level.

Applicable test procedures	Minimum limit	Maximum limit
11. Hearth and side panel temperatures at ambient temperature of 27 °C (see 3.11.1)		100 °C
13. Effects of voltage variation		
At both ± 10 % of nominal mains voltage:		
Smoke index		30
CO/CO ₂ ratio		0.02
Combustible gas index:		
a) Time above 50 cm ³ /m ³ equivalent hexane in air		60 s
b) Time of any peak above 250 cm ³ /m ³ equivalent hexane in air		15 s
For appliances with low level discharge of products of combustion:		
a) Time above 5 cm ³ /m ³ equivalent hexane in air		120 s
b) Time above 40 cm ³ /m ³ equivalent hexane in air		8 s
At -15 % of nominal mains voltage:		
Smoke index		40
CO/CO ₂ ratio		0.02
Combustible hydrocarbon gas level:		
Equivalent hexane in air cm ³ /m ³		800
14. Electrical safety		
Resistance between earthing terminal and components intended to be at earth potential		0.1 Ω
Resistance between line circuit and earthing terminal	1 M Ω	
Leakage current on heating elements		0.75 mA (or 0.75 mA/kW input whichever is the greater)
High voltage test	no arcing or tracking	
Protection against electric shock	shall pass finger test	
Distances and clearances between parts of different polarity	as in Table 4	
15. Boiler reliability and endurance: on/off appliances		
Smoke number		2
CO ₂	9 %	
CO/CO ₂ ratio		0.02
Flue gas temperature increase		50 °C
Combustible gas index:		
a) Time above 50 cm ³ /m ³ equivalent hexane in air		60 s
b) Time of any peak above 250 cm ³ /m ³ equivalent hexane in air		15 s
For appliances with low level discharge of products of combustion:		
a) Time above 5 cm ³ /m ³ equivalent hexane in air		120 s
b) Time above 40 cm ³ /m ³ equivalent hexane in air		8 s
Smoke index		
Cold start		20
Hot start		10
Shut-down		10

Applicable test procedures	Minimum limit	Maximum limit
18. Reliability and endurance: automatic and semi-automatic air heaters (on/off operation)		
Smoke number		2
CO ₂	9 %	
CO/CO ₂ ratio		0.02
Flue gas temperature increase		50 °C
Combustible gas index:		
a) Time above 50 cm ³ /m ³ equivalent hexane in air		60 s
b) Time of any peak above 250 cm ³ /m ³ equivalent hexane in air		15 s
For appliances with low level discharge of products of combustion:		
a) Time above 5 cm ³ /m ³ equivalent hexane in air		120 s
b) Time above 40 cm ³ /m ³ equivalent hexane in air		8 s
Smoke index		
Cold start		20
Hot start		10
Shut-down		10
19. Sensitivity to wind of an appliance designed to operate with its own integral flue arrangement		
CO/CO ₂ ratio		0.02
Smoke number during continuous burner operation		2
Smoke index during transient conditions		
Cold start		3
Hot start		3
Shut-down		3
Combustible gas index during continuous burner operation and transient conditions of cold and hot start and shut-down		
a) Time above 5 cm ³ /m ³ equivalent hexane in air		120 s
b) Time of any peak above 40 cm ³ /m ³ equivalent hexane in air		8 s
Surface temperature, accessible areas		120 °C

Table 2 — Summary of test procedures and measurement methods

No.	Test procedure	Related measurement methods
1	Primary screening	1, 2, 3, 4, 5, 7, 8, 9
2	Efficiency of boilers	2, 3, 4, 7, 10
3	Overall efficiency of indirect impelled convection air heaters	2, 3, 4, 7, 10
4	Overall efficiency of direct impelled convection air heaters	2, 3, 4, 7, 10
5	Efficiency of direct natural convection air heaters	2, 3, 4, 7, 10
6	Sensitivity to flue conditions (appliances with integral draught diverter)	1, 2, 3, 4, 5, 6, 7
7	Sensitivity to flue conditions (appliances without integral draught diverter)	1, 2, 3, 4, 5, 7, 8
8	Response to load change (manually controlled appliances)	1, 2, 4, 5, 7
9	Response to load change (semi-automatic appliances)	1, 2, 4, 5, 7
10	Start and shut-down combustion performance	1, 5
11	Hearth and side panel temperatures	
12	Fuel flooding test	1, 3
13	Effects of voltage variation	1, 2, 3, 5
14	Electrical safety	
15	Boiler reliability and endurance: on/off appliances	1, 2, 3, 4, 5, 7
16	Boiler reliability and endurance: high/low appliances	1, 2, 3, 4, 5, 7
17	Reliability and endurance: manually controlled natural convection air heaters	1, 2, 3, 4, 5, 7
18	Reliability and endurance: automatic and semi-automatic air heaters	1, 2, 3, 4, 5, 7
19	Sensitivity to wind: appliances with integral flue	1, 2, 3, 4, 5, 6, 7, 8
No.	Measurement methods	
1	Determination of smoke number and smoke index	
2	Determination of flue gas composition	
3	Determination of flue gas temperature	
4	Determination of flue draught	
5	Degree of incomplete combustion, determination of combustible gas index	
6	Determination of gas velocity by pitot tube	
7	Determination of fuel flow rate	
8	Determination of surface temperatures and effectiveness of guards	
9	Determination of float control temperatures	
10	Determination of exhaust gas heat losses	

Section 3. Test procedures

3.1 Test procedure 1: primary screening

3.1.1 General. This procedure is designed to disclose the behaviour of the principal operating mechanisms and successive performance characteristics of an appliance. Both of these may subsequently be related to and compared with deviations in their action or achievement when differing conditions are applied. Appliances dependent on a mains electrical supply and fitted with electrically actuated controls are subjected to tests to ascertain the various successive time intervals for positive action and response.

To ensure that the tests are representative of operating conditions, the appliance should be completely assembled in the form it should take in normal use.

The procedure is formulated to provide data which will be employed to assess the conduct of the appliance under two headings:

- a) *Control timings*. Control timings where simulated failure of the burner to ignite and failure of flame are employed to assess the function and adequacy of the control system.

NOTE It is expected that all electrically operated control boxes embodying timing mechanisms will be type tested for function at the extremes of temperatures declared by the control manufacturer.

- b) *Combustion performance*. Combustion performance where measurements of emissions of carbon dioxide, carbon monoxide, smoke and where applicable of the degree of incomplete combustion are taken. Additionally, surface temperatures are measured as well as the effectiveness of any guards.

3.1.2 Control timings

3.1.2.1 Outline of procedure. The appliance is operated under specified environmental conditions and when temperature stability is achieved the control box surface temperature is measured. Following this the burner and its controls are subjected to simulated failure, i.e. sham failure to ignite and a flame failure test. During these tests the timings of the control sequence to effect safe conditions are checked. It is essential that a minimum of 15 min elapses before repeat of tests on controls incorporating thermal timing elements.

3.1.2.2 Apparatus. The following apparatus is required:

- a) electrically operated stopclocks;
- b) relays, suitable for circuit voltages;
- c) low capacitance switches;
- d) portable contact thermometer;
- e) a prepared electrical circuit appropriate to the control system undergoing test.

3.1.2.3 Preparation of apparatus. The underlying principle of the test is the same for all classes of appliance employing electrically operated controls, although design differences may demand different test circuitry arrangements. When preparing for the test procedure, appropriate test circuits (e.g. Figure 1 and Figure 2) employing means to alter the circuit of specific actuating components are frequently necessary. Such test circuits include electric stopclocks so connected or operated that they are actuated (stopped or started) simultaneously with burner control functions.

Where a burner is dependent on an electrically driven motor to supply oil fuel to the combustion zone (e.g. pressure jet and wallflame) an electric stopclock is connected in parallel to the circuit so that the clock is actuated simultaneously with the motor when the circuit is energized or interrupted.

Where, however, the fuel supply to the combustion zone of a burner is interrupted and governed by a magnetic valve (e.g. some forced draught vaporizing burners) an electric stopclock is connected in parallel to the circuit so that the clock and valve are actuated simultaneously when the circuit is (de)energized. A suitable tapping is taken from the lock-out switch mechanism to actuate a stopclock.

Simulating "failure to ignite" can be achieved by interrupting the circuit continuity made by any flame sensing device normally employed as part of the control system. Where a photo-cell is used this can be removed from the burner and covered to prevent light detection. Where a fluestat or heat probe is used, a switch can be introduced into the circuit to govern current continuity at the will of the operator.

Where an appliance is dependent on a heat sensing device, such as a fluestat or heat probe, to sense burner operation for the purpose of assessing the control response to the loss of flame, during operation, the timing of the control effects are taken from the moment the oil supply is stopped when the burner is shut off by means of the water or air thermostat. With this type of appliance two electrically controlled stopclocks are connected into the burner circuit, one of them being remotely operated by a manual switch. A circuit example is given in Figure 1. The clocks are so interconnected with the burner control circuits that they become energized at the instant the water thermostat is switched to the "off" position and remain energized until the fluestat or flame probe switches to cold contact.

A switch is placed in series with one of the stopclocks and employed to energize the latter the instant complete loss of flame is observed or otherwise indicated. In this way three time sequences can be measured, i.e.

- a) the time taken from breaking of fuel supply circuit to actuation of flame sensing control;
- b) the time taken from actual flame out to actuation of flame sensing control;
- c) the time taken from breaking of fuel supply circuit to flame out.

Where the appliance incorporates a photo-electric cell, simulation of flame failure is effected by altering the cell circuit. Three electrically controlled stopclocks are connected into the burner component circuits as illustrated in Figure 2. The ganged switch in the photo-electric cell circuit is opened thereby starting stopclock 1 via relay contact A1. The burner is then allowed to run to lock-out during which the following sequence occurs.

On detecting the simulated flame failure the control energizes the ignition transformer circuit, stopping stopclock 1 and starting stopclock 2 via relay contacts A1 and B1. At the end of the period of running to lock-out the motor circuit is broken, stopping stopclock 2 and starting stopclock 3 via relay contact B2; when the lock-out can be reset this stopclock is de-energized.

After making the necessary modifications to the electrical circuits the appliance and its controls are checked to ensure that all relevant items are pre-set to the manufacturer's declared settings.

When the appliance incorporates a water heating section the water flow conditions with a cold feed shall achieve an outlet temperature equivalent to that at which the control thermostat cuts out at maximum setting when the flow temperature is raised at not more than 3 °C/min. The flow temperature is measured and taken as the maximum established temperature level governed by the thermostat. At this stage the thermostat is disconnected and the flow temperature controlled to remain at ± 3 °C of the established temperature.

The appliance is then permitted to operate for a period of 45 min or for such time in excess necessary to ensure stable conditions.

3.1.2.4 Procedure

3.1.2.4.1 Surface temperature of components. When stable conditions are reached, search the components for their maximum surface temperatures. The components selected shall include (where appropriate) the control box, the transformer, the photo-electric cell or switching head of other flame sensing devices, the pump, the switching head of thermostat(s), the electric motor and its capacitor.

Record these temperatures and the maximum temperatures after burner switch-off.

The temperatures shall be used for comparison with the component manufacturer's declared maximum temperature limits.

3.1.2.4.2 Flame failure during operation. Employing circuit modifications or other means applicable to the specific appliance undergoing test and using the same operating conditions as in 3.1.2.4.1, simulate flame failure by the appropriate means. From the moment when lock-out is signalled attempt to reset the lock-out switch at 1 s intervals. If this test method increases the lock-out to reset time beyond the manufacturer's declared lock-out to reset time, repeat the test, but do not commence the pressing of the lock-out button until 1 s before the manufacturer's declared lock-out to reset time.

By comparison of the times shown by the various stopclocks ascertain and record as applicable to the type of control the following time lapses:

- a) lapse between breaking fuel supply circuit to actuation of flame sensing control;
- b) lapse between breaking photo-cell circuit and ignition restored;
- c) lapse between actual "flame-out" and actuation of flame sensing device;
- d) lapse between b) and "lock-out";
- e) lapse between breaking fuel supply and actual "flame-out";
- f) lapse from "lock-out" to restart.

3.1.2.4.3 Normal function. Switch off the burner for 15 min with the water still flowing at the established rate; then switch on the unit by means of the water or air thermostat. By comparison of times shown by the various stopclocks ascertain and record:

- a) the time lapse to energize ignition circuit;
- b) the time lapse to the moment when fuel could be admitted to the combustion zone (this is taken as the moment of closing the motor circuit or the electric circuit controlling oil admission);
- c) the time lapse from b) to response of flame failure device.

3.1.2.4.4 Failure to ignite. Employing circuit modifications or other means applicable to the specific appliance undergoing the test, switch on the burner control and permit it to run through to the lock-out position. Record the time in seconds measured by the stopclock as from the moment fuel could be admitted to the combustion zone²⁾. From the moment when lock-out position is reached attempt to reset the lock-out switch at 1 s intervals. When this is achieved a stopclock will stop. Record the time in seconds from lock-out to reset. If this test method increases the lock-out to reset time beyond the manufacturer's declared lock-out to reset time, repeat the test but do not commence the pressing of the lock-out button until 1 s before the manufacturer's declared lock-out to reset time.

For many of the class 3 and class 5 appliances this is taken as the time of closing the magnetic valve circuit.

3.1.2.5 Reporting. All test results for control timings should be recorded on suitable forms as indicated in B.4 and B.5. A note should be made of any abnormal behaviour, e.g. incipient boiling.

3.1.3 Combustion performance

3.1.3.1 Outline of procedure. Where the appliance under test incorporates a water heating section it is operated with cold feed and an outlet temperature of 82 ± 3 °C except when checking the thermostat when the water flow is reduced to the point at which the thermostat at maximum setting is operated, the temperature rising at not more than 3 °C/min.

Combustion parameters are measured under a range of specified conditions.

Surface temperatures are measured at the manufacturer's declared maximum output and the recommended air/fuel ratio. In the case of class 1 appliances the latter condition is met by operating the appliance with the recommended flue draught. The positions of the maxima for accessible areas are established under the conditions of fuel flow rate as given in Appendix B. The effectiveness of guards fitted are determined only at the maximum firing rate. In addition surface temperatures of accessible areas are re-checked under the operating conditions specified in the test programme and recorded.

3.1.3.2 Apparatus. Apparatus is required for the determination of:

- a) smoke number and smoke index (method 1);
- b) flue gas composition (method 2);
- c) flue gas temperature (method 3);
- d) flue draught (method 4);
- e) degree of incomplete combustion, and combustible gas index (method 5);
- f) fuel flow rate (method 7);
- g) surface temperatures and effectiveness of guards (method 8).

A stopwatch or stopclock reading in minutes and seconds is also required.

3.1.3.3 Preparation of apparatus. The appliance is operated for a period of 45 min or for such time in excess necessary to ensure stable conditions at the selected fuel flow rate for the test concerned. Stability is considered to be achieved when:

- a) four consecutive readings of CO₂ taken at a minimum of 2 min intervals do not differ by more than 0.2 % between the highest and lowest reading and
- b) four consecutive readings of the draught developed taken at a minimum of 2 min intervals do not differ by more than 0.5 N/m² between the highest and lowest reading.

3.1.3.4 Procedure

3.1.3.4.1 At manufacturer's declared settings (high fire). With the appliance connected to the selected test chimney and, where applicable, the manufacturer's supplied draught stabilizer set to his requirements, allow conditions to stabilize for a further period of 5 min and obtain and record CO₂, CO, smoke number, flue gas temperature and fuel flow rate. Measure surface temperatures and carry out guard test where appropriate.

²⁾ For pressure jet burners with integral pump cut-off, and class 4 appliances, this is taken as the time of the closing of the motor circuit.

3.1.3.4.2 At varied air/fuel ratio

a) *Pressure jet appliances.* Set the air control(s) to provide a CO₂ percentage that is two percentage points³⁾ below the appliance manufacturer's declared setting and record CO₂ and smoke number. Adjust the air control(s) to obtain increments of approximately 1 % CO₂ until a value approximately two percentage points above the declared setting is obtained. At each increment record the CO₂ and smoke number.

If the air control(s) is such as to restrict the range of this investigation record the CO₂ and smoke number at the declared setting and the possible extremities of air/fuel ratio.

Measure surface temperatures.

b) *Appliances other than pressure jets or manually controlled burners.* Set the oil flow rate to 5 % below the manufacturer's declared high fire setting and record CO₂, CO, smoke number and degree of incomplete combustion after allowing at least 15 min for stable conditions to be obtained. Reset the oil flow rate to 5 % above (or the maximum possible if below 10 % of) the manufacturer's declared high fire flow rate and record CO₂, CO, smoke number and degree of incomplete combustion after allowing at least 15 min for stable conditions to be obtained. Carry out the procedure described in 3.1.3.4.5. Reset the oil flow rate to 10 % above⁴⁾ the manufacturer's declared high fire flow rate (or the maximum possible if below 10 %).

Measure surface temperatures.

3.1.3.4.3 *At manufacturer's declared low fire settings (high/low flame burners).* Set the oil flow rate to manufacturer's declared low fire setting and record CO₂, CO, smoke number, flue gas temperature and degree of incomplete combustion after allowing 15 min for stable conditions to be obtained. Reset the oil flow rate to 0.5 mL/min below and 0.7 mL/min above the manufacturer's declared low fire setting, and after allowing at least 15 min for stable conditions to be obtained at each setting, record CO₂, CO, smoke number and degree of incomplete combustion.

3.1.3.4.4 *Appliances with manually controlled burners.* Ignite the burner by the method, and at oil flow setting recommended by the manufacturer. Allow it to burn at this setting for 20 min. Turn the burner control to, or leave at, the low fire position as appropriate and after 10 min take measurements of CO₂, CO, smoke draught, oil flow rate, flue gas temperature and incomplete combustion. Advance the burner control to a position on the setting scale representing 25 % of the available travel between low and high fire and allow the burner to run for 20 min before taking the measurements again. Repeat this procedure at 50 %, 75 % and 100 % of the available travel on control and after carrying out the procedure described in 3.1.3.4.5 at 110 % of the manufacturer's declared high fire flow rate (or the maximum possible if below 110 %).

Measure surface temperatures.

3.1.3.4.5 *Fuel flow rate adjustment for all vaporizing burners.* The fuel flow rate adjustment is advanced until the maximum fuel flow rate is obtained and recorded.

3.1.3.5 *Precision.* Results of duplicate tests should not differ by more than the following:

Gas analysis	± 0.5 % from mean value CO ₂
Smoke number	1
Draught	0.5 N/m ²
Flue gas temperature	11 °C
Surface temperature	5 °C

3.1.3.6 *Reporting.* All test results should be recorded on suitable forms as indicated (see Appendix B). A note should be made of any abnormal behaviour, e.g. incipient boiling.

3.2 Test procedure 2: efficiency of boilers

3.2.1 **General.** This procedure measures efficiency in terms of transfer of heat from the fuel to water flowing through a boiler.

NOTE The test rig is similar to that shown in Figure 1 of DD 65-1:1979.

³⁾ One percentage point is one hundredth of the *total* amount concerned; in this instance, the total amount of flue gas.

⁴⁾ In order to carry out this part of the test it may be necessary to re-adjust the high fire limit stop.