

Specification for

Forced circulation hot water central heating systems for domestic premises

ICS 91.140.10

Committees responsible for this British Standard

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- Association of British Solid Fuel Appliances Manufacturers
- Association of Manufacturers of Domestic Unvented Supply Systems Equipment (MODUSSE)
- British Coal Corporation
- British Gas plc
- Chartered Institution of Building Services Engineers
- Consumer Policy Committee of BSI
- Domestic Solid Fuel Appliances Approval Scheme
- Electricity Supply Industry in England and Wales
- Heating and Ventilating Contractors' Association
- Hevac Association
- Institute of Domestic Heating Engineers
- Institute of Plumbing
- Institution of Gas Engineers
- Manufacturers' Association of Radiators and Convectors Limited
- National Association of Plumbing, Heating and Mechanical Services Contractors
- Sealed Expansion Vessel Association
- Society of British Gas Industries
- Solid Fuel Advisory Service
- Solid Smokeless Fuels Federation
- Waterheater Manufacturers' Association

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Foreword

This revision of BS 5449 has been prepared under the direction of the Refrigeration, Heating and Air Conditioning Standards Policy Committee. It supersedes BS 5449-1:1977 which is withdrawn. In 1977 there was an intention to produce a Part 2 on warm air heating systems, but as this was not proceeded with, Part 1 is deleted from the title of this revision.

In this revision, the opportunity has been taken to present BS 5449 in the format of a practice specification as defined in PD 6501-1. This allows the use of a format where the requirements of the specification are supported by recommendations. To comply with this specification, the user has to comply with all its requirements. He may depart from recommendations but this would be on his own responsibility and he would be expected to have good reasons for doing so.

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. In particular, attention is drawn to the Gas Safety (Installation and Use) Regulations and the Building Regulations of England and Wales and of Scotland, and to Water Supply Bye-laws.

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 38, an inside back cover and a back cover.

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Section 1. General

1 Scope

This British Standard specifies requirements and gives recommendations on good practice in the work involved in the general planning, designing and installation of forced circulation hot water central heating systems with heat requirements, which may include those for domestic hot water, up to a total of 45 kW.

The standard covers the following types of heating systems:

- a) open-vented smallbore and microbore;
- b) sealed smallbore and microbore.

NOTE The titles of the publications referred to in this standard are listed on page 37.

2 Definitions

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

2.1

heat emitters

a generic term including radiators, convectors, skirting heaters and radiant panels

2.2

boiler

an appliance designed for heating water either for space heating or for space heating combined with hot water supply

2.3

central heating

heating from a single central source within the dwelling, defined in detail as follows

2.4

whole house central heating

the simultaneous heating of all spaces in a dwelling so as to maintain specified temperatures (see Table 1 and clause 9), based upon calculated heat losses

2.5

part house central heating

the simultaneous heating of some of the spaces in a dwelling so as to maintain specified temperatures (see Table 1 and clause 9), based upon calculated heat losses

2.6

background central heating

the simultaneous heating of all or some of the spaces in a dwelling to temperatures below those specified in Table 1 and clause 9, based upon calculated heat losses

2.7

combined system

a system which, as well as providing central heating for rooms or spaces, heats water for domestic use

2.8

immersion primary heater

a unit which is fitted into a direct cylinder consisting of an element such as a coil of pipe through which is passed a heating fluid (e.g. hot water) in such a way that the heat is transferred through the walls of the element without mixing of the primary water in the element and the secondary water to be heated outside the element

2.9

smallbore heating system

a heating system incorporating circulation pipework normally within the size range of 15 mm to 35 mm outside diameter (1½ in to 1¼ in nominal bore)

2.10**microbore heating system**

a heating system incorporating circulation pipework normally within the size range of 6 mm to 12 mm outside diameter

2.11**open vented heating system**

a heating system which is open to the atmosphere and incorporates a feed and expansion cistern

2.12**sealed heating system**

a heating system which is not open to the atmosphere but which incorporates a sealed diaphragm expansion vessel

2.13**designer**

the consulting engineer, heating contractor, installer or other person responsible for the design of the heating installation

2.14**design heat requirement**

the design heat requirement of a room or space is the total heat required to provide space heating under design conditions

it is the calculated heat loss, with the addition of any intermittency factor for ensuring faster heat-up after a period out of operation

the design heat requirement of a dwelling is the sum of the design heat requirements of each heated room or space within the dwelling

2.15**ventilation heat loss**

the ventilation heat loss of a room or space within a dwelling is the heat lost to outside air by the replacement of heated internal air by cooler external air due to the design ventilation rate and design temperature differences

2.16**structural heat loss**

the structural heat loss of a room or space within a dwelling is the heat which is conducted through the enclosing surfaces of the room or space (walls and windows, floor and ceiling) due to the design temperature differences across them

it should take into account the exposure of external walls to climatic influence and any heat gain from those surfaces where the adjoining room or space is at a higher design temperature than that of the considered room or space

2.17**calculated heat loss**

the calculated heat loss of a room or space within a dwelling is the total heat loss from the room or space due to the design temperature differences and ventilation rate

it is the sum of the structural heat loss and the ventilation heat loss

2.18**pump overrun device**

a facility for allowing the circulation pump to operate for a period after the boiler has switched off to dissipate residual heat remaining in the appliance at the end of a cycle

2.19**room-sealed appliance**

an appliance which has the combustion system isolated from the room in which the appliance is installed

2.20**open-flued appliance**

an appliance which draws its combustion air from the room or internal space in which it is installed

3 Exchange of information

3.1 Preliminary design information

The designer shall consider with the potential customer and settle at the planning stage the following matters:

- a) Thermal characteristics of the building for calculation of heat requirements and possible improvements for energy conservation.
- b) Fuel to be used.
- c) Position of the boiler, bearing in mind access for maintenance, means of flueing and provision of combustion air.
- d) Type, location, dimensions, construction and suitability of chimney and flue terminal, where required.
- e) Location and size of fuel storage and access thereto, where required. For solid fuel, ash removal and disposal will require consideration.
- f) Position of feed and expansion cistern for open systems or expansion vessel, filling point and pressure gauge for sealed systems.
- g) Facilities for filling and draining the system.
- h) Requirements for domestic hot water supply.
- i) Position of any domestic hot water supply equipment, e.g. hot water storage cylinder, if required.
- j) Temperatures required to be maintained and the manner in which the dwelling and system are to be used, bearing in mind ventilation and condensation.
- k) Type and position of heat emitters.
- l) System control of heating and hot water including frost protection.
- m) Route and method of installing pipework.
- n) The need for compliance with relevant Building Regulations, Gas Safety (Installation and Use) Regulations 1998, BS 7671, Building Regulations 2000 (as amended), Building Regulations (Scotland) 1990 (as amended), Water Supply (Water Fittings) Regulations 1999 and relevant Bye-laws.

3.2 Contractual specification and presentation of scheme

3.2.1 The designer shall obtain sufficient details of the structure of the premises and dimensions of the rooms and spaces to be heated to enable heat losses to be calculated.

COMMENTARY AND RECOMMENDATIONS ON **3.2.1**. *The room temperatures and ventilation rates which are recommended for the purpose of heat loss calculations are given in Table 1.*

3.2.2 The designer shall provide the customer and the installation contractor with a written specification for the scheme stating type and output of the boiler and heat emitters and the room temperatures that will be attained at stated design conditions. This shall also detail the controls and other ancillary equipment to be fitted and the capacity of the domestic hot water storage vessel and associated water temperature controls, if provided. The method of providing any required ventilation and combustion air shall be stated.

COMMENTARY AND RECOMMENDATIONS ON **3.2.2**. *The designer's specification should indicate the locations of the boiler, heat emitters (including dimensions), exposed pipework, feed and expansion cistern or expansion vessel, the domestic hot water storage vessel (if provided) and where an open-flued boiler is used, the flue.*

Section 2. Materials, appliances and components

4 General

Wherever possible, all materials, appliances and components to be used shall comply with the requirements of applicable British Standards.

COMMENTARY AND RECOMMENDATIONS ON CLAUSE 4. *Where no British Standard exists, materials and equipment should be fit for their purpose and of suitable quality and workmanship.*

5 Boilers

5.1 General

Boilers fired by solid mineral fuel shall:

- a) have a water temperature operated thermostat or,
- b) in the case of open fires with back boilers and room heaters complying with BS 3378 without water temperature actuated combustion controls, have a heating system design which ensures adequate heat dissipation in compliance with **22.1**.

NOTE 1 For reasons of safety and ease of control it is essential that solid fuel appliances not having water temperature actuated combustion controls are installed and operated strictly in accordance with the manufacturer's instructions.

In all cases these boilers shall be selected from the list of "Approved domestic solid fuel appliances", or shall have been approved since publication of the latest list.

NOTE 2 Selection from this list will ensure that the boiler conforms to BS 1252, BS 3378, BS 4433 or BS 4834 as appropriate and is suitable for use in clean-air zones.

Boilers fired by gas shall be suitable for the gas with which they are to be supplied and shall be certified to BS 5258-1 or BS 5258-8 or BS 5258-15, and BS 6332-1 or BS 6332-3.

Boilers fired by oil shall comply with the requirements of BS 4876 and be suitable for the oil with which they are to be fired.

Electrical heating appliances shall be selected from the Supplementary List of Household Electrical Appliances issued by the Electricity Council.

5.2 Sealed systems

Boilers for use with sealed systems require specific controls (see clause **7** and clause **16**) and shall therefore be selected only from those designed specifically for this purpose and shall be installed in accordance with BS 7074-1.

COMMENTARY AND RECOMMENDATIONS ON CLAUSE 5. *The British Standards applicable to boilers are as follows:*

BS 1252 BS 4876
BS 1894 BS 5258-1, BS 5258-8 and BS 5258-15
BS 3378 BS 6332-1 and BS 6332-3
BS 4433

6 Pipes and pipe fittings

The feed and expansion pipe, open vent, circulation pipes and pipe fittings shall comply with the following standards as appropriate: BS 21, BS 143 and BS 1256, BS 864-2, BS 1010, BS 1387, BS 1740, BS 2051-1 and BS 2051-2, BS 2767, BS 2871-1, BS 2879, BS 4127, BS 5154, BS 7291-1, BS 7291-2 and BS 7291-3.

7 Safety valves

For sealed systems a safety valve shall be fitted having the following features.

- a) It shall be non-adjustable, spring loaded, preset to lift at a gauge pressure not exceeding 3 bar¹⁾
- b) It shall have a manual testing device.
- c) It shall have a valve or seating face material which will prevent sticking in the closed position and will give effective resealing.
- d) It shall have provision for connecting a full bore discharge pipe.

¹⁾ 1 bar = 10⁵ N/m² = 100 kPa.

Section 3. Design considerations

8 General

8.1 A central heating system shall be designed on the basis of calculated heat losses and shall include temperature and system operating controls (clause 22).

COMMENTARY AND RECOMMENDATIONS ON **8.1**. *In order to reduce unnecessary heat losses and operating costs of the installation, consideration should be given to the following.*

- a) *Minimizing air leaks through the structure, e.g. excessive air infiltration may be reduced by sealing cracks in boarded floors over a ventilated cavity, and by weather-stripping badly fitting external doors and windows and by closing unused open fireplaces. Some care and judgement should be exercised in carrying out such measures. An air change rate of about one room volume per hour is necessary in occupied rooms for fresh air supply and odour removal; even more is needed in kitchens for the removal of steam and odours from cooking and laundry (see Table 1). Too severe a restriction of the ventilation of the dwelling can augment the risk of condensation on cool surfaces. Although this standard requires the provision of an air inlet to supply combustion air for gas, oil and solid fuel boilers (other than room sealed appliances), allowance should be made for the supply of combustion air necessary for any other appliance (independent fire, cooker, water heater) in the room in which the boiler is situated.*
- b) *Insulation of ceilings and roof.*
- c) *Filling of cavity walls with insulating materials.*
- d) *Internal insulating linings and external cladding.*
- e) *Double glazing.*
- f) *Reflective or insulating surfaces behind radiators on external walls.*

8.2 If an open fireplace is to be closed at the base of the chimney, a small opening shall be retained to avoid dampness within the flue.

COMMENTARY AND RECOMMENDATIONS ON **8.2**. *Steps should be taken at the chimney terminal to prevent rain ingress to a disused flue. Any opening for ventilation should be at least 300 mm above the fireplace base.*

9 Heating requirements

9.1 The calculated heat losses shall be based on an outside air temperature no higher than -1°C .

COMMENTARY AND RECOMMENDATIONS ON **9.1**. *Reference should be made to appendix A for U-values of thermal transmittance and to Table 1 for room temperatures to be used for the calculation of structural heat losses and for air change rates to calculate ventilation heat losses. The calculated heat losses should normally be based on an outside air temperature of -1°C . External design air temperatures should be adjusted for the degree of exposure as well as altitude and latitude, and therefore outside air temperatures lower than -1°C should be considered for design purposes. Consideration should also be given to air change rates where small changes from the design rates may affect the actual operational heat losses significantly. This is particularly relevant in the case of highly insulated dwellings.*

Unless the system is to operate continuously, an addition to the calculated heat loss should be made and applied to the room heat emitters. This addition should be at least 10 %. A greater percentage addition is recommended for well-insulated dwellings because of their low design heat requirements, or where the heating system is in operation for short periods only. Account should be taken of the degree to which secondary heating systems are used.

In all types of dwelling there is a risk of condensation and consideration should be given to a minimum set-back temperature control.

Table 1 — Temperatures and ventilation rates

Room	Room temperature ^a °C	Ventilation rate (air changes per hour)
Living room	21	1.5
Dining room	21	1.5
Bedsitting room	21	1.5
Bedroom ^b	18	1
Hall and landing	18	1.5
Kitchen	18	2
Bathroom	22	2
Toilet	18	2

^a These temperatures are those recommended for whole house central heating and for heated rooms with part house central heating. In rooms where open-flued appliances are installed the rate of air change should be increased (see Table 2).

^b When used part time as bedsitting rooms or for study purposes a higher room temperature may be required.

Table 2 — Air change rates for rooms with open fires and flues up to 40 000 mm² (200 mm × 200 mm)

Approximate room size m ³	Throat restrictor	Ventilation rate (air changes per hour)
40	no	5
40	yes	3
70	no	4
70	yes	2

9.2 The design flow temperature shall not exceed 82 °C. The design return temperature shall be not less than 66 °C unless the boiler is of special condensing design or of the electric storage type.

COMMENTARY AND RECOMMENDATIONS ON 9.2. *In practice the system flow temperature may be significantly lower than the design flow temperature due to boiler cycling frequencies and intermittent operation. The system design temperature drop should be 10 °C unless the boiler is of special condensing design or of the electric storage type. In the case of condensing boilers the operating efficiency is improved by the use of lower return temperatures.*

Electric water storage boilers are not restricted to minimum return temperatures nor to a 10 °C temperature drop across the heating system. However, the temperature drop would not normally exceed 20 °C nor would the return temperature be below 40 °C. These values relate to the system controllability and to the heat emission from the system.

A greater design temperature drop may be advantageous but will require the use of correspondingly larger heat emitters. The boiler manufacturer's instructions should be consulted.

10 Domestic hot water requirements

The capability for providing hot water shall be related to the likely demand, as established in 3.1h). In highly insulated dwellings the peak demand for domestic hot water may be considerably in excess of the space heating requirement (by a factor of two or three). Where fast recovery of domestic hot water is required the boiler shall be sized taking into account the requirement of the domestic hot water rather than the overall heating load.

COMMENTARY AND RECOMMENDATIONS ON CLAUSE 10. *The capacity of the storage vessel should not be less than 114 L, but larger dwellings may require more. There are, however, circumstances, e.g. pumped primaries, as well as the use of specially designed appliances with integral storage, which permit the use of smaller capacities (see BS 6700).*

Where an electric immersion heater is provided the length and position of the element should be such as to heat the bulk of the stored water.

In order to reduce both delay in arrival of hot water at taps and the subsequent energy wastage from residual hot water in the draw-off pipes the hot water storage vessel should be sited as near as practicable to the most frequently used draw-off point, usually the kitchen sink.