



Code of practice for
**Central heating for
domestic premises**

Part 1. Forced circulation hot water systems
(formerly CP 3006 : Part 1)

Code de bonne pratique relatif au chauffage central pour les immeubles domestiques
Partie 1. Systèmes à circulation d'eau chaude sous pression

Richtlinien Zentralheizung für Haushaltsgrundstücke
Teil 1. Warmwasserraumversorgung mit Zwangsumlauf

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Foreword

This Part of this British Standard code of practice has been prepared under the authority of the Refrigeration, Heating and Air Conditioning Standards Committee in response to requests from industry. It is a revision of CP 3006 : Part 1 : 1969 and has been extended to include sealed systems and microbore systems. Unless otherwise stated all clauses refer to all types of forced circulation hot water heating systems.

As part of BSI's programme of metrication this Part of the code is expressed in metric terms. The metric values are given in SI units. In some cases, however, imperial equivalents are given for physical parameters.

This code of practice represents a standard of good practice and therefore takes the form of recommendations. **Documents**
with it does not confer immunity from relevant statutory and legal requirements.



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British Standard Code of practice for

Central heating for domestic premises

Part 1. Forced circulation hot water systems

Section one. General

1. Scope

This Part of BS 5449 deals with the work involved in the general planning, designing and installation of forced circulation hot water central heating systems with heat requirements up to 45 kW, which may or may not include an indirect cylinder for domestic hot water.

The code deals with the following types of heating systems:

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

Embedded pipe radiant heating systems are specifically excluded.

2. References

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

3. Definitions

For the purposes of this code the following definitions apply.

3.1 heat emitters. A generic term including radiators, convectors, skirting heaters and radiant panels.

3.2 boiler. An appliance designed for heating water either for space heating or for space heating combined with hot water supply.

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

3.3.1 whole house central heating. The simultaneous heating of all spaces in a dwelling so as to maintain specified temperatures (see table 1), based upon calculated heat losses.

3.3.2 part house central heating. The simultaneous heating of some of the spaces in a dwelling so as to maintain specified temperatures (see table 1), based upon calculated heat losses.

3.3.3 background central heating. The simultaneous heating of all or some of the spaces in a dwelling to temperatures below those specified (see table 1), based upon calculated heat losses.

3.3.4 packaged deal heating. Whole house, part house or background heating, as defined, with a specified total output, but not necessarily specified temperatures.

3.4 smallbore heating system. A form of heating system incorporating distribution pipework normally within the size range of 15 mm to 35 mm ($\frac{1}{2}$ in to $1\frac{1}{2}$ in nominal bore) outside diameter.

3.5 microbore heating system. A form of heating system incorporating distribution pipework normally within the size range of 6 mm to 12 mm ($\frac{1}{4}$ in to $\frac{1}{2}$ in nominal bore) outside diameter.

3.6 open vented heating system. A central heating system which is open to the atmosphere through an open vent pipe.

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

3.8 designer. The consulting engineer, heating contractor, installer or other person responsible for the design of the heating installation.

4. Exchange of information

4.1 Design information. To ensure a good and economical design for the selected heating system, the designer should consider and settle at the planning stage the following matters.

- (a) Position of the boiler and associated equipment in relation to access for maintenance and replacement; see also clause 36.
- (b) Fuel to be used.
- (c) Location and size of fuel storage and access thereto, where required; for solid fuel boilers the method of ash removal and storage will also require examination.
- (d) Type, location, dimensions, construction and suitability of chimney or flue outlet and terminal, where required.
- (e) Position of (1) feed and expansion cistern for open systems; (2) expansion vessel, filling point and pressure gauge for sealed systems.
- (f) Facilities for filling and draining the installation.
- (g) Source and nature of gas, electricity and water supplies with special attention to local authorities' and public utilities' requirements.
- (h) The thermal characteristics of the building. See 17.3.
- (i) Temperatures required to be maintained, and the manner in which the dwellings are to be used.
- (j) The type and position of heat emitters.
- (k) Relevant Building Regulations, Water Bye-laws and Codes of Practice.
- (l) Provision of air inlets to area where boiler is sited.

4.2 Preparation and presentation of scheme

4.2.1 The designer should be supplied with scale drawings and structural details of the premises to enable an assessment to be made of the thermal loss through the structure and of the most satisfactory pipe runs. Particular importance is attached to the provision of details of the thermal characteristics of the structural components of the building.

4.2.2 The designer should issue to the installation contractor and to the customer a full specification for the complete installation, stating capacities, ratings and conditions of performance of each item of equipment to comply with the specific requirements.

4.2.3 The designer should issue to the installation contractor drawings to scale indicating the layout of the boiler flue route and terminating position, circulating pump, feed and expansion cistern or expansion vessel, pipe runs and radiators or other forms of heating elements.

Section two. Materials, appliances and components

5. General

All materials, appliances and components used in the work described in this code should comply with the requirements of applicable British Standards.

Where no British Standard exists, materials and equipment should be of suitable quality and workmanship.

6. Boilers

6.1 Boilers fired by solid fuel should be selected from the list of 'Approved domestic solid fuel appliances' published on behalf of the Domestic Solid Fuel Appliances Approval Scheme, or should have been approved since publication of the latest list. Boilers for sealed systems should be selected from Section J4 of the list.

Boilers fired by gas should comply with the requirements of BS 5258 : Part 1 and of BS 1250 : Parts 1 and 3 where relevant, and should be suitable for the gas with which they are to be supplied.

Boilers fired by oil should be selected from the Domestic Oil Burning Equipment Testing Association (DOBETA) list of tested and approved domestic oil burning appliances, or should have been approved since publication of the latest list.

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

Boilers for use with sealed systems require specific controls and should therefore be selected only from those designed specifically for this purpose.

6.2 The British Standards applicable to boilers are as follows:

BS 1894	BS 4876
BS 3378	BS 5258 : Part 1
BS 4433	BS 5440 : Parts 1 and 2
BS 1250 : Parts 1 and 3	

7. Safety valves

For sealed systems it is essential that a safety valve should be fitted and should comply with the relevant requirements of BS 759 and should have the following features:

- (a) be non-adjustable, spring loaded, preset to lift at a gauge pressure not exceeding 3 bar* (45 lb/in²);
- (b) a manual testing device;
- (c) a valve or seating face material which will prevent sticking in the closed position and will give effective resealing;
- (d) provision for connecting a full bore discharge pipe.

8. Flue pipes

The British Standards applicable to flue pipes are as follows:
BS 41, BS 567, BS 715, BS 835, BS 4543.

9. Stoking and cleaning tools

As the type and size of boiler will determine the tools, etc., best suited for its safe and efficient operation, maintenance and cleaning, such tools as are necessary for these purposes should be provided by the installation contractor.

10. Circulating pumps

The British Standard applicable to circulating pumps is BS 1394 : Parts 1 and 2.

11. Pipes and pipe fittings

The British Standards applicable to pipes and pipe fittings are as follows:

BS 21	BS 1740
BS 143 and 1256	BS 2871 : Part 1
BS 864 : Part 2	BS 4127
BS 1387	

12. Valves

The British Standards applicable to valves are as follows:

BS 759	BS 1968	BS 2879
BS 1010	BS 2060	BS 3464
BS 1212	BS 2767	BS 5154
BS 1952		

13. Heat emitters

The British Standard applicable to radiators and convectors is BS 3528.

A number of types of radiators and convectors are available for use in connection with a domestic central heating installation, and apart from certain design considerations dealt with in later clauses they should be provided with (a) means of venting air, and (b) suitable supports.

14. Thermal insulation

The British Standards applicable to thermal insulation are as follows:

BS 1334, CP 3 : Chapter II, CP 99, CP 3005.

15. Feed and expansion cisterns and expansion vessels

The British Standards applicable to feed and expansion cisterns and expansion vessels are as follows:

BS 417, BS 2777, BS 4213, BS 4814.

*1 bar = 10⁵ N/m² = 100 kPa.

16. Indirect cylinders

Indirect cylinders should be of the grade appropriate to the working head. For sealed systems indirect cylinders should have primary heaters, preferably of the coil type, suitable for operating at a gauge pressure of 0.35 bar (5 lb/in²) in excess of the safety valve setting. Single feed indirect cylinders are not suitable for sealed systems.

The British Standards applicable to indirect cylinders are as follows:

BS 1565, BS 1566 : Parts 1 and 2 (see 31.4), BS 3198.

NOTE. Indirect cylinders may be obtained, from the manufacturers, with a pre-insulated covering.

Section three. Design considerations

17. General

17.1* A central heating system should be designed on the basis of calculated heat losses. The appropriate room temperatures and rates of air change for heat loss are given in table 1.

17.2* It is accepted practice for the design of an installation to be based on an outside air temperature of -1°C , but in exposed positions lower base temperatures may be used.

Heating circuits should be designed for a maximum flow temperature of 82°C for open systems; sealed systems may operate with higher temperatures up to $100^{\circ}\text{C}^{\dagger}$, see 28.5 and 30.1. The temperature drop under design conditions should generally not exceed 16°C .

17.3 In order to reduce unnecessary heat losses and operating costs of the installation, attention 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 code 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 for any other appliance (independent fire, cooker, water heater) in the room in which the boiler is situated.

If an open fireplace is closed at the base of the chimney, a small opening should be retained to avoid dampness and means taken to prevent rain ingress at the chimney terminal.

(b) Insulation of ceilings and roof.

Heat losses may be further reduced by:

- (1) filling of cavity walls with insulating materials;
- (2) internal insulating linings and external cladding;
- (3) double glazing;
- (4) reflective or insulating surfaces behind radiators on external walls.

Advice should be obtained concerning the economic advantages of (1), (2) and (3).

18. Space heating requirements

Reference should be made to the latest edition of publications prepared by the Institution of Heating and Ventilating Engineers for values of thermal transmittance to be used for the calculation of heat loss from buildings. Calculations of space heating requirements should include due allowance for the degree of exposure and number of air changes, and for intermittent operation of the system where applicable.

19. Boilers

19.1* The total heat loss from each room, and from the dwelling as a whole, should be calculated. The heating surface in each room should have an output (at the designed flow temperature) at least equal to the design heat loss. The boiler output rating should be at least equal to the total calculated heat loss, including emission from the system pipework.

If it is intended that the system shall operate intermittently at all seasons, an addition to the calculated heat loss should be made and applied to the room heating surface. The boiler output rating should then equal the total emission from the installed heating surfaces. This addition may range from 10 % in heavy structures with long periods of operation each day to 20 % or more in light structures and/or short periods of operation. Intermittent operation in cold weather generally involves some loss of comfort (during warming up period) and an increased risk of condensation, particularly in rooms which are heated for short periods only each day.

For off-peak electric heating the output is usually calculated in terms of energy stored and should be adequate to meet the 24 h heat requirement.

Where a boiler supplies both heating and hot water service without priority controls additional boiler power of up to 2.0 kW may be required depending upon the likely consumption of hot water, secondary circulation heat losses and the storage capacity of the indirect cylinder.

19.2 The boiler should be so located as to provide suitable access for inspection and for cleaning of combustion chamber, flue ways and burner.

19.3 For sealed systems it is essential that a safety valve should be fitted either directly to the boiler, or in the flow pipe as near as is practicable thereto, with no intervening valve or restriction. It should be fitted in an upright position, accessible for testing during the filling procedure, see 48.2.

The method of fitting should ensure that discharge of water or steam cannot create a hazard to the occupants of the premises, or damage to electrical components or wiring, and the point of discharge should be clearly visible.

*Packaged deal heating installations may not comply with the recommendations of this clause.

[†]Provided the boiler controls are approved for use at this temperature.

19.4 A pressure gauge with a fill pressure indicator should be fitted permanently to a sealed system. The gauge should be easily seen from the filling point and should preferably be connected at the same point as the expansion vessel. Where the pressure gauge is combined with a thermometer the combined gauge should be fitted in the boiler or in the flow pipe; it should not be fitted in a non-circulation pipe.

19.5 The boiler should be provided with clear operating instructions, preferably in the form of a durable plaque attached to the appliance.

19.6 Where two oil fired boilers are used in the same dwelling, the burners should be suitable for the same grade of oil.

19.7 Boilers fired by oil or solid fuel may incorporate a draught stabilizer. Alternatively, where necessary a draught stabilizer may be fitted in the flue connection or the chimney, see also **37.5**.

19.8 Natural draught, open flued gas fired boilers should be fitted with a draught diverter to eliminate adverse effects on combustion and performance due to draught variations. Usually the draught diverter forms an integral part of the boiler and, when installed, the manufacturer's instructions in respect of clearances around the draught diverter relief openings should be strictly followed.

Where the draught diverter is supplied as a separate component it should be fitted in the manner prescribed by the manufacturer.

20. Chimney and flue

20.1 The chimney structure should contain a flue(s) suitable for the type of boiler(s) connected and each flue should be of adequate cross-sectional area and height to remove, under natural draught conditions, the combustion products of the boiler or boilers when operating at maximum rating.

20.2 Where practicable chimneys should be located on an inside wall of the dwelling, and flues should be free from sharp turns, bends or pockets.

20.3 A flue should preferably serve one boiler or heating appliance only. Two or more appliances using dissimilar fuels or, except as provided in **20.6**, using the same fuel but located in separate rooms, should not be connected to the same flue.

20.4 Flues should terminate with an outlet appropriate to the type of fuel used and at a point related to the roof of the building of which it forms part or to the roof of any adjacent building, so as to minimize the risk of down draught or the creation of a nuisance.

20.5 The installing engineer should advise the customer or his agent of any work necessary to the chimney to make it suitable for the boiler.

Where a boiler fired by solid fuel is to be connected to a chimney in which, by its condition or location, excessive heat loss or condensation is likely to occur, the chimney should be lined with a suitable insulating and/or corrosion resistant material. Where a liner is to be fitted into an existing chimney then the chimney should be swept clean before installation work commences. Flexible liners are generally unsuitable for solid fuel, see CP 131.

Where a boiler fired by gas or oil is to be connected to a chimney, the chimney should be lined with a material impervious to the action of condensation and combustion acids. Where a flexible liner is to be fitted into an existing

chimney then the chimney should be swept clean before installation work commences. Where necessary a drain pipe of not less than 22 mm (1 in) diameter and of corrosion resistant material should be taken from the lowest point of the chimney to discharge externally in a suitable position.

20.6 Flues should be in accordance with recommendations of the boiler manufacturer and in the case of gas fired boilers should comply with the requirements of BS 5440 : Part 1.

20.7 A cleaning door should be fitted near the base of a chimney to which a boiler fired by solid fuel or oil is connected, and also to all bends in flue pipes.

20.8 Flues should not be carried further below the flue pipe connection from the boiler than is necessary to accommodate a cleaning door.

20.9 The flue connection between the boiler and the chimney should have a cross-sectional area not less than that of the boiler flue outlet and preferably should be short, should slope upwards towards the chimney, and should contain as few bends as possible. All bends should be not less than $112\frac{1}{2}^\circ$ and should be provided with access for cleaning.

20.10 Factory made insulated chimneys complying with the requirements of BS 715 and BS 4543 should be installed in accordance with manufacturers' instructions.

20.11 It is essential that single skin uninsulated flue pipes should not be used externally for solid fuel or oil fired boilers.

21. Velocity and pressure loss in circuits

21.1 To ensure quietness in operation the pipe circuits should be designed such that the velocity of water does not exceed 1.5 m/s (5 ft/s).

21.2 Figures for the determination of pressure loss due to friction are given in the publications of the Institution of Heating and Ventilating Engineers and other authoritative sources.

22. Circulating pump

22.1 The circulating pump should be selected to circulate the designed flow of water through the pipes, heat emitters and boiler against the calculated resistance.

22.2 A check valve should be fitted to prevent gravity circulation of hot water through the heating circuits when the circulating pump is not operating, if such gravity circulation is not required.

22.3 Where room temperature controls operate by switching the pump the following requirements should be met:

- (a) the pump should be suitable for such use, and declared so by the manufacturer;
- (b) the circulation by gravity in the pump heating circuit should not render the control equipment partially or wholly inoperative.

23. Feed and expansion cistern (open systems only)

23.1 A feed and expansion cistern and ball valve and float capable of withstanding a temperature of 100°C should be used for the sole purpose of accommodating the expansion of water in and supplying make-up water to the heating system. This should be fitted at least 1 m above the highest point of the circulating system or such lesser height as recommended in the boiler manufacturer's installation instructions (see **24.4**). A separate overflow pipe should be run from the cistern. The cistern should have a capacity as shown in table 2 and a cover through which the turned down end of the vent pipe should pass, but with the facility

for removing the cover. The lid should fit onto the cistern and not onto any box work supporting the insulating material (to avoid condensation on the outside of the cistern).

The ball valve should be fitted higher than the overflow pipe and should have a copper or equally suitable float which should be adjusted to shut off when the water in the system is cold at a level low enough to ensure that the increase in the volume of water in the system, when heated, does not cause the water level to rise higher than 25 mm below the overflowing level of the overflow pipe.

An independent stop valve should be fitted on the cold supply and as near to the cistern as practicable to allow ease of inspection, maintenance and removal of the ball valve.

23.2 The size of the mains cold water supply pipe to the ball valve in the cistern should be not less than $\frac{1}{2}$ in nominal size or 15 mm.

24. Cold feed pipes and vent pipes for open systems

24.1 The feed and vent pipes should be separate except where used with boilers conforming to 18.5 of BS 5258 : Part 1 : 1975.

24.2 A cold feed pipe to the system should be taken from the feed and expansion cistern which should not supply water for any other purpose. The size of the cold feed pipe should be in accordance with table 2. It is essential that no valve is fitted in the cold feed pipe.

24.3 An open vent pipe sized in accordance with table 2 should be taken from the system to discharge at a level above the overflow of the feed and expansion cistern. The vent pipe should rise continuously from the boiler to discharge over the cistern. It is essential that no valve is fitted in the open vent pipe. The vent pipe may be used as part of the circulating system.

Provision may need to be made for the venting of high points of heating circuits and the primary circuit to a double feed indirect cylinder, where fitted. A separate vent pipe for the primary circuit of a single feed indirect cylinder is not normally required.

24.4 Due consideration should be given to the position of the connections of the cold feed pipe and the open vent pipe to the circulating pipework of the system relative to the position and head of the circulating pump. 'The pressure difference between these two connections should be kept to a minimum in order to avoid excessive water movement in the vent pipe and therefore they should normally be installed close together.' Incorrect

selection of the point of connection may result in discharge of water from the open vent pipe and/or air entrainment into the system which can give rise to corrosion. The diagrams in figures 1 and 2 show some limitations to overcome this problem.

25. Expansion vessels (sealed systems only)

25.1 A sealed system should be provided with a diaphragm expansion vessel which has an acceptance volume sufficient to accommodate the volume change of system water when heated from 10 °C to 110 °C. The practical acceptance volume is that which the vessel will accept when the gauge pressure developed rises to 0.35 bar (5 lb/in²) less than the safety valve setting.

25.2 The vessel should contain air or nitrogen at a pressure not less than the static head at the point of connection to a circulating pipe.

25.3 The vessel may be directly connected to the system or supported remotely from it provided the connecting pipe has an internal diameter of not less than 13 mm. Installation should be in accordance with the manufacturer's instructions.

25.4 The vessel should be connected to the system at a point close to the pump inlet in order to maintain positive pressures throughout the system.

26. Provision for filling and make up (sealed systems only)

26.1 A sealed system should incorporate means for filling by an arrangement approved by the Water Undertaking.

26.2 Provision should be made for replacing water lost from the system either:

- (a) from an independent make up vessel or tank mounted in a position higher than the top point of the system, and connected through a non-return valve either to the system on the return side of the hot water cylinder or the return side from all heat emitters: or
- (b) where access to a make up vessel would be difficult, by pre-pressurization of the system, that is by filling the system to a design cold water pressure greater than that of the vessel gas charge pressure, thus providing in the vessel a reserve of water for making up losses due to air purging and minor leakage.

27. Venting

Provision should be made to enable the system to be vented during the filling and commissioning operations.

Air may be vented either by automatic air vents or manually. Hygroscopic types of automatic air vent should not be used for sealed systems as these allow continuous evaporation of small quantities of water. To assist in the venting of air in solution, an air separating device (with automatic air vent in the case of sealed systems) is recommended and should be fitted in accordance with the manufacturer's instructions.

28. Heat emitters

28.1* One or more heat emitters capable of meeting the calculated heat requirements of each room in which they are sited, should be selected.

28.2 Wherever practicable individual heat emitters (other than fan convectors) should be located beneath windows to offset the cooling effect: it is an advantage to choose an emitter of such a length that it occupies the full width of a window. Masking of emitters by curtains should be avoided.

28.3 The effect of painting with ordinary paints can be ignored as they do not significantly vary the emission from radiators and the colour is unimportant. Metallic paints such as aluminium or bronze may reduce the overall emission by up to 15 % and for this reason should not be used unless covered with two coats of clear varnish. The enclosure of radiators will substantially reduce the emission depending upon the type of enclosure.

28.4* Due allowance should be made for the heat emission from the exposed pipes in the room.

28.5 Where circulating temperatures greater than 82 °C are to be used, consideration should be given to the use of heating elements which have protected surfaces.

endations of this clause.



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