BRITISH STANDARD

BS EN 12828:2003

Incorporating Corrigendum January 2009

Heating systems in buildings — Design for water-based heating systems

ICS 91.140.10

British Standards

National foreword

This British Standard is the UK implementation of EN 12828:2003. Together with BS EN 12831:2003 and BS EN 14336:2004, it supersedes BS 5449:1990, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee RHE/24, Central heating installations.

A list of organizations represented on this committee can be obtained on request to its secretary.

Informative guidance on the use of EN 12828:2003 in the UK for forced circulation hot water central heating systems, which may include those for domestic hot water, with heat requirements up to a total of 45 kW is given in National Annex NA (informative).

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

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 22 August 2008

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31 January 2009	Revision of National Annex NA (informative). Update to supersession details and additional information added to National foreword.

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 12828

March 2003

ICS 91.140.10

English version

Heating systems in buildings - Design for water-based heating systems

Systèmes de chauffage dans les bâtiments - Conception des systèmes de chauffage à eau

Heizungssysteme in Gebäuden - Planung von Warmwasser-Heizungsanlagen

This European Standard was approved by CEN on 4 July 2002.

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

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

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

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

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Ref. No. EN 12828:2003 E

Contents

Foreword

This document EN 12828:2003 has been prepared by Technical Committee CEN/TC 228 “Heating systems in buildings”, the secretariat of which is held by DS.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by September 2003, and conflicting national standards shall be withdrawn at the latest by March 2004.

Annexes A, B, C, D and ZA are informative.

This document includes a Bibliography.

The subjects covered by CEN/TC 228 are the following:

¾ design of heating systems (water based, electrical, etc.);

¾ installation of heating systems;

¾ commissioning of heating systems;

¾ instructions for operation, maintenance and use of heating systems;

¾ methods for calculation of the design heat loss and heat load;

¾ methods for calculation of the energy performance of heating systems.

Heating systems also include the effect of attached systems such as hot water production systems.

All these standards are system standards, i.e. they are based on requirements addressed to the system as a whole and not dealing with requirements to the products within the system.

Where possible, reference is made to other CEN or ISO standards, a.o. product standards. However, use of products complying with relevant product standards is no guarantee of compliance with the system requirements.

The requirements are mainly expressed as functional requirements, i.e. requirements dealing with the function of the system and not specifying shape, material, dimensions or the like.

The guidelines describe ways to meet the requirements, but other ways to fulfil the functional requirements might be used if fulfilment can be proved.

Heating systems differ among the member countries due to climate, traditions and national regulations. In some cases requirements are given as classes so national or individual needs may be accommodated.

In cases where the standards contradict with national regulations, the latter should be followed.

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

1 Scope

This standard specifies design criteria for water based heating systems in buildings with a maximum operating temperature of up to 105°C. In case of heating systems with maximum operating temperatures over 105°C other safety aspects than those described in 4.6 may apply. The other clauses of this standard are still valid for those systems.

This standard does not cover additional safety requirements which may be applicable to heating systems greater than 1 MW design heat load.

This standard does not amend product standards or product installation requirements.

This standard covers the design of:

- heat supply systems;
- heat distribution systems;
- heat emission systems;
- control systems.

This standard takes into account heating requirements of attached systems (e.g. domestic hot water, process heat, air conditioning, ventilation) in the design of a heat supply, but does not cover the design of these systems.

This standard does not cover requirements for installation or commissioning or instructions for operation, maintenance and use of water based heating systems.

This standard does not cover the design of fuel and energy supply systems.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text, and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

EN 215-1
Thermostatic radiator valves - Part 1: Requirements and test methods.

EN 442-1
Radiators and convectors - Part 1: Technical specifications and requirements.

EN 442-2
Radiators and convectors – Part 2: Test methods and rating.

EN 442-3
Radiators and convectors – Part 3: Evaluation of conformity.

EN 563
Safety of machinery – Temperatures of touchable surfaces – Ergonomics data to establish temperature limit values for hot surfaces.

prEN 806-2
Specifications for installations inside buildings conveying water for human consumption – Part 2: Design.

EN 1264-1
Floor heating - Systems and components – Part 1: Definitions and symbols.

EN 1264-2
Floor heating - Systems and components – Part 2: Determination of the thermal output.

EN 1264-3
Floor heating - Systems and components – Part 3: Dimensioning.

prEN 1268-1
Safety devices for the protection against excessive pressure - Part 1: Safety valves.

EN 12170
Heating systems in buildings - Procedure for the preparation of documents for operation, maintenance and use - Heating systems requiring a trained operator.

EN 12171
Heating systems in buildings - Procedure for the preparation of documents for operation, maintenance and use - Heating systems not requiring a trained operator.

EN 12831
Heating systems in buildings - Method for calculation of the design heat load.

EN 13202
Ergonomics of the thermal environment - Temperatures of touchable hot surfaces - Guidance for establishing surface temperature limit values in production standards with the aid of EN 563.

prEN 13831
Closed expansion vessels with built-in diaphragm for installations in water systems.

EN 60730-2-9
Automatic electrical controls for household and similar use – Part 2-9: Particular requirements for temperature sensing controls (IEC 730-2-9:2000, modified).

EN ISO 7730
Moderate thermal environments - Determination of the PMV and PPD indices and specification of the conditions for thermal comfort (ISO 7730:1994).

3 Terms and definitions

For the purposes of this European Standard, the following terms and definitions apply.

3.1
attached system
ancillary system which may influence the design and heat load of the system but does not form an integral part of the space heating system. Examples of such ancillary systems include:

¾ domestic hot water systems;

¾ ventilation and air conditioning systems;

¾ process heating systems

3.2
central control
method of controlling the heat flow to a heat emission system by changing the flow rate and/or the flow temperature at a central point

3.3
design heat load
heat flow required to achieve the specified design conditions

3.4
design heat losses
quantity of heat per unit time leaving the building to the external environment under specified design conditions, i.e. heat losses calculated according to EN 12831

3.5
external design temperature
external air temperature which is used for the calculation of the design heat losses

3.6
external air temperature
air temperature outside the building

3.7
frost inhibitor
supplement to a heating medium lowering its freezing point

3.8
heat distribution system
configuration of interconnected components for the dispersal of heat between the heat supply system and the heat emission system or any attached system

3.9
heated space
space which is to be heated to the specified internal design temperature

3.10
heat emission system
configuration of interconnected components for the dispersal of heat to a heated space

3.11
heat gains
quantity of heat generated within or entering into a heated space from heat sources other than the heating system

3.12
heating period
time during which heating is required to maintain the internal design temperature

3.13
heat supply system
configuration of interconnected components/appliances for the supply of heat to the heat distribution system

3.14
internal design temperature
operative temperature at the centre of the heated space (between 0,6 and 1,6 m height) used for calculation of the design heat losses

3.15
local control
method of controlling the heat flow to a heat emission system by changing the flow rate or the flow temperature locally on the basis of the temperature of the heated space

3.16
open vented system
heating system in which the heating medium is open to the atmosphere

3.17
maximum operating pressure
maximum pressure at which the system, or parts of the system, is designed to operate

3.18
maximum operating temperature
maximum temperature at which the system, or parts of the system, is designed to operate

3.19
operative temperature
arithmetic average of the internal air temperature and the mean radiant temperature

3.20
pressure limiter
automatic operating device that causes shutdown and lock out of the heat supply when the maximum operating pressure of the heating medium is exceeded. The heat supply can only be restored when the pressure of the heating medium falls below the pressure limit and after resetting manually or using a tool

3.21
sealed system
heating system in which the heating medium is closed to the atmosphere

3.22
safety temperature limiter
automatic operating device that causes shutdown and lock out of the heat supply when the maximum operating temperature of the heating medium is exceeded. The heat supply can only be restored manually when the temperature of the heating medium falls below the operating temperature

3.23
temperature controller
automatic operating device that causes shutdown of the heat supply when the set operating temperature of the heating medium is exceeded. The heat supply will be restored automatically when the temperature of the heating medium falls below the set operating temperature

3.24
timing control
method of controlling the heat flow to a heat emission system by using a timed program for starting and shutdown of the heat flow

3.25
water level limiter
automatic operating device that causes shutdown and lock out of the heat supply when the set minimum water level of the heating medium is reached. The heat supply can only be restored when the water level of the heating medium rises above the set minimum water level and after resetting manually or using a tool

3.26
zone
space or groups of spaces with similar thermal characteristics

3.27
zone control
local control of a zone consisting of more than one space

4 System design requirements

4.1 Requirements for preliminary design information

The heating system shall be designed, installed and operated in a way that does not damage the building or other installations and with due consideration of costs and energy use.

The heating system shall be designed with due consideration to installation, commissioning, operation, maintenance and repair of components, appliances and the system.

At the planning stage or during the progress of design work the following items shall be agreed upon and documented:

a) clarification of the responsibilities of the designer and the installer and whether or not a qualified operator is required;

b) compliance with relevant local or statutory regulations;

c) thermal characteristics of the building for calculation of heat requirements and possible improvements of energy conservation;

d) external design temperature;

e) internal design temperature;

f) method of heat load calculation;

g) energy source;

h) position of the heat generator, bearing in mind access for maintenance, means of flueing and provision of combustion air;

i) type, location, dimensions, construction and suitability of chimney and flue terminal, if required;

j) location and size of fuel storage and access thereto, if required;

k) consideration of solid fuel, ash removal and disposal;

l) position of feed and expansion cistern for open vented systems or expansion vessel, filling point and pressure gauge for sealed systems;

m) facilities for filling and draining the system;

n) requirements for any attached system;

o) type and position of heat emitters;

p) control system of heating and attached system, including frost protection;

q) route and method of installing piping and insulation;

r) provisions and specification for balancing the system;

s) provision for measurement of energy consumption;

t) surface temperatures of exposed heating system surfaces;

u) provision for water treatment;

v) requirements for extra heating up capacity, including night-set-back or intermittent heating according to EN 12831 and buffer storage for hot water systems;

w) determination of the design factors f_{HL}, f_{DHW} and f_{AS} (see 4.2.2).

4.2 Heat supply

4.2.1 General

The heat supply system shall be designed to satisfy the design heat load of the building and the requirements of any attached system. The design heat load shall be calculated in accordance with EN 12831.

Any other recognized heat load calculation method may only be used if accepted by the client.

The heat supply system shall be designed and dimensioned taking into account the type of energy source.

General consideration should be given to energy efficiency of the heating system.

4.2.2 Sizing

The heat supply to serve the system shall be sized to meet the design heat load and the necessary additional heat supply requirements of any ancillary domestic hot water and other attached systems in accordance with the specifications agreed upon in 4.1.

If the total heat supply is provided by more than one heat generator or heat source, the following points shall be considered:

¾ the heat load;

¾ different operating periods, such as summer and winter;

¾ different operating conditions, such as for heating or for hot water;

¾ operating requirements, such as standby.

The capacity of the heat supply system shall be calculated as follows:

$$ {}_{SU} = f_{HL} \times {}_{HL} + f_{DHW} \times {}_{DHW} + f_{AS} \times {}_{AS} \qquad (1)$$

where:

${}_{SU}$	is the capacity of the heat supply system in kilo Watts (kW);
f_{HL}	is the design factor for the heat load;
${}_{HL}$	is the heat load capacity in kilo Watts (kW);
f_{DHW}	is the design factor for domestic hot water systems;
${}_{DHW}$	is the domestic hot water capacity in kilo Watts (kW);
f_{AS}	is the design factor for attached systems;
${}_{AS}$	is the capacity of attached systems in kilo Watts (kW);

The design factors f_{HL}, f_{DHW} and f_{AS} shall be determined on an individual basis subject to national limitations. It should be considered that the above heat load capacities may not be cumulative and the heat supply capacity should be determined based on agreed criteria for their demand.

4.3 Heat distribution

4.3.1 General

The heat distribution system shall be designed to distribute the heat supply to the heat emission system and, if necessary, to any attached systems.

The heat distribution system, including sub-circuits, shall be designed so as to enable hydraulic balancing.

Consideration shall be given to any variety of demand for attached systems and to the quality of the water.

Consideration shall be given to separate circuits for each type of heat emission system, the zoning requirement of buildings and the supply temperature and temperature difference of each heat emission system.

Provision for filling, draining and venting shall be provided for each circuit.

4.3.2 Design criteria

4.3.2.1 Water specification

The quality of the water in the heating circuit shall conform to the design and the selected components of the heating system.

Consideration shall be given to:

- the chemical characteristics of the water, e.g. pH, O_2, Cl_2 and carbonates;
- supplements for water treatment and/or anti-freeze, when necessary. These shall be used in accordance with the appliance, component and chemical manufacturers' requirements.

4.3.2.2 Water flow rate

The water flow rate and the initial setting of the balancing devices, where required in accordance with the specification, shall be stated and documented according to the flow rate requirements of the heat supply system as well as the heat emission system and any attached systems.

Consideration shall be given to:

- balancing devices;
- hydraulic decoupling devices;
- speed-controlled circulation pumps.

4.3.2.3 Circulation pumps

Circulation pumps shall be sized to circulate water at the flow rate required to distribute the heat load to the heat emission system and any attached systems.

Consideration shall be given to:

- the number of pumps, including stand-by provision;
- characteristic curves and the optimum range of application;
- the variable flow control system;
- minimizing the electric power required;

¾ provisions for insulation;

¾ noise transmittance;

¾ speed controlled circulation pumps;

¾ automatic on- off control;

¾ the static height provided at the suction side of the circulation pump, in accordance with the pump manufacturer's instructions, e.g. to avoid cavitation.

4.3.2.4 Pipework

Pipework shall be designed and sized to carry water at the appropriate heat flow rate to ensure required circulation to all parts of the heating system. Pipework and thermal insulation material shall be compatible.

Consideration shall be given to:

¾ temperature;

¾ design pressure;

¾ pressure drop;

¾ energy demand regarding electric power of the circulation pumps;

¾ corrosion and component compatibility, including glands and seals;

¾ noise transmittance, i.e. flow velocity and mechanical noise;

¾ thermal expansion and contraction;

¾ pipework routing and physical protection, accessibility for inspection and repairs;

¾ measurement of energy consumption;

¾ resistance to fire;

¾ service and maintenance, including filling, draining down and venting.

4.4 Heat emission

4.4.1 General

Heat emitters shall be selected on the basis of design heat load.

Consideration shall be given to:

¾ the design heat load;

¾ the system flow temperature;

¾ thermal comfort and noise in occupied spaces;

¾ safety of the occupants, e.g. surface temperature of the heat emitters;

¾ protection and prevention of damage to the building components;

¾ maintenance requirements, e.g. cleaning and repair;

¾ compatibility with heat supply, heat distribution and control system.

Thermal comfort should be in accordance with EN ISO 7730, where specified.

4.4.2 Sizing

Heat emitters shall be sized in accordance with the space by space design heat load calculated in accordance with EN 12831, with due allowance for heat emission from other system components, such as pipework.

The size of the emitter, temperature of the emitter and water flow rates shall be determined on the basis of manufacturer's data sheets according to EN 442-1 to 3 or EN 1264-1 to 3.

The design shall include consideration of factors that can affect the output of the emitter and take into account, that such effects are often cumulative, e.g. casing, connections, water flow rate, covering, paint, carpets, drapes.

Depending on the original design parameters, the designer may consider an additional allowance on the heat emitter output, e.g. for systems that are being operated intermittently (see EN 12831).

In rooms with high ceilings, a high vertical air-temperature difference may occur, rather than the uniform temperature assumed in the heat loss calculations. In such cases, the heat loss through the upper part of the heated space is larger, and an additional allowance on emitter output may be desired.

4.4.3 Positioning

When positioning heat emitters, the manufacturer's specific mounting requirements shall be considered.

In choosing the location of heat emitters, consideration shall be given to the overall effect upon the control of room temperatures and comfort conditions.

The positioning, type, number and size of the heat emitters in a space, together with the thermal transmittance of windows and/or walls, will influence the differences in the operative temperatures in the space, the radiant temperature asymmetry and draught.

4.4.4 Thermal environment

If required by the client, documentation and, if appropriate, calculation criteria of the thermal environment shall be fulfilled in accordance with EN ISO 7730, i.e. difference in operative temperature, radiant temperature asymmetry and draught.

4.4.5 Surface temperatures

In special cases, e.g. schools, nurseries and homes for the elderly, infirm or disabled, the surface temperatures of heat emitters shall be limited in accordance with local or statutory requirements (see EN 563 and EN 13202).

4.5 Controls

4.5.1 General

Control of the heating system shall enable the specified designed indoor temperatures to be achieved under the specified variation of internal loads and external climate and, if specified, protect buildings and equipment against frost and moisture damage when normal comfort temperature level is not required.

Heating systems shall be equipped with automatic and/or manual control devices. Classes for devices are given in annex A.

The design of control systems shall take into account the building, its intended use and the effective functioning of the heating system, the efficient use of energy and avoiding heating the building to full design conditions when not required. This shall include keeping distribution heat losses as low as possible, e.g. reducing flow temperature when normal comfort temperature level is not required.

Return water temperatures and/or the temperature drop across the supply and return connections shall be selected in accordance with the requirements of the manufacturer of the heat emitters.

Additional control requirements may be necessary in accordance with other component manufacturer's instructions.

Thermostatically controlled radiator valves shall comply with EN 215-1.

4.5.2 Classification

The control system shall be classified as follows:

a) classification based on heating control system level:

- ¾ Central control (C);
- ¾ Zone control (Z);
- ¾ Local control (L).

b) classification based on control system performance level:

- ¾ Manual (M),
- ¾ Automatic (A),
- ¾ Timing function (T),
- ¾ Advanced timing function (O).

For details, see annex A.

4.5.3 Central control

4.5.3.1 General

Central control of the heat flow to the heat distribution system shall be provided.

The central control, or part of it, can in some cases be part of the heat supply, e.g. a temperature controller on a heat generator.

In heating systems with single heating circuits, the indoor temperature may be controlled by the boiler control thermostat, draught regulator, circulation pump or time and central temperature control.

4.5.3.2 Heat flow to the distribution system

The heat flow to the heat distribution system shall be controlled to supply water with a heat content required by the heat emission system.

The heat flow to the heat distribution system depends on design criteria for the heating system relative to indoor and outdoor conditions, e.g. air temperature, wind and direct solar radiation.

The heat flow can be manually or automatically controlled. Care should be taken when locating and fixing sensors to ensure that the position chosen is representative. Outside air temperature sensors should be positioned so as not to be exposed to direct solar radiation and to avoid influences from any hot or cold sources, unless the control is designed to take account of such factors.

4.5.3.3 Heat flow rate to attached systems

The heat flow rate to the attached systems shall be controlled by central control of the heat supply in accordance with the heat demand of the attached systems.

4.5.4 Zone control

If specified, the heating system shall be divided into zones in the interests of energy conservation, measurement of energy consumption and indoor zone temperature control.

The temperature sensor for the controller shall be located in a position representative of the entire zone.

If the system is subdivided into zones, the design shall ensure that all emitters in different spaces of a zone have the same required operational parameters.

The spaces of a zone shall be selected in such a way that internal and solar gains are approximately the same both in rate and value.

Examples for controlling indoor zone temperature are given in annex A.

4.5.5 Local control

In order to achieve specific indoor temperatures, under varying loads, each heated space shall be equipped with local control. Local control can be achieved by manual or automatic regulation.

Local control shall enable the user to set up individual temperature preferences within the specified range.

The local controller shall be fitted in a position readily accessible to the user.

A local control may control one individual heat emitter or a group of heat emitters.

The control of the indoor temperature is influenced by the response time of the building (thermal mass), the response time of the heating system and the control strategy.

Automatic local control is especially useful for convenience of the users, for achieving possible energy savings and for adjusting for heat gains from internal loads or solar radiation.

Temperature sensors shall be fitted in a representative location to maintain design conditions, and so that undesirable effects from direct solar radiation, curtains, etc. are prevented.

4.5.6 Timing control

Timing control shall be considered in the interest of energy conservation and reduced operating costs.

If timing control is fitted, the supply of heat shall be controlled according to the use of the building, e.g. residential buildings, office buildings, schools, and its thermal characteristics, such as insulation, thermal inertia, etc., in one of the following ways:

- ON/OFF control;
- set-back control;
- intermittent control;
- optimizing control.

Timing control can be used to provide a variable heat flow rate. Timing control can regulate the supply temperature or supply flow rate.

4.6 Safety arrangements

4.6.1 General

Heating systems shall be equipped with safety arrangements against:

¾ exceeding the maximum operating temperature;

¾ exceeding the maximum operating pressure.

Safety arrangements shall be designed in accordance with:

¾ the type of heating system, i.e. sealed or open vented system;

¾ the type of energy source;

¾ the way in which the heat supply is provided to the heating system, i.e. automatically controlled or manually operated;

¾ the nominal output of the heat supply system.

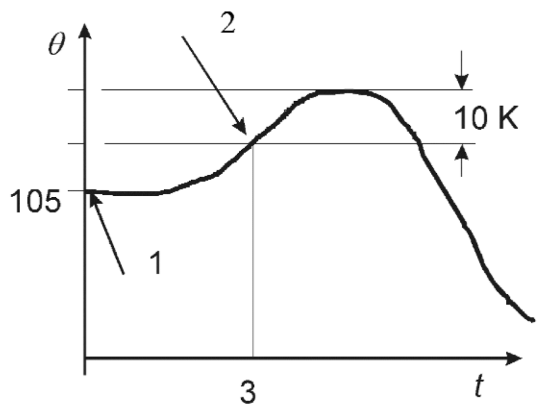
Safety arrangements, whether provided by the appliance manufacturer as a built-in part of the heat generator or heat source or not, shall be an integral part of the heating system. The appliance manufacturer's installation instructions shall be complied with.

4.6.2 Equipment required for sealed sysems

4.6.2.1 Protection against exceeding the maximum operating temperature

Each heat generator shall be served by a safety temperature limiter, including a specific sensor, which shall respond in case of the temperature rising to the set limit.

If the heat generator is not equipped with a safety temperature limiter by the manufacturer, such a device shall be fitted on the system flow pipe as near as possible to the heat generator, in order to achieve that the temperature at the heat generator shall not rise by more than 10 K after switching off the heating or fuel supply or restricting the fuel flow to a minimum, (see Figure 1).



Key

1 Maximum operating temperature
2 Activation of safety temperature limiter
3 System shutoff
= Temperature in degrees Celsius (C)
t = Time in hours (h)

Figure 1 — Typical system temperature development in a fault condition

If the heat supply system is a heat exchanger and the temperature on the primary side can cause a risk of steam formation in the secondary side of the system, a temperature limiter shall interrupt the supply of energy to the secondary side of the heat exchanger by a blocking valve connected to the primary side of the heat exchanger.

For temperatures up to 105 C on the primary side of the heat exchanger, it is only necessary to have an operating temperature controller on the secondary side.

Non-automatically controlled heat supply systems shall include special temperature limiters for emergency cooling.

If the heating system is equipped with a heat exchanger for emergency cooling, the temperature limiter shall operate as an over-temperature safeguard device if the maximum operating temperature rises by more than 10 K.

The temperature limiter shall conform to EN 60730-2-9.

Any system heated by a heat exchanger shall be equipped with a safety temperature detector that switches off the heating so that the operating temperature does not exceed the maximum operating temperature. For solid fuel appliances a heat distribution circuit shall be provided to operate in an overheat situation.

4.6.2.2 Protection against exceeding the maximum operating pressure

4.6.2.2.1 Safety valves, rating and arrangements

Each heat generator of a heating system shall be served by at least one safety valve in order to protect the system against exceeding the maximum operating pressure. If the heat generator is not equipped with a safety valve by the manufacturer, such a device shall be fitted on the system as near as possible to the heat generator.

In using more than one safety valve, the smaller valves shall have a discharge capacity of at least 40 % of the total flow.

The safety valve(s) shall be sized to serve the total pressure developed in the system or parts of the system.

Safety valve(s) shall:

¾ conform to prEN 1268-1, with a minimum size of DN 15;

¾ open at a pressure not exceeding the maximum design pressure of the system and shall be designed to prevent the maximum operating pressure from being exceeded by more than 10 %;

¾ be installed so that the pressure drop of the inlet pipe does not exceed 3 %, and the pressure drop of the discharge pipe does not exceed 10 % of the safety valve set pressure.

Safety valves shall be installed in an accessible location in the immediate vicinity of the heat generator flow pipe. There shall be no isolation valve between the heat generator and the safety valve(s).

Safety valves shall discharge safely. Therefore suitable installations shall be provided.

This can be achieved by a relief pipe of the safety valve(s) that discharges to a drain in a safe location. Special provisions may apply to heat generators greater than 300 kW nominal heat output. These shall be served by liquid separator(s) in the immediate vicinity of the safety valve(s) and a vapour discharging pipe rising to the open air.

Liquid separators may not be necessary in cases in which each heat generator is served by an additional temperature limiter and an additional pressure limiter.

4.6.2.2.2 Pressure limiter

Each heat generator greater than 300 kW nominal heat output shall be served by a pressure limiter. If the heat generator is not equipped with a pressure limiter by the manufacturer, such a device shall be fitted on the system as near as possible to the heat generator.

Where other assisting heat supply systems are present, e.g. solar systems, their specific safety requirements shall apply.

If the operating pressure of the heating system exceeds the given pressure limit, or in the case of auxiliary power interruption, the pressure limiter shall shut-off the heating or fuel supply and interlock it against automatic restoring. The pressure limiter shall be adjusted so that it responds before the safety valve(s) operate.

Systems served by heat exchangers may not require pressure limiters.

4.6.2.3 Safeguard against lack of water

Sealed heating systems, except electrode type heat generators and heating systems on the secondary side of heat exchangers, shall be equipped with a water level limiter or other device, e.g. minimum pressure limiter or flow controller, thus providing interlock protection against excess temperature rise on the heat emitting surface of the heat generator.

A water level limiter or other appropriate device is not required with generators up to 300 kW nominal heat output, if it is ensured that an unacceptable temperature rise cannot occur when there is lack of water.

If the generator is located higher than most of the heat emitters, a water level limiter or other appropriate device shall be used for all heat generators.

4.6.2.4 Expansion vessels

Expansion vessels shall be designed to accommodate at least the maximum expansion volume of the heating water of the system including a minimal water reserve volume. The expansion vessel shall conform to prEN 13831. The expansion vessel and the connecting pipe to the heating system shall:

- be dimensioned so that the temperature rise up to the maximum operating temperature does not cause a pressure rise in the system at which the pressure limiting device and safety valves respond;
- be installed in frost protected rooms or protected against freezing.

Diaphragm-type expansion vessels shall be positioned so that the maximum allowable temperature of the membrane given by the manufacturer cannot be exceeded. The installation should preferably be on the return pipe or at the point of the lowest system temperature. The expansion vessel manufacturer's installation instructions shall be paramount. For guidance on dimensioning, see annex D.

There shall be no shut-off device positioned between the expansion vessel and heat generator(s). Consideration may be given to an engineer’s lockable isolating valve for maintenance purposes.

4.6.3 Equipment required for open vented systems

4.6.3.1 Expansion cisterns

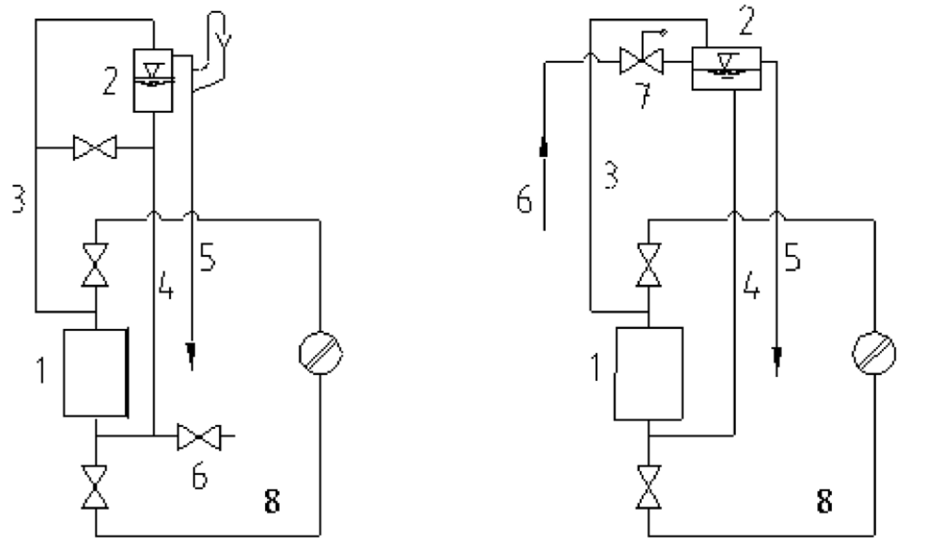
Heat generators in an open vented system shall be connected to an expansion cistern, which is installed at the highest point of the heating system.

Expansion cisterns shall be dimensioned so that changes in water volume due to heating up and cooling down can be accommodated.

Open vented system expansion cisterns shall be provided with a cistern vent and overflow pipe that cannot be blocked. The overflow pipe shall be dimensioned so that it can safely drain off the maximum mass flow rate entering the system, which can be achieved by selecting the overflow pipe to be one DN-size larger than the filling pipe.

Expansion cisterns, safety pipes, open vent and overflow pipes shall be designed and arranged to protect against freezing.

Installation examples are given in Figure 2.



Key

1 Heat generator
2 Expansion cistern
3 Safety pipe
4 Cold feed and expansion pipe
5 Overflow pipe
6 Filling pipe
7 Water level limiter
8 Return pipe

Figure 2 — Installation examples of expansion cisterns

4.6.3.2 Safety pipes and feed and expansion pipes

Heat generators shall be connected to an expansion cistern and served by an open vent pipe. The expansion cistern shall be vented to the atmosphere. The feed and expansion pipe shall be connected to the lower part of the expansion cistern. Unless otherwise stated in the appliance manufacturer's installation instructions for the heat generator, the minimum internal diameter of the open vent safety pipe and the feed and expansion pipe shall be:

safety pipe: $d_s = 15 + 1{,}4\sqrt{\ }$ [mm] (but not less than 19 mm internal diameter) (2)

feed and expansion pipe: $d_{fe} = 15 + 1{,}0\sqrt{\ }$ [mm] (3)

where:

is the nominal heat output of the heat generator in kilo Watts (kW).

Shutting off of the safety pipe or the feed and expansion pipes shall not be possible.

4.7 Operational requirements

4.7.1 General

In order to maintain a safe and economical operation, heating systems shall be equipped with:

¾ provision for monitoring the operation conditions, e.g. temperature, pressure in sealed systems and the water level in open vented systems;

¾ devices for controlling the operating temperature and/or the energy supply in an on-off, step control or modulating operation;

¾ devices, where specified, for controlling the operating pressure of the heating system.

4.7.2 Provision for monitoring operating conditions

Heating systems shall be served by at least one temperature measuring device with a range of at least 20 % higher than the maximum operating temperature and mounted in the flow pipe of the system.

Heating systems shall be served by at least one pressure gauge with a measuring range of at least 50 % higher than the maximum operating pressure.

Unless otherwise stated in the heat generator appliance manufacturer's installation instructions, open vented systems do not require the above.

4.7.3 Temperature controller

Heating systems shall be served by a temperature controller and/or similar device to adapt the heat supply to the heat demand.

The maximum setpoint of the temperature controller shall not exceed the maximum operating temperature of the heat supply system.

4.7.4 Pressure maintaining device

Heating systems should be equipped with a pressure maintaining control device to ensure the required minimum operating pressure of the system. This can be achieved for example by using an expansion vessel linked to a low pressure limiter, automatic refill-set or feed and expansion cistern.

4.7.5 Water level adjustment

Heating systems shall be equipped with devices to fill the system and provide adjustment of the water level. Connections to a drinking water supply system shall comply with prEN 806-2, e. g. back-flow prevention.

4.8 Thermal insulation

4.8.1 General

The components of the heat distribution system, including pipework throughout its entire length, which do not contribute directly to heat emission shall be insulated to:

¾ minimize heat losses;

¾ avoid harmful effects of too high surface temperatures to ensure the safety of the occupants, e.g. physical impact or skin contact with surfaces at operating temperatures;

¾ avoid damage to the heating installation caused by frost, e.g. frost protection.

The following design aspects shall be considered in addition:

¾ increase in internal temperatures;

¾ reduction in flow temperature;

¾ fire protection;

¾ selection of insulation materials to suit the application.

The insulation material shall be selected to suite the application and to avoid corrosion and incompatibility between components of the piping system and electrical cables, cords and electrical components.

Insulation material and thickness shall be selected in accordance with the national regulations concerning fire resistance and also be resistant to humidity, chemical and bacteriological effects under normal conditions.

If required, calculations for insulation thickness may be carried out in accordance with EN ISO 12241.

4.8.2 Undesirable heat losses

The following parameters shall be considered as a basis for selection of insulation:

¾ the nominal size of piping and/or components;

¾ the temperature of the heating medium;

¾ the average temperature of the environment during the heating period;

¾ the length of operation period of the heating system;

¾ the thermal transmittance of the insulation material.

Parts of the heating system located in unheated spaces shall be insulated to reduce undesirable heat losses. Suitable insulation classes can be selected from Table 1:

Table 1 — Thermal transmittance classes

Insulation class	Maximum thermal transmittance	
	Pipes with external diameter d_1 0,4 m W/m·K [a]	Pipes with external diameter d_1 > 0,4 m or plane surfaces [b] W/m²·K [c]
0	-	-
1	$3{,}3 \cdot d_1 + 0{,}22$	1,17
2	$2{,}6 \cdot d_1 + 0{,}20$	0,88
3	$2{,}0 \cdot d_1 + 0{,}18$	0,66
4	$1{,}5 \cdot d_1 + 0{,}16$	0,49
5	$1{,}1 \cdot d_1 + 0{,}14$	0,35
6	$0{,}8 \cdot d_1 + 0{,}12$	0,22

[a] Linear thermal transmittance per unit length of the pipe.

[b] Includes tanks and other installation units with plane or curved surfaces and large pipes with non-circular cross sections

[c] Thermal transmittance per unit area of the pipe.

The thickness of insulation corresponding to each thermal transmittance class is given in Table C.2.

Unless otherwise specified all components of a piping system shall be insulated to a level at least equivalent to that of the adjoining pipework.

Radiator supply pipes are usually not insulated when placed in the same zone as the radiator. In well insulated buildings, however, the part of the piping system that is not part of the heat emission system, should be insulated to avoid undesirable increases of internal air temperature. An increase of more than 2 K in room temperature at design conditions should be avoided.

4.8.3 Harmful effects of too high temperatures

Components of the heating system shall be insulated in order to avoid injuries to occupants and damage to other installations or building components (see EN 563 and EN 13202).

The following parameters shall be used as a basis for the calculation of insulation thickness:

- the design operating temperature of the heating medium;
- the design temperature of the environment;
- the thermal resistance of the insulation.

4.8.4 Frost protection

Components of the heating system exposed to frost shall be insulated.

The following parameters shall be used as a basis for the calculation:

- the external design temperature;
- the initial and final medium temperature;
- the thermal resistance of the insulation.

For extreme cold conditions, small pipes, i.e. less than DN 50, shall be protected against freezing by other means than insulation, e. g. automatic primary water circulation or trace heating.

5 Instructions for operation, maintenance and use

Instructions for operation, maintenance and use shall comply with EN 12170 or EN 12171, in accordance with the contract specification and be prepared prior to commissioning. The system design shall include the specification data for balancing the system.

6 Installation and commissioning

The designer shall declare the operating conditions for which the installation has been designed.

The system design shall include provisions for balancing the system.

Annex A
(informative)

Control system classification

A.1 Control system classification

A.1.1 General

The control system consists of a number of elements and design mainly involves deciding which combination of elements should be used. Starting from the heating control system mode and the performance of the control system, a classification can be set up as follows.

A.1.2 Heating control system modes

Three heating control system modes are detailed as follows:

- **Local control (L)**
  Heat supplied to the heated space is controlled;
- **Zone control (Z)**
  Heat supplied to the zone is controlled;
- **Central control (C)**
  Heat supplied to the whole building is controlled by a central system.

A.1.3 Control system performance modes

For each heating control system mode, four control system performance modes are detailed as follows:

- **Manual (M)**
  The heat supply to the heated spaces is only controlled by a manually operated device;
- **Automatic (A)**
  A suitable system or device automatically controls the heat to the heated spaces;
- **Timing function (T)**
  Heat supplied to the heated space is shut-off or reduced during scheduled periods, e.g. night set back;
- **Optimization of timing control (O)**
  Heat supply to the heated space is shut-off or reduced during scheduled periods. Re-starting of the heat supply is optimized based on various considerations, including reduction of energy consumption.

A.1.4 Control system classification table

Heating control system modes and control system performance modes are combined in Table A.1.

Table A.1 — Control system classification table

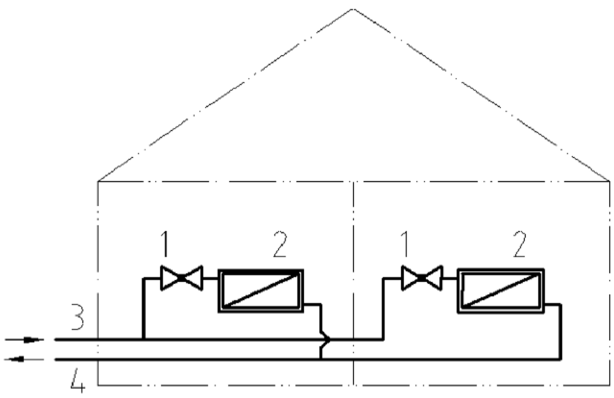
HEATING CONTROL SYSTEM MODE	CONTROL SYSTEM PERFORMANCE MODES			
	Manual	Automatic	Timing function	Optimization of timing control
Local				
Zone				
Central				

Table A.1 should be used to describe the type and performance of the control system. It can be used by the building owner or a representative to define how the heating system is to be controlled.

At the commissioning stage, Table A.1 can be used for checking the design performance of the control system.

A.2 Examples of control system classification

A.2.1 Local manual control



Key

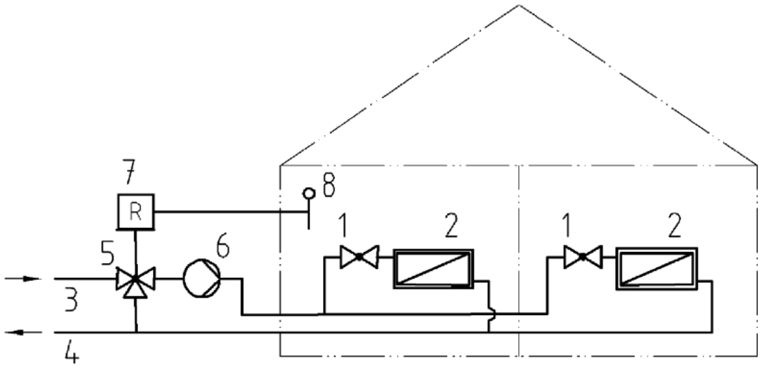
1 Manually operated valve
2 Radiator
3 Feed pipe
4 Return pipe

Figure A.1 — Indoor temperature control system with local manual mode in an individual house

Table A.2 — Control system classification

HEATING CONTROL SYSTEM MODE	CONTROL SYSTEM PERFORMANCE MODES			
	Manual	Automatic	Timing function	Optimization of timing control
Local	XXXXX			
Zone				
Central				

A.2.2 Local manual control and central automatic control



Key

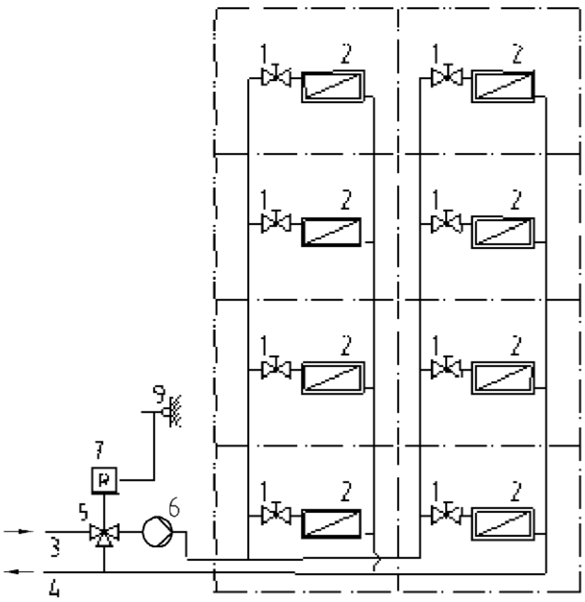
1 Manually operated valve
2 Radiator
3 Feed pipe
4 Return pipe
5 Heat flow mixing valve (3-way-valve)
6 Heat flow circulating pump
7 Central unit for automatic regulation
8 Indoor temperature sensor

Figure A.2 — Indoor temperature control system with local manual mode and central automatic mode in an individual house

Table A.3 — Control system classification

HEATING CONTROL SYSTEM MODE	CONTROL SYSTEM PERFORMANCE MODES			
	Manual	Automatic	Timing function	Optimization of timing control
Local	XXXXX			
Zone				
Central		XXXXX		

A.2.3 Local automatic control and central automatic control



Key

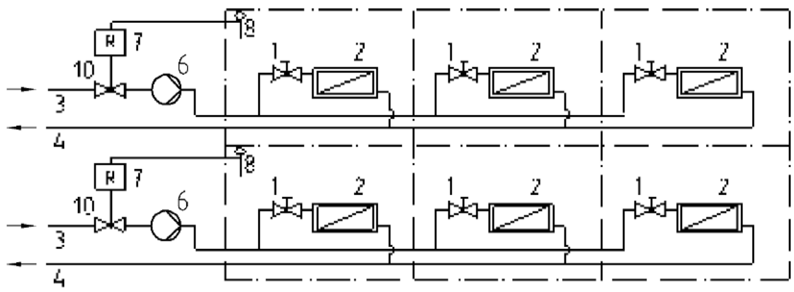
1 Thermostatic valve
2 Radiator
3 Feed pipe
4 Return pipe
5 Heat flow mixing valve (3-way-valve)
6 Heat flow circulating pump
7 Central unit for automatic control
9 Outdoor temperature sensor

Figure A.3 — Indoor temperature control system with an outdoor sensor, local automatic mode and central automatic mode in a multi-story residential building

Table A.4 — Control system classification

HEATING CONTROL SYSTEM MODE	CONTROL SYSTEM PERFORMANCE MODES			
	Manual	Automatic	Timing function	Optimization of timing control
Local		XXXXX		
Zone				
Central		XXXXX		

A.2.4 Local automatic control and automatic zone control



Key

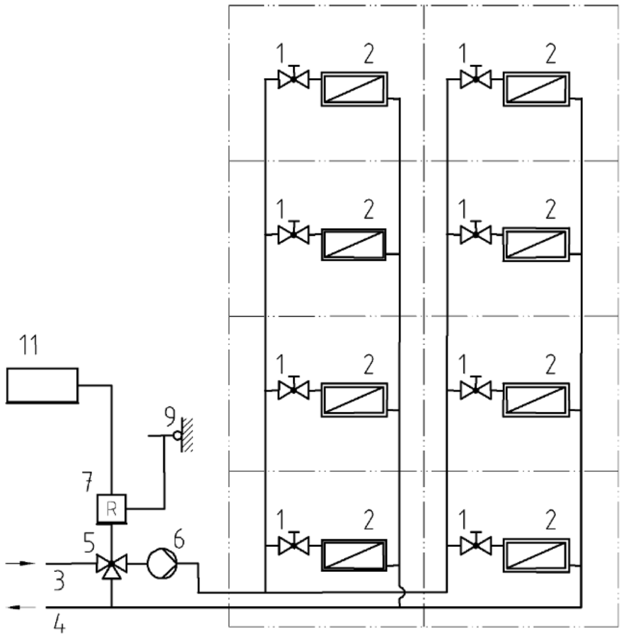
1 Thermostatic valve
2 Radiator
3 Feed pipe
4 Return pipe
6 Heat flow circulation pump
7 Central unit for automatic control
8 Indoor temperature sensor
10 Shut-off valve

Figure A.4 — Indoor temperature control system with local automatic mode and automatic zone control mode in a two-storey commercial building

Table A.5 — Control system classification

HEATING CONTROL SYSTEM MODE	CONTROL SYSTEM PERFORMANCE MODES			
	Manual	Automatic	Timing function	Optimization of timing control
Local		XXXXX		
Zone		XXXXX		
Central				

A.2.5 Local automatic control and central automatic control with optimization



Key

1 Thermostatic valve
2 Radiator
3 Feed pipe
4 Return pipe
5 Heat flow mixing valve (3-way-valve)
6 Heat flow circulation pump
7 Central unit for automatic control
9 Outdoor temperature sensor
11 Optimizer

Figure A.5 — Indoor temperature control system with an outdoor sensor, local automatic mode and central automatic mode with optimization program in a multi-storey office building

Table A.6 — Control system classification

HEATING CONTROL SYSTEM MODE	CONTROL SYSTEM PERFORMANCE MODES			
	Manual	Automatic	Timing function	Optimization of timing control
Local		XXXXX		
Zone				
Central		XXXXX		XXXXX

Annex B
(informative)

Thermal Environment

Criteria for thermal comfort should be based on the methods given in EN ISO 7730.

These criteria may be verified in existing buildings by measurements of the relevant parameters in accordance with EN ISO 7726.

Several of the comfort criteria, i.e. operative temperature, operative temperature difference between coldest and warmest position in a space, radiant temperature asymmetry from cold vertical surfaces or hot horizontal surfaces, draught from cold surfaces and floor surface temperatures, can be verified by calculations at the design stage.

Simplified hand calculation and computer models can give internal surface temperatures based on the knowledge of the outside temperature, insulation of the building elements and indoor temperature. From this it is possible to calculate mean radiant temperatures, operative temperatures, radiant temperature asymmetries and air velocities due to down draught from cold surfaces.

Operative temperature difference in a space, radiant temperature, e.g. asymmetry, and down draught from a cold surface are mainly influenced by the internal surface temperature of the outside window/wall.

If the average thermal transmittance, U_w, of the outside wall/window meets the following criteria, requirements for thermal comfort need not be verified.

The listed equations are based on the following assumptions:

¾ surface temperatures of outside wall/window is calculated as:

$$_{W} = {}_{d,i} \quad U_W \times 0,12 \times \left({}_{d,i} \quad {}_{d,e} \right);$$

¾ all surface temperatures of internal walls, floors and ceilings are equal to the indoor design temperature, $_{d,i}$;

¾ $_{o} = 0,5 \times \left({}_{a} + \bar{}_{r} \right).$

1) Operative temperature difference in a space

In EN ISO 7730 it is recommended that the difference is lower than 4 K. This will apply if:

$$U_W < \frac{128}{{}_{d,i} \quad {}_{d,e}} \qquad \frac{W}{m^2 \times K}$$

2) Radiant temperature asymmetry from cold surface

In EN ISO 7730 it is recommended that the asymmetry is lower than 10 K. This will apply if:

$$U_W < \frac{128}{{}_{d,i} \quad {}_{d,e}} \qquad \frac{W}{m^2 \times K}$$

3) Down draught from cold surface

In EN ISO 7730 it is recommended that the mean air velocity is lower than 0,18 m/s with low turbulence and a 20 °C air temperature. This will apply if:

$$U_W < \frac{150}{h \times (\quad _{d,i} \quad\quad _{d,e})} \qquad \frac{W}{m^2 \times K}$$

where:

U_W is the thermal transmittance of the outside wall/window in Watts per square metres per Kelvin ($W/m^2 \cdot K$);

$_{d,i}$ is the internal design temperature in degrees Celsius (°C);

$_{d,e}$ is the external design temperature in degrees Celsius (°C);

$_o$ is the operative temperature in degrees Celsius (°C);

$_a$ is the air temperature in degrees Celsius (°C);

$_r$ is the mean radiant temperature in degrees Celsius (°C);

h is the window height in metres (m).

For criteria 1 and 2, the average thermal transmittance of the outside wall and the window should be used.

For criteria 3, the thermal transmittance of the window should be used.

Example

Internal design temperature = 20 °C

External design temperature = -12 °C

Window height = 2 m

Criterion 1:

$$U_W < \frac{128}{32} = 4\ W / m^2 \times K$$

Criterion 2:

$$U_W < \frac{80}{32} = 2{,}5\ W / m^2 \times K$$

Criterion 3:

$$U_W < \frac{150}{2 \times 21} = 2{,}3\ W / m^2 \times K$$

If the thermal transmittance of the window is less than 2,3 $W/m^2 \cdot K$, the thermal comfort requirements need not be verified.

Annex C
(informative)

Thermal insulation

The operational parameter, I, is defined as: $I = \int f_a \times (\;_{w} \quad _{e}) \times dt$

where

$_{w}$	is the water temperature in degrees Celsius (°C);
$_{e}$	is the temperature of the surrounding environment in degrees Celsius (°C);
t	is time in seconds (s);
f_a	is the fraction of heat emission, considered as wasted;
	is the integration time (equal to the heating period) in seconds (s).

The operational parameter can be worked out by means of:

¾ the average temperature difference, $(\;_{W} \quad _{e})$;

¾ an estimated value of f_a;

¾ duration of the heating season, t.

The operational parameter is then equal to: $I = f_a \times (\;_{w} \quad _{e}) \times t$

Future alterations to the functions of the building and its installations should be considered because the highest operational parameter occurring during the life of the system may decide the insulation class. A lower class than determined is acceptable in special cases, for instance in buildings with a lifetime of less than five years.

The recommended insulation class depending on the operational parameter can be selected from Table C.1:

Table C.1 — Insulation classes

Insulation class	Operational parameter, I C×s / year x 10^9
0	$I < 0{,}05$
1	$0{,}05 < I < 0{,}17$
2	$0{,}17 < I < 0{,}35$
3	$0{,}35 < I < 0{,}70$
4	$0{,}70 < I < 1{,}40$
5	$1{,}40 < I < 2{,}80$
6	$I > 2{,}80$

Minimum insulation thicknesses, in millimetres, conforming to classes 1 to 6 of Table C.1, depending on conductivity, , and external pipe diameter, d_1, are given in Table C.2. It is assumed that the external surface heat transfer coefficient is 9 W/m²∗K.

The thermal transmittance for pipes is stated in Watts per metre per Kelvin (W/m∗K) and for plane surfaces in Watts per square metres per Kelvin (W/m²∗K). The conductivity, , is calculated on the basis of the average temperature during the operation period.

Linear interpolation is applicable.

Table C.2 — Insulation thickness in mm and thermal transmission coefficient for insulation classes 1 to 6

d_1 mm	Class 1					Class 2				
	U_L W/m∗K	W/m∗K				U_L W/m∗K	W/m∗K			
		0,03	0,04	0,05	0,06		0,03	0,04	0,05	0,06
10	0,25	1	3	6	11	0,23	2	5	8	14
20	0,29	5	7	11	16	0,25	7	12	19	27
30	0,32	8	12	17	23	0,28	11	17	25	36
40	0,35	10	14	20	28	0,30	14	21	30	42
60	0,42	12	18	26	37	0,36	17	26	37	50
80	0,48	14	22	31	41	0,41	20	29	41	54
100	0,55	15	23	32	44	0,46	22	32	43	57
200	0,88	19	26	35	46	0,72	27	37	49	62
300	1,21	21	29	39	50	0,98	28	39	51	64
plane	(1,17)	22	30	37	45	(0,88)	31	41	51	62

d_1 mm	Class 3					Class 4				
	U_L W/m∗K	W/m∗K				U_L W/m∗K	W/m∗K			
		0,03	0,04	0,05	0,06		0,03	0,04	0,05	0,06
10	0,20	4	7	13	20	0,18	6	11	19	31
20	0,22	10	17	26	38	0,19	13	23	36	56
30	0,24	14	23	35	50	0,21	19	31	49	72
40	0,26	18	28	41	58	0,22	24	38	58	84
60	0,30	23	35	50	69	0,25	30	47	70	99
80	0,34	26	39	55	74	0,28	35	54	77	107
100	0,38	29	42	59	78	0,31	38	58	82	112
200	0,58	35	50	66	85	0,46	47	68	92	120
300	0,78	38	53	69	86	0,61	51	72	95	122
plane	(0,66)	42	56	70	84	(0,49)	58	77	96	116

d_1 mm	Class 5					Class 6				
	U_L W/m∗K	W/m∗K				U_L W/m∗K	W/m∗K			
		0,03	0,04	0,05	0,06		0,03	0,04	0,05	0,06
10	0,15	9	17	29	49	0,13	13	22	40	62
20	0,16	18	33	54	86	0,14	25	36	70	110
30	0,17	16	45	71	111	0,14	35	57	94	148
40	0,18	32	54	85	128	0,15	43	68	110	156
60	0,21	41	67	102	150	0,17	60	90	138	210
80	0,23	48	76	113	162	0,18	70	108	155	240
100	0,25	53	82	120	169	0,20	75	115	165	260
200	0,36	65	97	134	178	0,28	83	133	180	280
300	0,47	71	102	137	178	0,36	89	149	223	290
plane	(0,35)	82	110	137	165	(0,22)	133	177	222	266

In the above tables:

U_L = linear thermal transmission coefficient for pipes in Watts per metre per Kelvin (W/m∗K);

= thermal conductivity of the insulation material in Watts per metre per Kelvin (W/m∗K);

d_1 = external pipe diameter in millimetres (mm);

plane = these values are used when considering plane surfaces.

Annex D
(informative)

Guidance for dimensioning diaphragm expansion vessels (sealed systems)

D.1 General

The following design considerations should be adhered to when a sealed diaphragm expansion vessel is incorporated:

a) the position of the expansion vessel in the heating system determines the neutral point of the system. At this position, the static, or final, pressure is always constant, independent of the operation of the circulation pump. This position should be selected so that the pressure on the suction side of the circulation pump is sufficient for operation, e.g. avoiding cavitation, and the temperature load on the diaphragm of the expansion vessel is kept at a minimum. The fill position should be between the expansion vessel connection point and the inlet of the circulation pump. The recommended point of connection of the expansion vessel to the system is shown in Figure D.1;

b) maximum design overshoot temperature. Since a fault condition may occur with the safety devices, the system temperature may rise above the maximum operating temperature to a higher temperature referred to as the maximum design overshoot temperature, $_{max}$. This maximum temperature of the heating system occurring in a fault condition should be used in the calculation of vessel size;

c) initial system design pressure. The initial system design pressure, p_0, should be at least equal to the sum of the static height pressure, p_{ST}, and the vapor pressure, p_D;

$$p_0 \quad p_{ST} + p_D$$

The minimum value of p_0 should normally be 0,7 bar. A practical margin which can be added to the static height pressure, instead of the vapor pressure, is 0,3 bar;

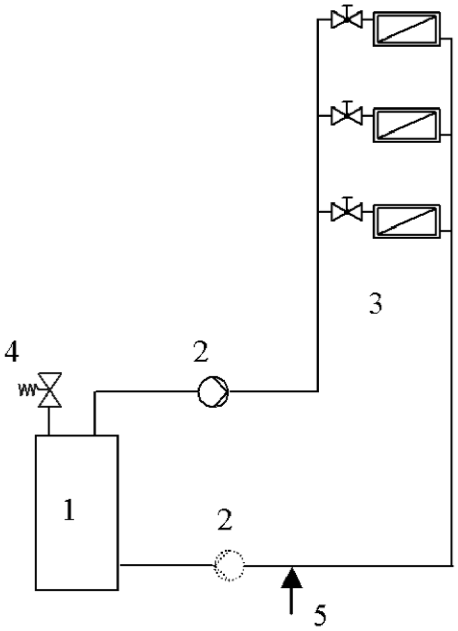
d) final system design pressure. The final system design pressure, p_e, should not be higher than the set pressure of the safety valve minus a difference in shut-off overpressure (typically 10% of the set pressure of the safety valve);

e) the difference in static height pressure between the location of the expansion vessel and the safety valve should be taken into account;

f) the total water content of the system, V_{system}, should be determined. Where it is not feasible to make an accurate calculation, extra care should be taken in estimating the volume;

g) the minimum capacity of the expansion vessel, $V_{exp,min}$, should be determined. The method given in D.2 for the accurate selection of the expansion vessel capacity should be followed. Where design information is not complete, Table D.1 can be used as a guide for selecting the size of the vessel. It should be noted that the values in Table D.1 are valid for a maximum design overshoot temperature of 110°C and no water reserve volume, i.e. V_{WR} = 0 litre;

h) in cases where a chemical inhibitor is added to the heating medium, e.g. to prevent corrosion in the system, care should be taken to ensure compatibility with the diaphragm, and other sealed system components.



Key

1 Heat generator
2 Circulation pump
3 Heating circuit
4 Safety valve
5 Recommended position for location of the expansion vessel

Figure D.1 — Recommended positioning of an expansion vessel in a heating system

D.2 Expansion vessel size calculation

The accurate size of the expansion vessel can be calculated as follows:

a) establish:

¾ the water content of the system, V_{system}, in litres. It is the total water content of the pipework, heat emitters, heat generators and auxiliary circuit;

¾ the maximum design overshoot temperature, $_{max}$, in degrees Celsius (°C);

¾ the expansion percentage, *e*, see Table D.2 or Figure D.2;

NOTE The addition of anti-freeze or similar fluid will affect the specific volume of the heating medium and thus the expansion percentage coefficient and can also affect the diaphragm material.

¾ the expansion volume, V_e, in litres using the expansion percentage at the maximum system flow temperature;

$$V_e = e \times \frac{V_{system}}{100};$$

¾ the water reserve volume, V_{WR}, in litres. In addition to the water volume resulting from thermal expansion, the expansion vessel should have minimal water reserve to compensate for possible water losses in the system. Expansion vessels with a capacity less than 15 litres should accommodate at least 20% of this volume as a water reserve. Expansion vessels with a capacity greater than 15 l should accommodate a water reserve of at least 0,5% of the total water content of the system, V_{system}, however, at least 3 l;

¾ the static height pressure, p_{ST}, in bar gauge.

NOTE Expansion vessels supplied into the domestic central heating market are pressurized during manufacture to pressures of 0,5 bar, 1,0 bar or 1,5 bar.

b) the total expansion vessel volume, $V_{exp,min}$, in litres, can now be calculated from:

$$V_{exp,min} = (V_e + V_{WR}) \times \frac{p_e + 1}{p_e \quad p_0}$$

c) in order for the expansion vessel to be capable of accommodating the water reserve, V_{WR}, when the system is in a cold state, the initial pressure, $p_{a,min}$, (system filling pressure) should fulfil the following:

$$p_{a,min} \quad \frac{V_{exp,min} \times (p_0 + 1)}{V_{exp,min} \quad V_{WR}} \quad 1$$

where $V_{exp,min}$, is the capacity of the selected expansion vessel in litres.

d) in order to prevent the final pressure, p_e, from being exceeded at the maximum design overshoot temperature, the initial pressure, $p_{a,max}$, (system filling pressure) should fulfil the following:

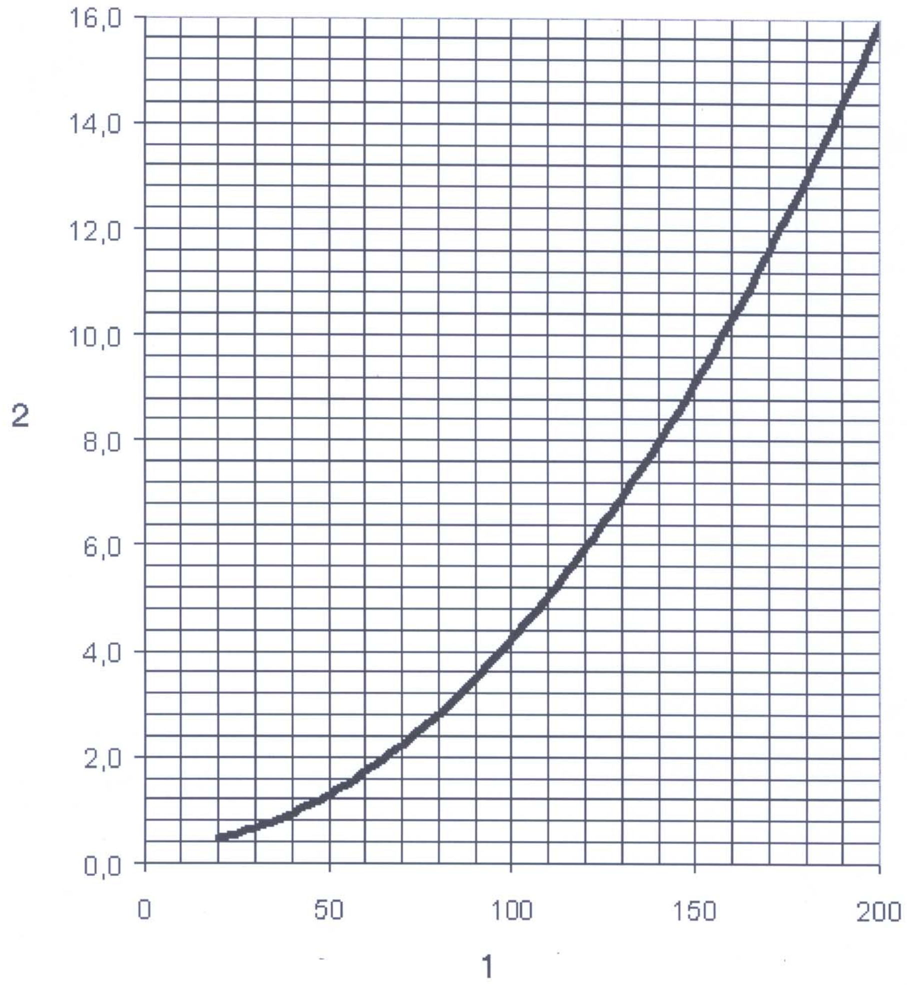
$$p_{a,max} \quad \frac{(p_e + 1)}{1 + \frac{V_e \times (p_e + 1)}{V_{exp,min} \times (p_0 + 1)}} \quad 1$$

Table D.1 — Capacities of expansion vessels for heating systems ($_{max}$ = 110 °C, V_{WR} = 0 l)

Safety valve setting	3,0 bar			2,5 bar			2,0 bar	
Vessel charge and initial system pressure, p_0	0,5 bar	1,0 bar	1,5 bar	0,5 bar	1,0 bar	1,5 bar	0,5 bar	1,0 bar
Total water content of the system, V_{system}	**Expansion vessel volume**							
litres	litres	liters	litres	litres	litres	litres	litres	litres
25	2,1	2,7	3,9	2,3	3,3	5,9	2,8	5,0
50	4,2	5,4	7,8	4,7	6,7	11,8	5,6	10,0
75	6,3	8,2	11,7	7,0	10,0	17,7	8,4	15,0
100	8,3	10,9	15,6	9,4	13,4	23,7	11,3	20,0
125	10,4	13,6	19,5	11,7	16,7	29,6	14,1	25,0
150	12,5	16,3	23,4	14,1	20,1	35,5	16,9	30,0
175	14,6	19,1	27,3	16,4	23,4	41,4	19,7	35,0
200	16,7	21,8	31,2	18,8	26,8	47,4	22,6	40,0
225	18,7	24,5	35,1	21,1	30,1	53,3	25,4	45,0
250	20,8	27,2	39,0	23,5	33,5	59,2	28,2	50,0
275	22,9	30,0	42,9	25,8	36,8	65,1	31,0	55,0
300	25,0	32,7	46,8	28,2	40,2	71,1	33,9	60,0
325	27,0	35,7	50,7	30,5	43,5	77,0	36,7	65,0
350	29,1	38,1	54,6	32,9	46,9	82,9	39,5	70,0
375	31,2	40,9	58,5	35,2	50,2	88,8	42,3	75,0
400	33,3	43,6	62,4	37,6	53,6	94,8	45,2	80,0
425	35,4	46,3	66,3	39,9	56,9	100,7	48,0	85,0
450	37,5	49,0	70,2	42,3	60,3	106,6	50,8	90,0
475	39,6	51,8	74,1	44,6	63,6	112,5	53,6	95,0
500	41,6	54,5	78,0	47,0	67,0	118,5	56,5	100,0
Multiplying factors for other system volumes	0,0833	0,109	0,156	0,094	0,134	0,237	0,113	0,2

Table D.2 — Expansion percentages, *e*, for various maximum design overshoot temperatures (filling temperature 10 °C – water volume base temperature 4 °C)

Maximum design overshoot temperature	**expansion percentage *e***
°C	%
30	0,66
40	0,93
50	1,29
60	1,71
70	2,22
80	2,81
90	3,47
100	4,21
110	5,03
120	5,93
130	6,90



Key

1 Maximum design overshoot temperature θ_{max} in °C
2 Expansion percentage, *e*, in %

Figure D.2 — Expansion percentage in % in relation to maximum design overshoot temperature, related to a filling temperature of 10 °C (graphical presentation)

Annex ZA
(informative)

A-deviation

A-deviation: National deviation due to regulations, the alteration of which is for the time being outside the competence of the CEN/CENELEC member.

This European Standard does not fall under any Directive of the EC.

In the relevant CEN/CENELEC countries, these A-deviations are valid instead of the provisions of the European Standard until they have been removed.

Clause	Deviation
4.5.1 Controls	**Sweden:**

Swedish Building regulation BBR (BFS 1993:57 with amendments):

According to chapter 9:235, the Swedish Building regulation BBR (BFS 1993:57 with amendments) requires that the heating system shall be equipped with automatic control devices.

Bibliography

EN 12098-1
Controls for heating systems – Part 1: Outside temperature compensated control equipment for hot water heating systems.

EN 12953-6
Shell boilers - Part 6: Requirements for equipment for the boiler.

prEN ISO 4126-1
Safety devices for protection against excessive pressure - Part 1: Safety valves (ISO/FDIS 4126-1:2003).

EN ISO 7726
Ergonomics of the thermal environment - Instruments for measuring physical quantities (ISO 7726:1998).

EN ISO 12241
Thermal insulation for building equipment and industrial installations - Calculation rules (ISO 12241:1998).

National Annex NA (informative) Guidance for the use of BS EN 12828:2003 in the UK

NOTE 1 The number in parenthesis ( ) in the title of each clause relates to the clause number in the main body of the standard BS EN 12828.

NOTE 2 The secondary references in square brackets [ ] refer to the clauses of BS 5449:1990 from which the text originated. "C and R" refers to commentary and recommendations.

NOTE 3 Annexes A to ZA of BS EN 12828:2003 are informative and are not considered relevant for this National Annex.

NA.1 Scope (1) [1]

This National Annex applies to the general planning and design of forced circulation hot water central heating systems, which may include those for domestic hot water, with heat requirements up to a total of 45 kW.

NOTE 1 The calculation of the design heat loss and the design heat load of those systems is covered by BS EN 12831 and the installation and commissioning of those systems by BS EN 14336.

This National Annex gives informative guidance on the following types of heating systems:

a) open vented smallbore and microbore;

b) sealed smallbore and microbore.

NOTE 2 The information about the maximum operating water temperature, in ºC, may be given in the appliance manufacturer's technical instructions.

NOTE 3 Temperatures which may be reached in an overheat condition should not be confused with the recommended design flow temperatures, which are detailed in **NA.4.3.3**

This National Annex also takes into account provisions for domestic hot water (see **NA.4.2** and **NA.4.6.3.1**).

NOTE 4 BS 6880-1, -2 and -3 may continue to be referenced for additional information in respect of the design of low temperature hot water systems of output greater than 45 kW.

NA.2 References (2)

The informative references that apply to this National Annex are included in its Bibliography.

NA.3 Terms and definitions (3) [2]

For the purposes of this National Annex, the terms and definitions given in BS EN 12828:2003 and the following apply.

NA.3.1
boiler
appliance designed for heating water either for space heating or for space heating combined with hot water supply

NA.3.2
combined system
system which, as well as providing central heating for rooms or spaces, heats water for domestic use

NA.3.3
heat emitter
component for the dispersal of heat to a heated space

NOTE Examples of heat emitters include radiators, convectors, skirting heaters and radiant panels.

NA.3.4
immersion primary heater
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

NA.3.5
microbore heating system
heating system incorporating circulation pipework normally within the size range of 6 mm to 12 mm outside diameter

NA.3.6
open-flued boiler
appliance which draws its combustion air from the room or internal space in which it is installed

NA.3.7
smallbore heating system
heating system incorporating circulation pipework normally within the size range of 15 mm to 35 mm outside diameter

NA.4 System design recommendations (4)

NA.4.1 Recommendations for preliminary design information (4.1) [3.1n), 3.2.1, C and R 3.2.2]

Where no standard exists, materials and equipment should be fit for their purpose and be of suitable quality and workmanship.

The designer should provide the customer and the installation contractor with a written specification for the scheme stating the type and output of the boiler and heat emitters and the room temperatures that will be attained at stated design conditions.

The designer's specification should indicate the locations of the boiler, heat emitters (including dimensions), exposed and concealed pipework, the 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 system.

Within the UK, attention is drawn to the relevant statutory regulations, including the following:

- The Gas Safety (Installation and Use) Regulations 1998 {1}.
- The Building Regulations 2000 {2} (for England and Wales).
- The Building (Amendment) Regulations (Northern Ireland) 2006 {3}.
- The Building (Scotland) Amendment Regulations 2007 {4}.
- The Building Regulations 2007 {5} (for the Isle of Man).
- The Water Supply (Water Fittings) Regulations 1999 {6}.

NA.4.2 Recommendations for any attached system (4.1n) [10, 21]

NA.4.2.1 ***General***

EN 12828:2003, **3.1**, gives a domestic hot water system as an example of an "attached system" and **4.2.2** specifies a calculation method for the sizing of the heat supply to serve the design heat load and any attached system.

NA.4.6.3.1.2 provides information on the temperature control of stored domestic hot water systems.

NA.4.2.2 ***Domestic hot water requirements***

The capability for providing hot water should be related to the likely demand. In highly insulated dwellings or dwellings with more than one bathroom the peak demand for domestic hot water may be considerably in excess of the space heating requirement.

The capacity of the storage vessel should be related to the likely consumption and recovery rate (see BS 6700).

Commentary and recommendations on NA.4.2.2

Where fast recovery of a domestic hot water storage vessel is required, the boiler should be sized taking into account the requirement of the domestic hot water rather than the overall heating load.

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.

The trend towards greater hot water usage (e.g. by second bathrooms and/or en-suite showers) can place exceptional demands on the hot water system and, subsequently, the peak boiler loads. If allowance is not made in such circumstances, i.e. at times of peak hot water demand, the performance of the space heating may be affected and consideration should be given to the effect of prioritizing domestic hot water recovery.

Some central heating appliances incorporate means for the instantaneous production of hot water and for these no storage vessel is required. The rate of delivery of hot water from such appliances is normally less than with a storage system and manufacturers' published performance figures should be checked to ensure that they satisfy all requirements for both heating and hot water.

The capacity of the storage vessel should be not less than 114 L, but larger dwellings may require a greater capacity. 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).

NA.4.2.3 ***Domestic hot water storage***

NA.4.2.3.1 *Combined system*

In a combined system incorporating a hot water storage vessel, the vessel should be of the indirect type.

Commentary and recommendations on NA.4.2.3.1

Any storage cylinder should conform to BS 1566-1 or BS 3198.

NOTE 1 Cylinders are available with a heat exchanger surface area greater than that required by these standards and which have improved performance and are capable of providing improved water heating efficiency, especially during the summer.

An immersion primary heater may be used to convert a direct hot water cylinder for indirect use. Such heaters should have a heat transfer rate of at least equal to that of BS 1566-1 cylinders of the same capacity and should only be fitted where the primary circulation is pumped. The probable life of any existing direct cylinder should be considered.

Provision of an electric immersion heater to BS EN 60335-2-73 as an alternative form of water heating may be considered, e.g. for use during the summer.

It is recommended that primary circulation to the cylinder should be pumped from the boiler. However, where primary circulation is by gravity the cylinder should be fitted at a sufficient height above the boiler to ensure good circulation and the pipes should be connected to the boiler in accordance with the manufacturer's instructions. Where no such guidance is provided, the flow and return pipes should be at least 25 mm internal diameter. To ensure correct circulation in the hot water circuit, the return boiler pipe should be connected to a separate return tapping on the boiler or into an injector-type fitting in the return pipe of the heating circuit. Pipework should be so designed that heat loss from stored water does not occur by gravity circulation.

NOTE 2 In considering domestic hot water supply by solid fuel boilers particular attention should be given to manufacturer's instructions.

NA.4.2.3.2 *Indirect cylinders*

Indirect cylinders fitted in sealed heating systems should be of the coil type, to BS 1566-1 or BS 3198.

Single feed cylinders should not be used.

Where the domestic hot water storage is of the unvented type, attention is drawn to the requirements of Schedule 1, Part G of the Building Regulations 2000 {2} (for England and Wales).

Commentary and recommendations on NA.4.2.3.2

A chemical water treatment formulation is normally to be added to the primary circuit of a central heating system to ensure that it conforms to the Building Regulations in England and Wales. This precludes the use of single feed cylinders.

NA.4.2.3.3 *Connections*

Connections to the storage cylinder should be of non-ferrous materials not subject to dezincification.

A draining tap should be fitted to permit removal of the stored water from the cylinder.

Commentary and recommendations on NA.4.2.3.3

Suitable connections should be made to facilitate easy removal of the cylinder. An accessible, key-operated draining tap with hose connection should be fitted at the lowest point of the adjacent cold water feed pipe, or, if provided, to a draining boss on the cylinder.

NA.4.2.3.4 *Cylinder insulation*

Hot water storage cylinders should be insulated to BS 1566 or BS 3198 for vented cylinders or BS 7206 for unvented cylinders.

NA.4.3 Heat supply (4.2)

NA.4.3.1 ***General (4.2.1) [27.1, C and R 27.1]***

Where the heat supply is to be provided by a boiler unit burning a fossil fuel, the location of the boiler should be considered at the design stage.

The boiler location should be decided upon taking into account flueing requirements, air supply needs and access for maintenance. The details of the considerations to be taken note of are covered in BS EN 14336:2004, **NA.4.1** to **NA.4.3**.

NA.4.3.2 ***Sizing (4.2.2) [11.1, C and R 9.1/9.2]***

The boiler output rating should be at least equal to the sum of the design heat requirement of the dwelling and the non-useful emission from the system pipework.

In the case of a boiler of condensing design, the output when operating in the non-condensing mode is the output that should be considered.

Electric off-peak storage boilers should be sized on the 24 h heat requirement of the dwelling taking due regard of the available heat gains and of the direct acting heat available during the off-peak period.

Where a boiler supplies both heating and hot water service without priority controls, additional boiler power of up to 2 kW may be required depending upon the likely consumption of hot water, secondary circulation heat losses and the storage capacity of the indirect cylinder. Where priority controls are used, the provision of domestic hot water should be in accordance with **NA.4.2**.

NA.4.3.3 ***Calculation of heat losses***

For information relating to the calculation of heat losses, reference should be made to BS EN 12831.

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.

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

NOTE Higher flow and return temperatures may be reached in systems covered by BS 6880.

In practice, the system flow temperature can be significantly lower than the design flow temperature due to boiler cycling frequencies and intermittent operation.

The system design temperature drop should be 10 ºC 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 need not be restricted to minimum return temperatures nor to a 10 ºC temperature drop across the heating system. However, the temperature drop would not normally exceed 20 ºC nor would the return temperatures be below 40 ºC. 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.

See also **NA.4.2** in relation to domestic hot water requirements.

NA.4.4 Heat distribution (4.3)

NA.4.4.1 ***Design criteria (4.3.2)***

NA.4.4.1.1 *Water flow rate (4.3.2.2) [C and R 19.2]*

Valves should normally be fitted to all heat emitters, to provide control, balancing and replacement of the emitter without emptying the system.

All sub-circuits in one-pipe systems should be provided with a valve to regulate the flow through these circuits.

A balancing valve should not normally be included in the primary circuit of the domestic hot water storage cylinder. Such a valve will prolong the recovery time of the cylinder impairing system efficiency.

NA.4.4.1.2 *Velocity and pressure drop in circuits (4.3.2.4) [13.1, C and R 13]*

To ensure quietness in operation, the pipe circuits should be designed such that the velocity of water does not exceed 1,5 m/s.

Values for the determination of pipework pressure drop due to friction are given in Table NA.1. When calculating the pipework pressure drop, an extra one-third should be allowed for fittings. In the case of systems plumbed in plastics, reference should be made to BS 5955-8 for pipework pressure drop.

Where values for pressure drop are not shown in Table NA.1 the water velocity will exceed 1,5 m/s.

Table NA.1 — Pressure drop per metre run due to flow of hot water through copper tubes

Tube size	6 mm	8 mm	10 mm	12 mm	15 mm	22 mm	28 mm	35 mm
Flow kg/s	pa	pa	pa	pa	pa	pa	pa	pa
0,00175	59,0							
0,00180	62,0							
0,00185	65,0							
0,00190	68,0							
0,00195	71,0							
0,0020	74,0							
0,0021	80,5							
0,0022	87,0							
0,0023	94,0							
0,0024	101							
0,0025	108							
0,0026	116							
0,0027	124							
0,0028	132							
0,0029	140							
0,0030	148							
0,0031	156							
0,0032	165							
0,0033	174							
0,0034	183							
0,0035	192	37,8						
0,0036	201	39,6						
0,0037	211	41,6						
0,0038	221	43,5						
0,0039	231	45,5						
0,0040	241	47,5						
0,0042	262	51,5						
0,0044	283	55,8						
0,0046	305	60,2						
0,0048	328	64,8						
0,0050	352	69,5						
0,0052	376	74,2						
0,0054	400	79,0						
0,0056	426	84,5						
0,0058	452	87,5						
0,0060	478	95,0	28,0					
0,0062	505	100	29,6					
0,0064	535	106	31,3					
0,0066	565	112	32,9					
0,0068	595	117	34,6					
0,0070	625	123	36,5					
0,0072	655	129	38,3					
0,0074	685	136	40,2					
0,0076	715	142	42,0					

Table NA.1 — Pressure drop per metre run due to flow of hot water through copper tubes
(continued)

Tube size	6 mm	8 mm	10 mm	12 mm	15 mm	22 mm	28 mm	35 mm
Flow kg/s	pa	pa	pa	pa	pa	pa	pa	pa
0,0078	745	148	44,0					
0,0080	780	155	46,0					
0,0084	850	169	50,0					
0,0088	920	183	54,0	20,3				
0,0092	990	197	58,5	21,9				
0,0096	1 070	212	63,0	23,6				
0,0100	1 150	228	67,3	25,3				
0,0105	1 250	247	73,5	27,6				
0,0110	1 360	268	80,0	30,0				
0,0115	1 460	290	86,0	32,4				
0,0120	1 580	311	92,5	34,8				
0,0125	1 700	333	99,0	37,4				
0,0130	1 820	356	106	40,0				
0,0135	1 940	381	113	42,7				
0,0140	2 060	405	120	45,5	15,3			
0,0145	2 190	430	128	48,3	16,2			
0,0150	2 330	455	136	51,0	17,2			
0,0155	2 460	482	144	54,1	18,2			
0,0160	2 600	510	153	57,2	19,2			
0,0165	2 740	537	161	60,4	20,3			
0,0170	2 880	565	170	63,5	21,4			
0,0175	3 030	595	178	67,0	22,5			
0,0180	3 180	625	187	70,5	23,6			
0,0185	3 340	654	196	74,0	24,7			
0,0190	3 500	684	205	77,5	25,8			
0,0195	3 600	714	215	81,0	27,0			
0,020	3 810	746	224	84,5	28,3			
0,021	4 150	810	244	92,0	30,8			
0,022	4 500	880	264	100	33,4			
0,023	4 860	950	286	108	36,1			
0,024	5 230	1 030	307	117	38,8			
0,025	5 600	1 100	330	125	41,6			
0,026	6 000	1 180	353	134	44,6			
0,027		1 260	376	143	47,6			
0,028		1 340	400	152	50,7			
0,029		1 420	425	162	54,0			
0,030		1 500	452	171	57,0			
0,031		1 590	478	182	60,5	9,1		
0,032		1 680	505	192	64,0	9,6		
0,033		1 770	532	202	67,5	10,1		
0,034		1 870	560	213	71,0	10,6		
0,035		1 960	587	224	74,5	11,2		
0,036		2 050	615	234	78,5	11,8		

Table NA.1 — Pressure drop per metre run due to flow of hot water through copper tubes
(continued)

Tube size	6 mm	8 mm	10 mm	12 mm	15 mm	22 mm	28 mm	35 mm
Flow kg/s	pa	pa	pa	pa	pa	pa	pa	pa
0,037		2 160	645	246	82,0	12,4		
0,038		2 260	675	257	86,0	13,0		
0,039		2 370	705	269	90,0	13,6		
0,040		2 480	740	281	94,0	14,2		
0,042		2 690	805	306	103	15,5		
0,044		2 920	870	332	112	16,8		
0,046		3 150	940	358	120	18,2		
0,048		3 380	1 010	385	129	19,5		
0,050		3 620	1 080	413	138	21,0		
0,052		3 870	1 160	442	148	22,5	6,48	
0,054		4 120	1 240	472	158	24,0	6,9	
0,056			1 320	503	168	25,6	7,35	
0,058			1 400	535	180	27,2	7,85	
0,060			1 480	568	191	28,8	8,3	
0,062			1 570	600	202	30,5	8,8	
0,064			1 660	634	213	32,3	9,3	
0,066			1 750	668	224	34,1	9,8	
0,068			1 840	702	236	35,8	10,3	
0,070			1 940	736	248	37,8	10,8	
0,072			2 030	772	261	39,8	11,4	
0,074			2 130	810	273	41,7	12,0	
0,076			2 230	848	286	43,7	12,6	
0,078			2 330	890	298	45,6	13,2	
0,080			2 430	930	312	47,7	13,8	4,85
0,084			2 640	1 010	341	52,0	15,0	5,3
0,088			2 850	1 100	368	56,3	16,3	5,75
0,092				1 180	397	60,8	17,6	6,23
0,096				1 270	430	65,5	19,0	6,70
0,100				1 370	462	70,5	20,4	7,20
0,105				1 490	502	77,0	22,3	7,55
0,110				1 620	545	83,5	24,2	8,55
0,115				1 740	588	90,5	26,1	9,25
0,120				1 880	633	97,0	28,2	9,95
0,125				2 020	680	104	30,2	10,7
0,130				2 160	728	113	32,4	11,5
0,135				2 310	775	121	34,6	12,3
0,140					828	128	36,8	13,1
0,145					880	136	39,3	13,9
0,150					930	144	41,7	14,7
0,155					980	153	44,2	15,5
0,160					1 040	162	46,6	16,4
0,165					1 090	171	49,3	17,4
0,170					1 150	180	52,0	18,3

Table NA.1 — Pressure drop per metre run due to flow of hot water through copper tubes
(continued)

Tube size	6 mm	8 mm	10 mm	12 mm	15 mm	22 mm	28 mm	35 mm
Flow kg/s	pa	pa	pa	pa	pa	pa	pa	pa
0,175					1 210	189	54,8	19,3
0,180					1 270	199	57,5	20,3
0,185					1 340	209	60,3	21,3
0,190					1 400	218	63,0	22,3
0,195					1 460	229	66,0	23,4
0,20					1 530	240	69,0	24,4
0,21					1 670	261	75,5	26,5
0,22					1 810	283	82,0	28,8
0,23						305	88,5	31,2
0,24						330	95,5	33,7
0,25						355	103	36,2
0,26						380	110	38,7
0,27						405	118	41,3
0,28						432	126	44,1
0,29						457	134	47,0
0,30						485	142	49,7
0,31						513	150	52,8
0,32						543	159	55,8
0,33						574	168	59,0
0,34						606	177	62,0
0,35						637	186	65,0
0,36						668	195	68,5
0,37						700	205	72,0
0,38						735	215	75,5
0,39						770	225	79,0
0,40						805	235	82,5
0,42						875	256	90
0,44						950	278	97
0,46						1 030	300	105
0,48							324	114
0,50							348	123
0,52							372	132
0,54							398	140
0,56							425	149
0,58							453	158
0,60							480	168
0,62							507	178
0,64							533	189
0,66							562	199
0,68							595	211
0,70							628	222
0,72							660	233
0,74							690	245

Table NA.1 — Pressure drop per metre run due to flow of hot water through copper tubes
(continued)

Tube size	6 mm	8 mm	10 mm	12 mm	15 mm	22 mm	28 mm	35 mm
Flow kg/s	pa	pa	pa	pa	pa	pa	pa	pa
0,76							725	256
0,78							755	268
0,80								280
0,84								304
0,88								331
0,92								358
0,96								385
1,00								415
1,05								453
1,10								490
1,15								530
1,20								570
1,25								
1,30								

NA.4.5 Heat emission (4.4)

NA.4.5.1 ***Positioning (4.4.3) [C and R 18/32]***

Wherever practicable, individual heat emitters (other than fan convectors) should be located on outside walls, preferably 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 the window taking due regard of the radiator output design requirement.

NA.4.6 Controls (4.5)

NA.4.6.1 ***General (4.5.1) [22.3, C and R 22.1]***

NOTE See **4.3.2** and **4.6.2**.

Various forms of system control are available and, when selecting a system control, account should be taken of the fuel or power to be used. The purpose of the controls is to provide the user with means to adjust the operation of the system to meet requirements and to achieve fuel economy.

The heating system should be provided with means to limit the temperature of the spaces it is heating.

Care should be exercised when selecting the various system controls for the heating and hot water circuits so as to ensure that they are compatible with each other and with the boiler controls.

If, after the control system has been selected, unwanted gravity circulation can occur, a means of preventing this circulation should be included.

Where individual thermostatic radiator valves (TRVs) are used, they should not be the sole means of control for the heating circuit but should be used in conjunction with other controls which ensure that the boiler is shut off, or reduced to minimum burning rate for solid fuel, when not required.

Where TRVs are used, they should not be fitted in the same room or area in which the air temperature sensor (room thermostat) is situated.

NA.4.6.2 ***Classification (4.5.2)***

There is no comparable control system classification in use in the UK. This is a matter for the system design specification.

NA.4.6.3 ***Central control (4.5.3)***

NA.4.6.3.1 *General (4.5.3.1) [22.1, C and R 22.3]*

Consideration should be given to the system of control to be used for both heating and domestic hot water circuits.

NA.4.6.3.1.1 *Control of heating system*

Control systems which prevent water circulation through the boiler should only be used in accordance with the boiler installation instructions.

In the interests of fuel economy and to prevent wasteful boiler cycling, the system controls should shut off the boiler when heat is no longer required, or, in the case of a solid fuel boiler, should reduce it to the minimum burning rate.

In the case of a boiler fired by solid fuel and not fitted with a water temperature actuated combustion control, adequate heat dissipation should be made available in accordance with the manufacturer's recommendations.

Systems using a solid fuel boiler should be designed so as to ensure that all heat generated when the boiler is slumbering is dissipated.

Motorized valves which include switch contacts capable of controlling the pump and, except in the case of solid fuel, the boiler are recommended.

A mixing valve may be used to control the circuit water flow temperature, by blending return water and boiler flow water in response to heating demand, and is normally controlled by an integral and/or external temperature sensor.

Where a circuit is so designed that circulation can take place only when the circulation pump is in operation, then some measure of control can be obtained by operating the pump directly from an air temperature sensor.

Commentary and recommendations on NA.4.6.3.1.1

Dissipation of heat generated when the boiler is slumbering may be ensured by installing the necessary heating surface in a gravity circuit to the cylinder and/or radiator(s), or incorporating it in a suitably designed fully pumped system with special controls. Such a circuit should not be provided with user-operated valves.

NA.4.6.3.1.2 *Temperature control of stored domestic hot water*

Where the cylinder is served by a gas- or oil-fired boiler, an adjustable thermostat should be fitted to control the temperature of the stored water. This thermostat should be capable, either directly or in conjunction with other devices, of shutting off the primary water circulation. Any electrical immersion heater fitted into the cylinder should incorporate a thermostat.

For solid fuel fired systems, a means of heat dissipation should also be provided (see **NA.4.6.3.1.1**) and, in the event of electrical failure with a fully pumped system, the primary flow and return pipes to the cylinder should revert to gravity circulation.

Any valve fitted in the primary flow or return pipe of the cylinder for actuation by the cylinder thermostat should be capable of switching to control the boiler (except for solid fuel) and pump (where the system is fully pumped).

Where a cylinder circuit is supplied by an independent pump controlled by the cylinder thermostat, it should be wired to be capable of switching to control the pump and, except in the case of solid fuel, the boiler. With such a multiple pump system, non-return valves should be used to prevent the pump on one circuit affecting the flow in the others.

Commentary and recommendations on NA.4.6.3.1.2

The thermostat sensor should be fitted at a height of one-quarter to one-third of the way up the cylinder and normally be adjusted to give a water temperature of 60 °C. In hard water areas it may be advantageous to adjust to a lower setting to minimize scale formation in the cylinder.

For solid fuel fired systems, dissipation of heat generated when the boiler is slumbering may be achieved by installing the necessary heating surface in a gravity circuit to the cylinder and/or radiator(s). Such a circuit should not be provided with user-operated valves.

The valve may be a two-port valve for independent control of the cylinder circuit or a three-port valve fitted in the common flow. In the latter case it is recommended that a mid-position valve be used which can allow shared flow distribution to the cylinder and heat emitter circuits. A "diverter" type of three-port valve which allows circulation to either the cylinder circuit or the heat emitter circuit may be used if the system design is intended for a priority flow arrangement.

NA.4.6.3.2 *Heat flow to the distribution system (4.5.3.2)*

See **NA.4.6.3.1**.

NA.4.6.3.3 *Heat flow rate to attached systems (4.5.3.3)*

See **NA.4.6.3.1**.

NA.4.6.4 ***Zone control (4.5.4) [22.3]***

The air temperature of any area or zone in a dwelling, e.g. upstairs or downstairs, may be controlled by installing a valve (zone valve) into the heating circuit which provides water circulation to that zone. The zone valve may be activated by an air temperature sensor positioned remotely from, or in direct contact with, the valve body. A two-port zone valve may be used to open or close a single circuit supplying one zone. A three-port zone valve may be used to control water circulation to two zones only, e.g. heating and hot water. Zone control can be achieved by in-line TRV control with a remote sensor in a location representative of zone temperature. Except in the case of solid fuel, full independent control can only be achieved by interlocking electrical switching.

Where the system consists of two or more circuits each controlled by a separate circulation pump, suitable valves should be used in each circuit to ensure that when only one pump is operating, flow cannot take place in the other circuits.

Where the cylinder is served by a gas- or oil-fired boiler, an adjustable thermostat should be fitted to control the temperature of the stored water. This thermostat should be capable, either directly or in conjunction with other devices, of shutting off the primary water circulation.

Any electrical immersion heater fitted into the cylinder should incorporate a thermostat. For solid fuel fired systems, a means of heat dissipation should also be provided (see **NA.4.6.3.1**), and, in the event of electrical failure with a fully pumped system, the primary flow and return pipes to the cylinder should revert to gravity circulation.

Any valve fitted in the primary flow or return pipe of the cylinder for actuation by the cylinder thermostat should be capable of switching to control the boiler (except for solid fuel) and pump (where the system is fully pumped).

The valve may be a two-port valve for independent control of the cylinder circuit or a three-port valve fitted in the common flow. In the latter case it is recommended that a mid-position valve be used which can allow shared flow distribution to the cylinder and heat emitter circuits. A “diverter” type of three-port valve which allows circulation to either the cylinder circuit or the heat emitter circuit may be used if the system design is intended for a priority flow management.

Where a cylinder circuit is supplied by an independent pump controlled by the cylinder thermostat, it should be wired to be capable of switching to control the pump and, except in the case of solid fuel, the boiler. With such a multiple pump system, non-return valves should be used to prevent the pump on one circuit affecting the flow in the others.

NA.4.6.5 ***Local control (4.5.5) [C and R 22.1 and 22.3]***

See **NA.4.6.1**.

NA.4.6.6 ***Timing control (4.5.6) [C and R 22.2]***

A time switch can be used to switch on and off automatically as required. Where the system consists of both heating and hot water circuits, a combined time switch and programmer can be used to control both circuits independently.

A time switch should not be used to switch off a mechanical fuel feed and/or a fan fitted to a solid fuel boiler. Set-back may be used when lower indoor temperatures are required.

NA.4.7 Safety arrangements (4.6)

NA.4.7.1 ***Equipment recommended for sealed systems (4.6.2)***

NA.4.7.1.1 *Protection against exceeding the maximum operating temperature (4.6.2.1)*

In most cases the appliance will be equipped with a safety temperature limiter. Where this is not the case, the advice of the appliance manufacturer should be sought.

NA.4.7.1.1.1 *Safety valves, rating and arrangements (4.6.2.2.1) [7]*

For sealed systems, a safety valve should be fitted having the following features:

a) it should be non-adjustable, spring-loaded, pre-set to lift at a gauge pressure not exceeding 3 bar[1];

b) it should have a manual testing device;

c) it should have a valve or seating face material which will prevent sticking in the closed position and will give effective resealing;

d) it should have provision for connecting a full-bore discharge pipe.

[1] 1 bar = $10^5 N/m^2$ = 100 kPa.

NA.4.7.1.2 *Expansion vessels (4.6.2.4) [C and R 16.2]*

The practical acceptance volume is that which the vessel will accept when the gauge pressure developed rises to 0,35 bar less than the safety valve setting. Vessel sizing should be in accordance with the boiler manufacturer's instructions. Where these are not available, Table NA.2 should be used. For a full method of calculation, reference should be made to BS 7074-1:1989.

Table NA.2 — Capacities of expansion vessels

Safety valve setting	bar 3,0			bar 2,5			bar 2,0	
Vessel charge and initial system pressure	bar 0,5	bar 1,0	bar 1,5	bar 0,5	bar 1,0	bar 1,5	bar 0,5	bar 1,0
Total water content of system **L**	**Expansion vessel volume** **L**							
25	2,1	2,7	3,9	2,3	3,3	5,9	2,8	5,0
50	4,2	5,4	7,8	4,7	6,7	11,8	5,6	10,0
75	6,3	8,2	11,7	7,0	10,0	17,7	8,4	15,0
100	8,3	10,9	15,6	9,4	13,4	23,7	11,3	20,0
125	10,4	13,6	19,5	11,7	16,7	29,6	14,1	25,0
150	12,5	16,3	23,4	14,1	20,1	35,5	16,9	30,0
175	14,6	19,1	27,3	16,4	23,4	41,4	19,7	35,0
200	16,7	21,8	31,2	18,8	26,8	47,4	22,6	40,0
225	18,7	24,5	35,1	21,1	30,1	53,3	25,4	45,0
250	20,8	27,2	39,0	23,5	33,5	59,2	28,2	50,0
275	22,9	30,0	42,9	25,8	36,8	65,1	31,0	55,0
300	25,0	32,7	46,8	28,2	40,2	71,1	33,9	60,0
Multiplying factors for other system volumes	0,0833	0,109	0,156	0,094	0,134	0,237	0,113	0,2

Care should be taken in the installation of boilers that incorporate an expansion vessel to ensure that adequate expansion capacity is provided; an additional expansion vessel may be required.

The vessel charge pressure should be not less than the static head pressure at the centre of the expansion vessel.

NA.4.7.2 ***Equipment recommended for open vented systems (4.6.3)***

NA.4.7.2.1 *Expansion cisterns (4.6.3.1) [14.2, 14.3, 14.4, C and R 14.1]*

The feed and expansion cistern should be fitted at least 1 m above the highest point of the circulation system. The boiler manufacturer's instructions will specify the minimum head required to serve the boiler.

NA.4.8 Operational recommendations (4.7)

NA.4.8.1 ***General (4.7.1)***

It should be noted that the water level in open vented systems and/or feed and expansion cisterns is monitored by the float valve (ball valve).

NA.4.8.2 ***Water level adjustment (4.7.5) [16.4]***

For sealed systems, attention is drawn to the requirements of the Water Supply (Water Fittings) Regulations 1999 {6} in relation to the method of filling.

NA.5 Instructions for operation, maintenance and use (5)

In EN 12828, clause **5**, reference is made to EN 12170 for heating systems requiring a trained operator or EN 12171 for heating systems not requiring a trained operator. The former refers to systems subject to boiler room management by an operator employed for that purpose. The latter refers to smaller premises, where the operation is controlled by the owner or occupier, of less than 2 500 m^3.

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BS EN 12170, *Heating systems in buildings — Procedure for the preparation of documents for operation, maintenance and use — Heating systems requiring a trained operator*

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