BS EN 12828:2012+A1:2014

BSI Standards Publication

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

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## National foreword

This British Standard is the UK implementation of EN 12828:2012+A1:2014. It supersedes BS EN 12828:2012 which is withdrawn.

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

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.

Guidance to support the use of BS EN 12828:2012+A1:2014 in the UK 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.


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

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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

# EN 12828:2012+A1

April 2014

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

Heizungsanlagen in Gebäuden - Planung von Warmwasser-Heizungsanlagen

This European Standard was approved by CEN on 6 October 2012 and includes Amendment 1 approved by CEN on 12 January 2014.

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# Contents

Page

# Foreword

This document (EN 12828:2012+A1:2014) has been prepared by Technical Committee A1⟩ CEN/TC 228 “Heating systems and water based cooling systems in buildings” ⟨A1, the secretariat of which is held by DIN.

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of an identical text or by endorsement, at the latest by October 2014, and conflicting national standards shall be withdrawn at the latest by October 2014.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document includes Amendment 1 approved by CEN on 12 January 2014.

This document supersedes A1⟩ EN 12828:2012 ⟨A1.

The start and finish of text introduced or altered by amendment is indicated in the text by tags A1⟩ ⟨A1.

The main changes A1⟩ between EN 12828:2003 and EN 12828:2012 were ⟨A1:

— restrictions concerning additional safety requirements for systems larger than 1 MW were removed;

— an informative annex for safety valves was added;

— definitions were corrected and added;

— the guidance for dimensioning of diaphragm expansion vessels (sealed systems) in Annex D was revised, and a figure describing the different pressure level was added;

— a specification for the water used has been added in 4.3.2.1;

— the requirements concerning safety arrangements (4.6) were revised and clarified;

— 4.7.4 concerning pressure maintaining control device was revised.

According to the CEN-CENELEC Internal Regulations, the national standards organisations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

## Introduction

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

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

— installation of heating systems;

— commissioning of heating systems;

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

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

— 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, e.g. 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 may 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.

# 1 Scope

This European 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 European Standard are still valid for those systems.

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

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

# 2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 215, *Thermostatic radiator valves — 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 806-2, *Specifications for installations inside buildings conveying water for human consumption — Part 2: Design*

EN 1264-1, *Water based surface embedded heating and cooling systems — Part 1: Definitions and symbols*

EN 1264-2, *Water based surface embedded heating and cooling systems — Part 2: Floor heating: Prove methods for the determination of the thermal output using calculation and test methods*

EN 1264-3, *Water based surface embedded heating and cooling systems — Part 3: Dimensioning*

EN 1264-4, *Water based surface embedded heating and cooling systems — Part 4: Installation*

EN 1264-5, *Water based surface embedded heating and cooling systems — Part 5: Heating and cooling surfaces embedded in floors, ceilings and walls — Determination of the thermal output*

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 14336, *Heating systems in buildings — Installation and commissioning of water based heating systems*

EN 15500, *Control for heating, ventilating and air-conditioning applications — Electronic individual zone control equipment*

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, modified)*

EN ISO 7730, *Ergonomics of the thermal environment — Analytical determination and interpretation of thermal comfort using calculation of the PMV and PPD indices and local thermal comfort criteria (ISO 7730)*

EN ISO 13732-1, *Ergonomics of the thermal environment — Methods for the assessment of human responses to contact with surfaces — Part 1: Hot surfaces (ISO 13732-1)*

## 3 Terms, definitions and symbols

For the purposes of this document, the following terms, definitions and symbols apply.

### 3.1 Terms and definitions

**3.1.1**
**attached system**
system connected to the heating system which may influence the design and heat load of the system

EXAMPLE Examples of such systems include:

— domestic hot water systems;

— ventilation and air conditioning systems;

— process heating systems

**3.1.2**
**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

**3.1.3**
**design heat load**
maximum heat output required from the heating system of a building, in order to maintain required internal temperatures without supplementary heating

[SOURCE: EN ISO 15927-5:2004, 3.1.1]

**3.1.4**
**design heat loss**
quantity of heat per unit time leaving the building to the external environment under specified design conditions

[SOURCE: EN 12831:2003, 3.1.5]

**3.1.5**
**external design temperature**
external air temperature which is used for the calculation of the design heat losses

**3.1.6**
**external air temperature**
air temperature outside the building

**3.1.7**
**frost inhibitor**
supplement to a heating medium lowering its freezing point

**3.1.8**
**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

**3.1.9**
**heated space**
room or enclosure which is to be heated to the specified internal design temperature

**3.1.10**
**heat emission system**
configuration of interconnected components for the dispersal of heat to a heated space

**3.1.11**
**heat gains**
quantity of heat generated within or entering into a heated space from heat sources other than the heating system

**3.1.12**
**heating period**
time during which heating is required to maintain the internal design temperature

**3.1.13**
**heat supply system**
configuration of interconnected components/appliances for the supply of heat to the heat distribution system

**3.1.14**
**internal design temperature**
operative temperature at the centre of the heated space (between 0,6 m and 1,6 m height) used for calculation of the design heat losses

**3.1.15**
**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

**3.1.16**
**open vented system**
heating system in which the heating medium is open to the atmosphere

**3.1.17**
**maximum operating pressure**
maximum pressure at which the system, or parts of the system, is designed to operate

**3.1.18**
**maximum operating temperature**
maximum temperature at which the system, or parts of the system, is designed to operate

**3.1.19**
**operative temperature**
arithmetic average of the internal air temperature and the mean radiant temperature

**3.1.20**
**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

**3.1.21**
**sealed system**
heating system in which the heating medium is closed to the atmosphere

**3.1.22**
**safety temperature lockout device**
device that causes safety shutdown and non-volatile lockout of the heat supply so as to prevent the water temperature exceeding a preset limit

**3.1.23**
**temperature controller**
automatic operating device that causes shutdown of the heat supply when the set operating temperature of the heating medium is exceeded

Note 1 to entry: The heat supply will be restored automatically when the temperature of the heating medium falls below the set operating temperature.

**3.1.24**
**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

**3.1.25**
**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

**3.1.26**
**zone**
space or groups of spaces with similar thermal characteristics

**3.1.27**
**zone control**
local control of a zone consisting of more than one space

**3.1.28**
**nominal heat output**
$\boldsymbol{\Phi}_{\mathrm{N}}$
value of the thermal power output of the heat generator as declared by the manufacturer

**3.1.29**
**efficiency**
ratio of the heat output to the heat input, expressed in %

**3.1.30**
**pressurisation system**
system equipment (membrane expansion vessels, compressor-controlled pressurisation units and pump-controlled pressurisation units) for pressure maintenance in closed heating systems

Note 1 to entry: The equipment provides to maintain the system pressure between defined limits and ensures the required minimal working pressure of the heating system. The equipment holds the accruing expansion water when the system water is heated and restores the volume when the heating system is cooling down and contracting. Due to the design of construction the expansion system simultaneously protects the expansion water from corrosion producing ingress of oxygen.

**3.1.31**
**maximum system safety temperature**
highest temperature any component of the heating system can accommodate

**3.1.32**
**lockout**
default condition resulting in a shutdown of the system and requiring a manual reset

Note 1 to entry: The intention of a lockout is to require the operator to investigate and eliminate the cause of the lockout.

**3.1.33**
**response overpressure**
pressure at which a safety valve opens at operating conditions

## 3.2 Symbols

**Table 1 — Symbols used in the standard**

| Symbol | Description | Unit |
|---|---|---|
| $A_{\mathrm{min}}$ | narrowest flow section of a safety valve | $mm^2$ |
| $d_{\mathrm{e}}$ | external pipe diameter | mm |
| $d_{\mathrm{fe}}$ | minimum internal diameter of the feed and expansion pipe | mm |
| $d_{\mathrm{in}}$ | nominal size of the safety valve’s inlet | |
| $d_{min}$ | narrowest flow diameter upstream of the valve seat | mm |
| $d_{\mathrm{out}}$ | nominal size of the safety valve’s outlet | |
| $d_{\mathrm{s}}$ | minimum internal diameter of the safety pipe | mm |
| $e$ | expansion coefficient | |
| $f_{\mathrm{AS}}$ | design factor for other attached systems | |
| $f_{\mathrm{DHW}}$ | design factor for domestic hot water systems | |
| $f_{\mathrm{HL}}$ | design factor for the heat load | |
| $f_{\mathrm{nrbl}}$ | fraction of heat emission, considered as wasted; | |
| $h_{\mathrm{st}}$ | static height | bar |
| $h_{\mathrm{Win}}$ | window height | m |
| $I$ | operational parameter | $C\cdot s/year\cdot 10^9$ |
| K | constant | $kW/mm^2$ |
| $K_{\mathrm{dr}}$ | specified reduced discharge coefficient for gases/vapours | / |

| | | |
|---|---|---|
| $l$ | specific latent heat quantity | kJ/kg |
| $p_{abs}$ | absolute pressure in the system (set pressure + admissible pressure increase) | bar |
| $p_{fil}$ | filling pressure – the required pressure in the system if the lowest possible temperature is not given (for filling or water make-up) | bar |
| $p_{fin}$ | final pressure | bar |
| $p_{ini}$ | initial pressure | bar |
| $p_v$ | vapour pressure | bar |
| $p_0$ | minimum operating pressure | bar |
| $p_{PAZ}$ | pressure at which the pressure limiter operates | bar |
| $p_{st}$ | static height pressure | bar |
| $p_{sv}$ | set pressure of the safety valve | Bar |
| $t$ | time | s |
| $U_L$ | linear thermal transmission coefficient for pipes | W/m·K |
| $U_W$ | thermal transmittance of the outside wall/window | W/m²·K |
| $V_{ex}$ | expansion volume | $m^3$ |
| $V_N$ | nominal volume of the expansion vessel to be determined | $m^3$ |
| $V_{N,min}$ | minimum nominal volume | $m^3$ |
| $V_{System}$ | total water content of the system | $m^3$ |
| $V_{wr}$ | real water reserve volume in the pressure vessel used | $m^3$ |
| $V_{wr,min}$ | minimal water reserve volume | $m^3$ |
| x | coefficient of pressure medium for saturated steam | $(h \cdot mm^2 \cdot bar)/kg$ |
| α | coefficient for valve design | |
| $\eta$ | utilisation degree | |
| $\Phi$ | heating capacity | kW |
| $\Phi_{AS}$ | capacity of other attached systems | kW |
| $\Phi_{DHW}$ | domestic hot water capacity | kW |
| $\Phi_{HL}$ | heat load capacity | kW |
| $\Phi_N$ | nominal heat output | kW |
| $\Phi_{SU}$ | capacity of the heat supply system | kW |
| $\lambda$ | thermal conductivity of the insulation material | W/m·K |
| $\rho_{\vartheta_{fil}}$ | density of water at the average system temperature during fill or make-up process | $kg/m^3$ |
| $\rho_{\vartheta_{max}}$ | density of water at the maximum set operating temperature | $kg/m^3$ |
| $\rho_{\vartheta_{min}}$ | density of water at the lowest system temperature | $kg/m^3$ |
| $\vartheta$ | temperature | °C |
| $\vartheta_a$ | air temperature | °C |
| $\vartheta_{d,e}$ | external design temperature | °C |

| | | |
|---|---|---|
| $\vartheta_{d,jnt}$ | internal design temperature | °C |
| $\vartheta_{env}$ | temperature of the surrounding environment | °C |
| $\vartheta_{o}$ | operative temperature | °C |
| $\overline{\vartheta}_{r}$ | mean radiant temperature | °C |
| $\vartheta_{W}$ | surface temperatures of outside wall/window | °C |
| $\vartheta_{w}$ | water temperature | °C |

**Table 2 — Indices used in the standard**

| Index | Definition |
|---|---|
| a | air |
| abs | absolute |
| AS | other attached systems |
| d | design |
| DHW | domestic hot water systems |
| dr | reduced discharge |
| e | external |
| env | environment |
| ex | expansion |
| fe | feed and expansion |
| fil | filling |
| fin | final |
| HL | heat load |
| in | Inlet |
| ini | initial |
| int | internal |
| j | summation index |
| L | linear thermal transmission |
| max | maximum |
| min | minimum |
| N | nominal |
| nrbl | heat emission, considered as wasted |
| o | operative |
| 0 | minimum operational |
| out | outlet |
| PAZ | pressure limiter |
| r | radiant |
| s | safety |

| | |
|---|---|
| st | static |
| SU | heat supply system |
| sv | safety valve |
| System | system |
| V | vapour |
| w | water |
| W | outside wall/window |
| Win | window |
| wr | water reserve |
| $\vartheta_{max}$ | maximum system temperature |
| $\vartheta_{min}$ | minimum system temperature |

# 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 to minimise 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) choice of suitable pressurisation,

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

n) facilities for filling and draining the system;

o) power requirements of any attached system;

p) type and position of heat emitters;

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

r) route and method of installing piping and insulation;

s) provisions and specification for balancing the system;

t) provision for measurement of energy consumption;

u) surface temperatures of exposed heating system surfaces;

v) provision for water treatment;

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

x) 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 of the building shall be calculated in accordance with EN 12831.

NOTE The determination of the thermal power of other attached systems is not part of this European Standard.

Any other recognised 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.

### 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 attached 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 additionally be considered:

— the fraction of the heat load supplied by each heat generator;

— different operating periods, such as summer and winter;

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

— operating requirements, such as standby.

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

$$\Phi_{SU} = f_{HL} \cdot \Phi_{HL} + f_{DHW} \cdot \Phi_{DHW} + f_{AS} \cdot \Phi_{AS} \qquad (1)$$

where

$\Phi_{SU}$ is the capacity of the heat supply system in kilo watts (kW);

$f_{HL}$ is the design factor for the heat load;

$\Phi_{HL}$ is the design heat load of the building in kilo watts (kW);

$f_{DHW}$ is the design factor for domestic hot water systems;

$\Phi_{DHW}$ is the domestic hot water capacity in kilo watts (kW);

$f_{AS}$ is the design factor for other attached systems;

$\Phi_{AS}$ is the capacity of other 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 requirements

The composition of the water used in the heating system shall be such that the function of the system components is maintained in order to guarantee a safe and economic operation.

Parameters for consideration may include:

— the chemical characteristics of the water, e.g. pH, $O_2$, chlorine and derivates, content of alkaline-earth- and hydrogen carbonate ions and carbonates;

— the electrical conductivity.

When necessary, supplements for water preparation, water treatment and/or anti-freeze, shall be used in accordance with the appropriate manufacturers' requirements.

Further information can be found in VDI 2035.

NOTE The following factors influence the quality of the water in the heating circuit:

- deterioration of the heat transfer on the transmission surfaces due to calcification;
- impairment of the function of the components due to sedimentation of corrosion products or component failure due to corrosion;
- oxygen insertion due to defective pressurisation or diffusion/permeation at membranes, plastic pipes, seals, etc.

#### 4.3.2.2 Water flow rate

The water flow rate and the initial setting of the balancing devices 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 so that at any point of the system the flow rate and the pressure difference required to fulfil the heat load are available.

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;

— minimising the electric power required;

— provisions for insulation;

— noise transmittance;

— speed controlled circulation pumps and their operation mode;

— automatic on- off control;

— 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 so that at any point of the system the flow rate and the pressure difference required to fulfil the heat load are available. Pipework and thermal insulation material shall be compatible.

Consideration shall be given to:

— temperature;

— design pressure;

— pressure drop;

— energy demand regarding electric power of the circulation pumps;

— corrosion and component compatibility, including glands and seals;

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

— thermal expansion and contraction;

— pipework routing and physical protection, thermal insulation, accessibility for inspection and repairs;

— measurement of energy consumption;

— resistance to fire;

— oxygen permeability;

— 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:

— the design heat load;

— the system flow temperature;

— thermal comfort and noise in occupied spaces;

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

— protection and prevention of damage to the building components;

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

— 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, Part 1 to 3 or EN 1264, Part 1 to 5.

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).

Depending on the type of heat emission system 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 an additional allowance on emitter output may be necessary (see EN 12831).

#### 4.4.3 Positioning

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.

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

#### 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 ISO 13732-1 and EN 1264-3).

### 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. Manually operated valves should not be used in connection with radiators and embedded heating systems, as they are not self-acting and control function is not provided.

NOTE Thermostatically controlled valves are not considered as manually operated valves.

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.

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

Self-acting thermostatic radiator valves, excluding differential pressure independent radiator valves, shall comply with EN 215.

Electronic radiator thermostats shall comply with EN 15500.

### 4.5.2 Classification

The control system shall be classified as follows:

a) classification based on heating control system level:

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

b) classification based on control system performance level:

- Manual (M),
- Automatic (A),
- Timing function (T),
- 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 installed in the interest of energy conservation and reduced operating costs.

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;

— optimising 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:

— exceeding the maximum operating temperature;

— exceeding the maximum operating pressure;

— lack of water.

Safety arrangements shall be designed in accordance with:

— the type of heating system, i.e. sealed or open vented system, and its pressurisation;

— the type of energy source;

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

— 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 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 systems

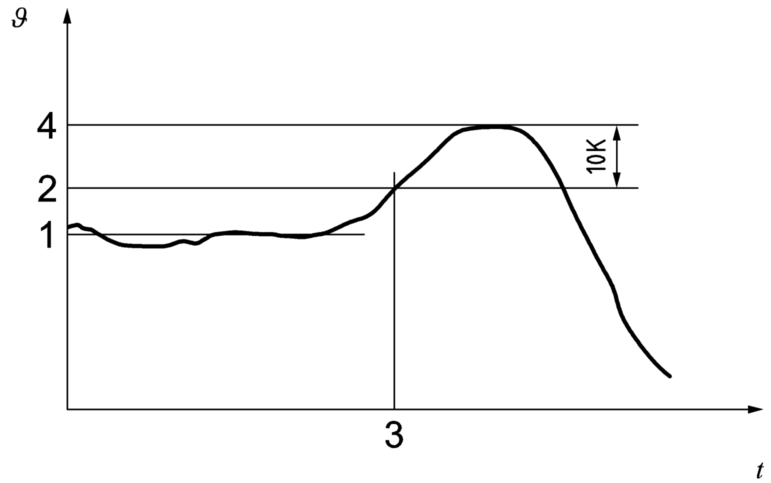
#### 4.6.2.1 Protection against exceeding the maximum system safety temperature

Each heat generator shall be served by a safety temperature lockout device which prevents the heat generator flow temperature exceeding the maximum system safety temperature. The set point temperature of the safety temperature lockout device shall be chosen accordingly. A typical system temperature development in a fault condition is shown in Figure 1.

This lockout device can be a safety temperature limiter, which shall conform to EN 60730-2-9.

If the heat generator is not equipped with such a lockout device by the manufacturer, it shall be fitted on the generator flow pipe as near as possible to the heat generator.

A lockout device is not required if the heat generator intrinsically cannot exceed the maximum system safety temperature (e.g. heat pumps).




**Key**

1 set operating temperature (shall not exceed 105 °C)

2 lockout set point temperature

3 generator lockout

4 maximum system safety temperature

*ϑ* temperature

*t* time

**Figure 1 — Typical system temperature development in a fault condition**

If the heat supply system is a heat exchanger, the following applies:

If the operating temperature on the primary side is higher than the maximum operating temperature on the secondary side, a safety temperature limiter complying with EN 60730-2-9 is necessary. The limiter shall de-energise the energy supply on the primary side of the heat exchanger via a shut-off device.

NOTE For solid fuel appliances a heat distribution circuit can 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:

— have a minimum size of DN 15;

— 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 %, except for maximum operating pressures not exceeding 3 bar a deviation of 0,5 bar is permissible. Possibilities to achieve these requirements are given in Annex E;

NOTE The information given in Annex E on safety valves is for informational purposes only and not meant to interfere with any product standard.

— 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).

To ensure a safe discharge of water and potentially forming of steam the relief pipe of the safety valve shall be dimensioned and positioned accordingly.

Heat generators with a heat capacity of more than 300 kW shall be served by an expansion trap within the relief pipe in the immediate vicinity to the valve. This shall be connected to a vapour discharging pipe rising to the open air and provide a safe water drain pipe (design according to Annex E). This also applies to heat exchangers, from which steam forming in case of a system failure cannot be ruled out. An expansion trap may not be necessary in cases in which each heat generator or heat exchanger 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 to prevent the maximum set pressure to be exceeded.

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, 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

[A1⟩ 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. ⟨A1]

### 4.6.2.4 Pressurisation systems

Each heat generator shall be individually connected to a pressurisation system by means of an expansion pipe. In cases where several heat generators are connected to the same pressurisation system, unintended circulation within the expansion pipes shall be avoided.

Pressurisation systems shall be designed to accommodate at least the maximum expansion volume of the water content of the heating system including a minimal water reserve volume at the maximum operating pressure. The pressurisation system 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 locations with suitable ambient temperatures (protection against frost and direct sun radiation).

Pressurisation systems shall be chosen and 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 pressurisation system manufacturer's installation instructions shall be paramount. For guidance on dimensioning, see Annex D.

The connection between the pressurisation system and the heat generator shall be kept open at all times during system operation. For maintenance purposes, an engineer lockable valve and a drain valve are recommended to be positioned as a shut-off device between the pressurisation system and the heat generator.

#### 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.

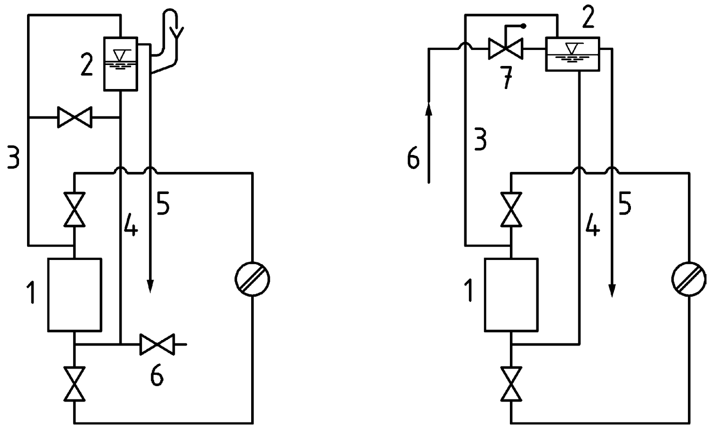
Expansion cisterns shall be dimensioned so that changes in water volume due to heating up and cooling down can be accommodated.

Expansion cisterns which are directly passed through by heating water should be avoided due to the high oxygen input.

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

**Figure 2 — Installation examples of expansion cisterns**

#### 4.6.3.2 Safety pipes and feed and expansion pipes

Heat generators which are connected to an expansion cistern shall be 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 calculated according to Formulae (2) and (3):

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

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

where

$\Phi_{\mathrm{N}}$ 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:

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

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

— 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 control device

Heating systems should be equipped with a pressure maintaining control device. This can be achieved for example by using an automatic refill-set or feed and expansion cistern or an expansion vessel linked to a low pressure limiter. In sealed systems, this device continuously monitors the pressure and in case of the pressure falling below the set limit either shuts off the heat supply system, initiates an automatic refill or gives a warning to the operator.

#### 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 EN 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:

— minimise heat losses;

— 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;

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

The following design aspects shall be considered in addition:

— increase in internal temperatures;

— reduction in flow temperature;

— fire protection;

— selection of insulation materials to suit the application.

The insulation material shall be selected to suit 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 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:

— the nominal size of piping and/or components;

— the temperature of the heating medium;

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

— the length of operation period of the heating system;

— 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 3:

**Table 3 — Examples of thermal transmittance classes**

| Insulation class | Maximum thermal transmittance: Pipes with external diameter $d_e \leq 0,4$ m W/m·K [a] | Maximum thermal transmittance: Pipes with external diameter $d_e > 0,4$ m or plane surfaces [b] W/m²·K [c] |
|---|---|---|
| 0 | - | - |
| 1 | $3,3 \cdot d_e + 0,22$ | 1,17 |
| 2 | $2,6 \cdot d_e + 0,20$ | 0,88 |
| 3 | $2,0 \cdot d_e + 0,18$ | 0,66 |
| 4 | $1,5 \cdot d_e + 0,16$ | 0,49 |
| 5 | $1,1 \cdot d_e + 0,14$ | 0,35 |
| 6 | $0,8 \cdot d_e + 0,12$ | 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 ISO 13732-1).

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.

For safety reason and in order to minimise energy losses installations subject to freezing conditions should be avoided.

## 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 commissioning shall be performed according to EN 14336, including 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;

— **Optimisation 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 optimised 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<br>MODE | CONTROL SYSTEM PERFORMANCE MODES | | | |
|---|---|---|---|---|
| | **Manual** | **Automatic** | **Timing function** | **Optimisation of timing control** |
| Local | | | | |
| Zone | | | | |
| Central | | | | |

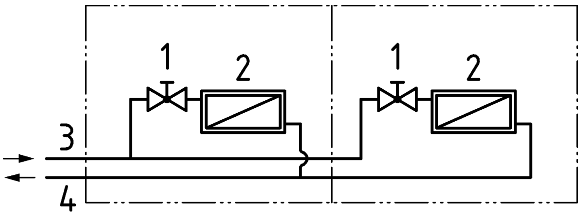
Table A.1 should be used to describe the type and performance of the control system. It can be used by the building owner or a representative to define how the heating system is to be controlled.

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

An example for local manual control is given in Figure A.1 and Table A.2




**Key**

1 manually operated valve

2 radiator

3 feed pipe

4 return pipe

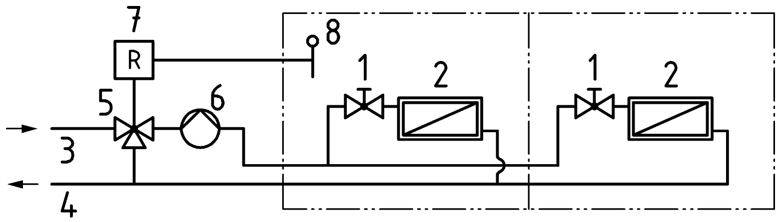
**Figure A.1 — Indoor temperature control system with local manual mode in an individual house**

**Table A.2 — Control system classification**

| HEATING CONTROL SYSTEM<br>MODE | CONTROL SYSTEM PERFORMANCE MODES | | | |
|---|---|---|---|---|
| | **Manual** | **Automatic** | **Timing function** | **Optimisation of timing control** |
| Local | XXXXX | | | |
| Zone | | | | |
| Central | | | | |

### A.2.2 Local manual control and central automatic control

An example for local manual control and central automatic control is given in Figure A.2 and Table A.3




**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

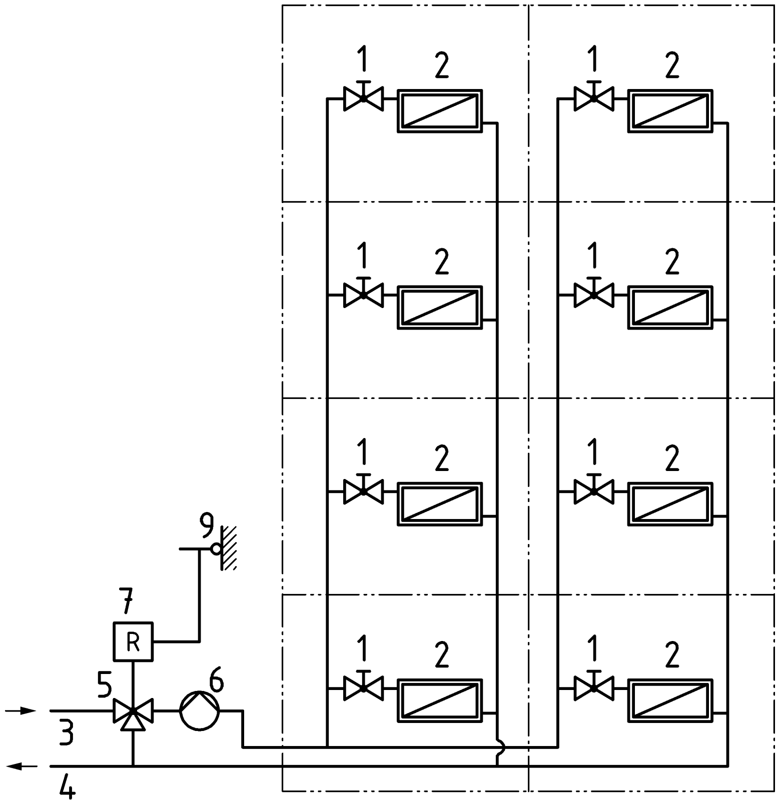
**Figure A.2 — Indoor temperature control system with local manual mode and central automatic mode in an individual house**

**Table A.3 — Control system classification**

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

### A.2.3 Local automatic control and central automatic control

An example for local manual control and central automatic control is given in Figure A.3 and Table A.4




**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

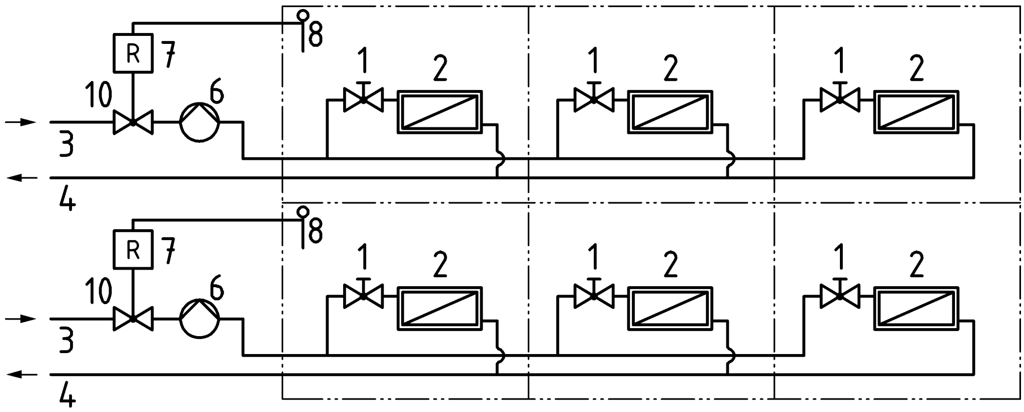
**Figure A.3 — Indoor temperature control system with an outdoor sensor, local automatic mode and central automatic mode in a multi-story residential building**

**Table A.4 — Control system classification**

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

### A.2.4 Local automatic control and automatic zone control

An example for local manual control and central automatic control is given in Figure A.4 and Table A.5




**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

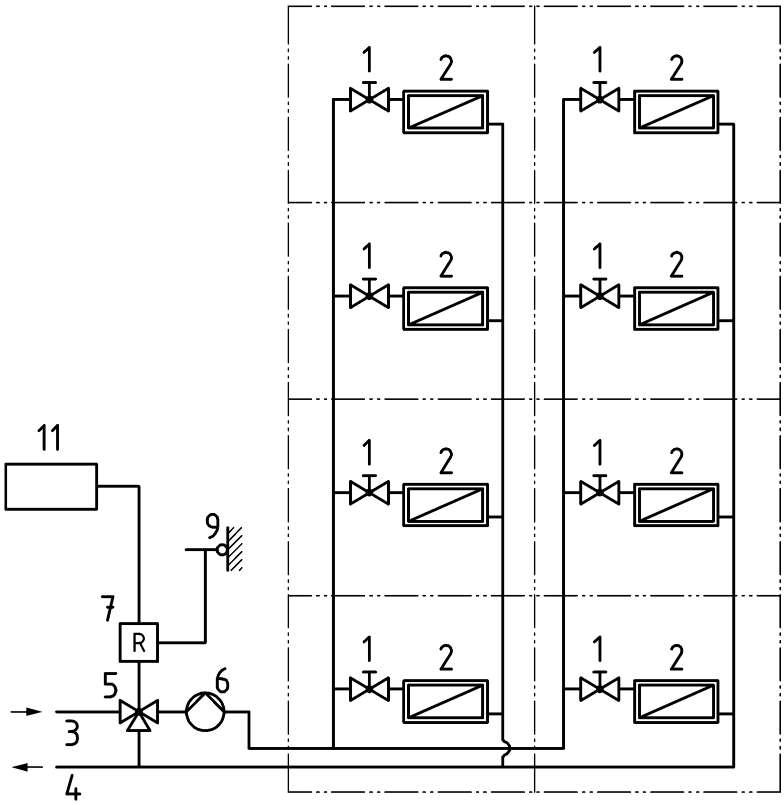
**Figure A.4 — Indoor temperature control system with local automatic mode and automatic zone control mode in a two-storey commercial building**

**Table A.5 — Control system classification**

| HEATING CONTROL SYSTEM MODE | CONTROL SYSTEM PERFORMANCE MODES | | | |
|---|---|---|---|---|
| | **Manual** | **Automatic** | **Timing function** | **Optimisation of timing control** |
| Local | | XXXXX | | |
| Zone | | XXXXX | | |
| Central | | | | |

### A.2.5 Local automatic control and central automatic control with optimisation

An example for local manual control and central automatic control is given in Figure A.5 and Table A.6




**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 optimiser

**Figure A.5 — Indoor temperature control system with an outdoor sensor, local automatic mode and central automatic mode with optimisation 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** | **Optimisation 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 differences 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 formulae are based on the following assumptions:

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

$$\vartheta_W = \vartheta_{d,int} - U_W \cdot 0{,}12 \cdot (\vartheta_{d,int} - \vartheta_{d,e}) \quad \text{(B.1)}$$

— all surface temperatures of internal walls, floors and ceilings are equal to the indoor design temperature, $\vartheta_{d,int}$;

$$\vartheta_o = 0{,}5 \cdot \left(\vartheta_a + \overline{\vartheta}_r\right) \quad \text{(B.2)}$$

**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:

$$U_W < \frac{128}{\vartheta_{d,int} - \vartheta_{d,e}} \qquad \left[\frac{W}{m^2 \cdot K}\right] \quad \text{(B.3)}$$

**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:

$$U_W < \frac{80}{\vartheta_{d,int} - \vartheta_{d,e}} \qquad \left[\frac{W}{m^2 \cdot K}\right] \quad \text{(B.4)}$$

**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:

$$U_{\mathrm{W}} < \frac{150}{h_{Win} \cdot (\vartheta_{\mathrm{d,int}} - \vartheta_{\mathrm{d,e}})} \qquad \left[\frac{W}{m^2 \cdot K}\right] \qquad \text{(B.5)}$$

where

$U_{\mathrm{W}}$ is the thermal transmittance of the outside wall/window in Watts per square metres per Kelvin (W/m²·K);

$\vartheta_{\mathrm{d,int}}$ is the internal design temperature in degrees Celsius (°C);

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

$\vartheta_{\mathrm{o}}$ is the operative temperature in degrees Celsius (°C);

$\vartheta_{\mathrm{a}}$ is the air temperature in degrees Celsius (°C);

$\overline{\vartheta}_{\mathrm{r}}$ is the mean radiant temperature in degrees Celsius (°C);

$h_{\mathrm{Win}}$ is the window height in metres (m).

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

For criterion 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:

$$U_{\mathrm{W}} < \frac{128}{32} = 4\, W / m^2 \cdot K \qquad \text{(B.6)}$$

Criterion 2:

$$U_{\mathrm{W}} < \frac{80}{32} = 2{,}5\, W / m^2 \cdot K \qquad \text{(B.7)}$$

Criterion 3:

$$U_{\mathrm{W}} < \frac{150}{2 \cdot 32} = 2{,}3\, W / m^2 \cdot K \qquad \text{(B.8)}$$

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

# Annex C
(informative)

# Thermal insulation

The operational parameter, $I$, is defined as:

$$I = \int_t f_{nrbl} \cdot \left(\vartheta_W - \vartheta_{env}\right) \cdot dt \quad (C.1)$$

where

$\vartheta_w$ is the water temperature in degrees Celsius (°C);

$\vartheta_{env}$ is the temperature of the surrounding environment in degrees Celsius (°C);

$t$ is time in seconds (s);

$f_{nrbl}$ is the fraction of heat emission, considered as wasted.

The operational parameter can be worked out by means of:

— the average temperature difference, $\left(\vartheta_W - \vartheta_{env}\right)$;

— an estimated value of $f_{nrbl}$;

— duration of the heating season, $t$.

The operational parameter is then equal to:

$$I = f_{nrbl} \cdot \left(\vartheta_W - \vartheta_{env}\right) \cdot t \quad (C.2)$$

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, $I$<br>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, $\lambda$, and external pipe diameter, $d_e$, are given in Table C.2. It is assumed that the external surface heat transfer coefficient is 9 W/m$^2$·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/m$^2$·K). The conductivity, $\lambda$, 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**

| $d_e$ mm | Class 1 | | | | | Class 2 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | $U_L$ W/m·K | $\lambda$ W/m·K | | | | $U_L$ W/m·K | $\lambda$ 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 |
| **$d_e$ mm** | **Class 3** | | | | | **Class 4** | | | | |
| | $U_L$ W/m·K | $\lambda$ W/m·K | | | | $U_L$ W/m·K | $\lambda$ 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 |

| $d_e$ mm | Class 5 | | | | | Class 6 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | $U_L$ W/m·K | $\lambda$ W/m·K | | | | $U_L$ W/m·K | $\lambda$ 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 |

$U_L$ = linear thermal transmission coefficient for pipes in Watts per metre per Kelvin (W/m·K) – for plane surfaces the thermal transmission coefficient is calculated in the unit (W/m²·K);

$\lambda$ = thermal conductivity of the insulation material in Watts per metre per Kelvin (W/m·K);

$d_e$ = external pipe diameter in millimetres (mm);

plane = these values are used when considering plane surfaces.

# Annex D
(informative)

# Guidance for dimensioning diaphragm expansion vessels and pressurisation systems (sealed systems)

## D.1 General

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

a) The overpressure of the heating system is determined by the working range of the pressurisation system at its connection point into the system.

NOTE All subsequently described pressures unless otherwise stated are overpressures relating to ambient pressure.

b) The recommended connection point of the pressurisation system is the suction side of the circulating pump (suction-side-pressurisation). Different alternatives are possible. Generally, it shall be ensured that admissible pressure ratios exist at each point of the system (see indents c to g).

The position of the integration point should be chosen in such a way that the pressure on the suction side of the circulation pump is sufficient for operation, e.g. avoiding cavitation, and high temperatures affecting the diaphragm of the expansion vessel.

c) The static height pressure $p_{st}$ is a result of the water column $h_{st}$ (static height) between the connection point of the pressurisation system (respectively pressure measuring point) and the highest point of the heating system.

d) The vapour pressure $p_V$ value used in the calculation is that at the maximum system operating temperature expressed as an overpressure.

e) For suction-side-pressurisation the minimum operating pressure $p_0$ should be at least equal to the sum of the static height pressure, $p_{st}$, and the vapour pressure, $p_V$. The pressure increase of the circulation pumps shall be considered when determining $p_0$ with pressurisation systems, which are not located on the suction side of the circulation pump.

The value of $p_0$ shall be chosen such that cavitation in pumps and valves is avoided under any operational conditions. In addition the minimum pressure requirements of other system components need to be taken into consideration when determining $p_0$. An addition of at least 0,2 bar to the static height is recommended. For diaphragm expansion vessels the pre set gas pressure is identical to the minimum operating pressure $p_0$.

f) The initial pressure $p_{ini}$ indicates the lowest pressure in the operating range of the heating system. $p_{ini}$ should be chosen that the overpressure measured at any point of the heating system is always greater than 0,5 bar. For diaphragm expansion vessels this can be achieved by adjusting $p_{ini}$ at least 0,3 bar higher than the recommended pre set gas pressure.

g) The final pressure $p_{fin}$ indicates the highest pressure in the operating range of the heating system. $p_{fin}$ should not be higher than the set pressure of the safety valve minus a difference in shut-off overpressure (see Annex E).

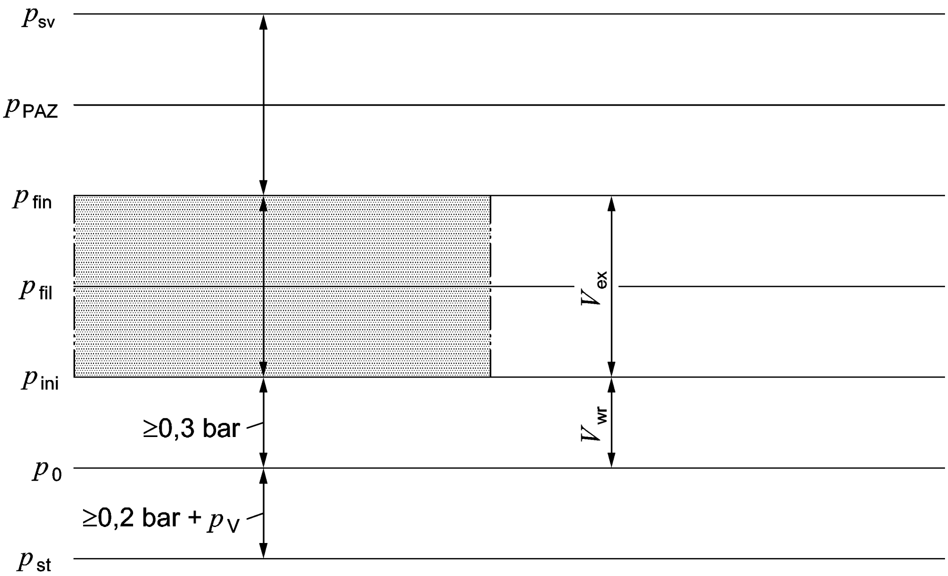
h) The difference in dynamic and static height pressure between the location of the pressurisation system and the safety valve should be taken into account;

i) 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;

j) For dimensioning the expansion vessel the method described in D.2 should be followed;

k) 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.

The different pressure levels are shown in Figure D.1.




**Key**

| | | | |
|---|---|---|---|
| $p_{sv}$ | set pressure of the safety valve | $p_0$ | minimum operating pressure (effectively avoiding evaporation, cavitation, vacuum), equal to the nominal inlet pressure of the pressurisation system |
| $p_{PAZ}$ | pressure at which the pressure limiter operates | $p_{st}$ | static height pressure – pressure only resulting from the difference in height between the position of the pressurisation system and the highest point of the heating system |
| $p_{fin}$ | final pressure | $V_{ex}$ | expansion volume |
| $p_{fil}$ | filling pressure – required pressure in the system if the lowest possible temperature is not given (for filling or water make-up) | $V_{wr}$ | real water reserve volume in the pressure vessel used |
| $p_{ini}$ | initial pressure | (shaded box) | operating band of the pressurisation system |
| $p_v$ | vapour pressure | | |

**Figure D.1 — Pressure levels**

## D.2 Expansion vessel size calculation

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

a) establish:

— the water content of the system, $V_{System}$. It is the total water content of the pipework, heat emitters, heat generators and connected auxiliary circuits;

— the expansion volume, $V_{ex}$.

$V_{ex}$ is the increase in volume caused by temperature increase between the lowest possible temperature of the heating system and the maximum set operating temperature of the heat generator.

$V_{ex}$ is determined by using the expansion coefficient e:

$V_{ex} = V_{system} \times e$

with

$$e = 1 - \frac{\rho_{\vartheta_{max}}}{\rho_{\vartheta_{min}}} \quad \text{(D.1)}$$

where

$\rho_{\vartheta_{max}}$ is the density of water at the maximum set operating temperature, in kg/m$^3$;

$\rho_{\vartheta_{min}}$ is the density of water at the lowest system temperature, in kg/m$^3$.

NOTE The density of water will be affected by the density of additive substances.

The expansion coefficient may also be calculated in a more detailed manner when the actual temperature conditions of the whole system are taken into account.

— the water reserve volume, $V_{wr}$. In addition to the water volume resulting from thermal expansion, the expansion vessel should have a minimal water reserve to compensate for possible water losses in the system. Expansion vessels with a nominal volume up to 15 l should accommodate at least 20 % of this volume as a water reserve. Expansion vessels with a nominal volume 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;

— the minimum nominal volume $V_{N,min}$:

$V_{N,min}$ of diaphragm expansion vessels:

$$V_{N,min} = \left(V_{ex} + V_{wr,min}\right) \cdot \frac{\rho_{fin} + 1}{\rho_{fin} - \rho_0} \quad \text{(D.2)}$$

$V_{N,min}$ of expansion vessels of compressor- or pump-controlled pressurisation systems:

$$V_{N,min} = \left(V_{ex} + V_{wr,min}\right) \cdot \frac{1}{\eta} \quad \text{(D.3)}$$

with

$\eta$ utilisation efficiency of the expansion vessel,

$V_N$ nominal volume of the expansion vessel to be determined

b) Selection of the expansion vessel:

$$V_N \geq V_{N,min} \quad \text{(D.4)}$$

The calculated nominal volume $V_N$ can be divided to several vessels.

$$\sum_{j=1}^{k} V_{N,j} \geq V_N \quad \text{(D.5)}$$

For diaphragm expansion vessels the initial pressure $p_{ini}$ shall be confirmed for the selected vessel as follows:

The initial pressure $p_{ini}$ is calculated with:

$$\rho_{ini} = \frac{\rho_{fin} + 1}{1 + \frac{V_{ex}}{V_N} \cdot \frac{\rho_{fin} + 1}{\rho_0 + 1}} - 1 \quad \text{(D.6)}$$

Correct dimensioning of the expansion vessel is ensured as long as:

$$\rho_{ini} >= p_0 + 0{,}3 \text{ bar} \quad \text{(D.7)}$$

Otherwise, the nominal volume $V_N$ should be increased until the condition above is met.

With the following formula the pressure required in a system in case expansion vessels are used and the lowest possible temperature is not given can be calculated:

$$p_{fil} = V_N \cdot \frac{p_0 + 1}{V_N - V_{System} * \left(1 - \frac{\rho_{\vartheta_{fil}}}{\rho_{\vartheta_{min}}}\right) - V_{wr}} - 1 \quad \text{(D.8)}$$

where

$p_{fil}$ is the filling pressure – the required pressure in the system if the lowest possible temperature is not given (for filling or water make-up), in bar;

$\rho_{\vartheta_{fil}}$ is the density of water at the average system temperature during fill or make-up process, in kg/m$^3$;

$\rho_{\vartheta_{min}}$ is the density of water at the lowest system temperature, in kg/m$^3$;

$V_{wr}$ is the real water reserve volume in the pressure vessel used, in m$^3$.

# Annex E
(informative)

# Safety valves for heating systems

## E.1 Classification

Safety valves according to 4.6 "Safety arrangements" can be divided into the following groups:

— safety valves marked “H” with a response overpressure of 2,5 bar or 3,0 bar for hot water with an admissible heating capacity up to 2 700 kW;

— safety valves marked “D/G/H” for hot water for all pressures and nominal capacities.

## E.2 General requirements

### E.2.1 General

Safety valves need to be spring-loaded.

### E.2.2 Materials

The materials (metallic, non-metallic) of all parts in contact with the medium should be state-of-the-art and designed to be suitable for the occurring pressures and temperatures; they should provide sufficient corrosion-resistance. This also applies to feed pipes, relief pipes and condensate drain pipes.

Materials for bodies should meet the requirements of [A1) EN 1503-1, EN 1503-2, EN 1503-3 and EN 1503-4 (A1].

### E.2.3 Protection against maladjustments

Safety valves should be protected against unauthorised alterations of the set pressure and operation.

### E.2.4 Guidance of the moveable parts

The safety valves’ design should allow the movable parts to move freely even when heated at different temperatures. Sealing elements that may impede the operation by frictional forces are not admissible.

### E.2.5 Easing gear

Safety valves complying with E.4 should be liftable. The disc should be liftable any time at static pressure by manual intervention from the outside without any special tools. Easing gears with rotary control should open anti-clockwise.

Safety valves complying with E.5 should open without special tools within the range ≥ 85 % of the response overpressure. The connection between the spindle and the disc should be positive (not rigid).

No additional load should be placed from the outside on the safety valves.

### E.2.6 Protection of sliding and rotating elements

Sliding and rotating elements as well as springs shall be protected against the medium's effects. The protecting device (for instance membrane, bellows or similar devices) should be designed and installed so that the force to be expected can be absorbed safely.

### E.2.7 Design of coil compression springs

Coil compression springs should be designed so that, when a lift is necessary, all coils of the spring remain separated from each other by a distance of 0,5 times the wire diameter or at least 2 mm.

### E.2.8 Transport protections

Fixing devices for transport should not impede the safety valves' safety function.

### E.2.9 Pipes, installation and body

**E.2.9.1** Safety valves should not become inoperative due to isolating devices. The installation of alternatively operating valves or blocking devices is allowed, when the device's design ensures that the required relief section remains free even when the changeover takes place.

**E.2.9.2** While taking the local operating conditions into account, the pipes and safety valves should be dimensioned and mounted so that the static, dynamic and thermal forces (reaction forces) can be absorbed safely.

**E.2.9.3** All pipes and components should be designed so that the required mass flow is drained reliably and the safety valve's operation is not impeded. The pressure loss in the feed pipe should not exceed 3 % of the response overpressure.

Back pressures on the outlet side that have an effect on the response overpressure, the opening forces or the mass flow should be taken into account.

**E.2.9.4** The bodies should allow the installation of relief pipes. The safety valves' outlet should be at least one nominal size bigger than the inlet.

**E.2.9.5** Pipes used to relieve steam and water safely should be equipped with special drain devices where the water cannot drain on its own. If the room is liable to frost, the pipes should be protected accordingly.

**E.2.9.6** The narrowest flow section upstream of the valve seat should be at least 12 mm and not bigger than the clear diameter of the feed pipe.

### E.2.10Marking

#### E.2.10.1 Marking on the body

The marking on the body of a safety valve can form an integral part of the body or be made on a data plate permanently attached to the body. It should be legibly and permanently marked with at least the following information:

— nominal size (inlet), e.g. DN XX;

— designation of the body's material;

— manufacturer's name or mark;

— arrow indicating the direction of flow.

Adhesive foils are not allowed.

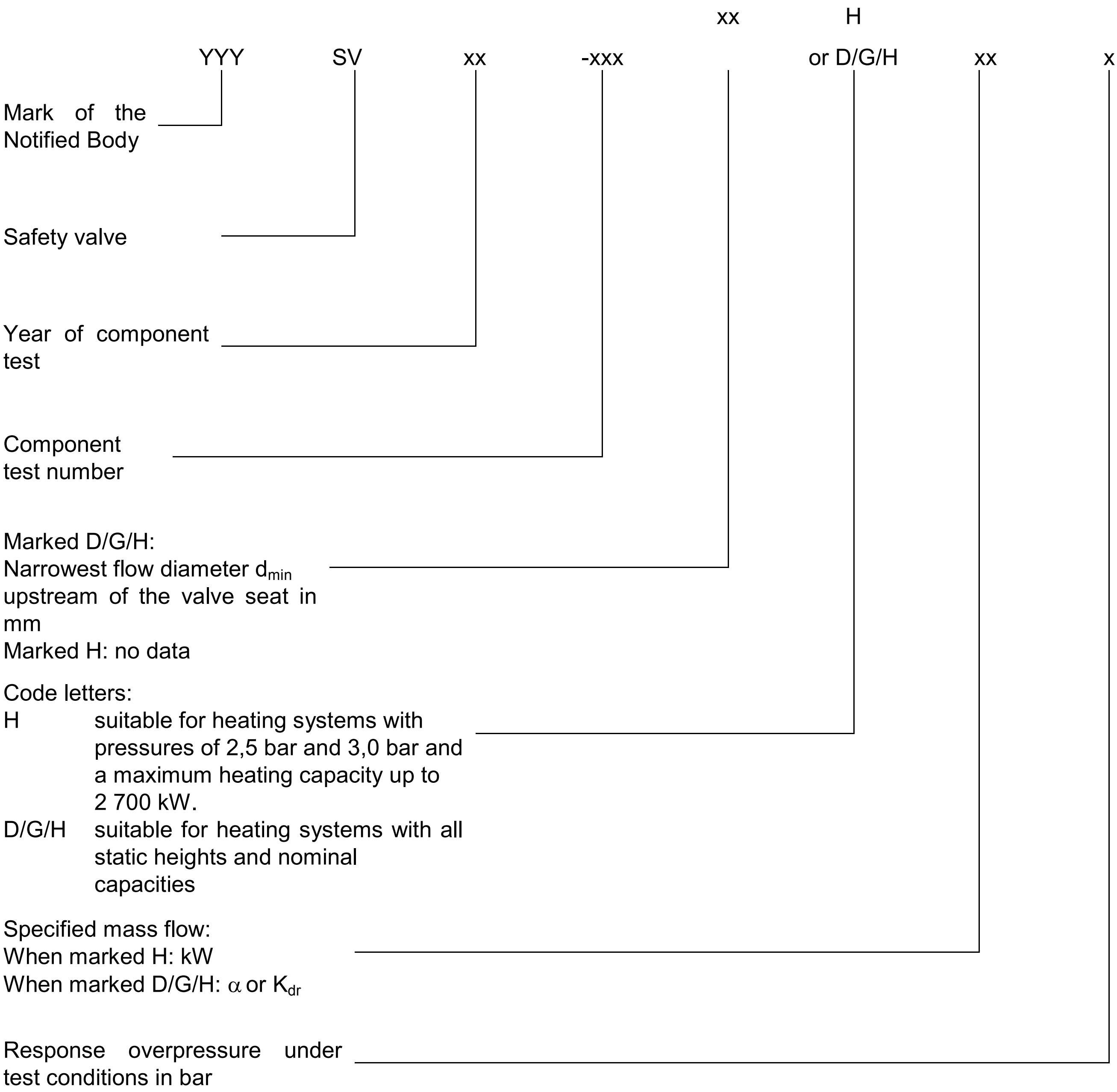
#### E.2.10.2 Marking of the safety valve

Component-tested safety valves should be legibly and permanently marked with the CE-mark and the granted component mark.

Adhesive foils are not allowed.

By affixing the component mark, the manufacturer guarantees that the safety valve conforms to the component test report including annexes, that the setting is correct and complies with the pressure indicated by the component mark and that the product is protected against maladjustments.

The component mark includes the following data:



## E.3 Calculation of the relief capacity

The relief capacity of a safety valve marked H or D/G/H, expressed as heating capacity $\Phi$ of the heat generator in kW, is determined according the following formula:

$$\Phi = A_{min} \cdot K_{dr} \cdot K \tag{E.1}$$

where

$A_{min}$ the narrowest flow section of a safety valve in mm$^2$;

$K_{dr}$ the specified reduced discharge coefficient for gases and/or vapours;

$K$ a constant.

The constant $K$ is calculated as follows:

$$K = \frac{\rho_{abs}}{x} \cdot l \cdot 2{,}78 \cdot 10^{-4} \quad \left[\frac{kW}{mm^2}\right] \tag{E.2}$$

where

$p_{abs}$ the absolute pressure in the system (set pressure + admissible pressure increase), in bar;

x the coefficient of pressure medium for saturated steam, in (h mm$^2$ bar)/kg;

$l$ the specific latent heat quantity, in kJ/kg;

2,78 $10^{-4}$ the conversion factor from kJ to kWh.

For indirectly heated heat generators where the temperature of the heating medium is equal to or lower than the water temperature of the heating system, with a saturated steam pressure corresponding to the safety valves' response overpressure, the safety valves are to be dimensioned only for the volume flow rate of the expansion water. The volume flow rate is estimated at 1 l/h per kW of nominal heating capacity.

These cases require no expansion trap. The pipe dimensions should at least conform to Tables E.2 and E.3.

## E.4 Requirements for safety valves marked H

### E.4.1 General

Safety valves marked H have a response overpressure of 2,5 bar or 3,0 bar and are suitable for hot water with an admissible heating capacity up to 2 700 kW.

### E.4.2 Body and spring cap design

**E.4.2.1** When the safety valves are designed as single device, the inlet of the medium should be located axially opposite the spring cap or valve head part.

**E.4.2.2** The medium's pressure should apply onto the valve disc. The protecting device for the spring and sliding or rotating elements should be pressure relieved when the safety valve is closed. The spring cap should include two ports with a diameter of at least 6 mm.

**E.4.2.3** The connection between the body and the spring cap should be able to sustain the forces to be expected and be designed so that after the removal and re-assembly of the spring cap the set pressure remains unchanged and the protecting device is not damaged.

### E.4.3 Threads on the inlet and outlet

The threads on the inlet and outlet should conform to EN 10226-1. It should be ensured that a pipe can be screwed in without impeding the operation of the safety valve.

### E.4.4 Connections

The threaded connection of the outlet should be at least one nominal size category higher than the threaded connection at the inlet.

### E.4.5 Calculation

The heating capacity $\boldsymbol{\Phi}$ in kW calculated for a valve according to E.3 is generally determined during the component test.

The various valve sizes should be able to carry off the heating capacities indicated in Table E.1. Higher values achieved in the component test should not be taken into account.

**Table E.1 — Heating capacities**

| Valve size[a]<br>Nominal size<br>DN | max. heating capacity in<br>kW |
|---|---|
| 15 (G ½) | **50** |
| 20 (G ¾) | **100** |
| 25 (G 1) | **200** |
| 32 (G 1¼) | **300** |
| 40 (G 1½) | **600** |
| 50 (G 2) | **900** |

[a] **The dimension of the inlet connection is considered as the valve size.**

### E.4.6 Setting

The safety valves should respond at the latest at an overpressure of 2,5 bar or 3,0 bar and be able to reliably prevent a pressure in excess of more than 0,5 bar.

When the pressure drops within a range of 0,5 bar, the closing pressure should be below the response overpressure.

## E.5 Requirements for safety valves marked D/G/H

### E.5.1 General

Safety valves marked D/G/H should be used for operating pressures and capacities that do not allow the use of safety valves marked H as described in E.4.

### E.5.2 Body and spring cap design

**E.5.2.1** The medium should not exert pressure onto the protecting device of the spring and sliding or rotating elements when the safety valve is closed. This protecting device should not have a sealing function for the valve seat at the same time.

**E.5.2.2** The spring should be positioned in a closed cap. The spring cap should have two ports located at the lowest possible point with a diameter of at least 6 mm each or one port located at the lowest possible point with a diameter of at least 10 mm.

### E.5.3 Design of the valve disc

The sealing surface of the valve disc should be compressible and designed with a metallic support.

### E.5.4 Protection of sliding and rotating elements as well as springs

Sliding and rotating elements as well as springs should be protected against the medium’s effects by means of bellows or a membrane or a similar device made from metal or elastomer.

### E.5.5 Safety valve with back pressure compensation

When back pressures exceed 15 % of response overpressure of the safety valve, the use of compensating metallic bellows should be considered.

### E.5.6 Setting

The safety valves should be dimensioned and set so that the operating overpressure cannot be exceeded by more than 10 %. When the operating overpressure is below 3 bar, a pressure in excess of maximal 0,3 bar is admissible. The safety valves should close when the pressure drops within a range of 10 % of the response overpressure. A pressure reduction of 0,3 bar is admissible with response overpressures below 3 bar.

**Table E.2 — Nominal sizes of safety valves marked H and dimensions of pipes, expansion traps, discharge pipes in water-based heating systems with relief pressures of 2,5 bar and 3 bar**

| Nominal capacity $\Phi_N$ of heat generator (corresponds to relief capacity in l/h in indirectly heated heat generators) | safety valve | | safety valve (with and without expansion trap) | | | safety valve (without expansion trap) | | | safety valve with expansion trap | | | | | | | expansion trap | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Feed pipe to safety valve | | | Discharge pipe of safety valve | | | Pipe between safety valve - expansion trap | | | Discharge pipe | | | Water drain pipe | | |
| | Inlet $d_{in}$ | Outlet $d_{out}$ | Z | Length | Bends | AB | Length | Bends | L | Length | Bends | AU | Length | Bends | WAB | Diameter Ø | Min. height exp. trap H |
| kW (l/h) | DN | DN | DN | m | unit | DN | ⟨A1⟩ m ⟨A1⟩ | unit | DN | m | unit | DN | m | unit | DN | mm | mm |
| ≤ 50 | 15 | 20 | 15 | ≤ 1 | ≤ 1 | 20 | ≤ 2 | ≤ 2 | 32 | ≤ 5 | ≤ 2 | 40 | ≤ 15 | ≤ 3 | 32 | 125 | 212,5 |
| | | | | | | 25 | ≤ 4 | ≤ 3 | | | | | | | | | |
| ≤ 100 | 20 | 25 | 20 | ≤ 1 | ≤ 1 | 25 | ≤ 2 | ≤ 2 | 40 | ≤ 5 | ≤ 2 | 50 | ≤ 15 | ≤ 3 | 40 | 150 | 255 |
| | | | | | | 32 | ≤ 4 | ≤ 3 | | | | | | | | | |
| ≤ 200 | 25 | 32 | 25 | ≤ 1 | ≤ 1 | 32 | ≤ 2 | ≤ 2 | 50 | ≤ 5 | ≤ 2 | 65 | ≤ 15 | ≤ 3 | 50 | 200 | 340 |
| | | | | | | 40 | ≤ 4 | ≤ 3 | | | | | | | | | |
| ≤ 300 | 32 | 40 | 32 | ≤ 1 | ≤ 1 | 40 | ≤ 2 | ≤ 2 | 65 | ≤ 5 | ≤ 2 | 80 | ≤ 15 | ≤ 3 | 65 | 250 | 425 |
| | | | | | | 50 | ≤ 4 | ≤ 3 | | | | | | | | | |
| ≤ 600 | 40 | 50 | 40 | ≤ 1 | ≤ 1 | 50 | ≤ 2 | ≤ 2 | 80 | ≤ 5 | ≤ 2 | 100 | ≤ 15 | ≤ 3 | 80 | 300 | 510 |
| | | | | | | 65 | ≤ 4 | ≤ 3 | | | | | | | | | |
| ≤ 900 | 50 | 65 | 50 | ≤ 1 | ≤ 1 | 65 | ≤ 2 | ≤ 2 | 100 | ≤ 5 | ≤ 2 | 125 | ≤ 15 | ≤ 3 | 100 | 400 | 680 |
| | | | | | | 80 | ≤ 4 | ≤ 3 | | | | | | | | | |


**Key**

1 inlet

2 outlet

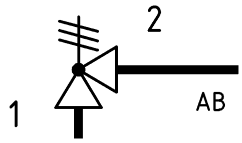
**Figure E.1 — Visual examples to Table E.2**

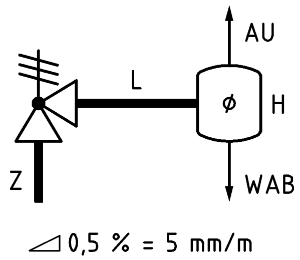
**Table E.3 — Dimensions of feed pipes, expansion traps, discharge pipes in water-based heating systems for all pressures and safety valves marked D/G/H**

| Relief pressure | safety valve (with and without expansion trap) | | | safety valve (without expansion trap) | | | safety valve (with expansion trap) | | | | | | | expansion trap | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Feed pipe to safety valve | | | Relief pipe of safety valve | | | Pipe between safety valve - expansion trap | | | Discharge pipe of expansion trap | | | Water drain pipe | Diameter Ø | Min. height expansion trap H |
| | Z | Length | Bends | AB | Length | Bends | L | Length | Bends | AU | Length | Bends | WAB | | |
| bar | DN | m | unit | DN | m | unit | DN | m | unit | DN | m | unit | DN | mm | mm |
| ≤ 5 | $d_{in}$ | ≤ 0,2 | ≤ 1 | $d_{in}$ + 2 DNSt*) | ≤ 5 | ≤ 2 | $d_{in}$ + 2 DNSt*) | ≤ 5 | ≤ 2 | $d_{in}$ + 3 DNSt*) | ≤ 10 | ≤ 3 | $d_{in}$ + 3 DNSt*) | ≥ 3 x L | ~ 5 x L |
| | $d_{in}$ + 1 DNSt*) | ≤ 1 | ≤ 1 | | | | | | | | | | | | |
| > 5 | $d_{in}$ | ≤ 0,2 | ≤ 1 | $d_{in}$ + 3 DNSt*) | ≤ 7,5 | ≤ 3 | $d_{in}$ + 3 DNSt*) | ≤ 7,5 | ≤ 2 | $d_{in}$ + 4 DNSt*) | ≤ 10 | ≤ 3 | $d_{in}$ + 4 DNSt*) | | |
| | $d_{in}$ + 1 DNSt*) | ≤ 1 | ≤ 1 | | | | | | | | | | | | |

$d_{in}$ = nominal size of the safety valve's inlet

*) DNSt = nominal size category




**Key**

1 inlet

2 outlet

**Figure E.2 — Visual examples to Table E.3**

# Annex F
(informative)

# A–deviations

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 EU. 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

[1] EN 1503-1, *Valves — Materials for bodies, bonnets and covers — Part 1: Steels specified in European Standards*

[2] EN 1503-2, *Valves — Materials for bodies, bonnets and covers — Part 2: Steels other than those specified in European Standards*

[3] EN 1503-3, *Valves — Materials for bodies, bonnets and covers — Part 3: Cast irons specified in European Standards*

[4] EN 1503-4, *Valves — Materials for bodies, bonnets and covers — Part 4: Copper alloys specified in European Standards*

[5] EN 10226-1, *Pipe threads where pressure tight joints are made on the threads — Part 1: Taper external threads and parallel internal threads — Dimensions, tolerances and designation*

[6] EN 12098-1, *Controls for heating systems — Part 1: Outside temperature compensated control equipment for hot water heating systems*

[7] EN 12953-6, *Shell Boilers — Part 6: Requirements for equipment for the boiler*

[8] EN 15316-1, *Heating systems in buildings — Method for calculation of system energy requirements and system efficiencies — Part 1: General*

[9] EN ISO 4126-1, *Safety devices for protection against excessive pressure — Part 1: Safety valves (ISO 4126-1)*

[10] EN ISO 7726, *Ergonomics of the thermal environment — Instruments for measuring physical quantities (ISO 7726)*

[11] EN ISO 8044, *Corrosion of metals and alloy — Basic terms and definitions (ISO 8044)*

[12] EN ISO 12241, *Thermal insulation for building equipment and industrial installations — Calculation rules (ISO 12241)*

[13] EN ISO 15927-5, *Hygrothermal performance of buildings — Calculation and presentation of climatic data — Part 5: Data for design heat load for space heating (ISO 15927-5)*

[14] VDI 2035-1, *Vermeidung von Schäden in Warmwasserheizanlagen; Blatt 1 —Steinbildung in Trinkwassererwärmungs- und Warmwasser-Heizungsanlagen / Prevention of damage in water heating installations — Part 1: Scale formation in domestic hot water supply installations and water heating installations*

[15] VDI 2035-2, *Vermeidung von Schäden in Warmwasserheizanlagen; Blatt 2 — Heizwasserseitige Korrosion / Prevention of damage in water heating installations — Part 2: Water-side corrosion*

# National Annex NA
(informative)

# Guidance to support the use of BS EN 12828:2012+A1:2014 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 those clauses of BS 5449:1990 from which the texts originate, where "C and R" refers to commentary and recommendations.

NOTE 3 Annexes A to F of BS EN 12828:2012+A1:2014 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 system smallbore and microbore.

NOTE 2 The information about the maximum operating water temperature, in °C, 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.4.3.4**.

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 12828:2012+A1:2014 and the following apply.

**NA.3.1**
**boiler**
an appliance designed to heat water for space heating or space heating combined with hot water supply.

**NA.3.2**
**combined system**
systems which in addition to providing central heating for rooms or spaces, will heat water for domestic use

**NA.3.3**
**heat emitter**
a room heating component designed and manufactured for the distribution of heat within occupied spaces

NOTE Examples of heat emitters are: radiators, convectors, fan convectors, skirting heaters, floor heating, and radiant panels.

**NA.3.4**
**microbore heating system**
heating system incorporating circulation pipework in the range of 6 mm to 12 mm outside diameter

**NA.3.5**
**smallbore heating system**
heating system incorporating circulation pipework in the range of 15 mm to 35 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.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]

The designer should provide the customer and the installation contractor with a written specification for the system based on a previously agreed operating strategy, stating the type and output of the boiler or heat generator, the heat emitters, attached systems, control system functions, including the listing of water and room temperatures with estimated system reheat times that will be attained at stated design conditions.

The designer's specification should indicate the location of the boiler, any fuel storage requirements, external energy source provisions, room heat emitters (including dimensions), routes of exposed and concealed pipework, the feed and expansion cistern or expansion vessel, the domestic hot water storage vessel (if provided) and the type of primary or auxiliary appliance flue system where selected.

Where no product standard exists, materials and equipment used in the system should be fit for their purpose and be of suitable quality and workmanship.

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

- The Gas Safety (Installation and Use) Regulations {1}.
- The Electrical Installations Requirements (IET 17th Edition) {!}
- The Building Regulations {2} (for England and Wales).
- The Building (Amendment) Regulations (Northern Ireland) {3}.
- The Building (Scotland) Amendment Regulations {4}.
- The Building Regulations 2007 {5} (for the Isle of Man).
- The Water Supply (Water Fittings) Regulations {6}.

### NA.4.2 Recommendations for any attached system (4.1n) [10, 21] NA.4.2.1 General

EN 12828:2003, 3.1, describes a domestic hot water system as an example of an "attached system' and 4.2.2 specifies a calculation method to size the heat supply which serves the design heat load and any attached system.

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

#### NA.4.2.2 Domestic hot water requirements

The capability for providing domestic hot water should be related to the likely demand of users. 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 actual capacity of the storage vessel should be related to likely hot water consumption and recovery rate (see BS 8558, and BS EN 806 – Design, Installation & Testing of Domestic Water Services).

**Commentary and recommendations on NA.4.2.2**

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

Where an electric immersion heater is provided, the element length and its position should be such that it is capable of heating 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.

Greater hot water usage occasioned by serving extra bathrooms places exceptional demand on the hot water generator system and thus, peak loads. If no allowance has been made for peak periods of hot water demand, then the performance of the space heating may be prejudiced, whereupon consideration should be given to 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.

Hot water storage capacity should be not less than 114 L for 3-bed homes. However, larger dwellings may require greater capacity. There are circumstances, e.g. vessels with pumped primaries, or integral storage appliances, where smaller capacities may be permitted (see BS 8558:2011).

#### 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**

Hot water storage cylinders should conform to BS 1566-1 (open vented), BS 3198 (unvented), or BS EN 12897.

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

An immersion type primary heat exchanger may be used to convert a direct hot water cylinder for indirect use. Such heat exchangers 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 installed 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 pipes from a boiler to the cylinder should be pumped. However, where primary circulation is achieved by gravity alone, the cylinder should be installed 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 When considering domestic hot water supply with solid fuel boilers, particular attention should be given to manufacturer's instructions in relation to the provision of auxiliary heat leak emitters where appropriate or necessary..

**NA.4.2.3.2 Indirect cylinders**

Indirect cylinder heat exchangers for use with sealed heating systems should be of the pipe coil type, to BS 1566-1 or BS 3198.

Single feed cylinders (self priming) should not be used.

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

**Commentary and recommendations on NA.4.2.3.2**

A chemical water treatment formulation is normally added to the primary circuit of a central heating system to ensure that it conforms to the Building Regulations in England and Wales. This water treatment precludes the use of single feed (internally vented) indirect cylinders. [21]

**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 EN 12897 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 which burns solid fuel, the location of the boiler and fuel storage requirements should be considered at the design stage.

The boiler location should account for all requirements including: combustion air supply provisions and maintenance access. Further details and considerations can be found in BS EN 14336:2004, NA.4.1 to NA.4.3.

#### NA.4.3.2 Sizing of heat supply (4.2.2) [11.1, C and R 9.1/9.2]

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

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/heat supply serves both heating and hot water service without priority controls, an additional allowance of up to 2 kW may be required depending upon the likely consumption of hot water, the 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.

For buildings with heating systems designed to operate intermittently (high/low or on/off), a reheat allowance of 20 % should be added to the calculated heat loss. Alternatively for greater precision see BS EN 12831 Table D 10b for interruptions of 1 to 4 hours and room temperature rises of 1 to 3 °C.

Also, if any secondary heating systems are in simultaneous operation these should be taken into account. For systems intended to run continuously (day and night), no extra allowance is necessary.

#### NA.4.3.4 System operating conditions

In all types of dwelling where condensation is a risk, consideration should be given to providing a minimum set-back temperature during cyclic 'on/off' operation or external temperature compensated operation.

The heating system design water flow temperature should not exceed 82 °C in UK residential properties.

Low temperature heating systems should be designed to operate with a flow temperature appropriate to the chosen heat emitter system and the heat generator for maximum performance and economy.

System design water temperature differential should preferably be one-seventh of the heating flow temperature.

The manufacturer's minimum operating water temperatures should be allowed for in the heating system design.

NOTE Solid fuel appliance boilers with rated outputs in excess of 50 kW, or oil fired appliance boilers with rated outputs in excess of 45 kW or gas fired appliance boilers with rated input in excess of 70 kW (net) are covered by BS 6880.

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 flat 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, however a balancing valve should not normally be included in the primary circuit of the domestic hot water storage cylinder. Such a valve, if used, could prolong the recovery time of the cylinder thus 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, pipework should be designed for a water velocity not exceeding 1,5 m/s.

Values for the determination of pipework pressure drop due to friction are given in Table NA.1. When calculating the pipe system pressure drop, allow an extra one-third for pipe fiipe hir In the case of systems with plastic pipework refer to BS 5955-8 for pipework pressure drop.

NOTE Where values for pressure drop are not shown in Table NA.1 the water velocity exceeds 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 | | | | | | | |

**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 |
| 0,0030 | 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 | | | | | |
| 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 | | | |

**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 |
| 0,0155 | 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 | | |
| 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 | |

**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 |
| 0,074 | | | 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 |
| 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 |

**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 |
| 0,38 | | | | | | 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 |
| 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 emitters (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.

The purpose of controls is to provide the user with automatic means of system control to meet requirements and to achieve reasonable fuel economy when accounting for the fuel or power source.

The system should be provided with means to limit the temperature of the spaces being heated.

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

If, after the control system has been installed unwanted gravity circulation occurs then a means of preventing this circulation should be included.

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

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

#### NA.4.6.2 Classification (4.5.2)

No comparable control system classification exists in the UK Building Regulations.

#### 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 a system of control which serves both heating and domestic hot water circuits independently.

#### NA.4.6.3.1.1 Control of heating system

Control systems which prevent water circulation through the heat generator or 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 auxiliary switch contacts capable of controlling the circulator pump are recommended in all cases except for that of Solid Fuel appliances.

A mixing valve may be used to control the heat emitter circuit water flow temperature, by blending cool return water with warmer flow water to an intermediate level in response to heating demand. The valve actuator is normally controlled by a proportional/integral 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 hot water storage cylinder (or other vessel) is served by a gas fired 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.

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 system (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 fired 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 circulator pump and heat generator, except in the case of solid fuel.

With such multiple pump systems, non-return valves should be used to prevent the circulator 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]**

An electrical time switch can be used to automatically switch the system on and off as required by users.

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 thermostats 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<br>3,0 | | | bar<br>2,5 | | | bar<br>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<br>L | Expansion vessel volume<br>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 8558:2011 (formerly BS 6700) Design, installation, testing and maintenance of services supplying water for domestic use within buildings and their curtilages — Specification

BS 6880-1:1988, Code of practice for low temperature hot water heating systems of output greater than 45 kW — Part 1: Fundamental and design considerations

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BS 6880-3:1988, Code of practice for low temperature hot water heating systems of output greater than 45 kW — Part 3: Installation, commissioning and maintenance

BS 7074-1:1989, Application, selection and installation of expansion vessels and ancillary equipment for sealed water systems — Part 1: Code of practice for domestic heating and hot water supply

BS 7206:1990, Specification for unvented hot water storage units and packages

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

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

BS EN 12831, Heating systems in buildings — Method for calculation of the design heat load

BS EN 14336, Heating systems in buildings — Installation and commissioning of water based heating systems

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