BS 8558:2015

BSI Standards Publication

Guide to the design, installation, testing and maintenance of services supplying water for domestic use within buildings and their curtilages – Complementary guidance to BS EN 806

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Contents

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 92, an inside back cover and a back cover.

Foreword

Publishing information

This British Standard is published by BSI Standards Limited, under licence from The British Standards Institution, and came into effect on 30 September 2015. It was prepared by Sub-committee B/504/2, *Internal systems and components*, under the direction of Technical Committee B/504, *Water Supply*. A list of organizations represented on these committees can be obtained on request to their secretary.

Supersession

This British Standard supersedes BS 8558:2011, which is withdrawn.

Information about this document

The content of this British Standard was originally taken from BS 6700:2006+A1:2009, which was withdrawn on publication of BS EN 806 (all parts). This is a full revision of the standard to keep it up to date.

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Presentational conventions

The guidance in this standard is presented in roman (i.e. upright) type. Any recommendations are expressed in sentences in which the principal auxiliary verb is "should".

Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.

Contractual and legal considerations

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

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

In particular, attention is drawn to the following statutory regulations which may be amended from time to time.

- The Water Industry Act 1981 [1];
- The Water and Sewerage Services (Northern Ireland) Order 2006, as amended [2];
- The Water (Scotland) Act 1980, as amended [3];
- The Workplace (Health, Safety and Welfare) Regulations 1992 [4];
- The Electricity Safety, Quality and Continuity Regulations 2002, as amended [5];
- The Electricity Safety, Quality and Continuity Regulations (Northern Ireland) 2012 [6];
- The Control of Asbestos at Work Regulations 2002 [7];
- The Control of Asbestos at Work Regulations (Northern Ireland) 2003 [8];

- The Water Industry Act 1999 [9];
- The Health and Safety at Work etc. Act 1974 [10];
- The "Water Quality Regulations", which set out provisions for the quality of drinking water provided by a public water supplier (water undertaker):
  - The Water Supply (Water Quality) Regulations 2000, as amended, in England [11];
  - The Water Supply (Water Quality) Regulations 2010, as amended, in Wales [12];
  - The Water Supply (Water Quality) Regulations (Northern Ireland) 2007, as amended, in Northern Ireland [13];
  - The Public Supply Water Supplies (Scotland) Regulations 2014, in Scotland [14];
- The "Private Water Supplies Regulations", which set out provisions for the quality of water from a private supply:
  - The Private Water Supplies Regulations 2009, as amended, in England [15];
  - The Private Water Supplies (Wales) Regulations 2010, as amended, in Wales [16];
  - The Private Water Supplies (Scotland) Regulations 2006, in Scotland [17];
  - The Private Water Supplies (Northern Ireland) Regulations 2009, as amended, in Northern Ireland [18];
- The "Water Fittings Regulations", which set out provisions for plumbing systems in premises to which a supply of public mains water has been provided:
  - The Water Supply (Water Fittings) Regulations 1999, in England and Wales [19];
  - The Water Supply (Water Fittings) (Scotland) Byelaws 2014, in Scotland [20];
  - The Water Supply (Water Fittings) Regulations (Northern Ireland) 2009, in Northern Ireland [21];
- The "Building Regulations":
  - The Building Regulations 2010 [22];
  - The Building (Scotland) Regulations 2004, as amended [23];
  - The Building Regulations (Northern Ireland) 2012, as amended [24].

0 Introduction

Table 1 provides cross references to the BS EN 806 series and this British Standard.

Table 1 **Cross references to the BS EN 806 series and this British Standard** *(1 of 3)*

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Normative references, Clause **2**	No additional guidance
Objectives, Clause **3**	No additional guidance
Competence and duties for design, construction and operation, Clause **4**	No additional guidance
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BS EN 806-2:2005	
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General requirements, Clause **3**	No additional guidance
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Components, Clause **6**	No additional guidance
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Guidelines for water meter installations, Clause **11**	No additional guidance
Water conditioning, Clause **12**	No additional guidance
Acoustics, Clause **13**	No additional guidance
Protection of systems against temperatures external to pipes, fittings and appliances, Clause **14**	No additional guidance
Boosting, Clause **15**	No additional guidance
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Combined drinking water and fire fighting services, Clause **17**	No additional guidance
Prevention of corrosion damage, Clause **18**	No additional guidance
Additional requirements for vented cold and hot water systems, Clause **19**	No additional guidance
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Aspects for water conditioning, Annex B	No additional guidance
Supplementary guidance	**4.3**

Table 1 **Cross references to the BS EN 806 series and this British Standard** *(2 of 3)*

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Normative references, Clause **2**	No additional guidance
Terms, symbols and units, Clause **3**	No additional guidance
Principles of pipe sizing calculations, Clause **4**	No additional guidance
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Normative references, Clause **2**	No additional guidance
Terms and definitions, Clause **3**	No additional guidance
General, Clause **4**	**6.1.1** and **6.1.2**
Documentation, Clause **5**	No additional guidance
Operation, Clause **6**	**6.1.2** and **6.1.3**
Interruptions to operation and disconnection, Clause **7**	No additional guidance
Resumption of supply, Clause **8**	No additional guidance
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Accessibility of fittings, Clause **11**	No additional guidance
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Table 1 **Cross references to the BS EN 806 series and this British Standard** *(3 of 3)*

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Inspection and maintenance, Clause **14**	No additional guidance
Recommended frequencies for inspection and maintenance of components for drinking water installations, Annex A	No additional guidance
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Specific inspection and maintenance procedures for water conditioning devices, Annex C	No additional guidance
Supplementary guidance	**6.2**

1 Scope

This British Standard provides complementary guidance to BS EN 806. It is a guide to the design, installation, alteration, testing, operation and maintenance of services supplying water for domestic use within buildings and their curtilages.

BS EN 806 does not cover underground pipework, but this British Standard gives guidance on underground pipework within the curtilage of a building.

This British Standard does not cover:

a) the detailed methods of chemical treatment and maintenance of water distribution systems;

b) workmanship; or

c) space heating systems.

NOTE Annex A gives examples of pumped systems. Annex B provides guidance on the calculation of hot water storage systems, while Annex C provides calculations for pipe sizing.

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.

BS 1010-2, *Specification for draw-off taps and stopvalves for water services (screw-down pattern) – Part 2: Draw-off taps and above-ground stopvalves* [1)]

BS 1710, *Specification for identification of pipelines and services*

BS 2456, *Specification for floats (plastics) for float operated valves for cold water services*

BS 2580, *Specification for underground plug cocks for cold water services* [1)]

BS 3251, *Specification – Indicator plates for fire hydrants and emergency water supplies*

BS 4991, *Specification for propylene copolymer pressure pipe*

[1)] Withdrawn.

BS 5114, *Specification for performance requirements for joints and compression fittings for use with polyethylene pipes* [2)]

BS 5163-2, *Valves for waterworks purposes – Part 2: Stem caps for use on isolating valves and associated water control apparatus – Specification*

BS 5268-3, *Structural use of timber – Part 3: Code of practice for trussed rafter roofs* [2)]

BS 5391-1, *Acrylonitrile-butadiene-styrene (ABS) pressure pipe – Part 1: Specification*

BS 5392-1, *Acrylonitrile-butadiene-styrene (ABS) fittings for use with ABS pressure pipe – Part 1: Specification*

BS 5422, *Method for specifying thermal insulating materials for pipes, tanks, vessels, ductwork and equipment operating within the temperature range –40 °C to +700 °C*

BS 5433, *Specification for underground stopvalves for water services*

BS 5493, *Code of practice for protective coating of iron and steel structures against corrosion* [3)]

BS 5955-7, *Plastics pipework (thermoplastics materials) – Part 7: Recommendations for methods of thermal fusion jointing* [2)]

BS 5970, *Thermal insulation of pipework, ductwork, associated equipment and other industrial installations in the temperature range of –100 °C to +870 °C*

BS 6144, *Specification for expansion vessels using an internal diaphragm, for unvented hot water supply systems*

BS 6280, *Method of vacuum (backsiphonage) test for water-using appliances*

BS 6283-2, *Safety and control devices for use in hot water systems – Part 2: Specifications for temperature relief valves for pressures from 1 bar to 10 bar*

BS 6283-4, *Safety and control devices for use in hot water systems – Part 4: Specification for drop-tight pressure reducing valves of nominal size up to and including DN 50 for supply pressures up to and including 12 bar* [2)]

BS 6920-1, *Suitability of non-metallic products for use in contact with water intended for human consumption with regard to their effect on the quality of the water – Part 1: Specification*

BS 6920-2, *Suitability of non-metallic products for use in contact with water intended for human consumption with regard to their effect on the quality of the water – Part 2: Methods of test*

BS 6920-3, *Suitability of non-metallic products for use in contact with water intended for human consumption with regard to their effect on the quality of the water – Part 3: High temperature tests*

BS 6920-4, *Suitability of non-metallic products for use in contact with water intended for human consumption with regard to their effect on the quality of the water – Part 4: Method for the GCMS identification of water leachable organic substances*

BS 7291-1, *Thermoplastics pipe and fitting systems for hot and cold water for domestic purposes and heating installations in buildings – Part 1: General requirements*

2) Withdrawn.

3) This standard also gives an informative reference to BS 5493:1977.

BS 7291-2, *Thermoplastics pipe and fitting systems for hot and cold water for domestic purposes and heating installations in buildings – Part 2: Specification for polybutylene (PB) pipe and associated fittings*

BS 7291-3, *Thermoplastics pipe and fitting systems for hot and cold water for domestic purposes and heating installations in buildings – Part 3: Specification for crosslinked polyethylene (PE-X) pipes and associated fittings*

BS 7671, *Requirements for Electrical Installations – IET Wiring Regulations*

BS EN 681-1:1996, *Elastomeric seals – Material requirements for pipe joint seals used in water and drainage applications – Part 1: Vulcanized rubber*

BS EN 806-1:2000, *Specification for installations inside buildings conveying water for human consumption – Part 1: General*

BS EN 806-2:2005, *Specification for installations inside buildings conveying water for human consumption – Part 2: Design*

BS EN 806-3:2006, *Specifications for installations inside buildings conveying water for human consumption – Part 3: Pipe sizing – Simplified method*

BS EN 806-4:2010, *Specifications for installations inside buildings conveying water for human consumption – Part 4: Installation*

BS EN 806-5:2012, *Specifications for installations inside buildings conveying water for human consumption – Part 5: Operation and Maintenance*

BS EN 1057:2006+A1:2010, *Copper and copper alloys – Seamless, round copper tubes for water and gas in sanitary and heating applications*

BS EN 1213, *Building valves – Copper alloy stopvalves for potable water supply in buildings – Tests and requirements*

BS EN 1254-1, *Copper and copper alloys – Plumbing fittings – Part 1: Fittings with ends for capillary soldering or capillary brazing to copper tubes*

BS EN 1254-2, *Copper and copper alloys – Plumbing fittings – Part 2: Fittings with compression ends for use with copper tubes*

BS EN 1254-3, *Copper and copper alloys – Plumbing fittings – Part 3: Fittings with compression ends for use with plastics pipes*

BS EN 1254-5, *Copper and copper alloys – Plumbing fittings – Part 5: Fittings with short ends for capillary brazing to copper tubes*

BS EN 1452-1, *Plastics piping systems for water supply – Unplasticized poly (vinyl chloride) (PVC-U) – Part 1: General*

BS EN 1452-2, *Plastics piping systems for water supply – Unplasticized poly (vinyl chloride) (PVC-U) – Part 2: Pipes*

BS EN 1452-3, *Plastics piping systems for water supply – Unplasticized poly (vinyl chloride) (PVC-U) – Part 3: Fittings*

BS EN 1452-4, *Plastics piping systems for water supply – Unplasticized poly (vinyl chloride) (PVC-U) – Part 4: Valves and ancillary equipment*

BS EN 1452-5, *Plastics piping systems for water supply – Unplasticized poly (vinyl chloride) (PVC-U) – Part 5: Fitness for purpose of the system*

BS EN 1490, *Building valves – Combined temperature and pressure relief valves – Tests and requirements*

BS EN 1491, *Building valves – Expansion valves – Tests and requirements*

BS EN 1567, *Building valves – Water pressure reducing valves and combination water reducing valves – Requirements and tests*

BS EN 1995-1-1, *Eurocode 5 – Design of timber structures – Part 1-1: General – Common rules and rules for buildings*

BS EN 10224, *Non-alloy steel tubes and fittings for the conveyance of water and other aqueous liquids – Technical delivery conditions*

BS EN 10255, *Non-alloy steel tubes suitable for welding and threading – Technical delivery conditions*

BS EN 10312, *Welded stainless steel tubes for the conveyance of water and other aqueous liquids – Technical delivery conditions*

BS EN 12201-3, *Plastics piping systems for water supply, and for drainage and sewerage under pressure – Polyethylene (PE) – Part 3: Fittings*

BS EN 12828, *Heating systems in buildings – Design for water-based heating systems*

BS EN 13076, *Devices to prevent pollution by backflow of potable water – Unrestricted air gap – Family A – Type A*

BS EN 13077, *Devices to prevent pollution by backflow of potable water – Air gap with non-circular overflow (unrestricted) – Family A – Type B*

BS EN 13959, *Anti-pollution check valves – DN 6 to DN 250 inclusive Family E, type A, B, C, and D*

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

BS EN 14814, *Adhesives for thermoplastic piping systems for fluids under pressure – Specifications*

BS EN 14451, *Devices to prevent pollution by backflow of potable water – In-line anti-vacuum valves DN 8 to DN 80 – Family D, type A*

BS EN 14623, *Devices to prevent pollution by backflow of potable water – Air gaps with minimum circular overflow (verified by test or measurement) – Family A, type G*

BS EN 29453, *Soft solder alloys – Chemical compositions and forms*

BS EN 60079-30-1, *Explosive atmospheres – Part 30-1: Electrical resistance trace heating – General and testing requirements*

BS EN 62395-1, *Electrical resistance trace heating systems for industrial and commercial applications – Part 1: General and testing requirements*

BS EN ISO 1452-3, *Plastics piping systems for water supply and for buried and above-ground drainage and sewerage under pressure – Part 3: Unplasticized poly(vinyl chloride) (PVC U) – Fittings*

BS EN ISO 15493, *Plastics piping systems for industrial applications – Acrylonitrile-butadiene-styrene (ABS), unplasticized poly (vinyl chloride) (PVC-U) and chlorinated poly (vinyl chloride) (PVC-C) – Specifications for components and the system – Metric series*

BS EN ISO 15877-1, *Plastics piping systems for hot and cold water installations – Chlorinated poly(vinyl chloride) (PVC-C) – Part 1: General*

BS EN ISO 15877-2, *Plastics piping systems for hot and cold water installations – Chlorinated poly(vinyl chloride) (PVC-C) – Part 2: Pipes*

BS EN ISO 15877-3, *Plastics piping systems for hot and cold water installations – Chlorinated poly(vinyl chloride) (PVC-C) – Part 3: Fittings*

BS EN ISO 15877-5, *Plastics piping systems for hot and cold water installations – Chlorinated poly(vinyl chloride) (PVC-C) – Part 5: Fitness for purpose of the system*

BS EN ISO 17672, *Brazing – Filler metals*

BS EN ISO 21003-2, *Multilayer piping systems for hot and cold water installations inside buildings – Part 2: Pipes*

BS ISO 17885, *Plastics piping systems – Mechanical fittings for pressure piping systems – Specifications* [4)]

3 Terms and definitions

For the purposes of this British Standard, the terms, definitions and symbols given in BS EN 806-1 apply, together with the following.

3.1 Terms and definitions

3.1.1 backflow
movement of the fluid from downstream to upstream within an installation contrary to the intended direction of flow

3.1.2 building
structure (including a floating structure) of a permanent character or not, and movable or immovable, connected to a water supply

3.1.3 cavity wall
structural or partition wall, formed by two upright parts of similar or dissimilar building materials, suitably tied together with a gap formed between them, which might (but need not) be filled with insulating material

3.1.4 chase
recess cut into an existing structure

3.1.5 cistern
fixed, vented container for holding water at atmospheric pressure

3.1.6 communication pipe
part of a service pipe for which the water supplier is responsible

*NOTE See **3.1.28**, Figure 1.*

3.1.7 composite fitting
combination of fittings or valves incorporated into one body

3.1.8 contamination
reduction in chemical or biological quality of water due to a change in temperature or the introduction of polluting substances

3.1.9 cover
panel or sheet of rigid material fixed over a chase, duct or access point, of sufficient strength to withstand surface loadings appropriate to its position

NOTE Except where providing access to joints or changes of direction (i.e. at an inspection access point), a cover may be plastered or screeded over.

3.1.10 cut-off end
redundant or disconnected/capped pipework or a short length of disconnected/capped pipework

[4)] In preparation.

3.1.11 dead leg
length of pipe (spur or branch) to a draw-off fitting where little or no flow can occur

NOTE This might include:

- *seldom or infrequently used fittings and cisterns; and*
- *hot water distributing pipe leading to taps that are not part of a secondary circulation system.*

3.1.12 disinfection
process which removes or renders inactive pathogenic microorganisms or parasites

3.1.13 distributing pipe
pipe (other than a warning, overflow or flushing pipe) conveying water from a storage cistern or from hot water apparatus supplied from a cistern and under pressure from that cistern

[SOURCE: BS EN 806-1:2000, **5.3.4**, modified]

3.1.14 duct
enclosure designed to accommodate water pipes and fittings, and other services if required

3.1.15 dwelling
premises, buildings or part of a building providing accommodation

NOTE This includes a terraced house, a semi-detached house, a detached house, a flat in a block of flats, a unit in a block of maisonettes, a bungalow, a flat within any non-domestic premises, a maisonette in a block of flats or any other habitable building, and any caravan, vessel, boat or houseboat that can accommodate a single family unit connected to the water supplier's mains.

3.1.16 expansion valve
pressure-activated valve designed to release expansion water from an unvented water heating system

3.1.17 feed and expansion cistern
cistern for supplying cold water to a hot water system without a separate expansion cistern

3.1.18 flushing cistern
cistern provided with a valve or device for controlling the discharge of the stored water into a water closet pan or urinal

3.1.19 inspection access point
position of access to a duct or chase allowing inspection of the pipe or pipes therein by removal of a cover fixed by removable fastenings that does not necessitate the removal of surface plaster, screed or continuous surface decoration

3.1.20 overflow pipe
pipe from a cistern in which water flows only when the level in the cistern exceeds a predetermined level

3.1.21 potable water
water suitable for human consumption that meets minimum legal requirements for wholesome water from mains or private extraction

NOTE Potable water is also known as "wholesome water".

3.1.22 pressure relief valve
pressure-activated valve that opens automatically at a specified pressure to discharge fluid

3.1.23 primary circuit
assembly of water fittings in which water circulates between a heat source and a primary heat exchanger inside a hot water storage vessel, and includes any space heating system

3.1.24 removable fastening
fastening that can be removed readily and replaced without causing damage, including turn buckles, clips, magnetic or touch latches, coin-operated screws and conventional screws, but not nails, pins or adhesives

3.1.25 responsible person
individual(s) appointed to take day-to-day responsibility for water quality and the control of any identified risk, including *Legionella* or other waterborne bacteria

NOTE The appointed "responsible person" can be a manager or director, or have similar status and sufficient authority, competence and knowledge of the installation to ensure that all operational procedures are carried out in a timely and effective manner with a clear understanding of their duties and the overall health and safety management structure and policy in the organization.

3.1.26 secondary circuit
assembly of water fittings in which water circulates in supply pipes or distributing pipes of a hot water storage system

3.1.27 self-regulating trace heating system
assembly of self-regulating heating cables and associated controls used for the purposes of:

- frost protection/freeze prevention of piped services in exposed or unheated parts of a building; and
- hot water temperature maintenance of a single pipe domestic hot water system without secondary return

3.1.28 service pipe
water pipe which supplies water from the local main to the potable water installation

[SOURCE: BS EN 806-1:2000, **5.3.1**]

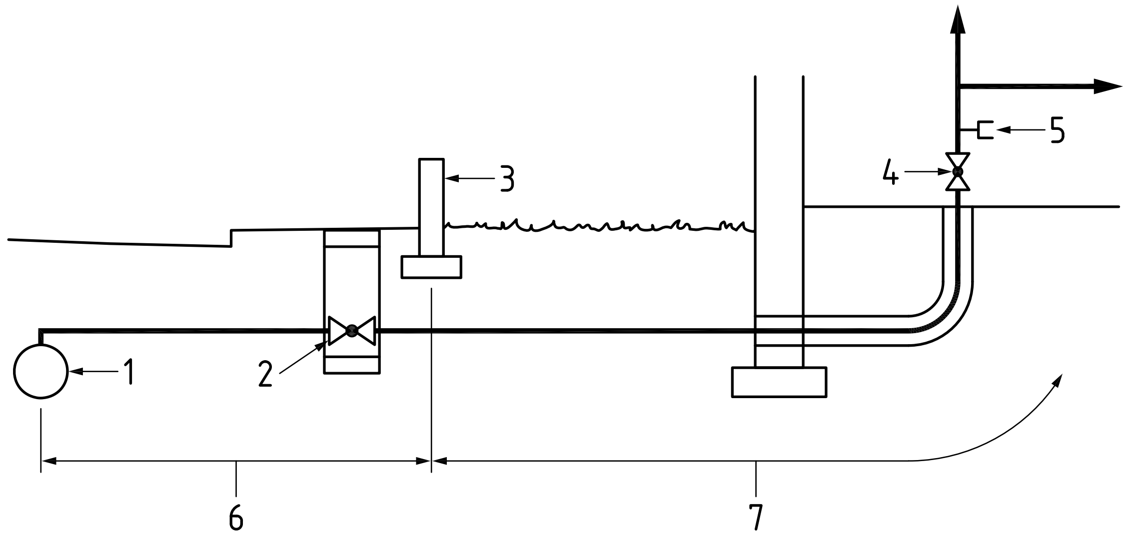
NOTE In the UK, the WRAS Water Regulations Guide *[25] defines "service pipe" as "so much of a pipe which is, or is to be, connected with a water main for supplying water from that main to any premises as is to be subjected to water pressure from that main, or would be so subject but for the closing of some valve" (see Figure 1).*

3.1.29 service stopvalve
water supplier's stopvalve which is the first valve in the service pipe after or included in the connection point to the main

NOTE A stopvalve is usually fitted at the end of the communication pipe at or near to the boundary of the property served (see Figure 1).

[SOURCE: BS EN 806-1:2000, **5.4.2**, modified]

Figure 1 **Example of service pipe**



Key

1	Main	5	Draining valve
2	Service stopvalve	6	Communication pipe (water supplier's responsibility)
3	Boundary of property	7	Supply pipe (consumer's responsibility)
4	Supply stopvalve		

NOTE 1 The service pipe includes the communication pipe and the supply pipe.

NOTE 2 The service stopvalve can be found inside the boundary.

3.1.30 servicing valve
valve for shutting off, for the purpose of maintenance, the flow of water in a pipe connected to a water fitting or appliance

3.1.31 sleeve
enclosure of tubular or other section of suitable material designed to provide a space through an obstruction to accommodate a single water pipe and to which access to the interior can be obtained only from either end

3.1.32 stagnation
process by which water quality deteriorates due to very low or zero movement

3.1.33 stagnant water
water stored with very low or no movement resulting in water quality deviation outside recommended control values

3.1.34 stopvalve
valve, other than a servicing valve, used for shutting off the flow of water in a pipe

3.1.35 storage cistern
cistern for storing water for subsequent use, not being a flushing cistern

3.1.36 supply pipe
water pipe that conducts water from the supply stopvalve to connection draw-off points and connection points of appliances

[SOURCE: BS EN 806-1:2000, **5.3.2**]

NOTE A supply pipe can also be defined as that part of any service pipe for which the water supplier is not responsible (see Figure 1).

3.1.37 supply stopvalve
first stopvalve in the premises which controls the downstream supply and may be included in a water meter assembly

[SOURCE: BS EN 806-1:2000, **5.4.3**]

NOTE The first stopvalve in the building or premises to which it supplies controls the whole of the supply to the building without shutting off the supply to any other premises (see Figure 1).

3.1.38 tank
closed vessel holding water at greater than atmospheric pressure

3.1.39 temperature relief valve
valve that opens automatically at a specified temperature to discharge fluid

3.1.40 terminal fitting
water outlet device

3.1.41 tundish
funnel for catching overflow or discharge

3.1.42 vent pipe
pipe, open to the atmosphere, which exposes the system to atmospheric pressure

3.1.43 walkway (or crawlway)
enclosure similar to a duct, but of such size as to provide access to the interior by people through doors or manholes, and which accommodates water pipes and fittings and other services if required

3.1.44 warning pipe
pipe from a cistern in which water flows only when the level in the cistern is about to exceed the predetermined overflow level to warn of impending overflow

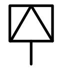
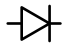
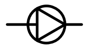
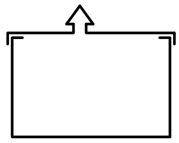
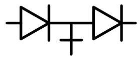
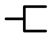
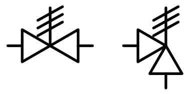
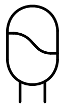
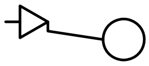
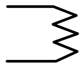
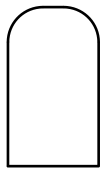
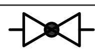
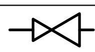
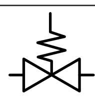
NOTE Cisterns over 1 000 L require both a warning pipe and an overflow pipe.

3.1.45 water age
duration for which a unit volume of water entering the building is retained within the distribution system before use

3.2 Symbols

The symbols used in this British Standard are described in Table 2.

Table 2 **Drawing symbols for BS 8558**

Name	Symbol
Air release valve	
Check valve or non-return valve	
Circulating pump	
Cold water storage cistern/feed cistern	
Double-check valve	
Draining valve	
Expansion (pressure) relief valve	
Expansion vessel	
Feed and expansion cistern	
Float operated valve	
Heat exchanger	
Hot water storage vessel (cylinder)	
Servicing valve	
Stopvalve	
Pressure reducing (limiting) valve	
Temperature relief valve	
Tundish	

4 Guidance on BS EN 806-2

4.1 Preliminary investigations

*COMMENTARY ON **4.1***

Where water is to be supplied by a public water supplier, the Water Fittings Regulations [19], [20] and [21] apply. The Water Fittings Regulations [19], [20] and [21] apply whenever the work involves either a new service or the modification or disconnection of existing services.

For information on the control of Legionella*, refer to the Health and Safety Executive's (HSE) Approved Code of Practice L8,* Legionnaires' disease: The control of Legionella bacteria in water systems *[26] and BS 8580. Further guidance is available for specific areas (see [27] and [28]).*

The following factors should be accounted for in the design:

a) the water supplier's requirements, including those of notification;

b) the estimated daily consumption and the maximum and average flow rates required, together with the estimated time of peak flow;

c) the location of the available supply;

d) the quality, quantity and pressure required and the available pressures at various times during a typical day;

e) the cold water storage capacity required;

f) the likelihood of ground subsidence, e.g. due to mining activities;

g) the likelihood of contamination of the site;

h) transient or surge pressures that might arise during the operation of the system; and

i) the risk of heat gain during the summer.

4.2 Guidance on specific BS EN 806-2 requirements

4.2.1 BS EN 806-2:2005, Clause 5: Acceptable materials

*COMMENTARY ON **4.2.1***

Where the system is receiving water from a public supply the material in contact with the water needs to conform to the Water Fittings Regulations [19], [20] and [21]. Where the water is exclusively provided from a private source, such as a well or borehole, the Private Water Supplies Regulations [15], [16], [17] and [18] apply.

4.2.1.1 The influence on water quality of the materials used in the construction of the water service installation, and of those in contact with the installation, is explained in BS 6920 (all parts).

4.2.1.2 Materials should be selected depending on the present and reasonably foreseeable character of the water supply and its intended use. Information on the character of the water supply is available from the local water supplier.

4.2.1.3 Internal corrosion leading to premature failure of metal pipes can occur with certain waters. External corrosion of pipes and fittings laid below ground can be a serious local problem depending on the particular ground conditions. Pipes and fittings should be protected against corrosion by using an internal lining, an external coating or a corrosion-resistant material. Where contamination of the soil is suspected, or where knowledge of the site raises concerns, an analysis of the soil should be obtained. Extended use of biocides can adversely affect both metal and plastic piping.

4.2.1.4 In all cases, care should be taken to avoid the use of incompatible materials supplying the same installation, particularly where dissimilar metals are in contact.

4.2.1.5 Only suitably approved materials or coatings should be used. The water supplier may be consulted for advice on the choice of an effective lining or coating material.

4.2.2 BS EN 806-2:2005, 5.1: Choice of materials

4.2.2.1 Lead

4.2.2.1.1 No pipe or other water fitting or storage cistern made from lead or internally lined with lead should be used in new installations or repairs on plumbing systems supplying water for domestic purposes.

4.2.2.1.2 Metallic pipes and fittings should not be connected to existing lead pipework without appropriate protection against electrolytic action.

4.2.2.1.3 Where an insertion of non-metallic pipe or fitting is used, continuity of electrical earth bonding should be maintained.

4.2.2.1.4 Repairs to existing lead services should be made with materials other than lead (see also **4.3.31.1**).

4.2.2.1.5 Lead, or any substance containing lead, should not be used in the jointing of pipes or fittings.

NOTE The WRAS Water Regulations Guide *[25],* ***G2.1****, states, "Particular materials unsuitable for use in contact with water intended for domestic or food production purposes include lead and bitumastic coatings derived from coal tar."*

4.2.2.2 Copper

4.2.2.2.1 Users of this British Standard are advised to consider the desirability of selecting copper tubes for which independent quality assurance certification to BS EN 1057:2006+A1:2010 has been obtained. Generally, copper is resistant to corrosion and is suitable for hot and cold water applications. Where supply waters are capable of dissolving an amount of copper such that unacceptable green staining is produced on pipework and fittings, consideration should be given to the use of water treatment or alternative materials.

4.2.2.2.2 In certain specialized installations, such as hospitals in aggressive water areas, the use of copper might not be appropriate due to the risk of contamination resulting from pitting of copper.

4.2.2.3 Copper alloys

Copper cannot corrode by dezincification because it does not contain zinc. Other recommended materials are gunmetal, which is also immune to dezincification, and brasses inhibited and treated to be highly resistant to this form of corrosion. For alloys in the latter category, a specific test of dezincification resistance is given in BS EN ISO 6509. For ease of identification, fittings manufactured from grade A dezincification-resistant brasses are marked with the recognized dezincification symbol "CR" or "DRA".

4.2.2.4 Stainless steel

The Water Fittings Regulations [19], [20] and [21] preclude the use of adhesive for the jointing of metal pipes laid below ground. However, it is an acceptable method of connection for above-ground pipework including, where accessible, pipework installed in a chase or duct. Although mixed copper and stainless steel systems may be used, jointing small copper areas to large stainless steel areas should be avoided due to corrosion risks. Jointing should be made using stainless-steel or copper capillary, or compression, push-fit or press fittings (see **5.1.3.3**). Jointing of stainless steel tubes by adhesive bonding may only be used where the water temperature does not exceed 85 °C.

4.2.2.5 Steel

4.2.2.5.1 Where used above ground for distributing pipes from a storage cistern, steel tube should be medium grade in accordance with BS EN 10255. Steel pipes should be internally lined with an approved material and, where appropriate, externally protected against corrosion. Guidance and recommendations on the zinc coating for corrosion protection are given in BS EN ISO 14713 (all parts).

4.2.2.5.2 Galvanizing offers only marginal protection against corrosion. Welded or brazed joints should not be used as this damages the galvanizing.

4.2.2.6 Plastics

4.2.2.6.1 General selection criteria and relevant standards

4.2.2.6.1.1 Coefficients of expansion for plastics pipes are greater than those for metal pipes, but this is generally not a problem where pipes are buried.

4.2.2.6.1.2 Below ground and in concealed locations above ground that are not accessible with hand tools, mechanical joints should be used rather than solvent cement joints due to the difficulty in making satisfactory solvent cement joints in such adverse conditions. Where mechanical joints are made with copper alloy fittings, they should be corrosion-resistant or immune to dezincification. Where there is adequate access in positions above ground, solvent cement joints may be used.

4.2.2.6.1.3 Plastics pipework systems for pressure applications are not automatically inter-compatible, and there are no British Standards for connector dimensions or methods of achieving a joint. Any plastics fittings and pipework should be compatible with each other. All non-metallic materials should conform to BS 6920 (all applicable parts).

4.2.2.6.2 Acetal

Fittings, mostly terminal water fittings, made from acetal are suitable for cold water applications. Jointing carried out by mechanical or push-fit methods is suitable.

4.2.2.6.3 Polybutylene (PB)

4.2.2.6.3.1 Pipes and fittings made from polybutylene (PB) and conforming to BS 7291-1 and BS 7291-2 or BS EN ISO 15876 (all parts) are suitable for hot and cold water applications. PB pipes provide good resistance to freezing, but should still be provided with thermal insulation for frost protection.

4.2.2.6.3.2 PB cannot be solvent welded, but may be jointed by push-fit or crimped fittings, other mechanical joints, or by thermal fusion.

4.2.2.6.4 Polyethylene (PE)

4.2.2.6.4.1 The use and installation of polyethylene (PE) pipelines for the supply of drinking water should be in accordance with BS 5955-7 [5)]. Requirements for pipes are specified in BS EN 12201-2. Copper alloy compression fittings for use with PE pipe should be in accordance with BS EN 1254-3 and joints should conform to BS 5114.

4.2.2.6.4.2 PE cold water storage cisterns conforming to BS 4213 are suitable for storage and expansion purposes.

4.2.2.6.4.3 PE cannot be solvent welded, but may be jointed by push-fit or crimped fittings, other mechanical joints, or by thermal fusion.

4.2.2.6.5 Propylene copolymer (PP)

4.2.2.6.5.1 Polypropylene pipe for drinking water use should conform to series 1 of BS 4991.

4.2.2.6.5.2 Propylene copolymer (PP) cannot be solvent welded. Cold water storage cisterns in PP conforming to BS 4213 are suitable for storage and expansion purposes.

4.2.2.6.5.3 Floats in PP for float-operated valves should conform to BS 2456.

4.2.2.6.6 Crosslinked polyethylene (PE-X)

4.2.2.6.6.1 Pipes and fittings made from crosslinked polyethylene (PE-X) conforming to BS 7291-1 and BS 7291-3 or BS EN ISO 15875 (all parts) are suitable for hot and cold water applications. PE-X pipes provide good resistance to freezing, but should still be provided with thermal insulation for frost protection.

4.2.2.6.6.2 PE-X cannot be solvent welded, but may be jointed by push-fit or other mechanical joints, crimped fittings, or by thermal fusion. These include fittings made from a plastics material that meets the applicable requirements of BS 7291 (all parts), and copper and copper-alloy compression fittings conforming to BS EN ISO 21003-3, BS EN 1254-2 and/or BS EN 1254-3.

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5) Withdrawn.

4.2.2.6.7 Unplasticized polyvinyl chloride (PVC-U)

4.2.2.6.7.1 PVC-U should be used only for cold water applications.

4.2.2.6.7.2 PVC-U pipe should conform to BS EN 1452-2 and the solvent cements to be used with the pipe should conform to BS EN 14814.

4.2.2.6.7.3 As PVC-U pipes become increasingly brittle with reducing temperatures, particular care should be taken in handling them at temperatures below 5 °C.

4.2.2.6.7.4 PVC-U may be solvent welded or jointed by push-fit or other mechanical joints, or by thermal fusion.

4.2.2.6.8 Chlorinated polyvinyl chloride (PVC-C)

4.2.2.6.8.1 PVC-C pipe should conform to BS EN ISO 15877 (all parts) and the solvent cements to be used with the pipe should conform to BS EN 14814.

4.2.2.6.8.2 As PVC-C pipes become increasingly brittle with reducing temperatures, particular care should be taken in handling them at temperatures below 5 °C.

4.2.2.6.8.3 PVC-C may be solvent welded or jointed by push-fit or other mechanical joints, or by thermal fusion.

4.2.2.6.9 Acrylonitrile butadiene styrene (ABS)

4.2.2.6.9.1 Pipes and fittings made from acrylonitrile butadiene styrene (ABS) conforming to BS 5391-1 and BS 5392-1 or to BS EN ISO 15493 are suitable for cold water applications.

4.2.2.6.9.2 ABS may be solvent welded or jointed by push-fit or other mechanical joints.

4.2.2.7 Coating and lining materials

4.2.2.7.1 For the prevention of contact of water with unsuitable materials, see **4.3.31.1**. BS 5493 gives recommendations for the protective coating of iron and steel structures, including pipes, fittings and cisterns, which should be consulted where detailed guidance is required. BS 5493 deals with non-saline water and is applicable to domestic water installations. It provides typical times to first maintenance and general descriptions of recommended coatings and their thicknesses. Tables give more detailed information about the coating systems. Of particular relevance is BS 5493:1977, Table 3, note n), which concerns fittings used with drinking water.

4.2.2.7.2 Internal protection of steel pipes should be in accordance with BS EN 10224.

4.2.2.8 Elastomeric materials

4.2.2.8.1 The materials of elastomeric sealing rings in contact with drinking water should conform to BS EN 681-1:1996, types WA, WB or WE (see also **4.3.31.1**).

4.2.2.8.2 For health care premises, the Trust should be consulted about any specific requirements relating to ethylene propylene diene monomer (EPDM) rubber components.

4.2.3 BS EN 806-2:2005, Clause 5: Acceptable materials and 10.2.5: Discharge pipes

Discharge pipes connected via a tundish to temperature or expansion-relief valves in hot water systems should be capable of withstanding intermittent hot water or steam discharges at system malfunction temperatures of 95 °C.

4.3 Supplementary guidance to BS EN 806-2

4.3.1 Extensions

If the existing supply is part of a common supply pipe (i.e. the supply pipe serves several properties), any additional demand, such as extending the plumbing system or property, can have an adverse effect on pressure/flow and quality, so the water supplier might require a separate service pipe to be provided. Where properties are being supplied with a new service from a water supplier's main, a separate service pipe(s) should be provided wherever feasible. The water supplier normally requires this.

4.3.2 Water mains

Full information about proposals should be supplied as early as possible to the water supplier. Site plans should be supplied showing the layout of roads, footpaths, buildings and boundaries. The work programme should provide for the water supplier not laying a main until at least the line and level of the kerb are permanently established on site.

4.3.3 Ground movement

4.3.3.1 Ground movement can occur due to underground mining operations, natural movements of the earth's strata or movement of superficial deposits. These movements can occur in both the horizontal and vertical planes, and vary in magnitude over the affected area. The effects of undermining can be predicted with reasonable accuracy by an appropriately qualified professional, such as a surveyor or geotechnical engineer, who should be consulted for advice on the adoption of precautionary measures. Movement of superficial deposits can be due to seasonal swelling and shrinkage, settlement (especially where fibrous organic soils are encountered) or slope stability failures. To enable an assessment of likely ground movement, a site investigation should be conducted to determine the ground conditions existing along the line of a proposed construction.

4.3.3.2 The extent of movements of superficial deposits can only be assessed by consideration of the findings of a site investigation. Where ground or groundwater level can move, a suitable type of flexible pipework should, where practicable, be "snaked" or undulated in the trench to accommodate movement. Where the pipes or the joints are not sufficiently flexible to accommodate movement in pipelines laid in recently disturbed ground, continuous longitudinal support should be provided.

4.3.3.3 When selecting the type of pipe or storage cistern, components of brittle materials should be more carefully protected from movement than inherently flexible materials.

4.3.3.4 Telescopic joints may be used to provide for thermal movement in pipelines. Angular deflections should be compensated for by using flexible type joints. The continuity of gradient towards washouts and air valves can be affected by subsidence. Where such a situation could occur, pipelines should be supported and reasonable gradients between high and low points on the pipeline should be ensured. Pipes passing through walls should be free to deflect.

4.3.4 Contamination

4.3.4.1 Contaminated land

Where assessing a site, advice should be sought from the local authority, the site owner and the water supplier. The previous uses of the site should be assessed.

NOTE See UK Water Industry Research Ltd.'s (UKWIR), Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites *[29].*

4.3.4.2 Hygiene

4.3.4.2.1 Drinking water points should be located in areas intended for food preparation and consumption, as well as in rooms provided for beverage making. Where beverage-making facilities are not provided, drinking water points should be sited in the vicinity of, but not inside, toilet areas or outside buildings.

4.3.4.2.2 All drinking water fountains should be of the shrouded nozzle type, discharging above the spillover level of the bowl (see BS 6465-1).

NOTE Attention is drawn to the Workplace (Health, Safety and Welfare) Regulations 1992 [4] with respect to drinking water provision in offices and other commercial buildings. For recommendations for collecting and investigating samples, where to sample and the selection of laboratory or on-site testing, see BS 8554.

4.3.5 Dead legs

4.3.5.1 General

4.3.5.1.1 To reduce the risk of stagnation, the layout of pipework should be arranged, where possible, so that fittings downstream of a drinking water point have regular use. To ensure efficient use of water and the maintenance of water quality, cold water should not be warmed above 25 °C, and ideally 20 °C, and hot water should be delivered at or above 50 °C to the water outlet within 1 min of running the water [see also a) and b)]. This should provide the most efficient water conservation measure. However, an overriding design consideration should be the control of *Legionella* bacteria in all water systems. Where possible, terminal pipe lengths to outlets and appliances should be designed such that they meet the following minimum thermal performance criteria.

a) **Cold water**

   To control *Legionella* the water temperature should be below 20 °C after running the water for up to 2 min.

   However, due to environmental factors, the incoming water temperature at some sites can become abnormally warm. The building user should be advised accordingly so that the information is available at the time the system is handed over and *Legionella* risk assessments are carried out.

b) **Hot water**

   To ensure suitable *Legionella* management in all buildings the water temperature at an outlet should be at least 50 °C within 1 min of running the water.

   The water supply to any thermostatic mixing valve (TMV) should be at a temperature of at least 50 °C within 1 min of running the water.

   Where appropriate, for water leaving and returning to a calorifier or hot water storage cistern, the outgoing water temperature should be at least 60 °C and returned to at least 50 °C or 55 °C.

NOTE 1 Where it is not practical to use pipework to recirculate hot water back to the calorifier, or where the minimum return temperature cannot be guaranteed, a single pipe system with electrical self-regulating trace-heating cables may be installed to ensure temperature maintenance of at least 50 °C, which will also enable the elimination of the deadleg, providing temperature maintenance to the draw-off point.

Trace heating might be necessary when the length of hot water pipework and the volume of water the pipework contains become such that it would take an unreasonable length of time to draw off the cool water

NOTE 2 For more detailed information, refer to the HSE's Approved Code of Practice L8, Legionnaires' disease – The control of Legionella bacteria in water systems *[26], HSG274 part 2 [30] and BS 8580. See also the Water Fittings Regulations [19], [20] and [21].*

4.3.5.1.2 Except in a dwelling, all taps that are supplied with cold water that is not drinking water should be labelled "Not Drinking Water". An alternative approach is to undertake a risk assessment to identify specific labelling requirements.

4.3.5.1.3 To minimize the amount of water drawn off before sufficiently hot or cold water arrives at the tap, dead legs should be insulated and be as short as practicable.

NOTE This guidance is based on balancing thermal efficiency and is not necessarily a recommendation for reducing microbiological risks (see Approved Code of Practice L8, Legionnaires' disease – The control of Legionella bacteria in water systems *[26] and HSG274 Part 2 [30]).*

4.3.5.1.4 Dead legs of secondary circulation (hot water) should not exceed a volume of 0.5 L. This also reduces the risk of stagnation which can lead to a reduction in water quality.

4.3.5.1.5 If it can be reasonably foreseen that sections of the distribution circuits will be used at relatively low frequency compared to those pipe runs serving kitchens or showers, check valves should be fitted to prevent backflow from entering flow drawn past the unions. Such design practice reduces the risk of relatively stagnant water contributing to biofilm colonization of such sensitive outlets and minimizes the associated contribution to *Legionella* and other microbiological contamination.

NOTE For recommendations for collecting and investigating samples, where to sample and the selection of laboratory or on-site testing, see BS 8554.

4.3.5.2 Cut-off ends

Where systems are modified and services are removed from either hot or cold water distribution networks, capped tails should be avoided. Where this is not practicable, tails should be cut as short as possible.

4.3.6 Water softeners

A separate, unsoftened mains-fed drinking water tap is recommended to ensure that drinking water is always available and that it serves two purposes (see Figure 2). Firstly, it enables samples to be taken to verify the quality of the incoming supply either by the occupier or the water supplier. The water supplier has an obligation to carry out compliance samples at mains water taps within consumer premises for compliance with the Water Quality Regulations [11], [12], [13] and [14]. Secondly, the Department of Health recommends that unsoftened water should be available for infant feed preparation and for those individuals on a medically-supervised low-sodium diet.

NOTE 1 For further information on the installation of ion exchange water softeners, see WRAS IGN 9-07-01, Information for Installation of Ion Exchange Water Softeners for Systems Supplying Water for Domestic Purposes *[31].*

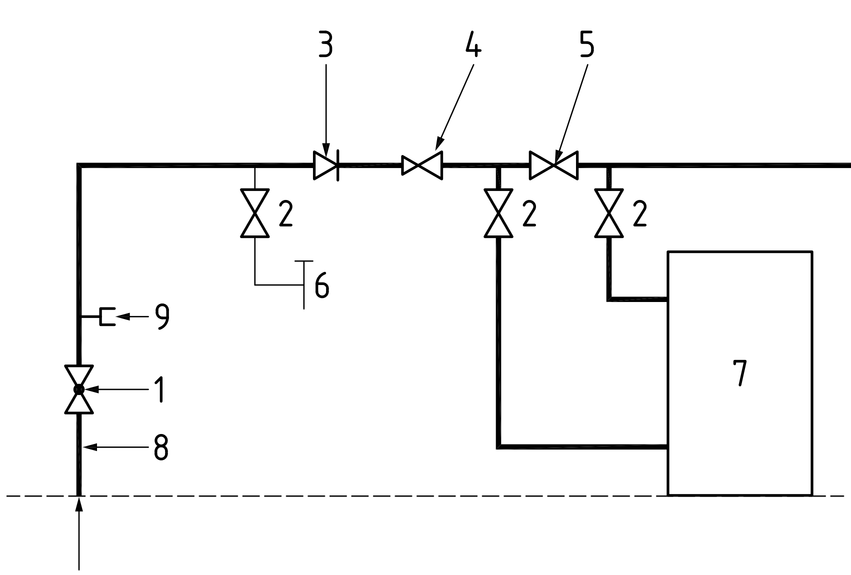
NOTE 2 The Water Fittings Regulations [19], [20] and [21] require that "All premises supplied with water for domestic purposes should have at least one conveniently situated tap for the drawing of drinking water."

NOTE 3 The parametric value for sodium of 200 mg/L stipulated in the Water Supply (Water Quality) Regulations [11], [12], [13] and [14] is only exceeded when it is softened in areas where the water supply is extremely hard, i.e. greater than 435 mg/L as $CaCO_3$ (assuming zero sodium in the mains supply).

The provision of an unsoftened drinking water tap is essential where the hardness of the public supply and its sodium content as supplied would result in the softened water exceeding 200 mg/L sodium limit.

For further guidance see The Building Regulations 2000: Approved Document G, Sanitation, Hot Water Safety and Water Efficiency *[32].*

Figure 2 **Example of pipework for installation of domestic water softener**



Key

1	Stopvalve	5	Bypass valve
2	Servicing valve	6	Drinking water tap
3	Check valve for single dwelling (double-check valve assembly for all other installations)	7	Water softener
		8	Supply pipe
4	Pressure reducing or limiting valve if required	9	Draining valve

4.3.7 Type of system

4.3.7.1 Where the pressure within the water mains is reliable and sufficient for the peak flow within the dwelling, a Type A (mains-fed) system should be installed as it has a lower installation cost and creates less risk of water stagnation and contamination. Where a Type A system cannot meet the system's requirements, the following options should be used as appropriate:

a) a proprietary pump-assisted supply (subject to agreement by the water supplier); or

b) an interposed ("break") cistern and conventional booster pump; or

c) a Type B (gravity) supply from a storage cistern.

4.3.7.2 Direct supply from a water main is recommended as inhalation of droplets or aerosols can occur when using supply via a storage system (see **4.3.31.2** on *Legionella*). Pressure and reliability of supply, particularly where dwellings are located at the extremity of the mains distribution system, should be assessed and documented.

4.3.7.3 The characteristics of direct supply from a water main are:

a) smaller pipes can be used in most cases;

b) the higher pressure that is usually available is more suitable for instantaneous type shower heaters, hose taps and mixer fittings used in conjunction with a high-pressure (unvented) hot water supply;

c) where single-outlet mixer fittings are used, measures to prevent backflow are necessary; and

d) where there is a lack of pressure, a pumped supply pipe might be necessary, requiring the written consent of the water supplier where the flow pump rates would exceed 0.2 L/s (directly or indirectly).

4.3.7.4 The characteristics of supply via a storage cistern are:

a) availability of a reserve of water for use in case of interruption of the mains supply;

b) additional protection of the mains from contamination;

c) reduced risk of waterhammer and reduced noise from outlets, but additional noise generated by the float-operated valve controlling the water supply to the cistern;

d) constant low pressure with reduced risk of leakage which is suitable for mixer fittings in conjunction with low-pressure (vented) hot water supply;

   NOTE The pressure available might be insufficient for some types of taps and might be insufficient for satisfactory showering in the absence of a booster pump depending on the type of shower and the needs of the user.

e) risk of frost damage;

f) space occupied and cost of storage cistern, structural support and additional pipework; and

g) need to ensure that the cistern is continuously protected against the ingress of any contaminant.

4.3.7.5 A combination of the two methods of supply (Type A and Type B) might be the best arrangement. For example, in a dwelling the ground floor cold outlets and any outside taps can be supplied under mains pressure while all other cold water outlets could be fed from a storage cistern. In these cases, precautions are necessary to prevent cross-connections and backflow.

NOTE BS 8515 and BS 8525-1 specify requirements for rainwater and greywater harvesting systems, which are unwholesome supplies of water.

4.3.8 Buildings other than dwellings

For small buildings where the water consumption is likely to be comparable to that of a dwelling, the characteristics listed in **4.3.7** should be assessed. For larger buildings, drinking water should be taken directly from the water supplier's main wherever practicable [using a pump system where necessary (see **4.3.9**)] or, when circumstances dictate otherwise, from a cistern protected in accordance with **4.3.12**.

4.3.9 Pump systems

Where the available pressure is insufficient to supply the whole of a building, a pumped system should be installed. The pumped system can serve either parts or the whole of the building. If the pump is intended to draw water directly from the water mains, the water suppliers do not normally allow the pump flow rate to exceed 2.0 L/s. However, in large systems the booster pump normally draws water from an interposed (break) cistern, in which case there is no limit on the pump capacity (see Figure A.1 to Figure A.3).

4.3.10 Cisterns

4.3.10.1 Cisterns should be made from corrosion-resistant material or coated internally with an approved non-toxic, corrosion-resistant material conforming to BS 6920-1.

4.3.10.2 Care should be taken to avoid undue heating of the water.

4.3.11 Storage cisterns

4.3.11.1 All cold water distributing pipes from a cistern should be connected at the lowest practicable point on the cistern and arranged to promote the movement of water within the cistern. Connections to pipes feeding hot water apparatus should be set at a level at least 25 mm above connections to cold water distributing pipes and should be for the supply of hot water apparatus only.

4.3.11.2 The water supply to the cistern should be fitted on the opposite side to the distribution pipes to promote movement of water. Consideration should be given to the use of delayed action inlet valves.

4.3.11.3 Storage capacity in relation to turnaround time should be considered at the design stage (see Annex B).

NOTE 1 For further information on thermal streaming, see AWWA's Passive Mixing Systems Improve Storage Tank Water Quality *[33] and AWWA's* Physical Modelling of Mixing in Water Storage Tanks *[34].*

NOTE 2 If correctly designed and balanced, the distribution can be more effective than other methods at delivering water of the desired quality throughout the whole distribution system.

4.3.12 Large storage cisterns (over 1 000 L nominal capacity)

4.3.12.1 To avoid interruption of the water supply, storage may be provided by a system of split compartments or multiple cisterns to facilitate repairs or maintenance. In such situations the water volume and the shape of each water storage compartment should be identical to ensure there is equal turnover of the stored water. Where more than one water storage compartment or cistern is to be used, the inlet and outlet piping should be arranged to stimulate equal water flow.

4.3.12.2 A washout pipe with the valve incorporated as close as practicable to the cistern should not be connected to a drain, but may be arranged to discharge into open air above a drain in accordance with the requirements of a type AA air gap.

4.3.12.3 A washout pipe should be provided flush with the bottom of the cistern at its lowest point. Where practicable, the floor of the cistern should be laid to a slight fall to the washout pipe for cleaning purposes. The washout pipe outlet should be controlled by a suitable fullway valve and blanked off with a plug or flange when not in use.

4.3.12.4 Where it is not practical to operate delayed action ball valves to effect maximum turnover on refilling, recirculating pump arrangements may be installed internally. This ensures that full mixing is induced and thermal column separation does not occur due to diurnal heating effects, which allows streaming of cold inlet water to track to diagonally opposite low-level outlets.

4.3.12.5 These features are necessary to prevent localized columns of stagnant water in large cisterns and to maximize the distribution of disinfectant within the vessel. Correct use of these techniques can help assess the efficacy of the disinfection dosing equipment. They also allow a more robust determination of the impact of water age on the residual disinfectant concentration at the extremes of the distribution system.

4.3.12.6 Sometimes, particularly for a complex of buildings, because of the larger volume of storage required or to provide the necessary head, it might be necessary to support the cistern in an independent structure outside the building(s). Although such a storage facility is often referred to as a tank or water tower, it is by definition a cistern.

4.3.12.7 Any cistern mounted outside a building, whether fixed to the building or supported on an independent structure, should be enclosed in a well-ventilated, but draughtproof, housing constructed to prevent ingress of birds, animals, and insects. It should also allow access to the interior of the cistern by authorized persons for inspection and maintenance.

4.3.12.8 When installed below ground level, cisterns for storing water for domestic use are notifiable to the water supplier and consultation is essential before installation.

4.3.12.9 To maximize water turnover in buildings that have variable occupancy rates, e.g. schools over summer holidays or phased occupation of premises, a variable height ball/control valve should be installed.

4.3.13 Warning and overflow pipes

4.3.13.1 Where overflow and warning pipes discharge externally, they should be arranged to prevent the inward flow of cold air, for example, by turning down the warning pipe into the cistern and below the water line, except where this could interfere with the operation of the flushing mechanism or float-operated valve in a WC flushing cistern (see the WRAS, *IGN 9-04-04, Cold Water Storage Cisterns – Design Recommendations for Mains Supply Inlets* [35]).

4.3.13.2 Siting of the exit of the overflow (and warning) pipe should be in a safe, visible position and discharged via a type AA airgap.

4.3.14 Stopvalves

4.3.14.1 Stopvalves fitted to supply pipes should conform to the applicable standard in Table 3.

Table 3 **British Standards for stopvalves**

Nominal size of pipe	British Standard	
	Above ground	**Below ground**
50 mm or smaller	BS 1010-2 (BS EN 1213)	BS 2580 [A)]
	BS 2580 [A)]	BS 5433
50 mm or larger	BS 5163-2	BS 5163-2

[A)] Withdrawn, but pipes conforming to this might still be encountered.

NOTE Other stopvalves which satisfy the relevant requirements of the regulators' specification may be used.

4.3.14.2 The stopvalve components of composite fittings should conform to the requirements for stopvalves.

4.3.14.3 When a stopvalve is installed below ground, it should be enclosed in a suitable accessible chamber.

4.3.14.4 For every building or part of a building to which a separately chargeable supply of water is provided, and in any premises occupied as a dwelling, whether or not separately charged for a supply of water, a stopvalve should be provided that controls the whole supply to those premises without shutting off the supply to any other premises. The stopvalve should, where practicable, be installed within the building or premises, in an accessible position above floor level and close to the point of entry of the pipe supplying water to the premises, whether this is a supply pipe or a distributing pipe.

4.3.14.5 Where a common supply or distributing pipe provides water to two or more premises, it should be fitted with a stopvalve that controls the water supply to all of the premises supplied by that pipe. The stopvalve should be installed inside or outside the building, in a position to which every occupier of the premises supplied has access.

4.3.14.6 A stopvalve should be installed in every pipe supplying water to any structure erected within the curtilage of a building but having no access from the main building. This stopvalve should be located in the main building as near as practicable to the exit point of the supply pipe to the other structure or, if this is not practicable, in the other structure itself as near as possible to the entry point of the supply.

4.3.14.7 Where a building is divided into separately occupied parts, the supply to each part should be capable of being shut off by a second stopvalve installed outside that part without shutting off the supply to other parts of the building, as shown in Figure 3 and Figure 4.

*NOTE The intention of **4.3.14.4** to **4.3.14.7** is to provide a ready means of isolating any private or common supply causing damage or nuisance, or for the purpose of effecting repairs, replacements or alterations.*

Figure 3 **Locations of stopvalves in blocks of flats with separate supply pipes to each flat**

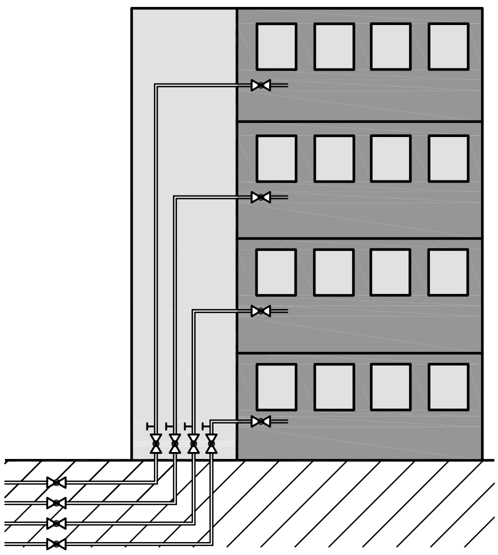
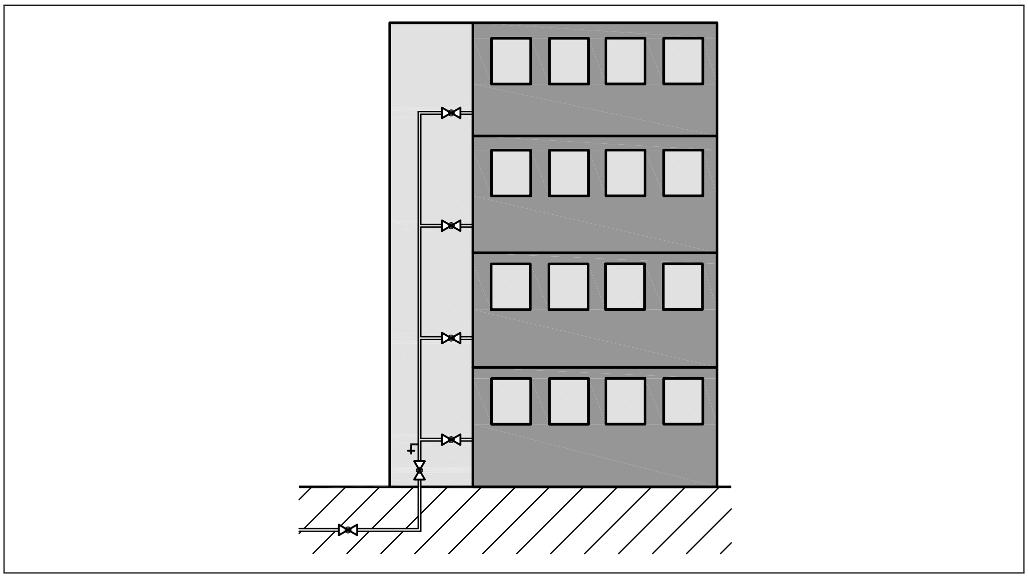


Figure 4 **Locations of stopvalves in blocks of flats supplied from a common supply pipe**



4.3.14.8 The supply should be capable of being drained down by an occupier to avoid frost damage and to shut off their own supply or a supply in unoccupied premises to prevent damage or nuisance by using a stopvalve to which each occupier has ready access.

4.3.15 Servicing valves

Servicing valves should be fitted near to outlets that might require maintenance, such as sanitary appliances or heating equipment, and should be of a design that limits casual operation.

NOTE Spherical ball valves are well suited for this purpose.

4.3.16 Draining taps

4.3.16.1 Good system design should facilitate the draining of all pipework.

4.3.16.2 Drain taps should not be buried in/under the ground or in concrete.

4.3.16.3 Pipework downstream of every stopvalve should be arranged so as to drain continuously towards draining taps or draw-off taps at the low points. All cisterns, tanks, cylinders and boilers should be fitted with draining taps unless they can be drained through pipes leading to draining taps or draw-off taps elsewhere. Provision should be made for draining both the primary and secondary parts of an indirect hot water cylinder or calorifier.

NOTE Combined stopvalves and draining taps are a convenient way of providing facilities for draining.

4.3.16.4 All draining taps should be capable of being fitted with removable hosepipes unless installed over a drain or discharging into a permanent draining pipe.

4.3.16.5 Draining taps should be used for draining purposes only. Where a draw-off tap is used for draining the installation, it should not be fitted with a hose unless it has backflow protection. Outlets of hoses connected to draining taps should be arranged to discharge freely into the air. Hose outlets should not be allowed to become submerged.

NOTE Attention is drawn to the Water Fittings Regulations [19], [20] and [21].

4.3.16.6 For effective draining, it is essential that air enters the pipework freely. Hot water cylinders are liable to collapse if air cannot enter the system.

Draw-off taps, float-operated valves and air inlet valves should be open when draining is carried out. Where the taps and float-operated valves in the system are not suitably located for this purpose, special air inlet valves should be fitted in appropriate locations.

NOTE Check valves and double-check valve assemblies are for backflow prevention at draw-off taps, particularly those with flexible hoses, and other equipment can prevent air entering the system during draining.

4.3.17 Meters

4.3.17.1 Meters on the incoming supply to premises for revenue charging purposes are usually supplied and installed by the water supplier and sited by agreement between the consumer and the water supplier.

NOTE Meters are traditionally installed at or near the street boundary of the premises supplied, which is, in most situations, the limit of the responsibility of the water supplier for maintenance of the service pipe. Whilst this remains the location of choice for the majority of installations, it is now more common for revenue meters to be installed within premises even though this does not alter the point of responsibility relating to service pipe ownership and maintenance.

4.3.17.2 The meter should be protected from the risk of damage by shock, vibration or frost induced by the surroundings at the place of installation.

4.3.17.3 When a water meter is to be fitted to an existing building and the water supplier installs a non-return valve to the meter installation then a survey of the existing hot and cold water installation should be carried out. If the property has an instantaneous water heater or a combination boiler installed and the expansion water was, prior to the meter being installed, allowed to expand into the supply pipework then the installer of the meter should provide an alternative method of accepting the expansion water, e.g. an expansion vessel as described in the Water Fittings Regulations [19], [20] and [21].

4.3.18 Bonding

The requirements for electrical bonding of pipework are given in BS 7671.

NOTE This satisfies the requirements of the Electricity Safety, Quality and Continuity Regulations [5] and [6].

4.3.19 External meters

4.3.19.1 External meters should be located so that access to them does not compromise safety.

4.3.19.2 Where an external meter is in a chamber, the clear opening of the cover should be the same as the internal dimensions of the chamber (see Figure 5). The type and size of the chamber and cover should be approved by the water supplier. The size of the chamber should allow access to the meter such that it is readily accessible for the purpose of reading, maintenance and replacement.

4.3.19.3 Other types of enclosure suitable for mounting on walls are readily available.

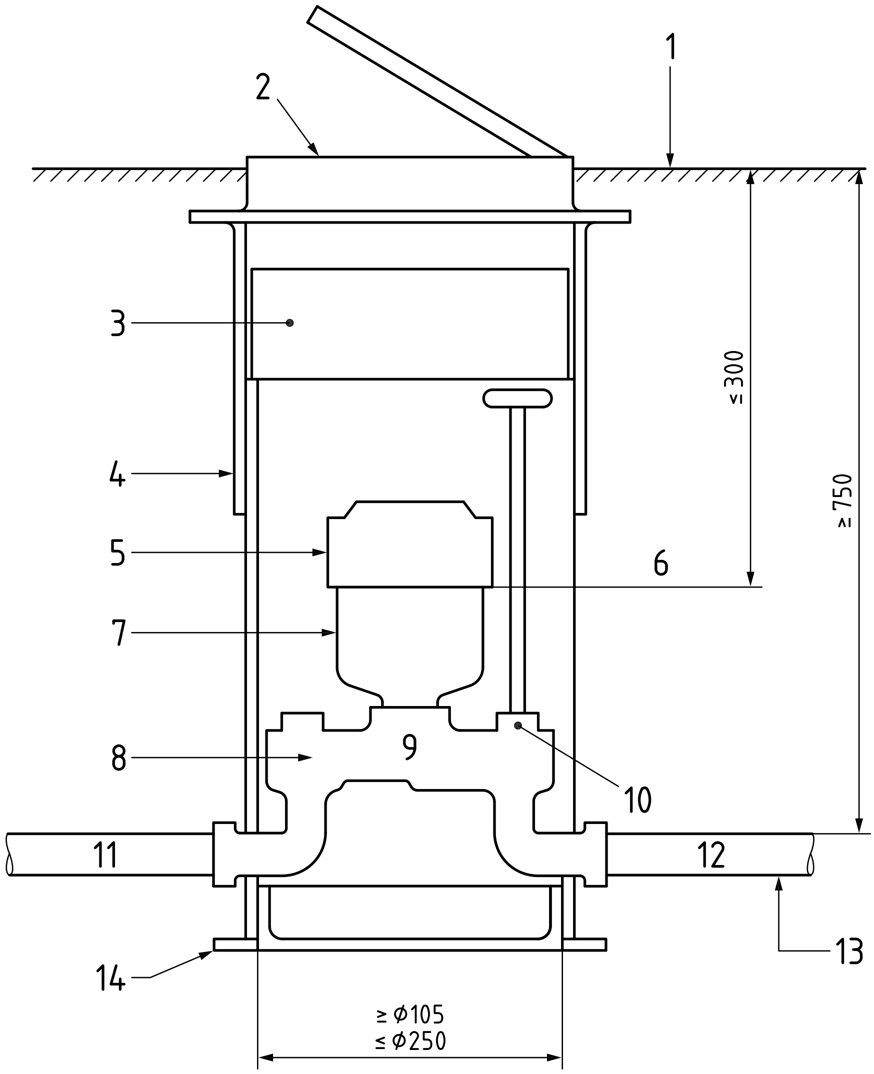
4.3.20 Internal meters

4.3.20.1 Where access to a meter is restricted, a remote read-out device may be installed with the water supplier's agreement.

4.3.20.2 Pipework should be adequately supported, leaving sufficient room for changing the meter with the connections provided.

Figure 5 **Example of a pre-assembled external meter installation**

Dimensions in millimetres



Key

1 Ground level
2 Frame and cover
3 Thermal insulation
4 Meter chamber with adjustable top section
5 Register
6 Highest meter capsule point
7 Meter capsule
8 Outlet reverse flow restrictor
9 Manifold
10 Inlet stopvalve
11 Outlet
12 Inlet
13 Service pipe
14 Base

4.3.20.3 A second stopvalve or servicing valve should be installed downstream of the meter.

4.3.20.4 Where the installation of meters in exposed locations, e.g. garages subject to frost, is unavoidable and agreed by the water supplier, adequate thermal insulation conforming to **4.3.34** should be provided, but not so as to impede reading or changing the meter.

4.3.21 Consumer non-revenue meters

The installation of consumer non-revenue meters should conform to **4.3.17** to **4.3.20**, except that the water supplier need not be consulted.

NOTE In large buildings, consumer non-revenue meters may be used to assess consumption through supplementary equipment such as softeners, water heating plant or other automated fill equipment, e.g. closed systems.

4.3.22 Hot water services

4.3.22.1 Consideration should be given to the recommendations of the HSE's Approved Code of Practice L8, *Legionnaires' disease – The control of Legionella bacteria in water systems* [26] and HSG274 part 2 [30] (see also **4.3.31.2**).

NOTE 1 For recommendations for collecting and investigating samples, where to sample and the selection of laboratory or on-site testing, see BS 8554.

NOTE 2 The HSE's guidance note HSG220, Health and Safety in Care Homes *[36] refers to scalding protection.*

4.3.22.2 Where circulation of secondary hot water circuits is maintained by pumping, the installation should not incorporate a standby pump as non-operating pumps create stagnant pockets of water that pose a *Legionella* risk. Hot water secondary circuits should be installed so that any entrained air can be released at taps without the need to incorporate automatic air eliminators or air bottles, as these can create stagnant pockets of water that pose a *Legionella* risk.

4.3.22.3 Towel rails should not be connected to a secondary hot water system; they should be connected to a primary system and/or be electrically heated.

4.3.22.4 Where multiple water heaters or hot water storage vessels are used to form a single hot water source, they should be connected in a way that promotes equal flow through the cold feed, secondary hot water outlet and secondary hot water return. In such installations each heater or vessel should be provided with isolating valves to enable any unit to be temporarily isolated for maintenance purposes. Each heater or vessel so connected should be provided with temperature gauges on each secondary flow and secondary return connection.

4.3.23 Storage type hot water systems

4.3.23.1 The main differences between vented and unvented systems are as follows.

a) **Vented systems:** vented hot water service systems are fed with cold water from a storage cistern which is situated above the highest outlet to provide the necessary pressure in the system and which accommodates expansion of the water when it is heated. For domestic installations the vent should be not less than 19 mm bore. An open vent pipe runs from the top of the hot water storage vessel to a point above the water storage cistern, into which it vents. Protection involving no mechanical devices is provided by the open vent and the cistern. For larger systems the nominal bore of the principal vent pipe should be not less than shown in Table 4.

   The open vent pipe should be extended sufficiently high above the overflow level within the associated feed cistern (see Figure 6 and Figure 7) in order to prevent thermo-circulation which could result in the collapse of the cistern in the event of a malfunction of the heating system controls. As combination hot water storage units conforming to BS 3198 do not have the necessary open vent pipe height to prevent thermo-circulation, high-temperature-resistant piping should be used for the overflow, and the potential hot water discharge at the termination point should be carefully considered.

Table 4 **Sizes of open vent pipes**

Boiler or water-heater rating	Nominal size of bore	
kW	mm	in
≤60	25–28	1
>60 ≤150	32–35	1¼
>150 ≤300	38–42	1½
>300 ≤600	50–54	2
>600 ≤1 500	65–76.1	3

b) **Unvented systems:** unvented systems are usually supplied from the supply pipe but can be supplied from a storage cistern, either directly or through a booster pump or accumulator. The main characteristics of unvented systems are as follows.

1) Explosion protection is provided by at least two independent safety devices.

2) Systems depend upon pressure continuity and the hot water flow cannot be guaranteed if pressures fall.

3) In unvented systems supplied from a supply pipe, the absence of a storage cistern can reduce the risk of frost damage to property and remove the source of refill or float-operated valve noise.

4.3.23.2 The safety aspects of vented and unvented, storage type hot water systems are subject to the Building Regulations [22], [23] and [24].

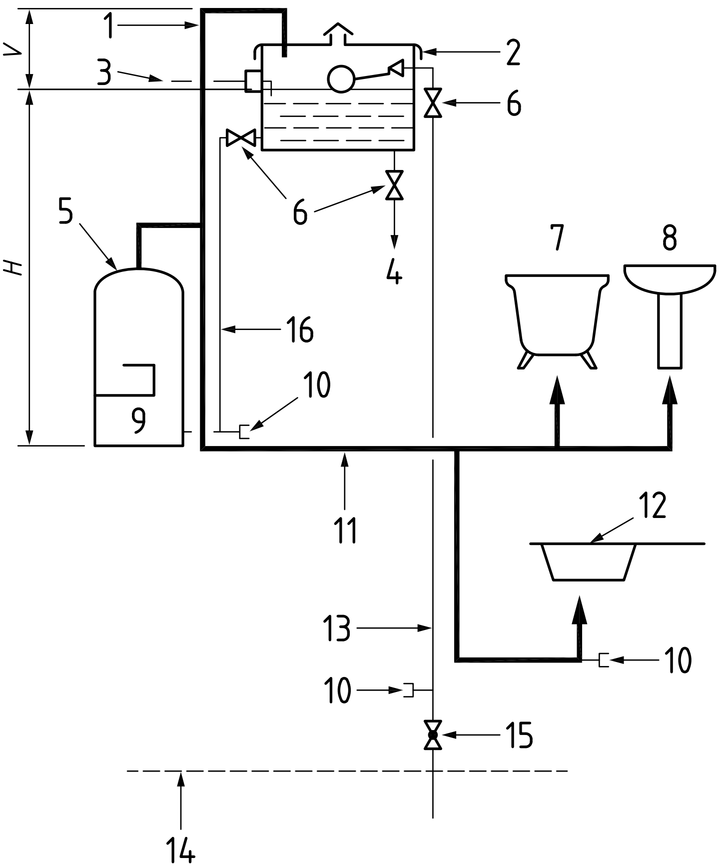
4.3.23.3 Except for supplies to dual stream (bi-flow) fittings, mixing fittings should be supplied with comparable hot and cold water supply pressures. For TMVs, balanced pressures might not be required and the manufacturer's instructions should be consulted for required operating pressure and temperature ranges.

4.3.24 Direct and indirect systems

Figure 6, Figure 7 and Figure 8 illustrate the basic differences between direct and indirect, and between vented and unvented systems. These figures are diagrammatic and should not be taken as complete designs. For simplicity, gravity circulation is shown and temperature controls and distribution pipework omitted.

NOTE The Building regulations [22], [23] and [24] in most cases require primary heating circuits to be fully pumped.

Figure 6 **Schematic example of a direct (vented) hot water system**

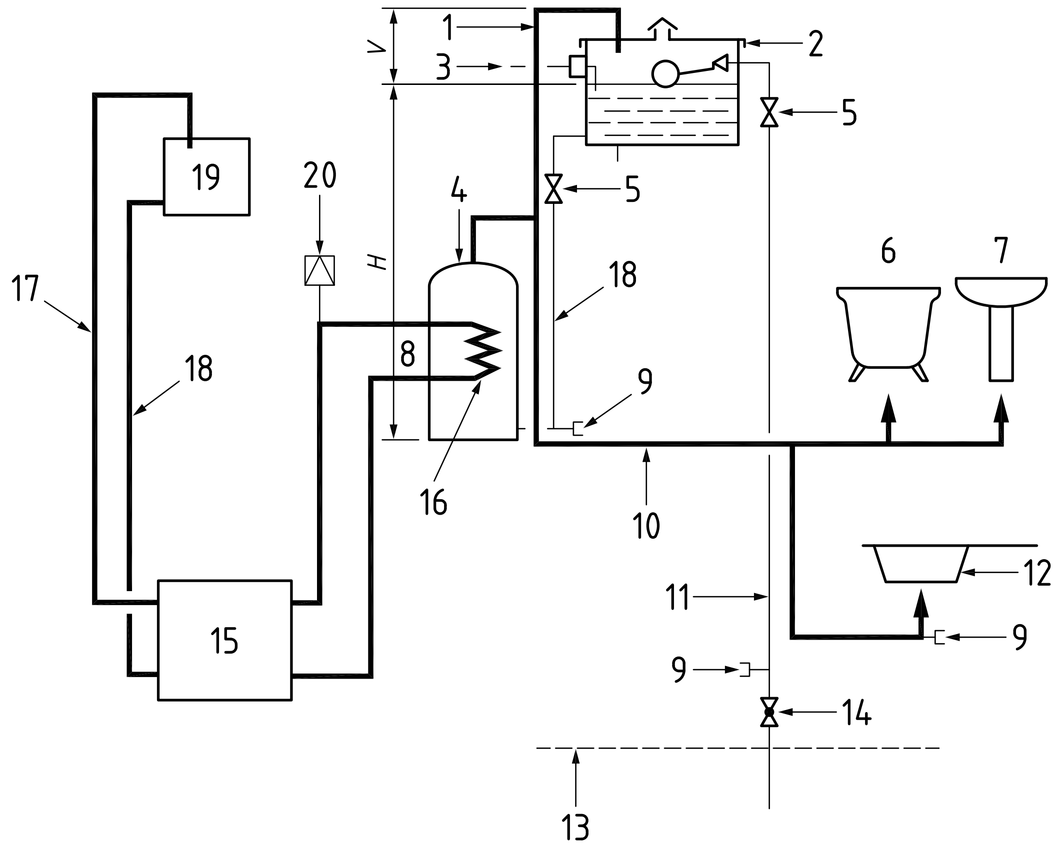


$V \le (H \times 0.04) + 0.15$

Key

1	Vent pipe	9	Heat source, e.g. immersion heater
2	Cold water storage cistern	10	Draining valve
3	Warning pipe	11	Hot water distributing pipes
4	Cold water distributing pipe	12	Kitchen sink
5	Direct (vented) hot water storage vessel	13	Supply pipe
6	Servicing valve	14	Floor level
7	Bath	15	Stopvalve
8	Wash basin	16	Cold feed pipe

Figure 7 **Schematic example of an indirect (vented) hot water system**



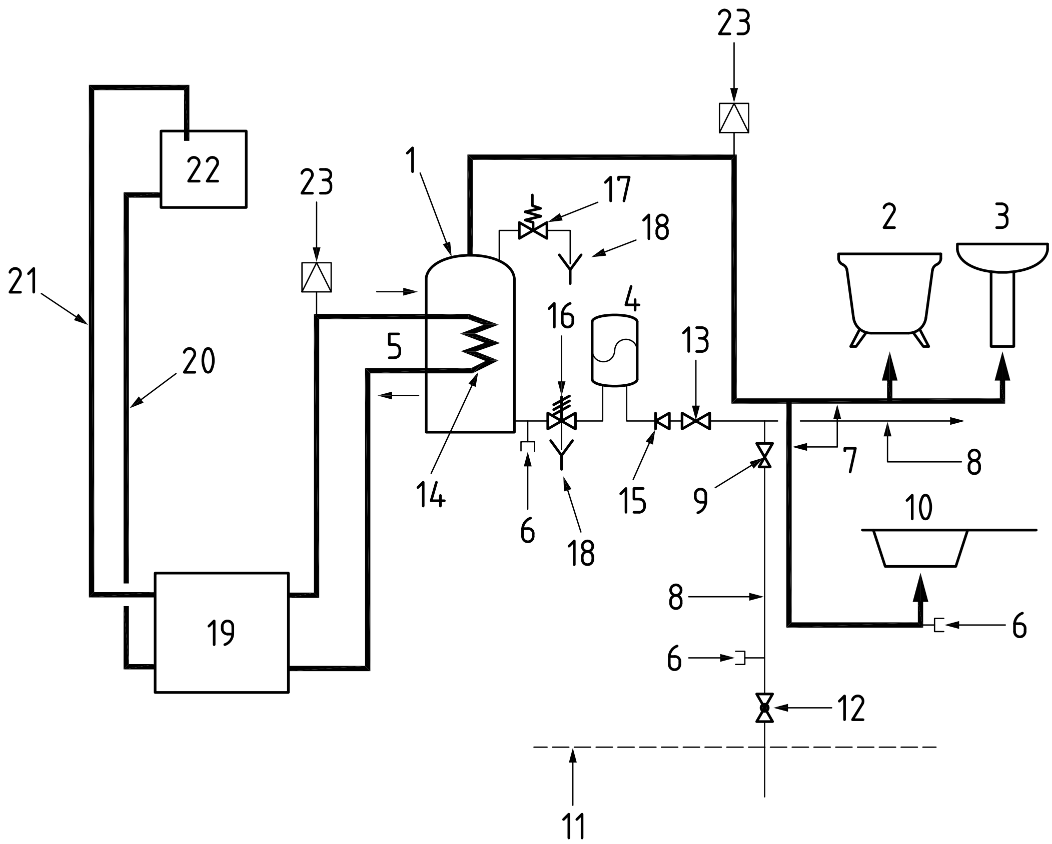
V ≤ (*H* × 0.04) + 0.15

Key

1	Vent pipe	11	Supply pipe
2	Cold water storage cistern	12	Kitchen sink
3	Warning pipe	13	Floor level
4	Indirect (vented) hot water storage vessel	14	Stopvalve
5	Servicing valve	15	Heat source, e.g. boiler
6	Bath	16	Heat exchanger
7	Wash basin	17	Vent pipe
8	Primary circuit	18	Cold feed pipe
9	Draining valve	19	Feed and expansion cistern
10	Hot water distributing pipe	20	Air release valve

NOTE Inlet fitting and warning pipe to feed and expansion cistern not shown.

Figure 8 **Schematic example of an indirect unvented (vented primary) hot water system**



Key

- 1 Unvented hot water storage vessel
- 2 Bath
- 3 Wash basin
- 4 Expansion vessel (flow-through type)
- 5 Primary circuit
- 6 Draining valve
- 7 Hot water supply pipes
- 8 Supply pipe
- 9 Pressure reducing valve
- 10 Kitchen sink
- 11 Floor level
- 12 Stopvalve
- 13 Servicing valve
- 14 Heat exchanger
- 15 Check valve
- 16 Expansion relief valve
- 17 Temperature relief valve
- 18 Discharge pipe/tundish
- 19 Heat source, e.g. boiler
- 20 Cold feed pipe
- 21 Vent pipe
- 22 Feed and expansion cistern
- 23 Air release valve

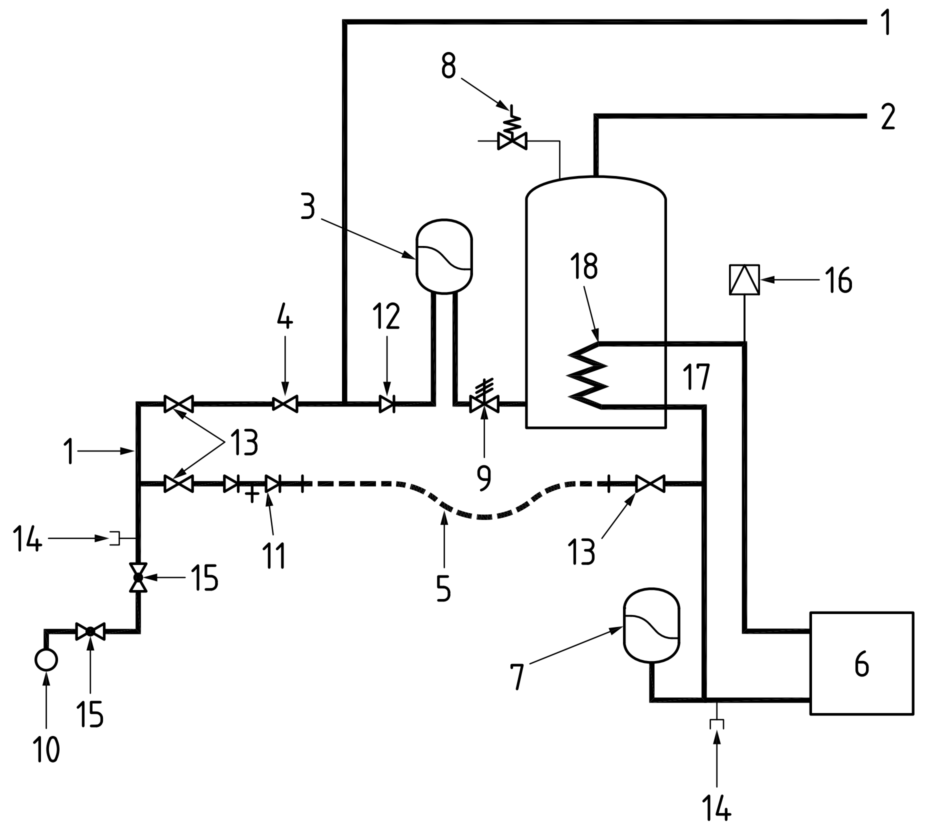
NOTE Inlet fitting and warning pipe to feed and expansion cistern not shown.

4.3.25 Sealed primary circuits

4.3.25.1 Pipes sizes in sealed primary circuits should conform to the relevant recommendations for vented primary circuits in **4.3.26** (see also Figure 9). In place of the expansion cistern and vent pipe, a sealed primary circuit should be fitted with an expansion vessel of sufficient capacity to accommodate, with the pressure differentials involved, the increase in volume of the water content of the whole of the primary system, including any space heating circuits, when heated from 10 °C to 110 °C.

4.3.25.2 Indirect cylinders fitted in sealed primary circuits should have primary heaters suitable for operating at a pressure of 35 kPa (0.35 bar) in excess of the pressure relief valve setting. The safety of sealed primary circuits should always be in accordance with the specific recommendations in **4.3.26** to **4.3.29** and **4.3.31**.

Figure 9 **Schematic example of an indirect unvented (sealed primary) hot water system**



Key

1	Cold water supply pipe	9	Expansion-relief valve [A)]
2	Hot water supply pipe	10	Main
3	Expansion vessel (flow-through type)	11	Double-check valve [B)]
4	Pressure reducing valve	12	Check valve
5	Temporary connection to supply pipe for filling only	13	Servicing valve [B)]
6	Heat source, e.g. boiler	14	Draining valve
7	Expansion vessel (primary circuit)	15	Stopvalve
8	Temperature relief valve or combined temperature and pressure relief valve	16	Air release valve
		17	Primary circuit
		18	Heat exchanger

A) A dosing and sampling point between the expansion-relief valve and the heat source is recommended to manage the closed system corrosion control chemicals.

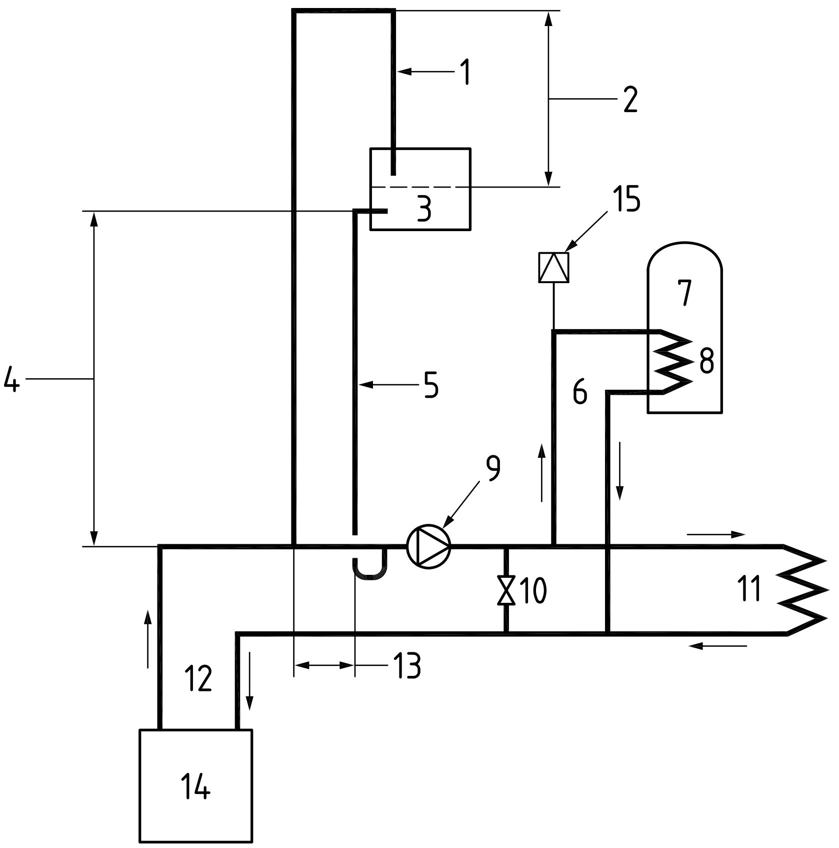
B) The distance between the servicing valve and the double-check valve should be as short as possible to prevent stagnation.

4.3.26 Vented primary circuits

4.3.26.1 Where the vent pipe is not connected to the highest point in the primary circuit, an air release valve should be installed at that point (see Figure 10).

4.3.26.2 Close coupled feed and vent pipes should only be used on the recommendation of the boiler manufacturer, and be installed in accordance with BS EN 12828 and BS EN 14336. Pipes should be installed to avoid air locks and laid to falls to facilitate draining.

Figure 10 **Schematic example of a vented primary circuit with close coupled feed and open vent**



Key

1	Open safety vent	9	Circulating pump
2	Minimum height 450 mm	10	Bypass with lockshield valve
3	Feed and expansion cistern (see Note 2)	11	Heating circuit
4	1 m minimum; 27.5 m maximum	12	Primary flow and return
5	Cold feed pipe	13	150 mm maximum
6	Primary circuit to cylinder	14	Heat source, e.g. boiler
7	Hot water storage vessel	15	Air release valve
8	Heat exchanger		

NOTE 1 The close coupled feed and vent may only be used on the recommendation of the heat source manufacturer.

NOTE 2 Inlet fitting and warning pipe to feed and expansion cistern not shown.

NOTE 3 Dimension 2 minimum height to allow for expansion of water in the pipework.

4.3.26.3 When an installation is designed for combined central heating and domestic hot water heating, and the central heating circuit includes a circulating pump while the parallel circuit to the primary heater in the hot water storage vessel operates by gravity circulation, the return pipes of the two circuits should be connected to separate connections on the heat source or should be combined by means of an injector type fitting installed near the heat source, unless the manufacturer's instructions specify otherwise.

NOTE Building Regulations [22], [23] and [24] in most cases require primary heating circuits to be fully pumped.

4.3.27 Safety devices

Pressure relief valves, temperature relief valves, combined temperature and pressure relief valves, check valves, pressure reducing valves, anti-vacuum valves and pipe interrupters should be fitted in accordance with **4.3.28**, **4.3.29** and **4.3.31** and should conform to BS 6280, BS 6283-2, BS 6283-4, BS EN 1567, BS EN 1490, BS EN 1491, BS EN 13076, BS EN 13077, BS EN 13959, BS EN 14451 and BS EN 14623, as applicable.

4.3.28 Energy control and safety devices

4.3.28.1 The Building Regulations [22], [23] and [24] require at least two independent safety devices to be used on stored hot water systems (vented and unvented) in addition to any thermostat used to control the temperature of the hot water. On a vented system, the vent acts as one safety device.

4.3.28.2 For systems that replenish water discharged through relief valves, e.g. a conventional storage water heater, the commonly used safety devices are a temperature-operated, non-self-resetting thermal cut-out and a combined temperature and pressure relief valve. These safety devices have different modes of operation and act upon different aspects of the system, i.e. the temperature-operated, non-self-resetting thermal cut-out operates upon the source of energy and the combined temperature and pressure relief valve dissipates energy by discharging hot water. However, where there is no automatic replenishment, for example with some water-jacketed tube heaters, a combined temperature and pressure relief valve might not be suitable. To protect this type of appliance, two independent temperature-operated, non-self-resetting thermal cut-outs may be used to shut off the flow to the primary heater.

4.3.28.3 Temperature relief valves, combined temperature and pressure relief valves, pressure relief valves, expansion valves, temperature-operated non-self-resetting thermal cut-outs and thermostats should be accessible, and all controls/devices should be located to prevent unauthorized interference.

4.3.28.4 The discharge from relief valves should be conveyed safely and be visible so as to indicate a fault with the system.

NOTE Relief valves discharge hot water at a flow rate of typically 12 L/min to 20 L/min with the water at a temperature approaching boiling point.

4.3.28.5 Unvented systems storing less than 500 L should be in the form of a proprietary unit or package.

4.3.29 Pressure control

4.3.29.1 For hot or cold water, all parts of the system should be capable of withstanding any hydraulic pressures to which it is, or is likely to be, subjected, including test pressures. The pressures in the system should never exceed the safe working pressures of the component parts. Where necessary, the supply pressure should be controlled by using break cisterns or pressure reducing valves in accordance with BS EN 1567. If the supply to a storage type water heater is through a pressure reducing valve of the type that permits backflow, the working pressure in the system should be assumed to be the maximum pressure upstream of the valve.

4.3.29.2 Expansion and/or temperature and/or pressure relief valve ratings should be the maximum working pressure plus 50 kPa to 150 kPa (0.5 bar to 1.5 bar).

4.3.29.3 For unvented systems, provision should be made to accommodate expansion either by:

a) design and installation, to accommodate both expanded water and any water this displaces within the supply pipe, and the replacement of any stopvalve with a loose washer plate that impedes such reverse flow with a valve with a fixed washer plate, or an equally effective valve; or

b) providing an expansion vessel conforming to BS 6144, or a vessel with a rechargeable integral gas space, to accommodate expansion water where reverse flow along the cold water pipe is prevented (for example, by a check valve, some types of pressure reducing valve or a stopvalve with a loose washer plate), that is:

   1) sized in accordance with the volume of water heated so that the pressure is limited to the maximum working pressure for the system; and

   2) installed such as to promote through flow in the vertical plane and to ensure that it is self-draining in the event that the system needs to be drained.

4.3.30 Pipe sizing

4.3.30.1 Simultaneous use of appliances can reduce flow rates, potentially below design values. The whole system should be designed so that flow rates are not reduced to such an extent as to adversely affect the satisfactory functioning of the system. In particular, where the reduction in flow could affect the temperature of water delivered to showers, measures should be taken to protect the user against excessive water temperatures (see **4.3.22**). In most buildings, appliances are rarely in simultaneous use, so for reasons of economy it is usual to provide for a demand less than the total demand of all appliances in use at the same time.

4.3.30.2 The simultaneous demand can be determined from data derived by observation and experience of similar installations or by the application of probability theory. A system of determination should be based on probability theory using loading units and incorporating the flow rate required at the appliance, the length of time in use, and the frequency of use. A method of pipe sizing is given in BS EN 806-3. The traditional method for the probability theory (loading units) in the UK is given in Annex C.

4.3.30.3 The loading unit system in BS EN 806-3 produces lower design flow rates when compared to the traditional UK loading unit system in Annex C. The subject of loading units is currently being investigated and, until the research is complete, the BS EN 806-3 loading unit system may be used for residential installations and the traditional UK loading unit system used for all other applications.

4.3.30.4 Flow rate for filling cold water storage cisterns can vary depending on the amount of storage provided, the pressure available from the source or main, and whether the supply is constant. Where other information is unavailable, a maximum of 4 h filling time may be assumed.

4.3.30.5 In other than small, simple installations, such as single dwellings, pipe sizes should be calculated using a recognized method of calculation, such as the method given in BS EN 806-3.

4.3.30.6 Design flow rates are given in Table 5. The design rate is the desirable delivery rate to the fitting or appliance. Table 5 is not intended for use as a guide to buying fittings or appliances. Guidance on the selection of appropriate appliances is given in BS 6465-3.

Table 5 **Pipe design flow rates for outlet fittings and appliances** A), B)

Outlet fitting or appliance	Rate of flow L/s	
	Design rate	Minimum rate
WC cistern (to fill in 2 min)	0.13	0.05
Urinal cistern (each position served)	0.004	0.002
Washbasin	0.15	0.10
Handbasin (spray or mixer taps)	0.05	0.03
Bidet	0.10	0.10
Bath (G ¾) C)	0.30	0.20
Shower head (15 mm)	0.20	0.10
Kitchen sink (G ½)	0.20	0.10
Kitchen sink (G ¾)	0.30	0.20
Washing machine	0.20	0.15
Dish-washing machine D)	0.15	0.10

A) These values can be used for sizing each individual pipe to the appliance referred to.

B) The choice of outlet fittings/appliances can affect the flow rate delivered at the outlet fitting/appliance. Manufacturer's advice should be obtained.

C) The design rate and minimum rate of flow for a bath is applicable to baths having a water capacity of not greater than 180 L to the overflow. Where a larger bath is installed, the rate should be increased proportionately.

D) The manufacturer should be consulted for required flow rates and pressures to washing and dish-washing machines for other than single dwellings.

NOTE 1 For residential installations supplying single and multiple dwellings the loading unit method in BS EN 806-3 ought to be used in preference to traditional UK loading units. This is because the BS EN 806-3 method produces significantly lower design flow rates, and based on data from live installations BS EN 806-3 appears to produce more realistic values, particularly near the point origin of the water supplies. It is important to note that, for assessing the hot water demand in multiple residential properties, CIBSE AM12 Manual [37] states that demand data in BS 6700 are "far too conservative".

NOTE 2 For non-residential installations supplying commercial and public buildings, traditional UK loading units ought to be used. The latest research into loading units suggests that the CIPHE loading unit ought to be used rather than the traditional BS 6700 loading unit system. The CIPHE loading unit system has the advantage of having three classifications of use: "low, medium and high", and therefore enables the designer to make a professional judgement about the most appropriate loading unit for the application, allowing the effect of over-sizing to be reduced. It is necessary to note that the CIBSE Guide G (2014) [38] makes reference to the CIPHE loading unit system.

NOTE 3 Care is needed when assessing the combined demand of hot and cold water supplies, for example at booster pumps, to reduce the effect of over-sizing. For appliances fed with both hot and cold water supplies, the traditional loading unit model assumes that the system demand imposed by the appliance is met fully by each separate supply. Although this is logical when separate hot and cold water taps are fitted to an appliance, it is not valid when mixer taps/valves are used, particularly when a flow-limiting device is fitted to, or is integral within, the mixer. For example, in the case of a shower with a flow-limiting device fitted after the shower mixing valve, the combined hot and cold water demand will not be any greater than if the end-user selects cold or hot only in use. Consequently, in this case, the relevant loading units separately to the hot and cold water supplies for pipe sizing ought not to be added together when sizing the combined hot and cold water demand.

4.3.31 Contamination

4.3.31.1 Prevention of contact of water with unsuitable materials

4.3.31.1.1 The Water Fittings Regulations [19], [20] and [21] require that no material or substance, either alone or in combination with another material or substance that causes or is likely to cause contamination, should be used in a system that conveys water for domestic or food production purposes. This does not apply where the water downstream of a terminal fitting is not required to be wholesome and a suitable arrangement or device is installed to prevent backflow.

4.3.31.1.2 In areas of contaminated ground, approved metallic tube with a factory-applied protective plastics coating or plastic barrier pipe should be used (see UKWIR's *Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites* [29]).

4.3.31.1.3 In larger building systems, water quality might require biocides for microbiological control. Building systems should be checked for crossover leaks at least annually.

NOTE For recommendations for collecting and investigating samples, where to sample and the selection of laboratory or on-site testing, see BS 8554.

4.3.31.1.4 Where a non-potable water system, e.g. rainwater harvesting system, is used, checks should be carried out to ensure there are no cross-connections with the potable system. A methodology for such a procedure is set out in BS 8525-1. Appropriate colouring and labelling should be used (see WRAS IGN 9-02-05, *Marking & Identification of Pipework for Water Reuse Systems* [39]).

NOTE Marking in accordance with BS 1710 is suitable for both potable and non-potable water supplies.

4.3.31.2 Prevention of contamination of drinking water by *Legionella* and other colonizing microorganisms, such as *Pseudomonas aeruginosa*

4.3.31.2.1 General

4.3.31.2.1.1 Measures should be taken in the design, installation, commissioning and operation of a hot and cold water system to prevent the contamination of the system with microorganisms, including *Legionella*. Where possible, these should include the avoidance of:

a) stagnation of water in pipes, cisterns and other storage vessels;

b) water temperatures within the range of 20 °C to 45 °C in any part of the system;

c) nutrient ingress, by ensuring that contamination is minimized in components and pipework, e.g. capping during storage; and

d) the use of materials with the greatest potential to harbour or provide nutrients for bacteria and other organisms.

   NOTE Materials are required to conform to the Water Fittings Regulations [19], [20] and [21].

4.3.31.2.1.2 Where possible, the potential for aerosol production should be minimized.

4.3.31.2.1.3 Legionnaires' disease is not transmitted from person to person, but is of environmental origin and is usually contracted by inhaling the organism in an aerosol produced from water contaminated with the organism. Aspiration of water containing *Legionella spp*. can also cause infection, particularly in hospitalized individuals. To determine the likelihood of any *Legionella*-related problems, a risk assessment should be undertaken (for guidance, see BS 8580).

4.3.31.2.1.4 Good practice is assumed if the recommendations of the HSE's Approved Code of Practice L8, *Legionnaires' disease – The control of Legionella bacteria in water systems* [26] and associated guidance HSG274 part 2 [30] are followed.

4.3.31.2.1.5 The Water Fittings Regulations [19], [20] and [21] contain requirements for the use of braided or flexible hoses in contact with drinking water.

NOTE For recommendations for collecting and investigating samples, where to sample and the selection of laboratory or on-site testing, see BS 8554. See also BS 7592 for Legionella*.*

4.3.31.2.2 Additional considerations for healthcare premises

4.3.31.2.2.1 In healthcare premises, such as hospitals and nursing and care homes, the risk of waterborne infections is greater than in other buildings due to the higher susceptibility of the population to waterborne infections. The range of potentially infectious hazards is greater and includes not only *Legionella pneumophila*, but other infectious species, such as *Legionella*, *Pseudomonas aeruginosa*, *Stenotrophomona*s and environmental *Mycobacteria*.

4.3.31.2.2.2 Additional guidance on precautions to avoid infection are given in Department of Health Guidance documents, including HTM 04-01 [28], and at HSE.gov.uk [viewed: 16 September 2015].

4.3.31.2.2.3 Hot water temperatures in high-risk areas should be at 55 °C at the hot outlets within 1 min of running the water. In addition:

a) Department of Health Technical Memoranda on water design and fitting [6]) should be heeded;
b) design should minimize the potential for outlet colonization, splashback from the drain, and splashing of the immediate environment;
c) components should be easily removable for disinfection and any new components disinfected before fitting, especially if pressure-tested by water prior to purchase;
d) a comparative risk assessment should be carried out on the relative risks from waterborne infections and the fitting of TMVs;
e) all stages of a new build should have the approval of the water safety group, where applicable, and any WSP should be followed to minimize risks from waterborne illness, from the planning stage to normal operation.

[6]) https://www.gov.uk/government/collections/health-technical-memorandum-disinfection-and-sterilization [viewed: 16 September 2015].

4.3.32 Backflow prevention

4.3.32.1 General

4.3.32.1.1 Backflow can be avoided by good system design and the provision of backflow prevention arrangements and devices suitable for the fluid category to which the drinking water is discharged. A description of fluid risk categories is shown in Schedule 1 of the Water Fittings Regulations [19], [20] and [21].

4.3.32.1.2 Wherever practicable, systems should be protected against backflow without reliance on mechanical backflow protection devices. This can often be achieved by point-of-use protection, such as a "tap gap" above the spillover level of an appliance.

NOTE For further guidance, see the WRAS Water Regulations Guide *[25] for detailed information on backflow protection or consult the local water supplier.*

4.3.32.2 Secondary or zone backflow protection

4.3.32.2.1 Backflow protection is specified by the Water Fittings Regulations [19], [20] and [21]. The local water supplier can provide advice on the level of backflow protection to be installed. Further information is available from WRAS, *IGN 9-04-05, Report of the Expert Group on the Risk of Contamination of the Public Water Supply by Backflow* [40].

NOTE If contamination enters the public mains distribution system, the consequences can be dire for public health. There could also be cost and legal implications for the installer, occupier/company. There are some premises where there would be significant consequences from contamination of the public water supply following a backflow incident. There are also certain installations that pose additional risk of breach of backflow protection no matter how well the installation is managed and maintained. Particular risks are the presence of Fluid Category 5 alternative water supplies with pressurized systems at or above mains pressure.

4.3.32.2.2 On sites with buried pipework, the risk of inadvertent cross-connection is greatly increased, particularly where accurate site layout drawings are not available. Whole site or part site backflow protection should be used.

4.3.33 Protection of water pipes and fittings

4.3.33.1 General

4.3.33.1.1 Installations should be protected against conditions arising from adverse temperatures external to pipes, fittings and appliances. Protection should be provided against:

a) ice formation in pipework and fittings;

b) heating of cold supply pipes;

c) condensation;

d) thermal stresses; and

e) excessive system pressure due to operating conditions.

4.3.33.1.2 Where the placing of pipes and fittings above ground outside buildings is unavoidable, these pipes and fittings should be protected by thermal insulation with a weatherproof finish in accordance with **4.3.34**. Where pipes rise from the ground, the thermal insulation should extend to the depth below ground stated in **4.3.34**.

4.3.33.1.3 To reduce the risk of bursting, interruption of supply, waste, leakage and consequent damage to the pipes and building, the following should be provided:

a) thermal insulation;

b) self-regulating trace-heating tapes;

c) local heating; and

d) adequate protection to prevent damage from any other cause, including the environment through which they pass.

4.3.33.1.4 In winter, water might only just be above freezing point when delivered into the consumer's pipes and a further reduction in temperature could cause freezing.

4.3.33.1.5 Particularly vulnerable locations which require protection include those where flow is very slow, infrequent or through small diameter pipes.

4.3.33.1.6 To prevent freezing of water services in a building, the inside of the building should be kept continuously warm by the provision and maintenance of adequate heating. When the whole building is not heated, or where heating is only intermittent, heating water pipes and fittings (self-regulating trace heating) or their immediate surroundings (local heating) might be sufficient.

4.3.33.1.7 Alternatively, when buildings are not used in freezing conditions and no heating is available, the plumbing system should be drained down (see the WRAS *Water Regulations Guide* [25], **G4.3**). Where low temperatures persist, thermal insulation only delays the onset of freezing. Its efficiency is dependent upon its thickness and thermal conductivity in relation to the size of pipe, time of exposure, location and possibly wind chill factor.

4.3.33.1.8 In addition to thermal protection, pipework and fittings should also be protected from their surroundings, e.g. plastic pipes being exposed to sunlight. This may be physical protection in the form of a casing or other measures applied either above or below ground.

4.3.33.1.9 The layout of the water service should be planned to avoid the following:

a) external locations above ground;

b) unheated spaces;

c) positioning near a window, air brick or other ventilator, external door or any other place where cold draughts can occur; and

d) a chase or duct formed in an external wall.

4.3.33.1.10 Care should be taken in the control of temperatures where self-regulating trace heating is installed with plastics pipes.

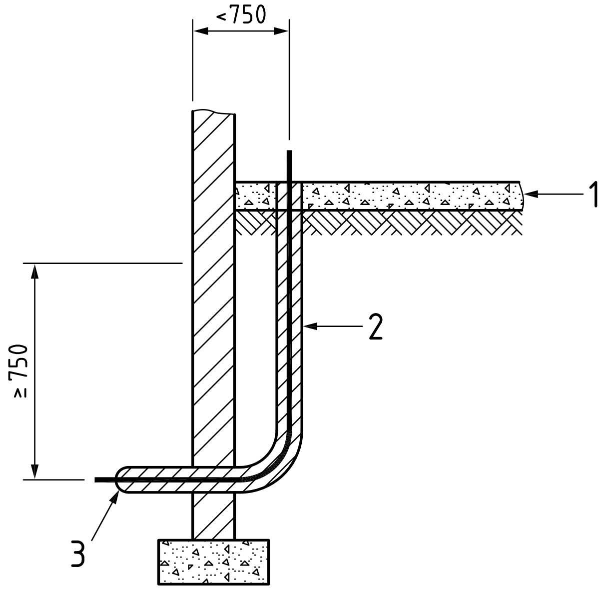
4.3.33.2 Underground pipes

4.3.33.2.1 Pipes laid underground outside buildings should be laid at a depth of not less than 0.75 m and not greater than 1.35 m, to give protection against freezing. Where this cannot be achieved, the water supplier should be consulted. Where the depth of cover is less than 0.75 m, thermal insulation should be in accordance with **4.3.34** or as agreed with the water supplier (see Figure 11).

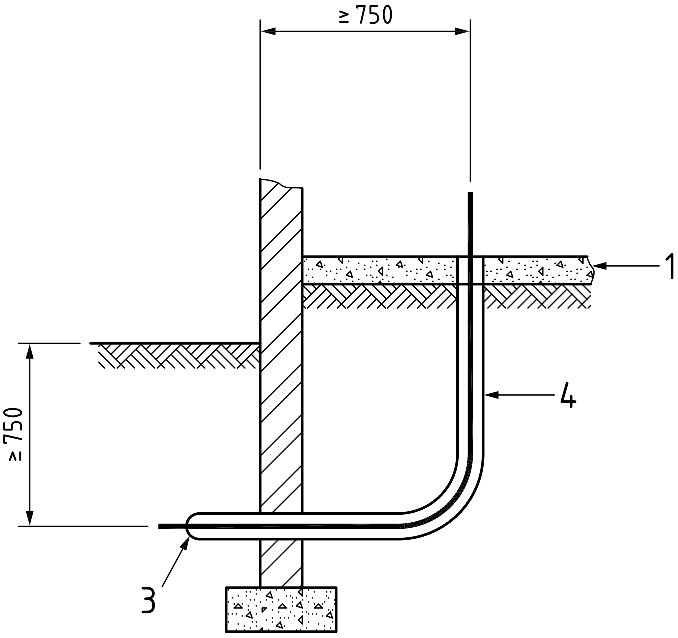
4.3.33.2.2 Underground stopvalves should not be brought up to a higher level merely for ease of access.

Figure 11 **Typical examples of pipes entering buildings** [A)]

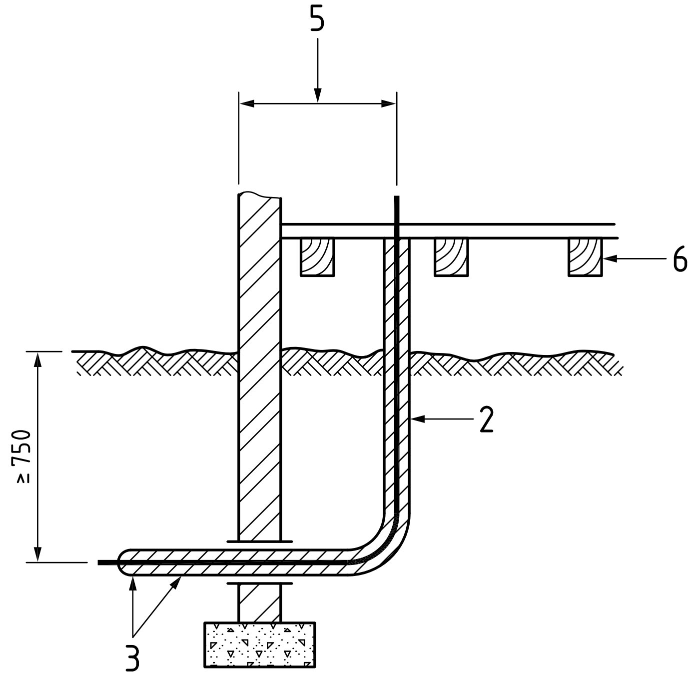
Dimensions in millimetres



a) Rising pipe in duct less than 750 mm from face of external wall



b) Rising pipe in duct more than 750 mm from face of external wall



c) Rising pipe through ventilated suspended floor

Key

1 Solid internal floor
2 Pipes laid in duct with thermal insulation
3 Sealed
4 Pipes laid in duct, no thermal insulation required
5 Any distance
6 Suspended floor

[A)] Ideally, a duct should be constructed so that access to the interior can be obtained either throughout its length or at specified points by removal of a cover or covers.

4.3.33.3 Pipes entering buildings

Where pipes rise from below the ground, waterproof thermal insulation should extend to at least 0.75 m below ground in accordance with **4.3.34** (see Figure 11, **4.3.38** and **5.2.1.10**).

4.3.33.4 Pipes and fittings inside buildings

4.3.33.4.1 Pipes and fittings should be thermally insulated in accordance with **4.3.34**. Thermal insulation should be provided on the top and sides of any storage cistern.

4.3.33.4.2 Where pipes are attached to the inside faces of external walls in a part of a building that is heated, it should not be necessary to insulate them, but it is advantageous to fix such pipes clear of the wall on brackets or clipped to a pipe board.

4.3.33.4.3 To avoid thermal transfer between hot and cold pipes, it might be necessary to appropriately insulate these.

4.3.33.4.4 Cold water pipes should be protected to prevent the formation of condensation. Where cold water pipes pass through areas of relatively high humidity, condensation forms unless prevented. Thermal insulation, as a measure to prevent condensation, is subject to the same recommendations as thermal insulation against heat loss or gain (see **4.3.34**).

4.3.34 Thermal insulation

4.3.34.1 Thermal insulating materials should conform to BS 5422 and should be installed in accordance with BS 5970.

NOTE Detailed guidance on the thermal insulation of pipework and ductwork is given in TIMSA guidance for achieving compliance with Part L of the Building Regulations *[41]. See also [42].*

4.3.34.2 Copper cold water pipes should be thermally insulated to the minimum thickness given in Table 6 and Table 7.

Table 6 **Calculated minimum thickness of thermal insulation to protect copper pipes fixed inside premises for domestic cold water systems**

Outside diameter mm	**Inside diameter (bore)** mm	**Thermal conductivity at 0 °C** W/(m·K)			
		0.025	0.035	0.045	0.055
		Thickness of thermal insulation mm			
15	13.6	30	62	124	241
22	20.2	12	20	30	43
28	26.2	8	12	17	23
35	32.6	6	9	12	15
42	39.6	5	7	9	11

Table 7 **Calculated minimum thickness of thermal insulation to protect copper pipes fixed inside premises against freezing for commercial and institutional applications**

Outside diameter mm	Inside diameter (bore) mm	Thermal conductivity at 0 °C W/(m·K)			
		0.025	0.035	0.045	0.055
		Thickness of thermal insulation mm			
15.0	13.6	31	56	83	109
22.0	20.2	13	21	31	45
28.0	26.2	8	13	18	24
35.0	32.6	7	9	13	16
42.0	39.6	5	7	9	12
54.0	51.6	4	5	7	8
76.1	73.1	3	4	5	6
108.0	105.0	2	3	3	4
Above 108.0 mm outside diameter and flat surfaces		2	3	3	4

NOTE Water temperature: +5 °C; ambient temperature: –3 °C; evaluation period: 24 h; permitted ice formation: 50%.

4.3.34.3 Thermal insulation slows down the impacts of frost or a hot environment, but does not prevent heat transfer from or into the water. Thermal insulation does not give complete protection if the temperature falls to or below freezing point. However, a suitable thickness of thermal insulation does delay the onset of freezing in cold environments and can reduce the rate of heat gain in relatively hot environments.

4.3.34.4 The thickness of insulating materials specified in BS 5422, while giving protection, is not considered practicable for protection of small diameter pipes fixed inside buildings. However, the thickness of insulating material identified in Table 8, under the appropriate thermal conductivity values, is considered practicable and suitable for small diameter pipework to provide reasonable protection for pipes fixed inside normally occupied buildings.

Table 8 **Examples of insulating materials**

Thermal conductivity W/(m·K)	Material
Less than 0.020	Rigid phenolic foam
0.021 to 0.035	Polyurethane foam
0.040 to 0.055	Corkboard
0.055 to 0.07	Exfoliated vermiculite (loose fill)

4.3.34.5 Unless the thermal insulation material used is sufficiently impermeable to water vapour, a vapour barrier with a permeability not exceeding 0.05 g/(s·MN) should be applied on the outside surface of the thermal insulation to protect against damage where necessary.

4.3.34.6 The gap between the thermal insulation material on the copper pipe should not exceed that recommended by the thermal insulation manufacturer to reduce the risk of under-lagging corrosion.

4.3.34.7 Pipes passing through areas with no heating, such as basements, garages and roof spaces, should have greater levels of protection.

4.3.34.8 Further advice on thermal insulation is given in the WRAS *Water Regulations Guide* [25] and can be obtained from manufacturers. There are also thermal calculation tools available, e.g. WRAS.

4.3.35 Local and trace heating

4.3.35.1 Electric self-regulating trace heating should conform to BS EN 62395-1 and BS EN 60079-30-1, with the electrical installation conforming to BS 7671.

4.3.35.2 Any self-regulating trace heating provided for the protection of any pipes or fittings should be additional to, and not a substitution for, the insulation recommended in **4.3.33** and **4.3.34**.

4.3.35.3 Where self-regulating trace heating is provided, it should be fitted before the insulation is applied.

4.3.35.4 Local heating, in conjunction with a frost thermostat, should only be used where other methods of frost protection are unsuitable, e.g. for pipes in unheated roof spaces when it is inconvenient to drain them and the building is to be unheated for a period during the winter.

4.3.36 Drainage of system to prevent frost damage

4.3.36.1 Arrangements should be provided for isolating and draining pipes and fittings (see **4.3.14** to **4.3.16**).

4.3.36.2 Where a building is divided into parts, the pipes and fittings in each part should be arranged so that they can be isolated and drained without affecting the supply to any other part. Stopvalves and drain taps should be located in positions convenient for use as close as practicable to the point of entry of the pipe into the building or part thereof.

4.3.36.3 Unless the stopvalve is installed within a normally heated building, it should be protected against freezing in accordance with **4.3.33** to **4.3.35**.

4.3.36.4 Every external standpipe, livestock watering appliance, garden tap, garage tap, or similar water fitting should be supplied through a stopvalve located in a position convenient for use within a normally heated building or protected against freezing and damage in accordance with **4.3.33** to **4.3.35**.

4.3.36.5 The pipes and fittings in any part of a building not used in winter, any unheated building or part of a building, including any water-closet, garage or conservatory, or any other outbuilding, should be arranged to enable them to be isolated and drained separately.

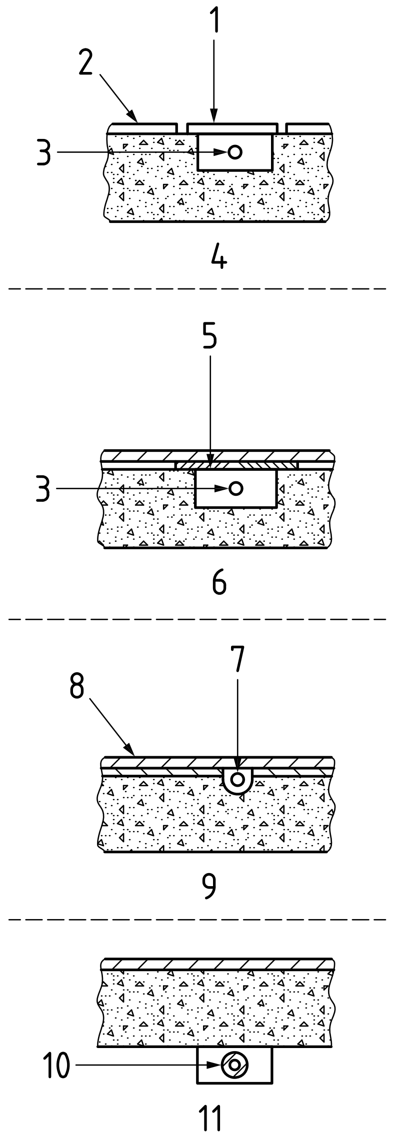
4.3.37 Accessibility of pipes and water fittings

The following factors should be assessed (see Figure 12).

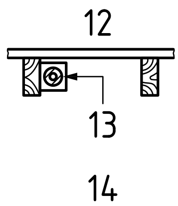
a) The purpose for which the building is to be used: importance of aesthetic considerations, consequences of leakage from inaccessible parts of the pipework and whether or not the system is subject to routine inspection and maintenance.

b) The pipework materials and jointing methods: reliability of joints, resistance to both internal and external corrosion and the flexibility of pipe when inserted in curved ducts or sleeves.

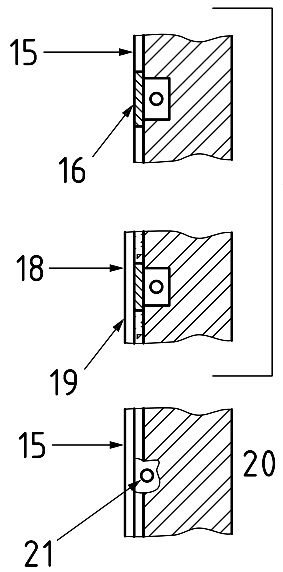
Figure 12 **Accessibility of pipework** *(1 of 2)*



a) Accessibility of pipes under solid floors

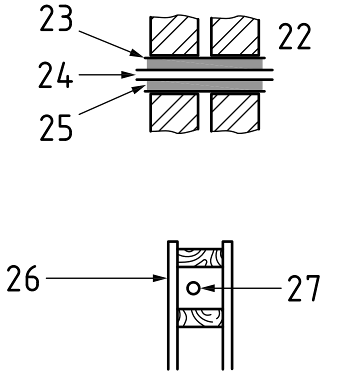


b) Accessibility of pipes under suspended floors

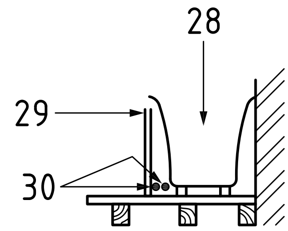


c) Accessibility of pipes in solid walls (see Note 1)

NOTE 1 This is only permitted in an internal wall and if pipe can be capped off or isolated if a leak becomes apparent.

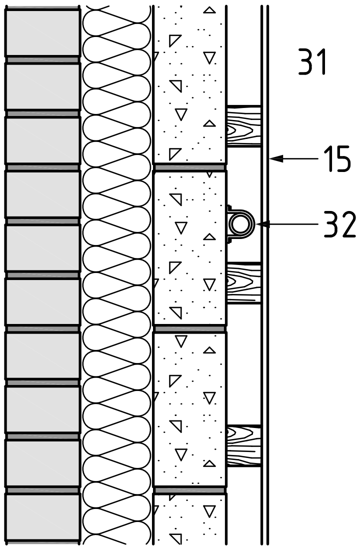


d) Accessibility of pipes in cavity walls [A)]



e) Accessibility of pipes behind bath panels

Figure 12 – Accessibility of pipework *(2 of 2)*



f) Accessibility of pipes in studded internal walls

NOTE 2 Copyright is claimed in Figure 12f). Reproduction of this figure and making products from it might infringe that copyright. Details of the copyright owner can be found in the Foreword, Information about this document.

Key

1 Removable cover (recommended)
2 Floor finish
3 Pipes in purpose-made chase
4 Thermally insulated if an unheated building
5 Tiling or other surface finish over wood or metal cover
6 Acceptable only where few joints are enclosed and pipe can be withdrawn for examination
7 Void maintained around pipe located in purpose-made chase/duct within screed, i.e. pipe not bedded or set into the chase and does not contain any screed/concrete
8 Surface finish to floor
9 Only acceptable where few joints are enclosed
10 Pipe thermally insulated in purpose-made duct under floor
11 Acceptable only where pipes are of continuous length and can be withdrawn for inspection and/or replacement
12 Ground floor
13 Pipe thermally insulated
14 Boards removable at intervals of not more than 2 m and at every pipe joint or inspection of whole length of pipe
15 Surface finish
16 Removable cover over purpose-made duct
17 Pipes fixed on external face of an external wall, or located within the internal face of a wall with no in-built thermal insulation (i.e. a solid wall), to be thermally insulated
18 Wood or metal cover
19 Plaster or tiling
20 Internal wall
21 Pipe in chase
22 Cavity wall
23 Duct/sleeve
24 Pipe in duct
25 Thermal insulation
26 Plaster board and studding wall (internal)
27 Pipe run within wall
28 Bath
29 Removable bath panel
30 Correct position for pipes [B)]
31 Dry lining or studding on external wall
32 Pipe located within wall

[A)] No pipes should be laid within a cavity.

[B)] The pipes should be laid on the side of the bath adjacent to the removable panel.

4.3.38 Pipes passing through walls and floors

Where fire regulations and other considerations require the ends of sleeves to be sealed, such sealing should be of a permanently flexible form to allow movement of the pipe.

4.3.39 Underground stopvalves

Stopvalves installed on an underground pipe should be enclosed within a pipe guard or chamber under a surface box of the appropriate grade for the traffic loading according to the location (see BS 5834-2).

4.3.40 Above ground valves

For control valves where access is required for emergency purposes, access to the valve should not require the use of tools to remove the access cover.

4.3.41 Cisterns

4.3.41.1 Every storage cistern should be placed and equipped so that the interior can be inspected and cleansed and the float-operated valve can be maintained (see Figure 13). A clear space of not less than 350 mm should be provided between the top of the storage cistern and any ceiling or other obstruction above the cistern. For small storage cisterns the overhead, unobstructed space may be reduced to 225 mm provided no dimension of the cistern exceeds 450 mm in any plane.

4.3.41.2 A storage cistern should be supported throughout the whole of its base on a level platform capable of supporting the weight of the cistern when full to its brim. Where the cistern is fitted within a prefabricated timber trussed roof system, the support members should conform to BS 5268-3 or BS EN 1995-1-1, and the timber or wood-based material should be of not less than 18 mm thick, moisture-resistant boarding. The platform should be extended beyond the outside edges of the cistern, not less than 150 mm on all sides and, where appropriate, be extended to provide sufficient space for maintenance personnel to safely access the associated valves and cistern access cover(s). The provision of lighting is also recommended to facilitate ease of routine inspections.

4.3.41.3 WC and urinal flushing cisterns should be accessible for repair/ maintenance.

4.3.42 Water economy

NOTE 1 Attention is drawn to the Water Fittings Regulations [19], [20] and [21] for the arrangement of WC flushing and the Building Regulations [22], [23] and [24] for requirements on water economy.

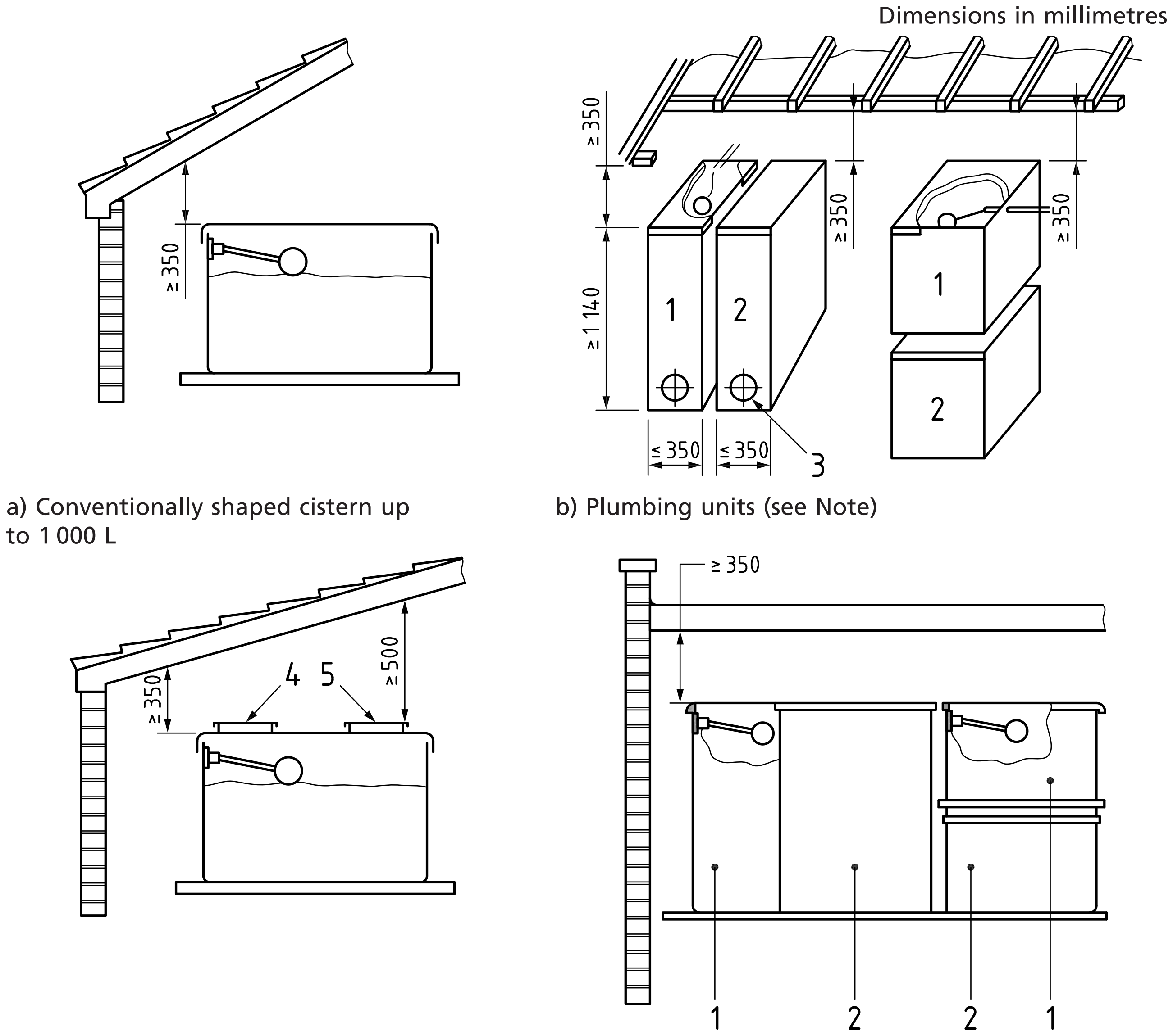
The discharge/flushing of a WC suite is dependent on the combined performance of the flushing cistern when used in conjunction with a specific WC pan. Arbitrary reduction in the flush is not recommended.

NOTE 2 Where modifications are made to existing systems, pipe and cistern size might need to be evaluated with regard to water quality.

4.3.43 Urinal flushing

A user-operated or actuated flush for individual stalls or bowls may be fitted for water saving if each unit is used less frequently than the automatic flushing rate.

Figure 13 **Clear space needed above cisterns**



a) Conventionally shaped cistern up to 1 000 L

b) Plumbing units (see Note)

c) Greater than 1 000 L capacity cistern with bolted-on lid

d) Hot water storage combination units

Key

1 Cold water cistern

2 Hot water storage vessel

3 Handhole

4 Access to float valve

5 Access for inspection

NOTE Acceptable sizes and positions of handholes are given in BS 3198.

4.3.44 Waste plugs

Every waste outlet from a bath (other than a shower bath or shower tray), washbasin, sink or similar appliance should be provided with a well-fitting plug and retaining chain, pop-up plug or equally effective closure, except where the water supply is from a fitting supplying water to a washing trough or basin fitted with self-closing taps at a rate not exceeding 3.6 L/min per appliance.

4.3.45 Risk-based approach

The designer/building owner has a responsibility to provide fittings that offer suitable protection for the intended end-user. A risk assessment can be used to determine the appropriateness of an intended fitting, e.g. where the risk assessment identifies the potential end-user as not able-bodied, a fitting with enhanced safety features should be used.

4.3.46 Energy conservation: pipework and hot water storage

4.3.46.1 With the exception of certain solid fuel appliances, all hot water storage systems should be fitted with a thermostat to control the maximum water temperature.

4.3.46.2 All pipes forming part of a primary or secondary hot water system for supplying domestic hot water and all pipes supplying hot water to any draw-off tap or outlet should be thermally insulated in accordance with the *Domestic Building Services Compliance Guide* [43] or the *Non-domestic Building Services Compliance Guide* [44].

4.3.46.3 Where self-regulating trace heating is used, it should be of the electric self-regulating type specifically formulated for domestic hot water systems. The system should conform to BS EN 62395-1 and BS EN 60079-30-1.

4.3.46.4 Reducing the quantity and temperature of hot water, heated and/or stored water to meet recommendations, produces energy savings in addition to those achieved by thermal insulation and controls. Storage vessels should therefore be sized without excessive over-capacity. Devices such as double element or twin electric immersion heaters, or manually controlled economy valves on directly-heated gas circulator systems that enable a reduced quantity of water to be heated when desired, should be fitted accordingly.

4.3.47 Scale control

4.3.47.1 Formation of scale in boilers and water heaters occurs due to the hardness of the water supply. Hard water contains dissolved minerals, mainly calcium, magnesium and associated anions bicarbonate, sulfate and chloride. When hard water is heated, bicarbonate decomposes and calcium carbonate is deposited in the heater and associated pipework. Whilst this can cause blockage and equipment failure, it also coats the heating surfaces, effectively insulating them so that their efficiency is impaired.

4.3.47.2 For primary circuits during final filling of the system, an appropriate chemical water treatment formulation should be added to the primary circuit to control corrosion and the formation of scale and sludge.

4.3.47.3 For secondary circuits (i.e. feed water to water heaters and the hot water circuit of combination boilers) in areas where water hardness is greater than 200 ppm, consideration should be given to fitting a base-exchange water softener, scale inhibitor or physical water conditioner, or continuous dosing.

4.3.48 Pumping cold water

Where mains pressure is insufficient to supply the upper floors of a building, mains supply to the lower floors without pumping should be considered. Where more than 0.2 L/s of water is to be pumped, the water supplier’s consent should be obtained before the installation commences. The examples of pumped systems in Annex A may also be considered.

4.3.49 Bending of pipes

4.3.49.1 Rippling and restricting the diameter of pipes should be avoided when forming bends.

4.3.49.2 Where appropriate, purpose-designed equipment should be used.

4.3.50 Above-ground pipework

Adaptor couplings are available for jointing different materials, involving a range of different jointing methods and including both direct and union type couplings. These should be used whenever possible. Where suitable adaptors are not available for the particular joint required, both materials should be adapted to BS P threaded ends, which should be screwed together if male and female or connected by a nipple, socket or union of a material compatible with the pipe material that does not lead to corrosion.

4.3.51 Below-ground pipework

4.3.51.1 Joints in buried pipework should be kept to the absolute minimum and joints between pipes of different materials should be restricted to connections between large supply pipes similar to suppliers' mains and pipes serving individual buildings (see also **4.2.1**).

4.3.51.2 Service connections to cast-iron pipes should be made either by drilling and tapping the pipe and screwing in a copper alloy union ferrule or, where the size of the proposed service connection dictates, a threaded saddle or collar.

4.3.51.3 When making service connections to unplasticized PVC pipes, a saddle should be fixed round the larger pipe and a ferrule screwed into the saddle. The installer should follow the manufacturer's instructions. For fibre cement pipes, the same method should be used or a proprietary threadless ferrule should be used in accordance with the manufacturer's instructions.

4.3.51.4 Service connections to PE pipes should be made using either a saddle fusion fitting (for PE service pipes only) or a self-tapping saddle.

4.3.51.5 Pipes should be laid to ensure even support throughout their length and should not rest on their sockets or on bricks, tiles or other makeshift supports. Plastics pipes should be laid on a bed free from sharp stones.

4.3.51.6 Pipes should be kept clean and, immediately before laying each pipe and fitting, should be thoroughly cleansed internally and the open end temporarily capped until jointing takes place. The joint surfaces should be clean. After laying and jointing, the leading end should remain capped.

4.3.51.7 Where permitted, the trench excavation should be backfilled at regular intervals to prevent flotation of the capped pipes in case the trench becomes flooded.

4.3.51.8 Requirements for below-ground pipework are specified in BS EN 805.

4.3.52 Location of pipes and valves

4.3.52.1 The location and position of underground pipes and valves should be recorded. Surface boxes should be marked to indicate what service is below them. Durable markers with stamped or set-in indexes should be set up to indicate pipe service, size, position and depth below the surface. Indicator plates for hydrants should conform to BS 3251.

4.3.52.2 Marker tapes are available for use and are generally laid a short distance above the pipe in the trench.

4.3.53 Identification

4.3.53.1 In any building other than a single dwelling:

a) water piping should be self-coloured or colour-banded in accordance with BS 1710; and

b) every supply pipe and every pipe for supplying water solely for firefighting purposes should be clearly and indelibly marked to distinguish them from each other and from other pipes in the building.

4.3.53.2 The Water Fittings Regulations [19], [20] and [21] require that any water fitting conveying rainwater, recycled water, any fluid other than from a water supplier, or any fluid that is not drinking water, is clearly identified so as to be easily distinguished from any supply pipe or distributing pipe.

4.3.53.3 For further guidance, see WRAS *IGN 9-02-05, Marking & Identification of Pipework for Water Reuse Systems* [39].

4.3.54 Inspection

4.3.54.1 The water supplier should be given the opportunity to carry out visual inspections.

4.3.54.2 All internal pipework should be inspected to ensure that it has been securely fixed.

4.3.54.3 All cisterns, tanks, hot water cylinders and water heaters should be inspected to ensure that they are properly supported and secured, that they are clean and free from debris and that cisterns are provided with correctly fitting covers before testing takes place.

4.3.54.4 Unvented hot water storage installations, if not installed by a member of a recognized compliant scheme, should be notified to the building control body to verify that they conform to the Building Regulations [22], [23] and [34].

4.3.54.5 Before accepting a pipeline, a check should be made that valve and hydrant boxes are aligned, that operating keys are provided for the valves and, for deep valves, that extension spindles are installed.

4.3.54.6 Where visual inspection of underground pipework is carried out, particular attention should be paid to the pipe bed; the line and level of the pipe; irregularities at joints; the correct fitting of air valves, washout valves, sluice valves and other valves; and warning/tracing tapes, together with any other mains equipment specified, including the correct installation of thrust blocks where required, to ensure that protective coatings are undamaged.

4.3.54.7 To guard against frost and mechanical damage due to traffic, ploughing or agricultural activities, trenches should be inspected to ensure that excavation is to the correct depth.

4.3.54.8 No part of the pipe trench should be backfilled until these conditions have been satisfied and the installation seen to conform to the drawings and specifications and the Water Fittings Regulations [19], [20] and [21].

4.3.54.9 A person approved by the undertaker or certified by an organization specified by the Regulator in accordance with the Water Fittings Regulations [19], [20] and [21] can self-certify that the installation conforms to the Water Fittings Regulations [19], [20] and [21].

4.3.55 Connection to water supply system

4.3.55.1 When all inspections and tests have been successfully completed and the system accepted from the installer, the water supplier should be informed that the system is available for permanent connection to the supply.

4.3.55.2 Each draw-off tap, shower fitting and float-operated valve should be checked for rate of flow against the specified design requirements. Performance tests should also be carried out on any connected specialist items to show that they meet the requirements of the specification.

4.3.56 Compatibility

4.3.56.1 When carrying out renewals, the existing pipework should be identified and appropriate adaptors used, particularly where the original pipework is an imperial size.

4.3.56.2 Pipes, fittings, components and materials from one manufacturer are not always compatible with those of another manufacturer, even when they conform to the same British Standard. This applies particularly to welding of plastics pipes, sockets for patent elastomeric ring joints and the threads on compression fittings.

4.3.57 Thermal insulation

4.3.57.1 Any substandard insulation, or damage to thermal insulation or fire stopping revealed during inspection should be rectified. Self-regulating trace heating should also be checked for continuity.

4.3.57.2 Where practicable, the integrity of thermal insulation used for frost protection of supplies and boiler condensate drainage should be checked at the beginning of winter.

5 Guidance on BS EN 806-4

5.1 Guidance on specific BS EN 806-4 requirements

5.1.1 BS EN 806-4:2010, 4.1: General

5.1.1.1 All materials and components used for the construction of a water system should be handled with sufficient care and attention to prevent their deterioration or the ingress of contaminants. Such deterioration can impair their serviceability or affect the system impact on water quality.

5.1.1.2 Some pipes are manufactured from asbestos cement. Work on these pipes, in common with work on all asbestos containing materials, is subject to the Control of Asbestos at Work Regulations [7] and [8], and the overriding duty is to keep exposure to asbestos dust as low as is reasonably practicable. Asbestos cement pipes contain about 10% white asbestos and might also contain 1% brown asbestos. These pipes are generally safe to handle, but precautions should be taken for cutting and grinding operations to keep dust generated to the minimum and to prevent people inhaling the dust. This may be achieved by damping down and using hand rather than power tools. If in doubt, guidance should be sought from the Health and Safety Executive.

5.1.1.3 Manufacturers' advice should be followed as to how their products should be loaded, transported, unloaded and stored. Pipes, fittings and components of any material should be handled carefully to reduce damage.

5.1.1.4 Recommendations for workmanship on building sites are given in BS 8000-15.

5.1.2 BS EN 806-4:2010, 4.4.1: General

5.1.2.1 Specially-designed cutting tools should be used to limit pipe distortion and the pipe should be cut square to the axis.

5.1.2.2 Any pipe ends that are distorted should be re-rounded using a suitable tool prior to the joint assembly.

5.1.3 BS EN 806-4:2010, 4.4.2: Pipe materials and jointing methods

5.1.3.1 Copper pipes

5.1.3.1.1 Capillary solder joints

5.1.3.1.1.1 When making a capillary joint, the mating faces of the pipe and fitting should be abrasively cleaned with nylon cleaning pads or emery strip (not steel wool) and flux applied sparingly to the spigot. The joint may be made by proprietary capillary fittings or made using a purpose-made swaging tool.

5.1.3.1.1.2 The ends of annealed pipes should always be re-rounded.

5.1.3.1.1.3 The type of fitting and jointing methods used should be in accordance with Table 9, using tin/copper alloy number 23 or number 24, or tin/silver alloy number 28 or number 29 conforming to BS EN 29453.

5.1.3.1.1.4 For capillary fittings, the joint should be heated until the solder, which is either constrained within the fitting (integral ring) or is fed in with a solder stick or wire (end feed), flows by capillary attraction to fill the joint space. The Water Fittings Regulations [19], [20] and [21] require the use of lead-free solder only. The joint should remain untouched until the solder has cooled and solidified, but any surplus flux on the assembly should be carefully removed. Use of excessive amounts of flux should be avoided.

5.1.3.1.2 Capillary brazed joints

Brazed joints, using either capillary type joints formed by special tools or copper alloy fittings, should be made with brazing alloys conforming to BS EN ISO 17672 together with a suitable flux where necessary.

5.1.3.1.3 Autogenous welding

Autogenous welded joints, either directly between pipes or using copper or copper alloy fittings suitable for welding, should be made with a filler rod of copper or suitable zinc-free copper alloy together with a suitable flux.

5.1.3.1.4 Compression fittings (type A)

5.1.3.1.4.1 When completing the joint, it should not be over-tightened. Manufacturer’s instructions should be referred to for details.

5.1.3.1.4.2 Non-manipulative types of compression joint do not require any working of the pipe end other than cutting square. The joint is made tight by means of a loose ring or sleeve that grips the outside wall of the pipe when the coupling nut is tightened. Non-manipulative compression fittings are not suitable for installation below ground or for other inaccessible positions.

5.1.3.1.5 Compression fittings (type B)

For the manipulative type of compression joint, the end of the pipe is flared, cupped or belled with special forming tools and compressed with a coupling nut against a shaped end of corresponding section on the fitting or a loose thimble.

Table 9 **Jointing of copper tube and stainless steel tube**

Tube	**Fitting conforming to BS EN 1254-2**			**Other methods**			
(with BS EN 1057:2006 +A1:2010, Table 1, designation where applicable)	Compression type A non-manipulative [A)]	Compression type B manipulative	Capillary (soft soldier) (see BS EN 1254-1)	Brazing (see BS EN 1254-1 or BS EN 1254-5)	Autogenous welding	Press fittings [A)]	Push-fittings [A)]
Annealed copper tube conforming to designation R220 [B)]	Yes (with appropriate tube support liner)	Yes	Yes	Yes	Yes	No	Yes (might require tube support liner)
Half-hard copper tube conforming to designation R250	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Hard copper tube conforming to designation R290	Yes	No	Yes	Yes	No	Yes	Yes
Stainless-steel tube conforming to BS EN 10312	Yes	Yes	No	Yes	Yes	Yes	Yes

A) Not to be used underground.

B) Tube to be re-rounded before jointing.

5.1.3.1.6 Push fittings

To prevent movement before system pressurization, sufficient pipe clipping should be provided when using push fittings.

5.1.3.2 Steel pipes

5.1.3.2.1 Welded joints should not be used where a protective lining can be damaged by heat.

5.1.3.2.2 Screwed joints in steel piping should be made with screwed socket joints using wrought-iron, steel or malleable cast-iron fittings. A thread filler or an appropriate synthetic fibre and suitable jointing paste should be used to make joints leak tight. Natural hemp fibres or oil-based jointing pastes (e.g. linseed oil-based paste) should not be used. Exposed threads left after jointing should be painted or, where installed underground, thickly coated with bituminous or other suitable corrosion preventative in accordance with BS 5493.

5.1.3.2.3 Flange joints should be made with screwed or welded flanges of steel or cast iron using jointing rings and, if necessary, a suitable jointing paste.

5.1.3.2.4 For flanged joints the nuts should be carefully tightened, in opposite pairs, until the jointing ring or gasket is sufficiently compressed between the flanges for a watertight joint.

5.1.3.3 Stainless steel pipes

5.1.3.3.1 Compression fittings

Compression joints on plain-ended stainless-steel tube should be made with copper alloy or stainless steel compression fittings (see Table 9).

5.1.3.3.2 Capillary fittings

Capillary joints on plain-ended stainless-steel tube should be made with copper, copper alloy or stainless-steel fittings using silver solder or brazing conforming to BS EN ISO 17672, but not soft solder.

5.1.3.3.3 Push fittings

To prevent movement before system pressurization, sufficient pipe clipping should be provided when using push fittings.

5.1.3.4 Unplasticized PVC pipes

5.1.3.4.1 Mechanical joints

5.1.3.4.1.1 Mechanical joints in unplasticized PVC piping of nominal diameter DN 2 (i.e. 2 in) and upwards should be made in accordance with BS EN ISO 1452-3, by the use of push-fit integral elastomeric sealing rings which are compressed when the plain-ended pipes are inserted into the adjoining sockets. The plain pipe ends should be chamfered and the surfaces cleaned and lubricated.

5.1.3.4.1.2 The chamfered pipe end should be inserted fully into the adjoining socket (except where provision is to be made for expansion) or as far as any locating mark put on the spigot end by the manufacturer. The sealing rings should conform to BS EN 681-1.

5.1.3.4.2 Compression joints

Compression joints should only be used with unplasticized PVC piping of nominal diameter DN2 and smaller. The joints should be of the non-manipulative type. Over-tightening should be avoided.

5.1.3.4.3 Solvent cement welded joints

Solvent cement welded joints in unplasticized PVC piping should be made using a solvent cement conforming to BS EN 14814 recommended by the pipe manufacturer. The dimensions of the spigots and sockets should conform to BS EN 1452 (all parts).

NOTE Joints may also be made using integral sockets formed in the pipes and solvent cemented.

5.1.3.4.4 Flanged joints

Flanged joints used for connections to valves and fittings should use full-face flanges or stub-flanges, both with corrosion-resistant or immune backing rings and bolting. Where necessary, the joints should be wrapped with an appropriate protective material.

5.1.3.5 Chlorinated polyvinyl chloride (PVC-C)

PVC-C pipes should conform to BS EN ISO 15877-2. When installing such pipes they should be cut with the tools recommended by the manufacturer to ensure that joints are formed with the lowest potential for mechanical failure and the risk of trapping materials which would promote a biofilms is reduced to a minimum. The use of solvent welded systems should be controlled in accordance with the manufacturer's recommendations and the approvals granted under the Water Fittings Regulations [19], [20] and [21].

5.1.3.6 Polybutylene pipes

Mechanical joints in polybutylene pipes conforming to BS 7291-2 should be made using fittings conforming to the same standard.

5.1.3.7 Polyethylene (PE) pipes

5.1.3.7.1 PE fittings should conform to BS EN 12201-3 and mechanical joints should conform to BS ISO 17885. Mechanical joints should be made using either plastics or metal proprietary compression fittings, e.g. brass or gunmetal. These should include liners to support the bore of the pipe, except where the manufacturer of the fittings instructs otherwise.

5.1.3.7.2 Compatibility of the materials from which the pipe and fittings are made should be established to ensure satisfactory jointing. The manufacturer's instructions should be followed carefully.

5.1.3.7.3 PE piping should not be jointed by solvent cement welding.

5.1.3.8 Crosslinked polyethylene (PE-X) and multi-layered pipes

5.1.3.8.1 Mechanical joints should be made using either plastics or metal proprietary compression fittings, e.g. brass or gunmetal. These should include liners to support the bore of the pipe, except where the manufacturer of the fittings instructs otherwise. Electrofusion and other thermal methods are widely used.

5.1.3.8.2 Compatibility of the materials from which the pipe and fittings are made should be established to ensure satisfactory jointing. The manufacturer's instructions should be followed carefully.

5.1.3.8.3 Crosslinked pipes should not be jointed by solvent cement welding. Mechanical joints in piping should be made in accordance with BS 7291-3 and BS EN ISO 21003-2.

5.1.3.9 Acrylonitrile butadiene styrene (ABS) pipes

5.1.3.9.1 Mechanical joints

Mechanical joints should be made using either plastics or metal proprietary compression fittings that are recommended by the pipe manufacturer. These should include liners to support the bore of the pipe, except where the fitting's manufacturer instructs otherwise.

5.1.3.9.2 Compression joints

Compression joints should only be used with ABS piping of nominal diameter DN2 (or 63 mm) and smaller. The joints should be of the non-manipulative type. Over-tightening should be avoided.

5.1.3.9.3 Solvent cement welded joints

Solvent cement-welded joints in ABS piping should be made using a solvent cement recommended by the pipe manufacturer. The dimensions of the pipes, spigots and sockets should conform to BS 5391-1 and BS 5392-1 or to BS EN ISO 15493, as applicable.

NOTE Joints may also be made using integral sockets formed in the pipes and solvent cemented.

5.1.3.9.4 Flanged joints

Flanged joints used for connections to valves and fittings for ABS piping should use full-face flanges or stub-flanges, both with corrosion-resistant or immune backing rings and bolting. Where necessary, the joints should be wrapped with an appropriate protective material.

5.1.4 BS EN 806-4:2010, 4.7.1: Allowances for thermal movement and prevention of noise

5.1.4.1 In installations that do not have limited straight runs and many bends and offsets, allowance for expansion and contraction of the pipes should be made by forming expansion loops. This can be achieved by introducing changes of direction to avoid long straight runs or by fitting proprietary expansion joints.

5.1.4.2 This is particularly important where temperature changes are considerable, e.g. hot water distribution pipework, and where the pipe material has a relatively large coefficient of thermal expansion, e.g. plastics. In installations with limited straight runs and many bends and offsets, thermal movement is accommodated.

5.1.5 BS EN 806-4:2010, 4.7.2.6: Fixings for insulated piping

Ducts and chases should be constructed as the building structure is erected and should be finished to receive pipe fixings.

5.1.6 BS EN 806-4:2010, 4.7.4: Piping passing through structures

5.1.6.1 Notching and boring of structural timbers is covered in the Building Regulations *Approved Document A* [45], by reference to BS EN 1995-1-1.

5.1.6.2 Structural timber joists should not be notched or drilled such that the integrity and stability of the structure is compromised.

5.1.6.3 The recommendations for notching and drilling of solid timber joists (see Figure 14) do not apply to proprietary wood-engineered joists or to metal web joists. Manufacturers' product and design literature should be consulted.

5.1.6.4 For structural solid timber joists, notches and holes should be as small as necessary to receive pipes. Notches should be U-shaped and formed by parallel cuts to previously drilled pilot holes. The structural members should not be weakened by notching and drilling. In this respect, the positions of notches and holes are as important as their size and extent. Notches and holes in solid timber floor and flat roof joists should be within the limits shown in Figure 14. Trimmers, trimmed, trimming joists and beams supporting floor joists should not be notched or drilled unless justified by engineering calculation.

5.1.6.5 The sizing of structural timber members is covered by the Building Regulations *Approved Document A* [45], by reference to BS EN 1995-1-1 and, for certain solid timber joist members, by reference to BS 8103-3.

5.1.6.6 To prevent accidental damage or injury when inserting pipework below suspended floors, a visual inspection should be carried out beforehand to identify the position of any electrical cables, junction boxes and ancillary equipment.

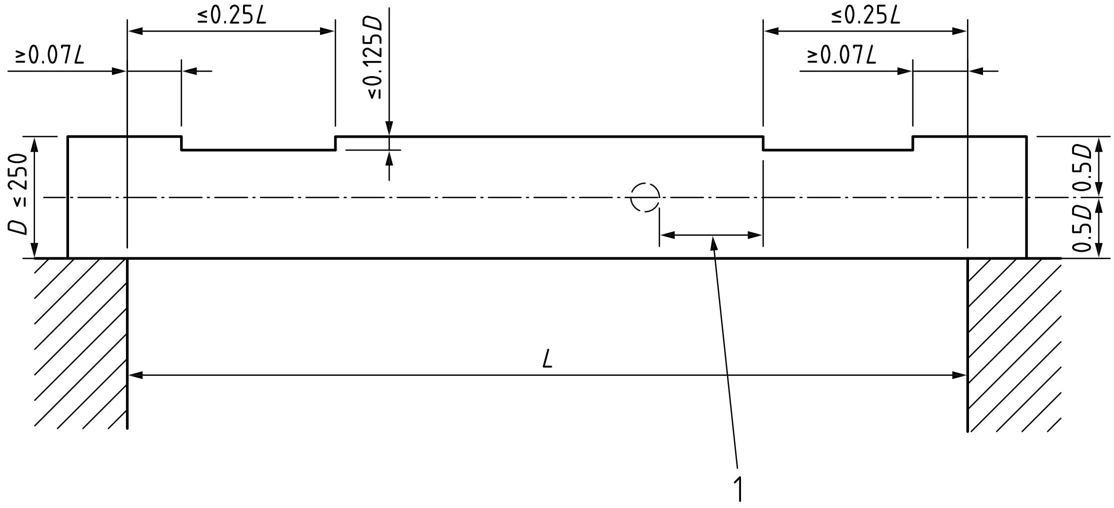
5.1.6.7 Damage to the pipes by nails or screws should be prevented when re-fixing flooring. Where possible, the flooring should be appropriately marked to warn others.

5.1.7 BS EN 806-4:2010, 4.8: Valves and taps

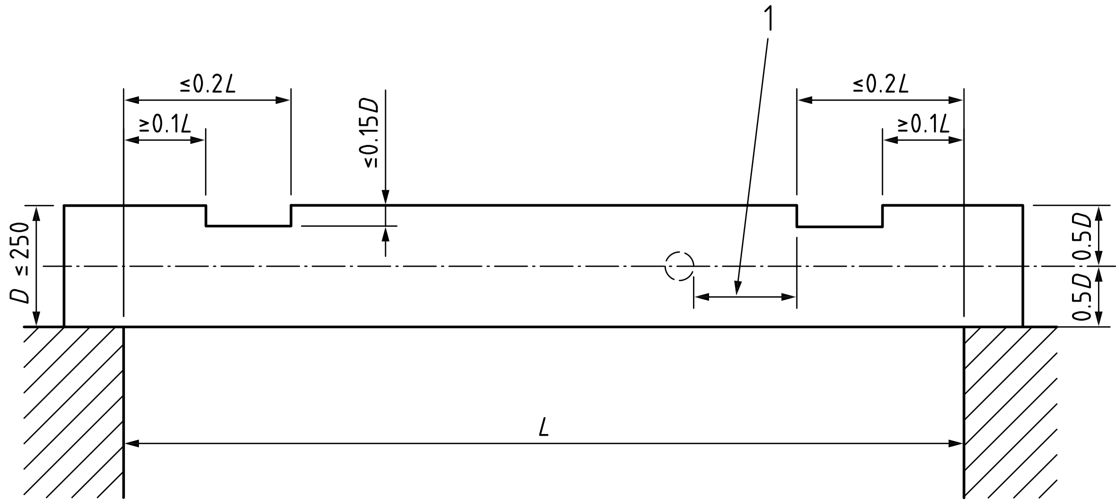
5.1.7.1 Taps not fixed directly to an appliance should be screwed into a suitable pipe fitting. The fitting or the pipe immediately adjacent to the tap should be firmly secured to a support capable of preventing strain on the pipe and its joints when the tap is operated.

5.1.7.2 A backplate elbow to receive the tap, and a wall flange plugged and screwed to the wall or support should be used.

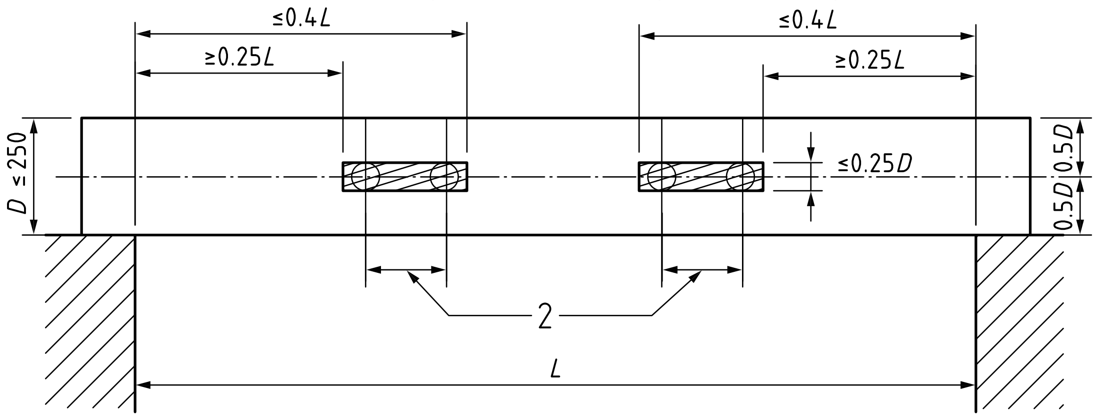
Figure 14 **Limits for notching and drilling of solid timber floor joists** *(1 of 2)*



a) Limits for notching top of joist where drilling and notching occur (see Note 1)



b) Alternative limits for notching top of joist where drilling and notching occur (see Note 1)



c) Limits for drilling of joists where drilling and notching occur (see Note 1)

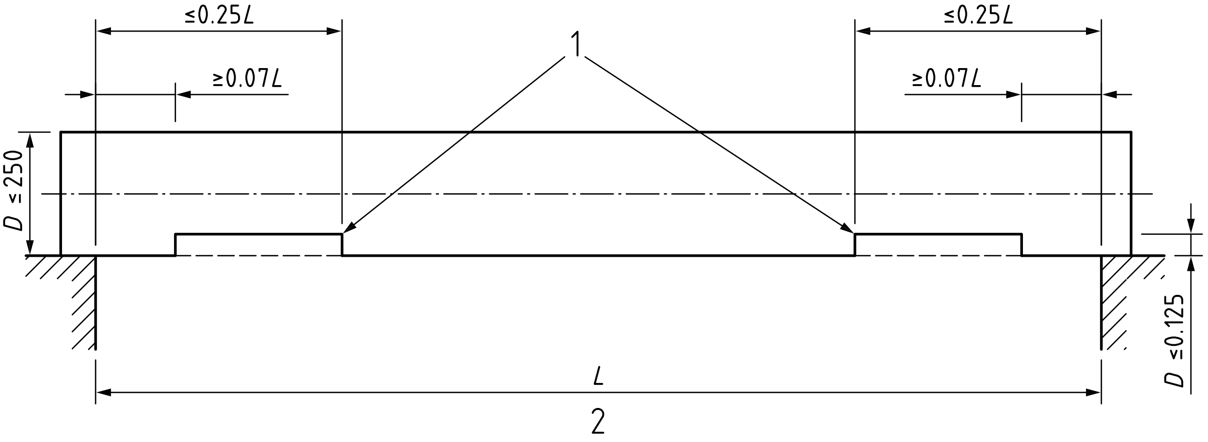
Key

1 Min. 100 mm between notch and hole

2 Holes not closer than 3 × diameter

NOTE 1 The notching can occur at both ends, either on top or bottom, without a design check.

Figure 14 – Limits for notching and drilling of solid timber floor joists *(2 of 2)*

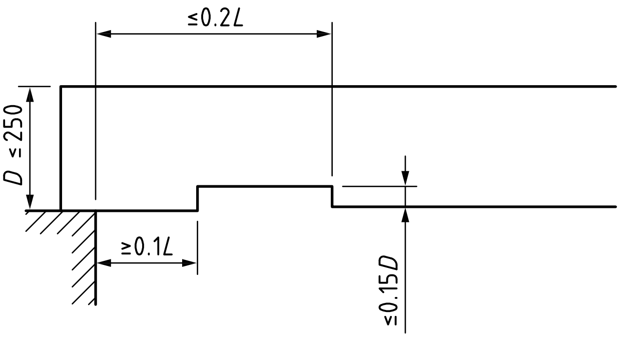


Key

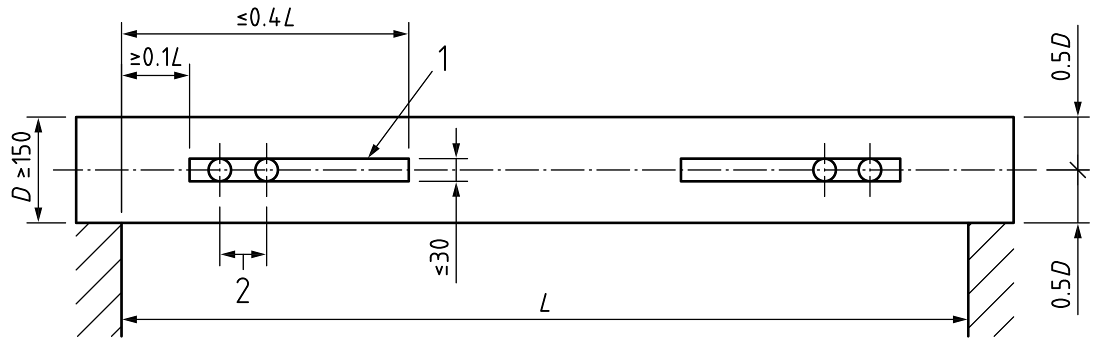
1 Positions within which notching can occur on the bottom with a design check. Minimum 100 mm between the notch and any holes [see Figure 14a)].

2 Clear span simply supported joist (not a trimmer, trimming joist or beam)

d) Limits for notching bottom of joist where drilling and notching occur (see Note 2)



e) Alternative limits for notching: bottom of joist where drilling and notching occur (see Note 2)



f) Alternative drilling zone where no notching occurs (see Note 2)

Key

1 Drilling zones where no notching occurs

2 Holes not closer than 3 × diameter of largest hole and a maximum 8 × 30 mm hole can be accommodated within each drilling zone. No notching is permitted.

NOTE 2 The notching can occur at both ends, either on top or bottom, without a design check.

5.1.8 BS EN 806-4:2010, 4.9.3: Record of installation

To determine the identity and function of each valve in a system, a diagrammatic drawing should be provided for every installation, particularly for non-domestic use. The building owner/occupier should be provided with copies of the installation records.

5.1.9 BS EN 806-4:2010, 6.1.1: General

5.1.9.1 General

Pneumatic pressure testing is possible, but not recommended due to the risk of explosion involved.

5.1.9.2 Timing of tests

Satisfactory completion of an interim test does not constitute a final test.

5.2 Supplementary guidance to BS EN 806-4

5.2.1 BS EN 806-4:2010, 4.6: Underground pipe laying

5.2.1.1 General

5.2.1.1.1 Pipes should be laid to ensure even support throughout their length and should not rest on their sockets or on bricks, tiles or other makeshift supports. Plastics pipes should be laid on a bed free from sharp stones slightly snaked in the trench to accommodate movement.

5.2.1.1.2 Pipes should be laid true to line to the general contours of the ground and at a sufficient depth for the pipe diameter to allow for the minimum cover below finished ground level.

5.2.1.2 Trench excavations

5.2.1.2.1 The bottom of trench excavations should be prepared to ensure a firm, even surface so that the barrels of the pipes when laid are well-bedded for their whole length. Mud, rock projections, boulders, hard spots and local soft spots should be removed and replaced with selected fill material consolidated to the recommended level.

5.2.1.2.2 Where rock is encountered, the trench should be cut at least 150 mm deeper than other ground and replaced with selected fill material consolidated to the recommended level.

5.2.1.3 Trench backfilling

When backfilling trenches, the pipes should be surrounded with suitable material consolidated to resist subsequent movement of the pipes. No large stones or sharp objects should be in contact with the pipes.

5.2.1.4 Ingress of dirt

5.2.1.4.1 Pipes should be kept clean. Immediately before laying each pipe and fitting, they should be thoroughly cleansed internally and the open end temporarily capped until jointing takes place. The joint surfaces should be kept clean. After laying and jointing, the leading end should remain capped.

5.2.1.4.2 Flotation of the capped pipes should be prevented in case the trench becomes flooded.

5.2.1.5 Chemical permeation risk

5.2.1.5.1 Where pipework is to be laid in ground that is subject to spillage of hydrocarbons (such as oil, petrol or creosote), or where the ground has been subjected to chemical contamination that is hazardous to health, the pipe, pipe fittings and pipe jointing materials shall be selected to resist premature degradation and to prevent permeation of chemicals through the pipe into the water being conveyed.

5.2.1.5.2 Guidance on the selection of pipe materials to be laid in contaminated ground is given in the UKWIR's *Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites* [29].

5.2.1.6 Protective coatings

Coatings, sheathings or wrappings should be examined for damage, repaired where necessary, and made continuous before trench excavations are backfilled.

5.2.1.7 Restraint of pipes

5.2.1.7.1 Pipe restraints designed to resist the thrusts produced by the test pressure to be applied should be installed at all changes of direction and blank ends, except where the method of jointing and normal trench backfill is adequate to prevent longitudinal movement. The magnitudes of these thrusts, which act in the directions shown in Figure 15, should be calculated as follows:

$$T_{\text{end}} = AP$$

$$T_{\text{radial}} = AP_{\sin}\frac{\theta}{2}$$

where:

T_{end} is the end thrust (in kN);

T_{radial} is the radial thrust at bends (in kN);

A is the cross-sectional area of the inside of socket (in m^2);

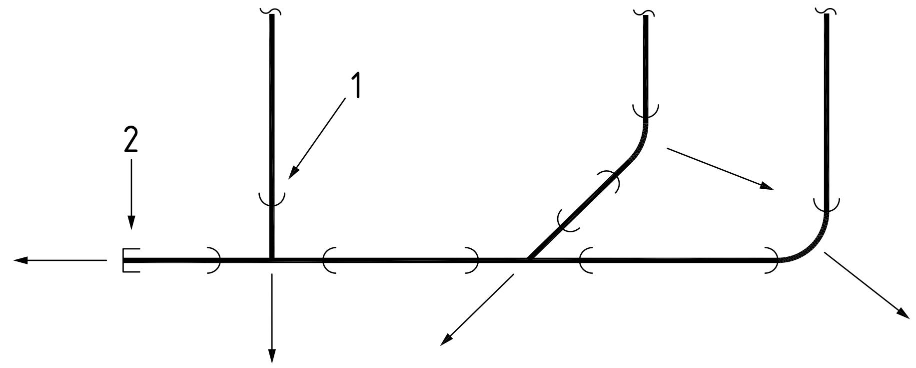
P is the test pressure (in kPa); and

θ is the angle of deviation of bend.

5.2.1.7.2 Alternatively, when standard fittings are used, the thrusts should be calculated by multiplying the values given in Table 10 by the test pressure (in bar).

5.2.1.7.3 Thrust blocks for the restraint of pipelines should have adequate bearing area to resist the thrust, calculated using the data given in Table 11 or from measuring soil-bearing capacity for horizontal thrusts made on site.

Figure 15 **Directions of thrusts developed in a pipeline due to internal pressure**



Key

1 Joint 2 Stop end

NOTE Figure 15 is based on a figure taken from the Chartered Institute of Plumbing and Heating Engineering (CIPHE) Plumbing engineering services design guide *[46], by kind permission of CIPHE. Copyright is claimed in this figure. Reproduction of this figure and making products from it might infringe that copyright. Details of the copyright owner can be found in the Foreword, Information about this document.*

Table 10 **Thrust per bar internal pressure**

Nominal internal diameter of pipe mm	**End thrust** kN	**Radial thrust on bends of angle** kN			
		90°	45°	22½°	11¼°
50	0.38	0.53	0.29	0.15	0.07
75	0.72	1.02	0.55	0.28	0.15
100	1.17	1.66	0.90	0.46	0.24
125	1.76	2.49	1.35	0.69	0.35
150	2.47	3.50	1.89	0.96	0.49
175	3.29	4.66	2.52	1.29	0.65
200	4.24	5.99	3.24	1.66	0.84
225	5.27	7.46	4.04	2.06	1.04
250	6.43	9.09	4.92	2.51	1.26
300	9.38	13.26	7.18	3.66	1.84
350	12.53	17.71	9.59	4.89	2.46

Table 11 **Bearing capacity of soils**

Soil type	**Safe bearing load** kN/m²
Soft clay	24
Sand	48
Sandstone and gravel	72
Sand and gravel bonded with clay	96
Shale	240

5.2.1.8 Valve chambers

5.2.1.8.1 Surface boxes should be provided to give access to operate valves and hydrants. They should be supported on concrete or brickwork, which should not be allowed to rest on the pipes, transmitting loads to them, with allowance made for settlement.

5.2.1.8.2 Alternatively, vertical guard pipes or precast concrete sections should be provided to enclose the spindles of valves. Brick or concrete hydrant chambers should be constructed of sufficient dimensions to permit repairs.

5.2.1.9 Contamination

Precautions should be taken to avoid contamination of the supply pipe when making a connection. Before connection and return to service, the pipe should be flushed and, where necessary, disinfected.

5.2.1.10 Building entry

5.2.1.10.1 Underground pipes entering a building should do so at the level given in **4.3.34.4** (see also **4.3.37** and **4.3.38**).

5.2.1.10.2 Where a pipe enters a building, it should be accommodated in a sleeve that has been solidly built in. The space between the pipe and the sleeve should be filled with non-hardening, non-cracking, water-resistant thermal insulating material for a minimum length of 150 mm at both ends to prevent the passage of water, gas or vermin (see Figure 11).

5.2.2 Electrical bonding

5.2.2.1 No water pipe should be used as an electrode for earthing purposes, but all metal pipes should have equipotential bonding applied which connects to the installation main earth terminal as near as possible to the point of entry into the building.

5.2.2.2 The connection should be mechanically and electrically sound and not subject to corrosion.

5.2.2.3 Main equipotential bonding should be in a position where it is accessible, can be visually observed and fitted with a warning label stating: "Safety electrical connection: Do not remove".

5.2.2.4 Recommendations for earthing are given in BS 7430.

5.2.2.5 Supplementary equipotential bonding may be required in special locations, e.g. bathrooms.

5.2.2.6 Electrical installation requirements are specified in BS 7671.

5.2.3 Flushing and disinfection

5.2.3.1 Every new water service, cistern, distributing pipe, hot water cylinder or other appliance, and any extension or modification to such a service, should be thoroughly flushed with potable water before being put into service. The primary reason for this process is to remove any debris and organic matter which encourages the growth of biofilms and subsequent deterioration of water quality.

5.2.3.2 During construction, where water systems have not been used for up to 30 days, they should be re-flushed.

5.2.3.3 Larger pipes, e.g. with an internal diameter greater than 50 mm, or pipes in specialized installations, such as healthcare buildings, where contamination is suspected should be disinfected after flushing. Guidance on disinfection is given in PD 855468.

6 Guidance on BS EN 806-5

6.1 Guidance on specific BS EN 806-5 requirements

6.1.1 BS EN 806-5:2012, Clause 4: General

6.1.1.1 The degree of formalization of maintenance depends upon the size and use of the installation, although the principles involved apply to all installations.

6.1.1.2 Maintenance of ducts does not normally apply to single dwellings, but other requirements should be satisfied by the owner of the building.

6.1.1.3 For single dwellings, the responsibility for maintenance normally rests with the householder. This includes identifying and correcting leakages and any discharges from overflow pipes or regular discharges from any valves.

6.1.1.4 The owner of the building should be provided with maintenance instructions and an accurate drawing of the installation, particularly showing where pipe runs are concealed. Control valves should be clearly labelled. The labels should be renewed or protected when redecorating. Any alterations should be recorded on inspection and a check made that these do not introduce undesirable features or contravene statutory requirements. All of these aspects should be controlled as part of the health and safety documentation for a non-domestic building.

6.1.2 BS EN 806-5:2012, Clause 4: General and Clause 6: Operation

6.1.2.1 Except for single dwellings, checks should be made on the temperature of water in pipes, cold water cisterns, hot water storage vessels, and the discharge from taps to ensure that they are within the limits listed in **4.3.28** to **4.3.30**.

6.1.2.2 These checks should be carried out taking account of the most adverse conditions, e.g. at the end of a weekend, during hot weather, full central heating load in cold weather and during high draw-off in cold conditions. If the checks identify unacceptable temperatures, additional thermal insulation or self-regulating trace heating should be installed, or modifications or repairs to the system should be carried out.

6.1.3 BS EN 806-5:2012, Clause 6: Operation

6.1.3.1 When carrying out renewals, the existing pipework should be identified and appropriate adaptors used, particularly where the original pipework is an imperial size.

6.1.3.2 Pipes, fittings, components and materials of one manufacturer are not always compatible with those of another manufacturer, even when they conform to the same British Standard. In particular, this applies to welding of plastics pipes, sockets for patent elastomeric ring joints and the threads on compression fittings.

6.1.4 BS EN 806-5:2012, 9.1: Change in water quality

6.1.4.1 Except for single dwellings, regular analyses of water samples should be carried out at intervals not exceeding six months wherever drinking water is stored.

6.1.4.2 Periodic chemical and microbiological analysis of water samples is a useful guide to the condition of an installation. For new installations in large buildings or complexes and where extensive repairs or alterations have been carried out to such installations, water samples should be collected and analysed.

6.1.4.3 Where samples indicate poor water quality, investigations should be undertaken to establish the cause and appropriate rectification carried out. Rectification can include removal of disused pipework, insulation of pipework and flushing. Further sampling should be conducted after rectification to determine whether this has resolved the problem.

6.1.4.4 Exceptionally, disinfection of the water system may be undertaken:

a) for both the hot and cold water system, as described in PD 855468; and

b) for the hot water system only, by thermal disinfection procedures (see the HSE's *Approved Code of Practice L8, Legionnaires' disease – The control of Legionella bacteria in water systems* [26] and HSG274 Part 2 [30]).

NOTE HSE Guidance might also apply to some single dwellings owned by a third party.

6.1.5 BS EN 806-5:2012, 13.1: Cisterns

6.1.5.1 Cisterns, as points of debris collection and subsequent contamination, should be inspected to ensure that overflow and warning pipes are unobstructed, that covers are not airtight but exclude light and insects and are securely fixed, and that there are no signs of leakage or deterioration likely to result in leakage. Cisterns storing drinking water should be inspected annually or more frequently if fouling is suspected. Cleaning and disinfection should take place annually or sooner if monitoring indicates deterioration in aesthetic or microbiological quality.

6.1.5.2 Overflow and warning pipes should be checked at least annually to ensure that they conform to **4.3.13**. Cisterns should have all debris removed and should be emptied, cleaned and disinfected. Where drinking water has been stored in an inadequately protected cistern, microbiological testing should be carried out (see **6.1.4**) and adequate protection installed. Metal cisterns showing signs of leakage or corrosion should be replaced. Alternatively, they may be repaired by internal coating or lining in accordance with the manufacturer's instructions with a material conforming to BS 6920-1 suitable for use in contact with drinking water.

6.1.5.3 In cistern installations, a check should be made for stagnant water. If stagnant water is found, the cistern(s) should be flushed and the flow configuration modified so that the flow displaces the whole of the contents continually when the cistern is in routine use. This check should be made by assessing the stored water age and carrying out microbiological analysis together with checks on the concentration of residual disinfection.

NOTE Stagnation in cisterns occurs if the residual disinfection at any point in the system is below the value defined as the minimum recommended to prevent the formation of microbiological regrowth.

6.1.6 BS EN 806-5:2012, B.22: Pipework

Pipes showing signs of serious external corrosion should be replaced. The replacement pipe should have suitable protection (e.g. factory plastics-coated, spirally-wrapped or sleeved with an impervious material) or should be of a corrosion-resistant material compatible with the remaining pipework.

6.2 Supplementary guidance to BS EN 806-5

6.2.1 Waste prevention

6.2.1.1 Where WCs with internal overflows are discharging at a low rate, it can be difficult to witness the discharge. Similarly, when urinals are flushing at an elevated frequency it can be difficult to observe.

6.2.1.2 For metered installations, the water meter provides an easy means of monitoring consumption.

6.2.1.3 The meter(s) should be read at regular intervals and the owner/occupier advised if an unexplained increase in consumption is indicated.

6.2.2 Terminal fittings, valves and meters

6.2.2.1 In addition to preventing leakage, the free movement of infrequently used float-operated valves, particularly those fitted to the feed and expansion cisterns of hot water or space heating systems, should be checked at least annually.

6.2.2.2 Spray heads on taps and showers should be cleaned and descaled periodically. This is dependent on the hardness of the local water supply, but should be carried out at least annually.

6.2.2.3 Stopvalves should be operated at least once per year to ensure free movement of working parts.

6.2.2.4 All materials used should be suitable for contact with wholesome water (see **4.2.1**).

6.2.2.5 Operation of easing gear, such as that found on temperature and pressure relief valves, can cause valves to leak.

6.2.2.6 Where necessary, meters (other than the water supplier's meters) should be removed for cleaning, worn parts replaced and the meters recalibrated.

6.2.2.7 Any indication of malfunction of a pressure control valve should be investigated and corrected. Discharge from an expansion valve or from a cistern warning pipe indicates a possible malfunction of a pressure reducing valve, pressure limiting valve or expansion vessel or control valve.

6.2.3 Ducts

6.2.3.1 Ducts should be kept accessible, clear of debris and free from vermin.

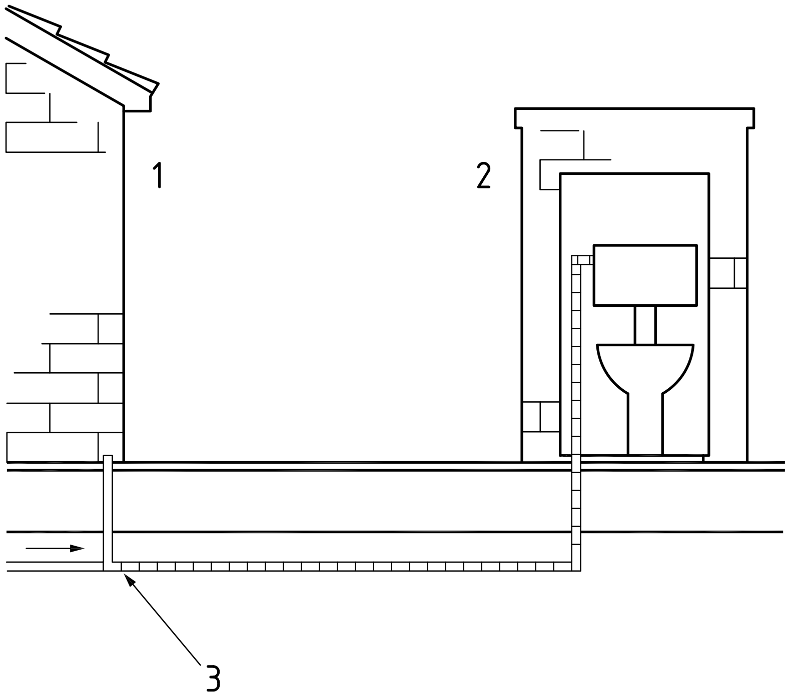
6.2.3.2 All access points should be checked to ensure that they have not been obstructed. Inspections should be made twice-monthly to detect any vermin and determine the need for disinfestation. Crawlways and subways should be checked at intervals not exceeding six months for leakage from pipework, ingress of ground or surface water and accumulation of flammable materials.

6.2.4 Disconnection of unused pipes and fittings

6.2.4.1 If any part of an installation becomes redundant and, in particular, if any appliance or fitting is disconnected other than for repair, maintenance or renewal, all the pipework supplying water to the disconnected or unused appliance or fitting should be disconnected at its source (see Figure 16).

6.2.4.2 It is undesirable and potentially unsafe to have lengths of pipework containing stagnant water connected to the service installation.

Figure 16 **Cutting off redundant pipes**



Key

1 House

2 Outside WC

3 Correct point of disconnection after removal of appliance (such as outside WC).

Annex A (informative) Examples of pumped systems

A.1 General

There are many ways of using pumps to increase the water pressure available in a building. These can be divided into direct boosting and indirect boosting systems. Indirect systems are more common than direct systems. The latter are often prohibited by water suppliers because they reduce the mains pressure available to other consumers and can increase the risk of backflow.

However, where insufficient water pressure is available in the supply pipe and the demand is less than 0.2 L/s, or if the demand is greater and the water supplier agrees, drinking water may be pumped directly off the supply pipe.

Aeration of water in boosted systems can be caused by air entrainment within the cistern used for the pump suction connection, where a combination of splashing infill water and minimal retained water volume can agitate the store water. This effect can be reduced by the provision of baffles or a "stilling pipe" within the storage cistern. Although aerated water does not cause deterioration of water quality, the turbid appearance can cause concern amongst consumers.

The following are options for supplying boosted water systems within buildings:

a) indirect boosting to elevated storage cistern (less common today than in the past, as the draw-off points would be supplied with gravity distribution pipes);

b) indirect boosting with hydraulic accumulator (very common); and

c) direct boosting from the incoming water supply, where the pumped flow rate is less than 0.2 L/s or where the water supplier has given consent (typically applicable to single dwellings or small buildings).

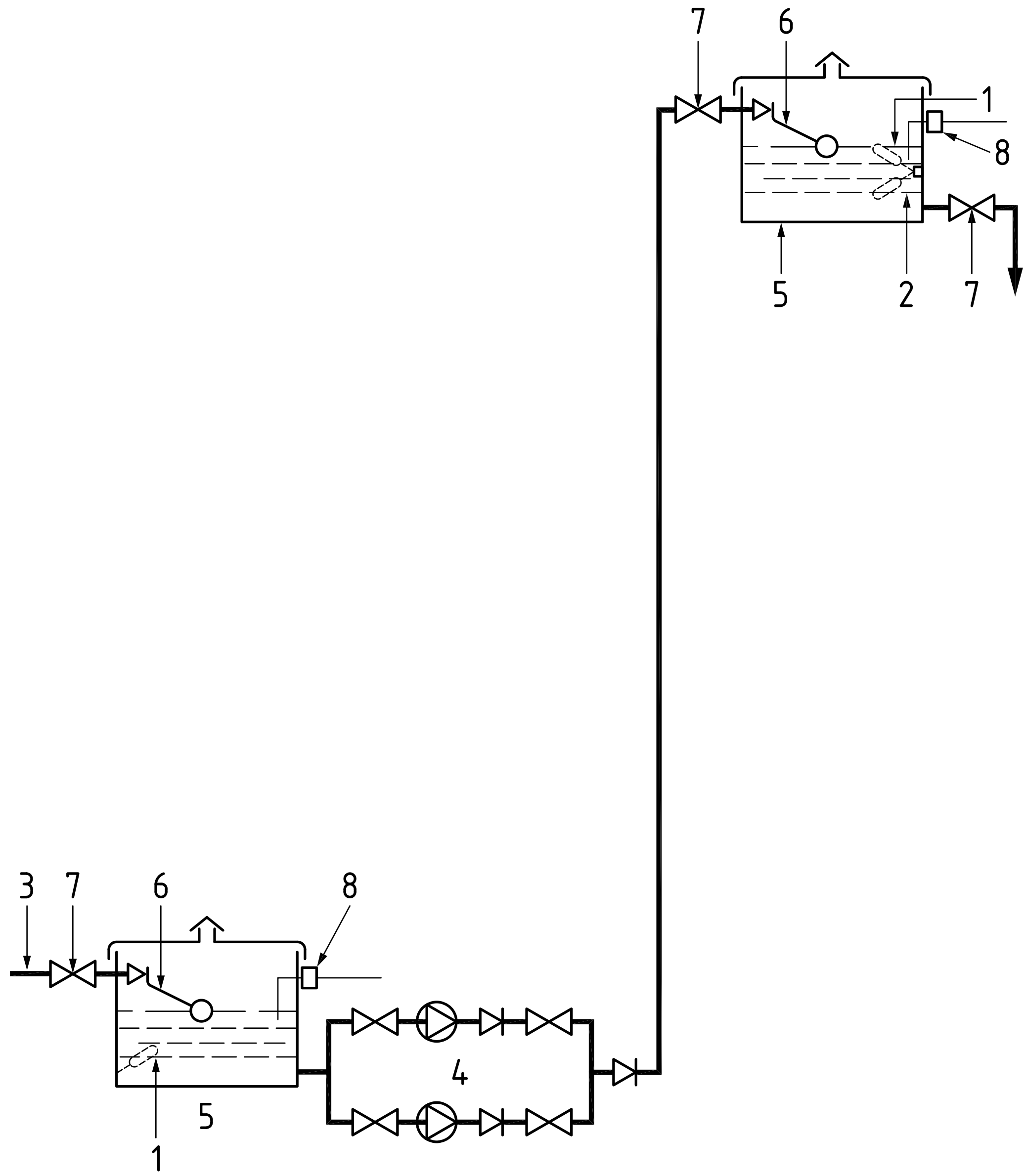
A.2 Indirect boosting to storage cistern

Where the water supplier insists on a break cistern being incorporated in the installation, the pump is fitted to the outlet from the break cistern. The effective capacity of the break cistern is decided after consideration of the total water storage requirements and its location within the building, but is not less than 15 min of pump output. The cistern ought not to be oversized as this could result in stagnation of the water. The combined storage volume ought not generally to exceed 25% or 50% of the daily demand, depending on the application (see CIPHE's *Plumbing Engineering Services Design Guide* [47] for further guidance).

The water level in the storage cistern or cisterns is monitored by water level sensors to control the pumps, which are normally fixed-speed motors. When the water level in the elevated cistern or cisterns drops to a predetermined value, the pumps start and are run until the water level sensor has registered that the cistern is full. To ensure that the pumps are prevented from dry running, the cistern connected to the pump suction can be provided with a water level sensor which stops the pumps if the water in the cistern drops to a predetermined critical level. It is possible to reduce the height of the critical low water level by fitting a downward-facing bend on the suction connection within the cistern, or by using a proprietary anti-vortex fitting.

*NOTE Figure A.1 does not show any additional backflow prevention devices that might be recommended in accordance with **4.3.31.2** and **4.3.32**.*

Figure A.1 **Indirect boosting from break cistern to storage cistern**



Key

1	Stop pumping	5	Break cistern
2	Start pumping	6	Float-operated valve
3	Supply pipe	7	Servicing valve
4	Duplicate pumping set	8	Warning pipe

NOTE Care is necessary to ensure that any standby pumps or pumps not in regular use are maintained to avoid stagnation of the water supply.

A.3 Indirect boosting with pressure vessel

In a building where a pressurized supply is required to serve a number of outlets (or cisterns) on different floor levels, it is common to control the pumps by sensing the pressure within the system. To prevent the pumps from frequent cycling, a hydraulic accumulator is normally used, which is pre-pressurized with air or nitrogen.

An alternative method of control is a pneumatic pressure vessel which contains both air and water under pressure (see Figure A.2). Normally the pressure vessel, pumps and air compressor, together with all control equipment, are purchased as a packaged pressure set.

Figure A.2 **Indirect boosting with hydraulic accumulator** *(1 of 2)*

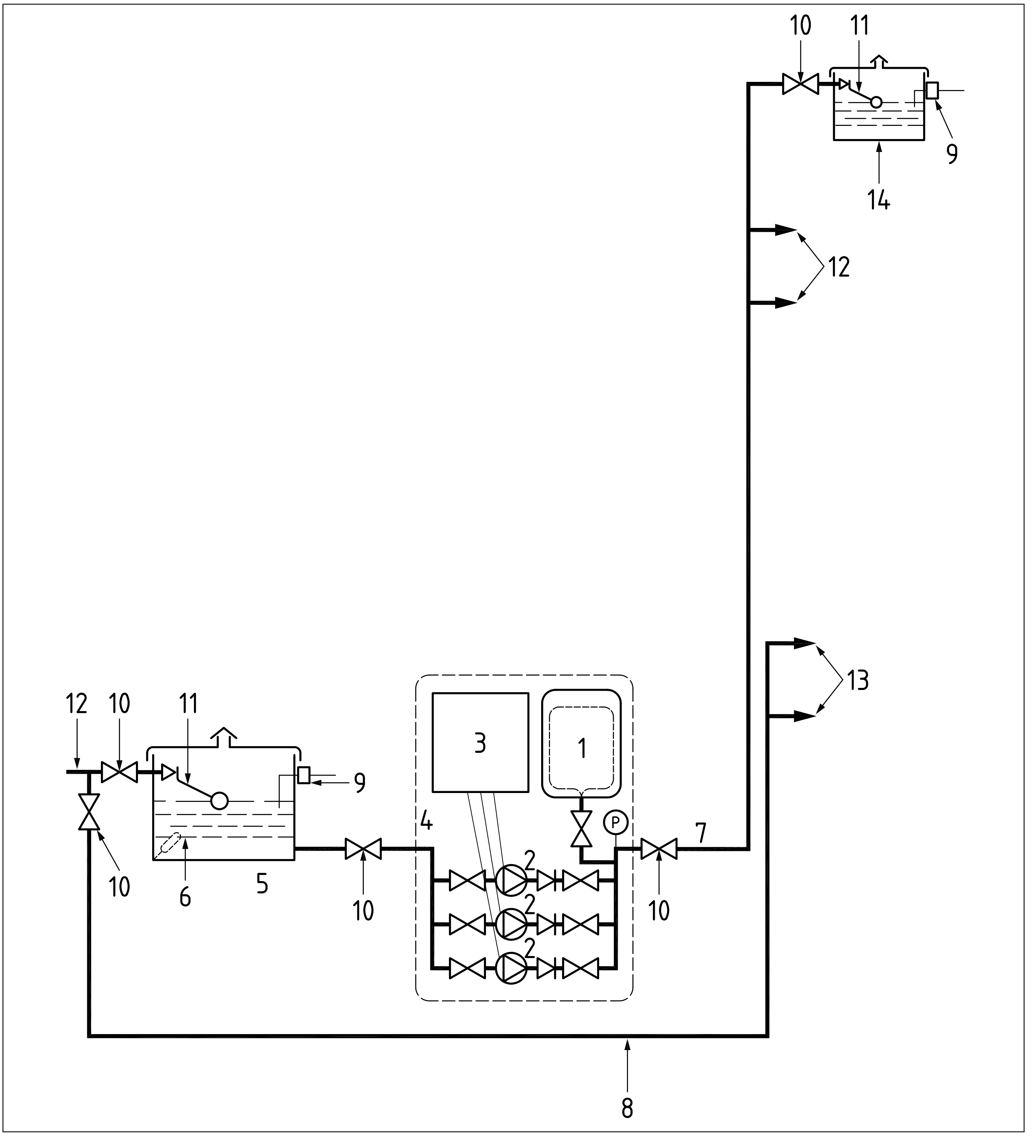


Figure A.2 **Indirect boosting with hydraulic accumulator** *(2 of 2)*

Key

1 Hydraulic accumulator pre-charged with air to suit the system pressure with integral water-filled diaphragm. Size selected to suit the pump duty. May be supplied as part of the skid-mounted package or supplied loose for mounting nearby
2 Booster pump (two or more pumps to be provided to suit the system demand, allowing for the peak design demand to be met if one pump fails)
3 Control panel to facilitate sequential stop/starting of the pumps
4 Extent of equipment normally supplied as part of a factory-assembled/designed package complete with all the necessary controls and wiring
5 Pump suction “break” cistern
6 Dry run protection level switch
7 Boosted supply pipe
8 Un-boosted supply to lower levels (where appropriate)
9 Warning pipe
10 Servicing valve
11 Float-operated valve
12 Boosted water supplies to upper floors
13 Un-boosted water supplies to lower floors (where mains pressure is sufficient)
14 Pump suction “break” tank for booster pumps supplying additional upper storeys (e.g. in high-rise building over 15 stories)

*NOTE Figure A.2 does not show any additional backflow prevention devices that might be recommended in accordance with **4.3.31.2** and **4.3.32**.*

A.4 Direct boosting

Direct boosting from the incoming water supply (see Figure A.3) is permissible where the pumped flow rate is less than 0.2 L/s or where the water supplier has given consent. This is typically used in single dwellings or small buildings. To provide an increase in the flow rate for a limited time interval, package pumping systems are available that incorporate a hydraulic accumulator which acts as a supplementary supply source during a period of user demand.

A.5 Direct boosting with drinking water header

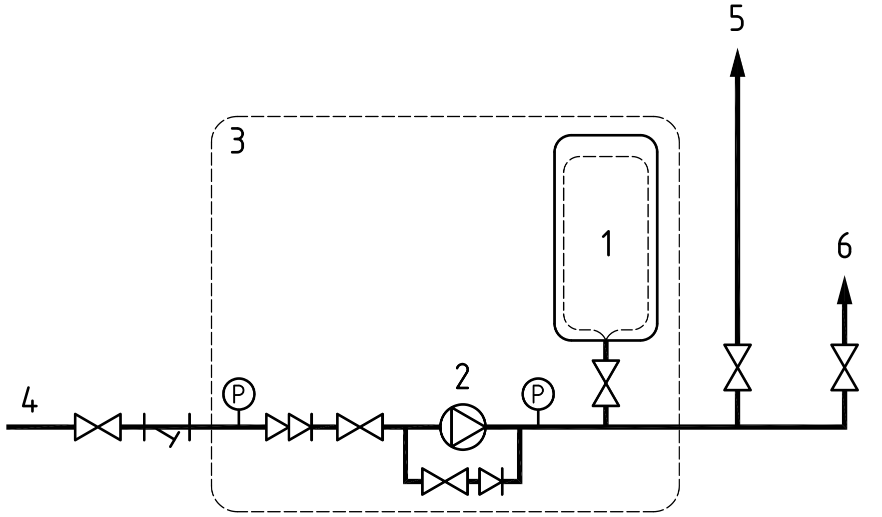
Where required, the supply drinking water points at high level when the pump is not running can be provided by a pipe arrangement of limited capacity called a header. Level switches are provided to control the filling of the cold water storage cisterns for non-drinking water. Excessive pressures are not generated, since high pressures at draw-off points cause splashing and waste of water when taps are opened. The boosting pumps are controlled in two ways:

a) by the emptying of, or drop in level of, the water in the header; and

b) by the fall of the level of water in one of the storage cisterns.

The cold water main header is sized on the basis of providing 5 L to 7 L per day per dwelling served. The rising pipe from the header is provided with an automatic air inlet valve to allow air to enter and be vented from the header.

Figure A.3 **Direct boosting**



Key

1 Hydraulic accumulator pre-charged with air to suit the system pressure with integral water-filled diaphragm, the size of which is selected to suit the likely demand
2 Booster pump rated at not more than 0.2 L/s (to satisfy the Water Fittings Regulations [19], [20] and [21])
3 Line indicates extent of equipment normally supplied as part of a factory-assembled/designed package complete with all the necessary controls and wiring
4 Supply pipe
5 Boosted cold water supply to serve cold outlets
6 Boosted cold water supply to serve unvented water heater, combination boiler or instantaneous water heater

NOTE Figure A.3 does not show any additional backflow prevention devices that might be recommended in accordance with ***4.3.31.2*** *and* ***4.3.32****.*

A.6 Pumps and equipment

Pumps for pressure boosting applications are normally supplied as a factory-assembled package, often referred to as a "booster set". The booster-set consists of pumps, interconnection pipework, controls and a pressure accumulator. Pumps used on booster sets are normally the multiple-stage vertical centrifugal type with electric motors. When the booster set is being used in indirect boosting applications (Figure A.1), pumps with fixed-speed motors are normally used. For most direct boosting applications, fixed-speed or verifiable-speed pump motors can be used, the latter being frequently preferred due to less deviation in system operating pressure and a reduction in the size of the pressure accumulator. The provision of a standby power supply for the booster set may be considered where a generator is installed for emergency power supplies.

The booster set can be provided with two or more pumps mounted in series to achieve the necessary design flow. The pumps ought to be able to meet the system design flow when one pump has failed. To prevent water stagnation within the booster set, the controls ought to ensure that there is no dedicated standby pump and the starting sequence of the pumps is automatically rotated to ensure that the all pumps run as the lead pump at some point within the cyclic operation. The pump head ought to be sized to overcome the static lift, plus frictional losses created by pipework and valves, and to provide the necessary residual pressure at appliances to ensure that they are able to function as intended.

Transmission of pump and motor noise can be reduced by the use of flexible connections and anti-vibration mountings or pads. Small power motors of the squirrel cage induction type are suitable for most installations. Pumps and pipes are sized so as to minimize the risk of waterhammer from surge when pumps are started and stopped.

A.7 Maintenance and inspection

A responsible person oversees the proper execution of the scheme and the owner/occupier arranges for regular maintenance and inspection of the pumps and plant.

All work and inspections carried out are recorded in a suitable logbook which is kept in the plant room.

NOTE Attention is drawn to the Health and Safety at Work etc. Act 1974 [10] with respect to the inspection of pumps and plant.

Annex B (informative) Guidance on the calculation of hot water storage capacity

B.1 Calculation of storage capacity

The storage capacity required to achieve an acceptable quality of service depends on the rate of heat input to the stored hot water as well as on the pattern of use. The time (in min), M, taken to heat a quantity of water through a specified temperature rise is given by:

$$M = \frac{(VT)}{(14.3P)} \qquad \text{(B.1)}$$

where:

V is the volume of water heated in litres (L);

T is the temperature rise in degrees celsius (°C); and

P is the rate of heat input to water in kilowatts (kW).

Equation B.1 ignores heat losses from the hot water storage vessel, since their effect is usually small over the relatively short times involved in reheating water after a draw-off has taken place.

For an electric immersion heater, a directly gas-fired storage water heater and a direct boiler system, the value of P is the output of the heating appliance. For an indirect boiler system, the value of P depends on the temperature of the stored water, since heat passes from the primary circuit to the secondary circuit at a faster rate when the secondary water is cold than when it is hot. For practical purposes, taking an average value for P is usually sufficient to provide a simple approximation. An indirect cylinder conforming to BS 1566-1 accepts heat inputs up to 20 kW with pumped primary flow.

Typical values for P are:

- 3 kW for an electric immersion heater;
- 3 kW for a gas-fired circulator;
- 6 kW for a small boiler and direct cylinder;
- 10 kW for a medium boiler and indirect cylinder;

- 10 kW for a directly gas-fired storage water heater (domestic type); and
- 15 kW for a large domestic boiler and indirect cylinder.

B.2 Example calculations

The application of equation B.1 to the sizing of hot water cylinders is best illustrated by the following examples, in which the values have been rounded.

Case 1. Small dwelling with one bath installed.

Maximum recommendation: one bath (60 L at 60 °C plus 40 L cold water) plus 10 L hot water at 60 °C for kitchen use, followed by a second bath fill after 25 min.

Therefore, draw-off of 70 L at 60 °C followed after 25 min by 100 L at 40 °C is necessary, which can be achieved by mixing hot at 60 °C with cold at 10 °C.

Assume good stratification, e.g. heating by the top-entry immersion heater.

To heat 60 L from 10 °C to 60 °C using a 3 kW input takes (60 × 50)/(14.3 × 3) = 70 min, so the second bath has to be provided from storage. In 25 min the volume of water heated to 60 °C is (14.3 × 3) × (25/50) = 21 L.

Therefore, the minimum storage capacity to meet recommendations is (70 + 60) – 21 = 109 L.

To heat 60 L from 10 °C to 60 °C using a 6 kW input takes (60 × 50)/(14.3 × 6) = 35 min, so the second bath has to be provided from storage. In 25 min the volume of water heated from 10 °C to 60 °C is (14.3 × 6) × (25/50) = 42 L.

Therefore, the minimum storage capacity to meet recommendations is (70 + 60) – 42 = 88 L.

To heat 60 L from 10 °C to 60 °C using 10 kW input takes (60 × 50)/(14.3 × 10) = 21 min, so the second bath needs no storage and minimum storage requirement to provide bath plus kitchen use, i.e. 70 L.

With 15 kW input of heat to the water, the storage volume could be reduced to 60 L while the first bath is running, taking about 3 min. The heat input to the water is sufficient to raise approximately 11 L water from 10 °C to 60 °C, so providing for kitchen use. This could be negated by mixing and is not recommended for this duty.

Now, assuming good mixing of the stored water as occurs with heating by a primary coil in an indirect cylinder, the temperature of the stored water immediately after the 70 L draw-off would be [60(V – 70) + (70 × 10)]/V, which simplifies to 60 – 3 500/V. The equation shows that heating for 25 min at 3 kW raises the temperature through 3 × 25 × 14.3/V or 1 072.5/V.

Since a water temperature of at least 40 °C is recommended to run a second bath:

$$\left(\frac{60-3500}{V}\right)+\left(\frac{1072.5}{V}\right)= \geq 40 \quad \text{(B.2)}$$

where:

V = 122 L

Using 6 kW heat input, the temperature rise in 25 min is 2 145/*V*, which gives a minimum size of 68 L. However, this does not meet the recommendation of 100 L at 40 °C for a bath. A vessel of 88 L capacity, which attains a temperature of approximately 44.5 °C after 25 min, is just sufficient, but for simplicity a cylinder of about 100 L capacity is normally chosen.

For heat inputs of 10 kW and 15 kW, a 70 L hot water storage vessel is necessary with the need to draw off for bath and kitchen use dictating the minimum storage capacity.

Therefore, for Case 1 the minimum sizes of storage vessel are as given in Table B.1.

Table B.1 **Minimum sizes of storage vessel for Case 1**

Heat input to water kW	**Minimum storage capacity** L	
	With stratification	**With mixing**
3	109	122
6	88	88
10	70	70
15	70	70

Case 2. A dwelling with two baths installed and having a maximum recommendation of 130 L draw-off at 60 °C (two baths + 10 L for kitchen use), followed by a further bath (100 L at 40 °C) after 30 min.

The calculations follow the same procedures as for Case 1 and the results for Case 2 are given in Table B.2.

Table B.2 **Minimum sizes of storage vessel for Case 2**

Heat input to water kW	**Minimum storage capacity** L	
	With stratification	**With mixing**
3	165	260
6	140	200
10	130	130
15	120	130

These calculations, which may be carried out for any particular situation, indicate the value of promoting stratification wherever possible and show the order of savings in storage capacity that can be made without prejudice to the quality of the service to the user by increasing the heat input to the water.

Annex C (informative) Pipe sizing calculations

C.1 Determination of flow rates

C.1.1 General

In small, simple installations, such as those in single dwellings, it is often acceptable to size pipes on the basis of experience and convention. In all other cases the peak design flow rates should be assessed using a recognized method of calculation given in this annex or specified in BS EN 806-3. The latter method produces significantly lower simultaneous design flows than the UK method. It is acknowledged that there is evidence to suggest that the traditional UK loading unit method overestimates the likely peak demand within a building, and scientific evaluation is currently ongoing. Overestimation of the peak demand can result in larger than necessary pipe sizes, which can produce several adverse effects. Until such time as validated research has been published, either the loading unit method within BS EN 806-3 or the method within this annex may be used, as appropriate.

For residential installations supplying single and multiple dwellings the loading unit method in BS EN 806-3 may be used.

For non-residential installations supplying commercial and public buildings, traditional UK loading units may be used, as explained in this annex. Care is needed when assessing the combined demand of hot and cold water supplies, for example at booster pumps, to reduce the effect of over-sizing. For appliances fed with both hot and cold water supplies, the traditional loading unit model assumes that the system demand imposed by the appliance is met fully by each separate supply. Although this is logical when separate hot and cold water taps are fitted to an appliance, it is not valid when mixer taps/valves are used, particularly when a flow-limiting device is fitted to the outlet or integral within the mixer. For example, in the case of a shower with a flow-limiting device fitted after the shower mixer, the combined hot and cold water demand will not be any more than if the user selects cold only or hot only at the appliance. Consequently, the relevant loading unit applied separately to the hot and cold water supplies for pipe sizing ought not to be added together when sizing the combined hot and cold water demand.

Pipes ought to be sized in order that water velocity is kept below reasonable limits to prevent objectionable noise, and to prevent avoidable corrosion/erosion of piping.

C.1.2 Assessment of probable demand

In most buildings all appliances are seldom in simultaneous use. For reasons of economy a simultaneous demand, which is less than the maximum demand from all appliances, should be provided for. This simultaneous demand can be estimated either from data derived by observation and experience of similar installations, or by application of probability theory using loading units.

C.1.3 Loading units (LU)

Loading units are factors which take into account the flow rate at the appliance, the length of time in use and the frequency of use. The number of each type of appliance, fed by the length of pipe being considered, ought to be multiplied by the LU, as given in Table C.1, and the total LU derived for the pipe. Using Figure C.1 the total number of LU can be converted into the total simultaneous demand for the pipe in L/s.

Due to the difference in rates of flow and pattern of demand between hot and cold outlets, the LU applicable also show some variation, but for most practical purposes the same LU can be used for both hot and cold outlets.

Table C.1 is based on normal domestic usage and customary (or statutory) provision of appliances. It is not applicable where usage is intensive, for example, in theatres and conference halls; in such cases, it is necessary to establish the pattern of usage and appropriate peak flow demand for the particular case.

Table C.1 **Loading unit: Hot or cold supply**

Type of appliance	Loading unit
WC flushing cistern	2
Wash basin ½ – DN 15	1.5 to 3
Bath tap ¾ – DN 20	10
Bath tap 1 – DN 25	22
Shower	3
Sink tap ½ – DN 15	3
Sink tap ¾ – DN 20	5
Domestic clothes or dishwashing machines ½ – DN 15	3

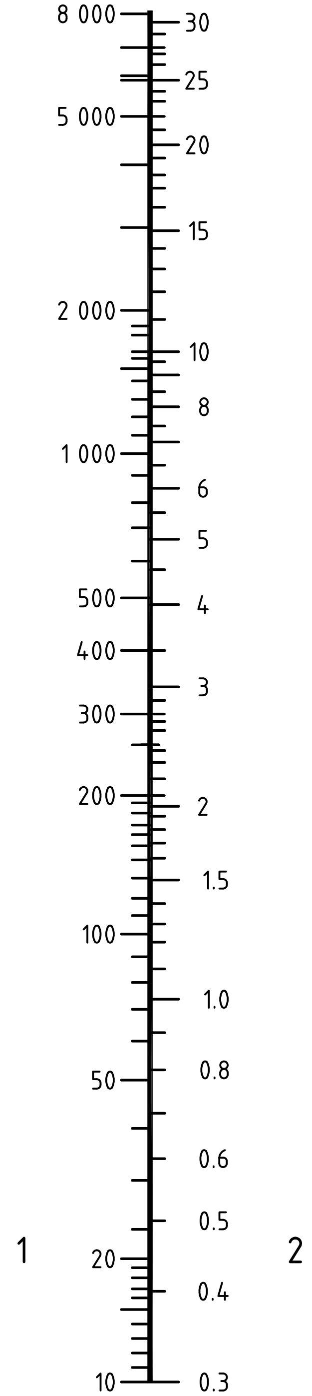
NOTE 1 WC cisterns with either single or dual flush control have the same LU.

NOTE 2 The wash basin LU is for use where pillar taps are installed. The larger LU is applicable to situations such as schools and those offices where there is a peak period of use. Where spray taps are installed, an equivalent continuous demand of 0.04 L/s is assumed.

NOTE 3 Urinal cistern demand is very low and is normally disregarded.

NOTE 4 Outlet fittings for industrial purposes or requiring high peak demands are taken into account by adding 100% of their flow rate to the simultaneous demand for other appliances obtained by using LUs.

Figure C.1 **Conversion of loading units to design flow rate**



Key

1 Loading units
2 Design flow rate in litres per second (L/s)

C.2 Pressure losses in pipes and fittings

C.2.1 Pipes and pipe fittings

Pressure, or head, losses due to resistance of pipes and fittings at various flows are published in the form of tables for pipes of different materials by the various pipe manufacturers' organizations. Figure C.2 is a nomogram showing pressure losses and flows of water at a temperature of 10 °C through pipes, based on Lamont's smooth pipe formula S3:

$$v = 0.5545d^{0.6935}i^{0.5645}$$

where:

v is the velocity in metres per second (m/s);

d is the diameter in millimetres (mm); and

i is the hydraulic gradient

Typical values for equivalent pipe lengths for elbows and tees are shown in Table C.2.

NOTE 1 The wall friction gradient (head loss) in kPa per metre, R, in Figure C.2 is calculated thus:

$$R = 10\left(\frac{v}{0.5545d^{0.6935}}\right)^{1.7715}$$

where:

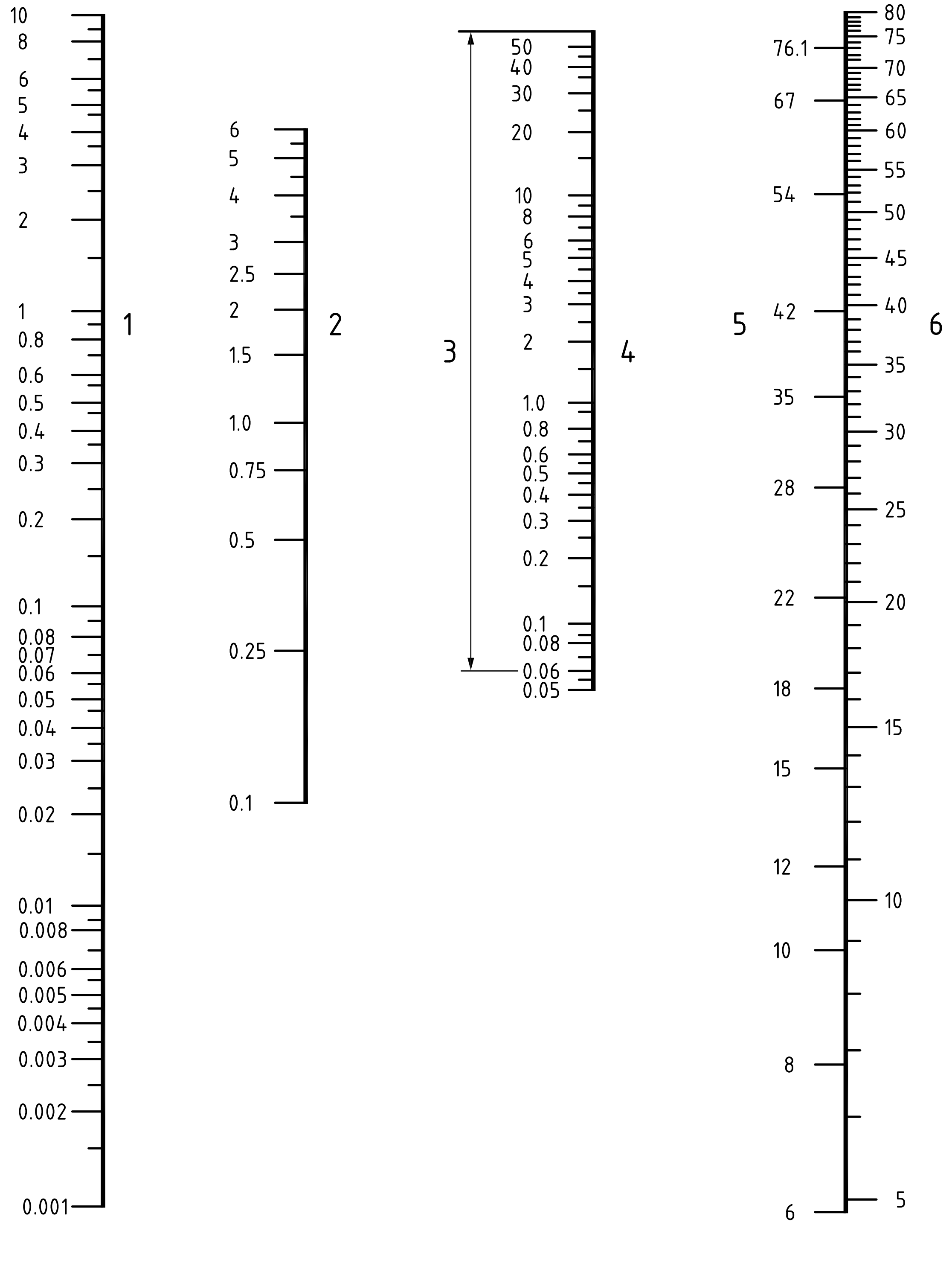
R is the wall friction gradient in kilopascals (kPa);

v is the velocity in metres per second (m/s); and

d is the diameter in millimetres (mm).

*NOTE 2 Figure C.2 does not show any additional backflow prevention devices that might be recommended in accordance with **4.3.31** and **4.3.32**.*

Figure C.2 **Determination of pipe diameter – Water at 10 °C**



Key

1 Wall friction gradient (head loss) in kPa per metre, *R*

2 Velocity in metres per second (m/s)

3 Formula applicable between these limits only

4 Flow in litres per second (L/s)

5 Outside diameter of copper tube in millimetres

6 Actual bore of pipe in millimetres

NOTE Warning pipe to cold water storage cistern not shown.

Table C.2 **Typical equivalent pipe lengths (copper, plastics and stainless steel)**

Bore of pipe	**Equivalent pipe length**, m			
	Elbow	**Tee**	**Stop valve**	**Check valve**
12	0.5	0.6	4.0	2.5
20	0.8	1.0	7.0	4.3
25	1.0	1.5	10.0	5.6
32	1.4	2.0	13.0	6.0
40	1.7	2.5	16.0	7.9
50	2.3	3.5	22.0	11.5
65	3.0	4.5	–	–
73	3.4	5.8	34.0	–

NOTE 1 The losses through tees are taken to occur on a change of direction only. Losses through fully open gate valves may be ignored.

NOTE 2 The values in this table are applicable to traditional pipe fittings having the same internal bore as the pipe. Some crimp-jointing systems for composite pipe incorporate a nozzle that is inserted into the pipe bore, which has significantly smaller internal bore than the pipe. Information on head losses in these fittings can be obtained from the manufacturers.

C.2.2 Draw-off taps

The residual head available at each tap or outlet fitting should be at least equal to the loss of head through the tap at the design flow rate. Alternatively, the loss of head may be expressed as an equivalent length of pipe.

Some typical losses for low pressure taps are shown in Table C.3.

Table C.3 **Typical loss of pressure through UK low resistance taps and equivalent pipe lengths**

Nominal size of tap	**Flow rate**	**Loss of pressure**	**Equivalent pipe**
	L/s	kPa	m
½	0.15	5	3.7
½	0.20	8	3.7
¾	0.30	8	11.8
1	0.60	15	22.0

NOTE Pressure losses and equivalent lengths are typical only and will vary with taps of different manufacture.

C.2.3 Valves

The loss of head through stopvalves, ball valves and check valves is relatively large. These losses are expressed either as the loss of head through an equivalent length of pipe as in Table C.3 and added to the actual length, or the actual head loss determined from Figure C.3 and subtracted from the head available. The losses through full way gate valves can be ignored.

C.2.4 Meters

If there is a meter in the pipeline, the loss of head through the meter at design flow is deducted from the available head. The loss of head at specific flows can be obtained from the meter manufacturer or from the water supplier.

C.2.5 Float-operated valves

The nominal size of a float-operated valve, the diameter of its orifice and the size of the float are all dependent on the residual head of water available at the inlet to the valve and the flow required. The relationship between discharge, size of valve, orifice and head loss is shown in Figure C.4, based on:

$$Q = AV \times 0.75$$

$$V = \sqrt{0.2gH}$$

where:

Q is the flow in litres per second (L/s);

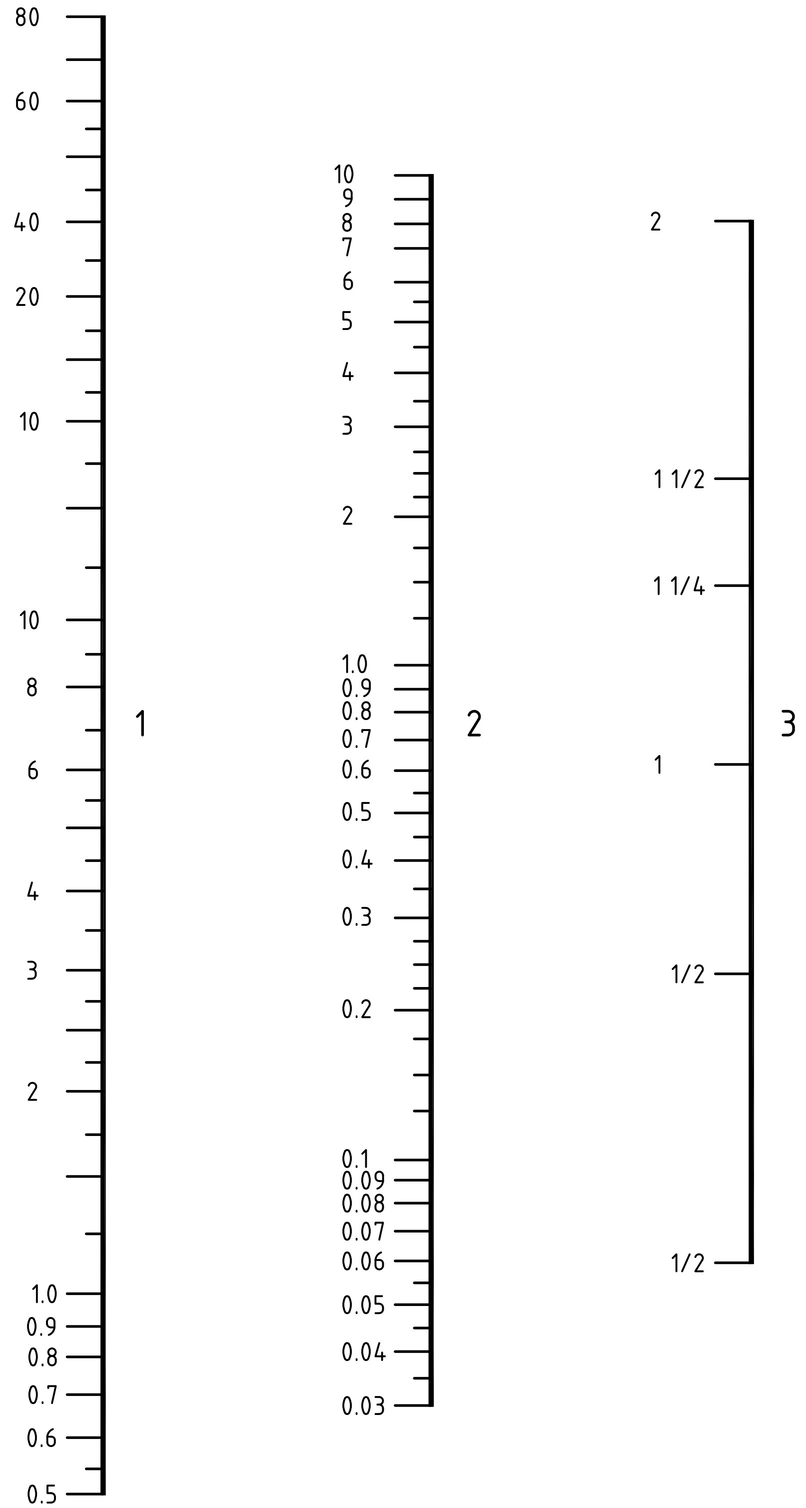
V is the velocity of flow (metres per second) (m/s);

g is the acceleration due to gravity in metres per second squared (m/s^2); and

H is the pressure head of water at the float valve in kilopascals (kPa).

Where non-standard float valves are used, the data relating the flow rate to the head of water available at the inlet is to be obtained from the manufacturer.

Figure C.3 **Head loss through stopvalves**



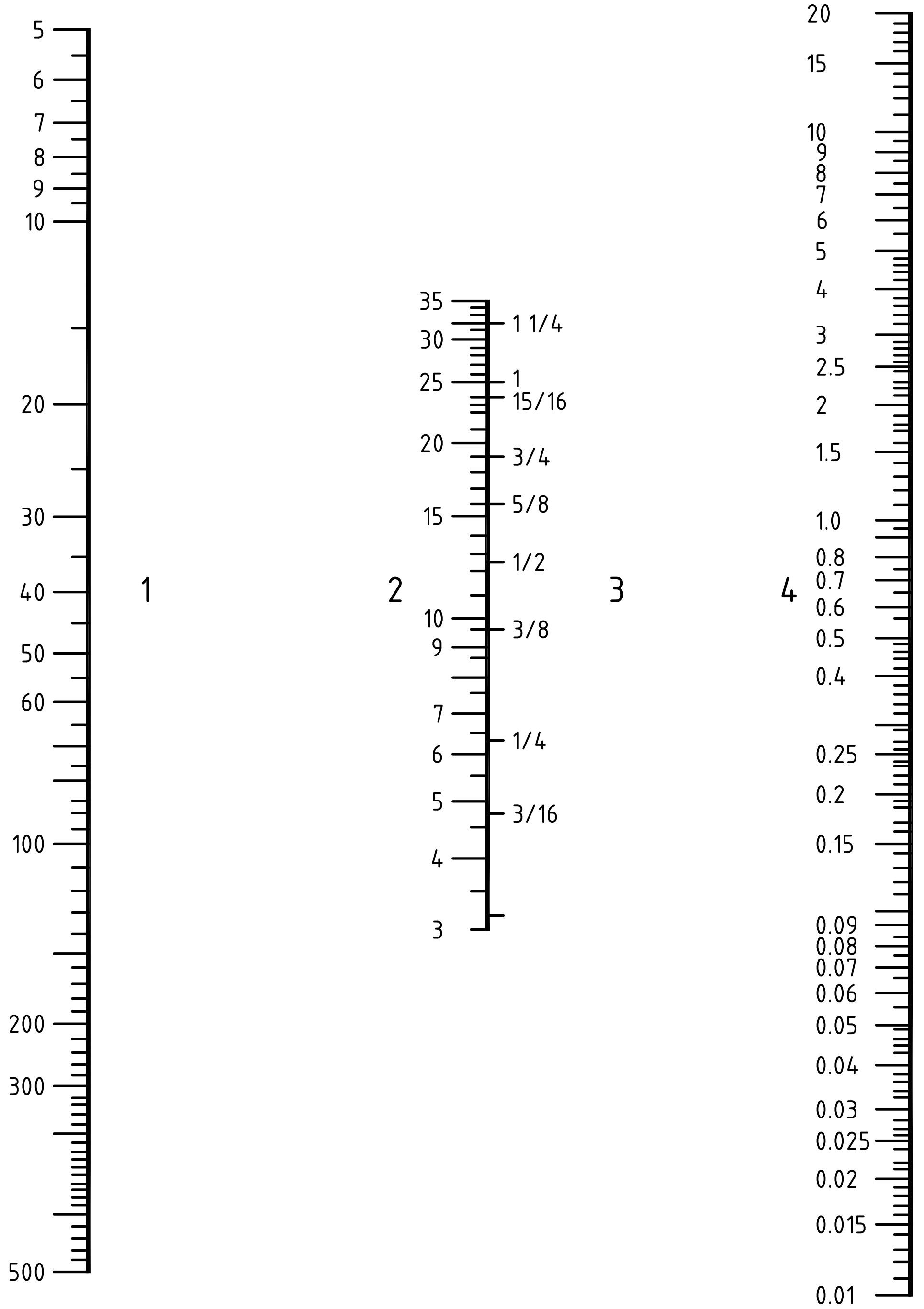
Key

1 Head loss (kPa)

2 Flow in litres per second (L/s)

3 Nominal size of stopvalve

Figure C.4 **Head loss through float-operated valves**



Key

1 Pressure head of water in kPa

2 Diameter of orifice in millimetres

3 Diameter of orifice in inches

4 Flow through orifice in litres per second (L/s)

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