BS 8558:2011

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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Publishing and copyright information

ISBN 978 0 580 71654 6

ICS 91.140.60

The following BSI references relate to the work on this standard:
Committee reference B/504
Draft for comment 11/30228295 DC

Publication history

First published as BS 6700 April 1987
Second edition, April 1997
Third edition, December 2006
First published as BS 8558 December 2011

Amendments issued since publication

Date	Text affected

Contents

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 86, an inside back cover and a back cover.

Foreword

Publishing information

This British Standard is published by BSI and came into effect on 31 December 2011. It was prepared by Technical Committee B/504, *Water Supply*. A list of organizations represented on this committee can be obtained on request to its secretary.

Supersession

Together with BS EN 806-1, BS EN 806-2, BS EN 806-3, BS EN 806-4 and BS EN 806-5, this British Standard supersedes BS 6700:2006+A1:2009, which is withdrawn.

Information about this document

In the area of Domestic Water Supply, BS 6700 is the lead document until such time as BS EN 806-5 is published (scheduled for June 2012), at which point BS 6700 will be withdrawn and BS 8558 will become the lead document. The content of this British Standard was taken from BS 6700:2006+A1:2009, which will be withdrawn following the publication of BS EN 806 (all parts).

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 regulations which may be amended from time to time. The commentary in this British Standard reflects the state of the regulations in 2011.

- The Workplace (Health, Safety and Welfare) Regulations 1992 [1];
- The Water Supply (Water Quality) Regulations 2010 [2];
- The Electricity Safety, Quality and Continuity Regulations 2002 [3];
- The Control of Asbestos at Work Regulations 2002 [4];
- The Water Industry Act 1999 [5];
- The Health and Safety at Work etc. Act 1974 [6].

In this British Standard, the following national regulations, which apply to plumbing systems in premises to which a supply of public mains water has been provided, are referred to as the "Water Fittings Regulations" [7]:

- The Water Supply (Water Fittings) Regulations 1999, in England and Wales;
- The Water Byelaws 2004 (Scotland), in Scotland;
- The Water Supply (Water Fittings) Regulations (Northern Ireland) 2009, in Northern Ireland.

Additionally, the following national regulations are referred to as the "Building Regulations" [8]:

- The Building Regulations (England and Wales) 2010;
- The Building (Scotland) Regulations 2004;
- The Building Regulations (Northern Ireland) 2000.

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**

BS EN 806 part and clause reference	BS 8558 clause reference
BS EN 806 1:2000+A1	
Scope, Clause **1**	No guidance given
Normative references, Clause **2**	No guidance given
Objectives, Clause **3**	No guidance given
Competence and duties for design, construction and operation, Clause **4**	No guidance given
Terms and definitions, Clause **5**	
distributing pipe, **5.3.4**	**3.13**
service pipe, **5.3.1**	**3.28**
service stopvalve, **5.4.2**	**3.29**
supply pipe, **5.3.2**	**3.36**
supply stopvalve, **5.4.3**	**3.37**
Graphic symbols and abbreviations, Clause **6**	No guidance given
Examples for the use of graphic symbols, Annex A	No guidance given
BS EN 806-2:2005	
Scope, Clause **1**	No guidance given
Normative references, Clause **2**	No guidance given
General requirements, Clause **3**	
Water supply, **3.1**	**4.2.1**
Private water supplies, Clause **4**	No guidance given
Acceptable materials, Clause **5**	**4.2.2** and **4.2.4**
Choice of material, **5.1**	**4.2.3**
Components, Clause **6**	No guidance given
Pipework inside buildings, Clause **7**	No guidance given
Cold potable water services, Clause **8**	No guidance given
Hot water systems, Clause **9**	No guidance given
Prevention of bursting, Clause **10**	
Discharge pipes, **10.2.5**	**4.2.4**
Guidelines for water meter installations, Clause **11**	No guidance given
Water conditioning, Clause **12**	No guidance given
Acoustics, Clause **13**	No guidance given
Protection of systems against temperatures external to pipes, fittings and appliances, Clause **14**	No guidance given
Boosting, Clause **15**	No guidance given
Pressure reducing valves, Clause **16**	No guidance given
Combined drinking water and fire fighting services, Clause **17**	No guidance given
Prevention of corrosion damage, Clause **18**	No guidance given
Additional requirements for vented cold and hot water systems, Clause **19**	No guidance given
List of acceptable materials (non-exhaustive), Annex A	No guidance given
Aspects for water conditioning, Annex B	No guidance given
Extra guidance	**4.3**
BS EN 806-3:2006	
Scope, Clause **1**	No guidance given

Table 1 **Cross references to the BS EN 806 series and this British Standard**

BS EN 806 part and clause reference	BS 8558 clause reference
Normative references, Clause **2**	No guidance given
Terms, symbols and units, Clause **3**	No guidance given
Principles of pipe sizing calculations, Clause **4**	No guidance given
Simplified method of pipe sizing, Clause **5**	**4.3.31**
Special-installations, Clause **6**	No guidance given
Example for the determination of pipe sizes for standard-installations, Annex A	No guidance given
Design flow rates in relation to total flow rates, Annex B	No guidance given
List of national pipe sizing methods, Annex C	No guidance given
BS EN 806-4:2010	
Scope, Clause **1**	No guidance given
Normative references, Clause **2**	No guidance given
Terms and definitions, Clause **3**	No guidance given
Work on site, Clause **4**	
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Fixings for insulated piping, **4.7.2.6**	**5.1.5**
Piping passing through structures, **4.7.4**	**5.1.6**
Valves and taps, **4.8**	**5.1.7**
Record of installation, **4.9.3**	**5.1.8**
Dissimilar metals, Clause **5**	No guidance given
Commissioning, Clause **6**	
General, **6.1.1**	**5.1.9**
Pipe system material specifications, jointing procedures and pipe installation for different types of materials, Annex A	No guidance given
Calculation and compensation for thermal effects of pipes, Annex B	No guidance given
Recommended maximum spacings of fixings for metal pipes, Annex C	No guidance given
Extra guidance	**5.2**
BS EN 806-5:2012	
Scope, Clause **1**	No guidance given
Normative references, Clause **2**	No guidance given
Terms and definitions, Clause **3**	No guidance given
General, Clause **4**	**6.1.1** and **6.1.2**
Documentation, Clause **5**	No guidance given
Operation, Clause **6**	**6.1.2** and **6.1.3**
Interruptions to operation and disconnection, Clause **7**	No guidance given
Resumption of supply, Clause **8**	No guidance given
Damage and faults, Clause **9**	
Change in water quality, **9.1**	**6.1.4**
Alterations, extensions and refurbishment, Clause **10**	No guidance given
Accessibility of fittings, Clause **11**	No guidance given
Maintenance, Clause **12**	No guidance given
Additional requirements for vented systems, Clause **13**	
Cisterns, **13.1**	**6.1.5**

Table 1 **Cross references to the BS EN 806 series and this British Standard**

BS EN 806 part and clause reference	BS 8558 clause reference
Inspection and maintenance, Clause **14**	No guidance given
Recommended frequencies for inspection and maintenance of components for drinking water installations, Annex A	No guidance given
Inspection and maintenance procedures, Annex B	
Pipework, **B.22**	**6.1.6**
Specific inspection and maintenance procedures for water conditioning devices, Annex C	No guidance given
Extra guidance	**6.2**

1 Scope

This British Standard provides complementary guidance to BS EN 806. It is a guide to the design, installation, 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 standard gives guidance on underground pipework within the curtilage of the building.

2 Normative references

Standards publications

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

BS 534:1990, *Specification for steel pipes, joints and specials for water and sewage*

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*

BS 1212 (all parts), *Float operated valves*

BS 1427, *Guide to on-site test methods for the analysis of waters*

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*

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

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

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

1) Obsolescent.

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

BS 5412, *Specification for low-resistance single taps and combination tap assemblies (nominal size ½ and ¾) suitable for operation at PN 10 max. and a minimum flow pressure of 0.01 MPa (0.1 bar)* [2)]

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 5493:1997, *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* [4)]

BS 5970, *Code of practice for thermal insulation of pipework and equipment in the temperature range of –100 °C to +870 °C*

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 6920 (all parts), *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*

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 8550, *Guide for the auditing of water quality sampling*

BS 8551, *Provision and management of temporary water supplies and temporary distribution networks (not including supplies in case of statutory emergencies) – Code of practice*

BS EN 200, *Sanitary tapware – Single taps and combination taps for water supply systems of type 1 and type 2 – General technical specification*

BS EN 246, *Sanitary tapware – General specifications for flow rate regulators*

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, *Specifications for installations inside buildings conveying water for human consumption – Part 1: General*

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

BS EN 806-3, *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*

[2)] Obsolescent.
[3)] Obsolescent.
[4)] Withdrawn.

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

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

BS EN 1254-2, *Copper and copper alloys – Plumbing fittings – 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 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 10255, *Non-alloy steel tubes suitable for welding and threading – Technical delivery conditions*

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

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

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 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 1452-2, *Plastics piping systems for water supply and for buried and above-ground drainage and sewerage under pressure – Unplasticized poly(vinyl chloride) (PVC-U) – Part 2: Pipes (ISO 1452-2:2009)*

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 5667-1, BS 6068-6.1, *Water quality – Sampling – Part 1: Guidance on the design of sampling programmes and sampling techniques*

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 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 5667-5, *Water quality – Sampling – Part 5: Guidance on sampling of drinking water from treatment works and piped distribution systems*

Other publications

[N1] HEALTH AND SAFETY EXECUTIVE. *Approved Code of Practice L8, Legionnaires' disease – The control of Legionella bacteria in water systems – Approved Code of Practice and guidance*. Sudbury: 2000. ISBN 9780717617722.

3 Terms and definitions

For the purposes of this British Standard, the terms, definitions and symbols (see Table 2) given in BS EN 806-1:2000 apply, together with the following.

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

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

3.3 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 be (but need not be) filled with insulating material

3.4 chase
recess cut into an existing structure

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

3.6 communication pipe
part of a service pipe for which the water supplier is responsible (see Figure 1)

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

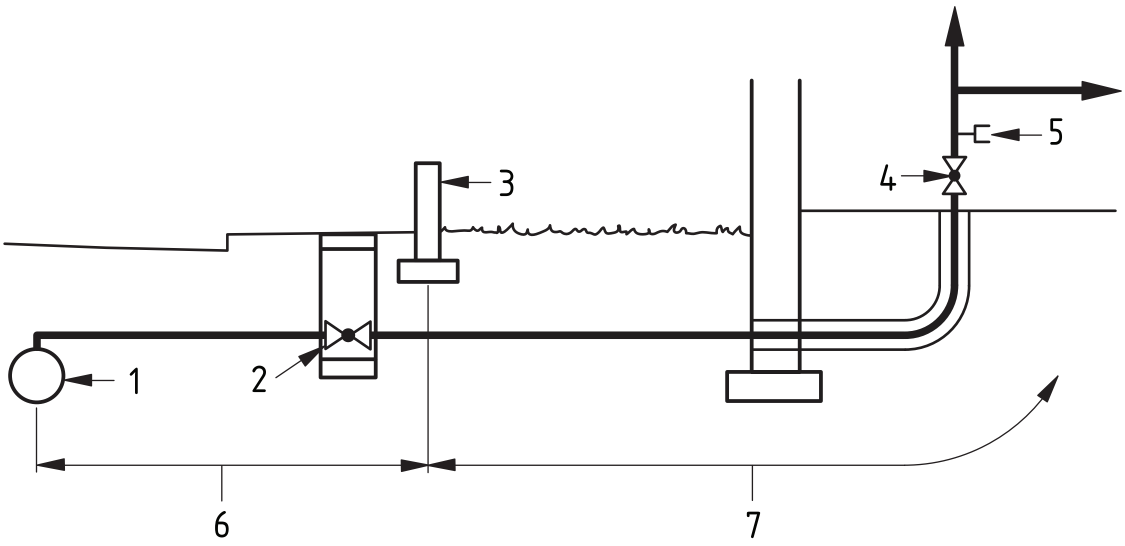
3.8 contamination
any reduction in chemical or biological quality of water due to a change in temperature or the introduction of polluting substances

3.9 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.

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

Figure 1 **Service pipe and components**



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.

3.11 dead leg
length of pipe to a draw-off fitting where little or no flow might 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.*

3.12 disinfection
specialized cleansing technique that reduces the time it takes for biofilms to form or regrow by killing the majority of microbiological organisms capable of infestation

3.13 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

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

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

3.15 dwelling
premises, buildings or part of a building providing accommodation, including 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

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

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

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

3.19 infestation
presence or growth of sufficient organisms that adversely impacts water quality

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

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

3.22 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.

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

3.24 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

3.25 removable fastening
fastenings 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

3.26 responsible person
individual 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, 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.

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

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

NOTE In the UK, the WRAS "Water Regulations Guide" [9] 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).

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

3.29 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).

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

3.30 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

3.31 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

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

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

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

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

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

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).

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

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

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).

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

3.38 tank
closed vessel holding water at greater than atmospheric pressure

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

3.40 terminal fitting
water outlet device

3.41 tundish
funnel for catching overflow or discharge

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

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

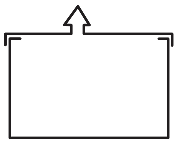
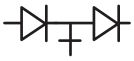
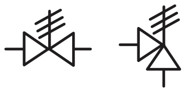
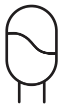
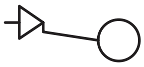
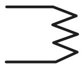
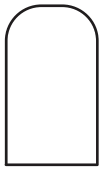
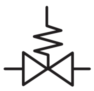
3.44 warning pipe
pipe from a cistern in which water flows only when the level in the cistern is about to exceed the predetermined overflow level to warn of impending overflow

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

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

3.46 wholesome water
see “potable water”

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 [7] apply. The Water Fittings Regulations [7] apply whenever the work involves either a new service or the modification or disconnection of existing services.

When designing plumbing installations, the Building Regulations [8] (particularly Approved Documents G [10], J [11], L (all parts) [12], and P [13] in England and Wales) apply.

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" [N1] and BS 8580. Further guidance is available for specific areas, see [14] and [15].

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; and

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

4.2 Guidance on specific BS EN 806-2 requirements

4.2.1 BS EN 806-2:2005, 3.1 – Water supply

*COMMENTARY ON **4.2.1***

Water systems within buildings and their curtilages are controlled by both building and water regulations. Different systems apply in different administrative areas of the UK; the main pieces of legislation are indicated in Table 3, but other legislation also exists.

Table 3 **Main pieces of legislation regarding Building and Water Regulations**

Area	Water Regulations	Building Regulations
England	Water Supply (Water Fittings) Regulations 1999 [7]	The Building Regulations (England and Wales) 2010 [8], particularly Part G to Schedule 1 and Part 7
Wales	As England	Until 31 December 2011, as England
Scotland	The Scottish Water Byelaws 2004 [7]	The Building (Scotland) Regulations 2004 [8], particularly section 4 of the *Scottish Building Standards Technical Handbooks* [16]
N Ireland	Water Supply (Water Fittings) Regulations (Northern Ireland) 2009 [7]	The Building Regulations (Northern Ireland) 2010 [8] Part P

The Building Regulations [8] generally cover:

- *health, safety and welfare of persons in and about buildings;*
- *accessibility of buildings; and*
- *water and energy efficiency of buildings.*

Compliance with the Building Regulations [8] is enforced by building control bodies, often the local authority, but also private sector approved inspectors. The Building Regulations [8] only apply at the time that work is being carried out, with various types of work (such as like-for-like replacement) being exempt.

The Water Fittings Regulations [7] prevent waste, misuse, undue consumption, contamination and erroneous measurement of water.

The Water Fittings Regulations [7] are enforced by the water supplier in its area of supply. They require the water system to conform to the regulations not only when installed but also during operation, maintenance and decommissioning.

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

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 given in BS EN 806-2:2005, Clause **5**.

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

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 by using a corrosion-resistant material. Where contamination of the soil is suspected or where knowledge of the site raises concern, an analysis of the soil should be obtained.

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.

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

4.2.3.1 Lead

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.

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

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

Repairs to existing lead services should be made with materials other than lead (see also **4.3.32.1**).

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

NOTE The WRAS "Water Regulations Guide", G2.1 [9] refers to "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".

4.2.3.2 Copper

It is strongly recommended that independent quality assurance certification of copper tubes to BS EN 1057 is 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.

4.2.3.3 Copper alloys

Copper cannot corrode by dezincification because it does not contain zinc; other recommended materials are gunmetal, which is also immune to dezincification, or 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".

4.2.3.4 Stainless steel

The Water Fittings Regulations [7] 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 or press fittings (see **4.3.32.1**). Jointing of stainless steel tubes by adhesive bonding may only be used where the water temperature does not exceed 85 °C.

4.2.3.5 Steel

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.

Galvanizing offers only marginal protection against corrosion. Welded or brazed joints should not be used because this would damage the galvanizing.

4.2.3.6 Plastics

4.2.3.6.1 General selection criteria and relevant standards

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

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. Where there is adequate access in positions above ground, solvent cement joints may be used.

Taps should conform to BS 5412 [5)] or BS EN 200 and float operated valves should conform to BS 1212 (all parts).

Plastics pipework systems for pressure applications are not automatically inter-compatible, and there are no British Standards specifications for connector dimensions or methods of achieving a joint. Plastics pipework systems should be comprised of a proprietary system package with third party approval. All non-metallic materials should comply with BS 6920-1, BS 6920-2 and BS 6920-3.

4.2.3.6.2 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.

4.2.3.6.3 Polybutylene (PB)

Pipes and fittings made from polybutylene (PB), conforming to BS 7291-1 and BS 7291-2 or BS EN ISO 15876 (all parts), are suitable for hot and cold water applications. The material is suitable where resistance to freezing temperatures and abrasion is required.

PB cannot be solvent welded. Jointing by push fit, or other mechanical joints, crimped fittings or by thermal fusion is suitable.

4.2.3.6.4 Polyethylene (PE)

The use and installation of polyethylene (PE) pipelines for the supply of drinking water should be in accordance with BS 5955-7 [6)]. 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.

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

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

4.2.3.6.5 Propylene copolymer (PP)

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

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

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

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5) Obsolescent.
6) Withdrawn.

4.2.3.6.6 Crosslinked polyethylene (PE-X)

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. The material is particularly suitable where resistance to freezing temperatures is required.

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.

4.2.3.6.7 Unplasticized polyvinyl chloride (PVC-U)

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

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

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

4.2.3.6.8 Acrylonitrile butadiene styrene (ABS)

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.

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

4.2.3.7 Coating and lining materials

For the prevention of contact of water with unsuitable materials see **4.3.32.1**. BS 5493 [7)] gives recommendations for the protective coating of iron and steel structures, including pipes, fittings and cisterns. This should be consulted where detailed guidance is required. BS 5493 [7)] deals with non-saline water and is applicable to domestic water installations. It provides typical times to first maintenance, general descriptions of recommended coatings and their thicknesses. Other tables give more detailed information about the coating systems. Of particular relevance is BS 5493:1977, Table 3, note n) [7)], which concerns fittings used with drinking water.

Internal protection of steel pipes should be in accordance with BS 534:1990, Clause **27**.

4.2.3.8 Elastomeric materials

The materials of elastomeric sealing rings in contact with drinking water should conform to the requirements of types WA, WB or WE of BS EN 681-1:1996. See also **4.3.32.1**.

4.2.4 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.

[7)] Obsolescent.

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, which includes extending the plumbing system or property, can have an adverse effect on pressure/flow and quality; the water supplier may require a separate service pipe to be provided. Where properties are being supplied with a new service from a water supplier's main, it is strongly advised that 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

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.

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 be, where practicable, "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.

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

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

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, see the UK Water Industry Research Ltd's (UKWIR), *Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites* [17].

Drinking water points should be located in areas intended for food preparation and consumption as well as for 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 of buildings.

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 [1] with respect to drinking water provision in offices and other commercial buildings.

4.3.5 Dead legs

4.3.5.1 General

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. Cut-off ends should not exceed twice the pipe diameter. This should provide the most efficient water conservation measure. However, an overriding design consideration should be given to guidance on the control of Legionella bacteria in water systems. Where possible, terminal pipe lengths to outlets and appliances should be designed such that they meet the following thermal performance criteria:

- Cold water

  The water temperature should be below 20 °C after running the water for up to two minutes. The water should be below 20 °C at all times.

  However, during a prolonged hot summer, the incoming water temperature at some sites can become abnormally warm. If the incoming water is above 20 °C, the water supplier should be informed. 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.

- Hot water

  The water temperature should be at least 50 °C within a minute of running the water.

  If fitted, input to thermostatic mixing valves (TMVs), the water supply to the TMV temperature should be at least 50 °C within a minute of running the water.

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

NOTE 1 For more detailed information, refer to the HSE's "Approved Code of Practice L8, Legionnaires' disease – The control of Legionella bacteria in water systems" [N1] and BS 8580.

Except in a house, all taps that are supplied with cold water that is not drinking water should be labelled "Not Drinking Water".

To minimize the amount of water drawn off before sufficiently hot or cold water arrives at the tap (which wastes both water and energy), dead legs should be insulated and should not exceed 1.5 L.

NOTE 2 This guidance is based on balancing thermal efficiency and is not necessarily a recommendation for reducing microbiological risks, see the HSE's "Approved Code of Practice L8, Legionnaires' disease – The control of Legionella bacteria in water systems" [N1].

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

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.

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 not exceed a length of greater than two times the outside diameter of the service pipe, irrespective of the material of construction. This allows the smallest possible surface area to volume ratio available for the generation of biofilm pockets while maximizing the efficacy of disinfection procedures. This pipe length is also designed to allow practical access for completing the required work. Where the 2:1 length to diameter ration is not achievable, e.g. where the cut-off tail extends through a wall, reconfiguration of the system should be considered.

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 water quality regulations. Secondly, the Department of Health recommends that unsoftened water should be available for both infant feed preparation, to help prevent hypernatraemia, and to reduce sodium intake in the general population.

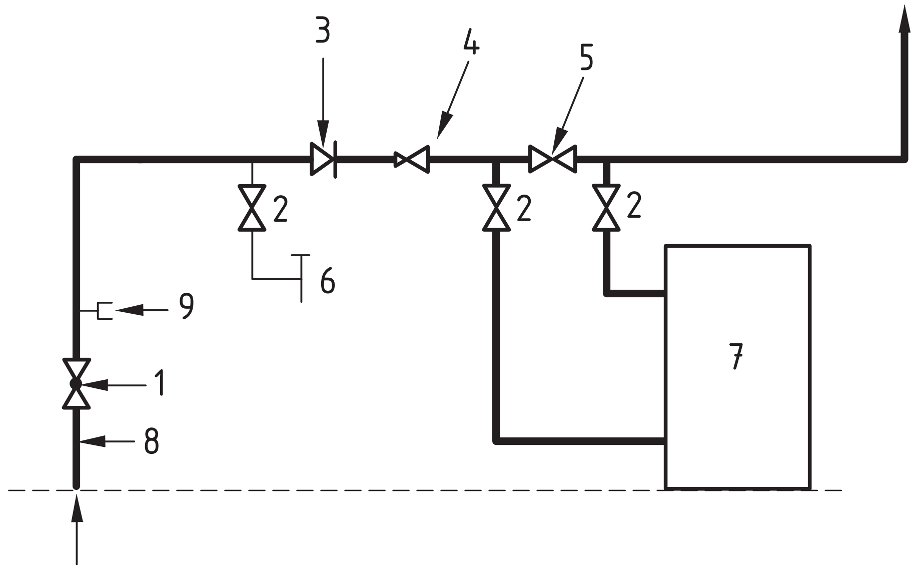
NOTE 1 The Water Fittings Regulations [7] recommend that “All premises supplied with water for domestic purposes should have at least one conveniently situated tap for the drawing of drinking water”.

NOTE 2 The parametric value for sodium of 200 mg/L stipulated in the Water Supply (Water Quality) Regulations 2010 [2], is only exceeded when it is softened in areas where the water supply is extremely hard, viz. greater than 435 mg/L as $CaCO^3$ (assuming zero sodium in the mains supply).

The installation of a water softener can adversely affect certain pipework, therefore manufacturer’s instructions should be consulted.

NOTE 3 For further information on installation of ion exchange water softeners, see the WRAS “IGN 9-07-01, Information for Installation of Ion Exchange Water Softeners for Systems Supplying Water for Domestic Purposes” [18].

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



Key

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

4.3.7 Type of system

Direct supply from a water main is recommended as inhalation of droplets or aerosols can occur when using supply via a storage system (see **4.3.32.2** 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.

The characteristics of direct supply from a water main are:

- smaller pipes may be used in most cases;
- 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;
- where single outlet mixer fittings are used, measures to prevent backflow are necessary when used in conjunction with a low pressure (vented) hot water supply; and
- where there is a lack of pressure, a pumped supply pipe might be necessary. This requires the written consent of the water supplier. Alternatively a break cistern is required.

The characteristics of supply via a storage cistern are:

- availability of a reserve of water for use in case of interruption of the mains supply;
- additional protection of the mains from contamination;
- reduced risk of water hammer and reduced noise from outlets, but additional noise generated by the float operated valve controlling the water supply to the cistern;

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

  NOTE 1 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.

- risk of frost damage;
- space occupied and cost of storage cistern, structural support and additional pipework; and
- need to ensure that the cistern is continuously protected against the ingress of any contaminant.

A combination of the two methods of supply 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 2 BS 8515 and BS 8525-1 cover the 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 house, 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 the parts of or the whole of the building.

4.3.10 Cisterns

Cisterns should be made from corrosion-resistant material or coated internally with an approved non-toxic corrosion-resistant material conforming to BS 6920-1, BS 6920-2 and BS 6920-3.

4.3.11 Storage cisterns

All cold water distributing pipes from cisterns 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.

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 float valves.

NOTE 1 The 25 mm recommendation minimizes the risk of scalding from outlets, such as showers, if the water supply fails.

NOTE 2 For further information on thermal streaming, see AWWA's "Passive mixing systems improve storage tank water quality" [19] and AWWA's "Physical modelling of mixing in water storage tanks" [20].

NOTE 3 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)

To avoid interruption of the water supply, storage should be provided by a system of split compartments or multiple cisterns to facilitate repairs or maintenance.

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 airgap.

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.

Where it is not practical to operate delayed action ball valves to affect 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 allow streaming of cold inlet water to track to diagonally opposite low level outlets.

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.

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.

Cisterns mounted outside buildings, whether fixed to the building itself 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.

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

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

4.3.13 Warning and overflow pipes

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* [21].

4.3.14 Stopvalves

Stopvalves fitted to supply pipes should conform to the relevant standard in Table 4.

Table 4 **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 [8)]
	BS 2580 [8)]	BS 5433
50 mm or larger	BS 5163-2	BS 5163-2

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

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

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

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 concerned in an accessible position above floor level and close to the point of entry of the pipe supplying water to that premises, whether this be a supply pipe or a distributing pipe.

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 either inside or outside the building in a position to which every occupier of the premises supplied has access.

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.

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 principle for these recommendations 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.

It should be ensured that the supply can be drained down by any occupier to avoid frost damage and to shut off their own supply or a supply in unoccupied premises causing damage or nuisance by using a stopvalve to which each occupier has ready access.

[8)] Obsolescent.

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

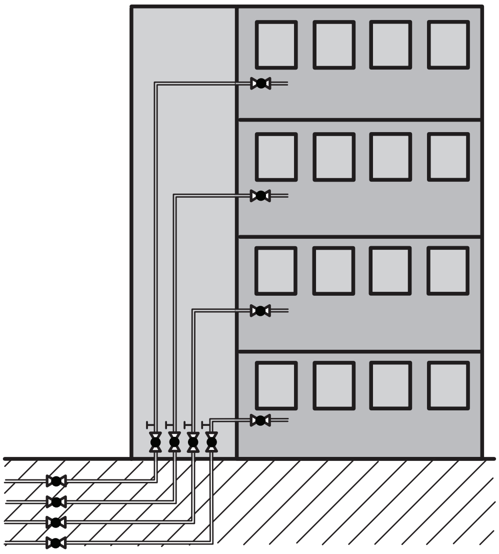
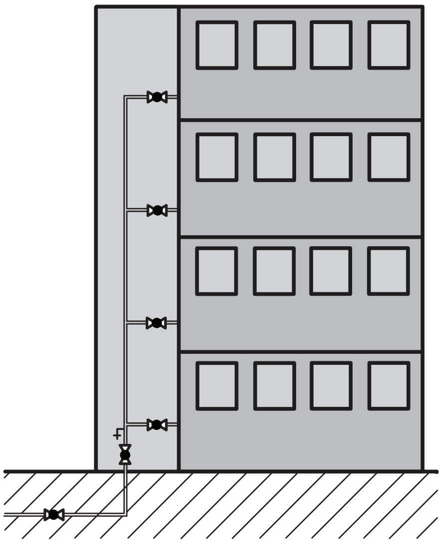


Figure 4 **Locations of stopvalves in blocks of flats supplied from a common supply pipe**



4.3.15 Servicing valves

Spherical valves (ball valves) are well suited for fitting near to single outlet fittings and appliances as servicing valves. Copper alloy gate valves conforming to BS 5154 can be used, but they have a higher hydraulic resistance than spherical valves.

4.3.16 Draining taps

Good system design should facilitate the draining of all pipework.

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

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

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

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 2 Attention is drawn to the Water Fittings Regulations [7].

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 3 Check valves and double check valve assemblies 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

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.

Where possible, meters should be installed at or near the street boundary of the premises supplied, which is the limit of the responsibility of the water supplier for maintenance of the service pipe.

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

4.3.18 Bonding

The requirements for electrical bonding of copper pipework are given in BS 7671 (IET Wiring Regulations).

NOTE These regulations satisfy the requirements of the Electricity Safety, Quality and Continuity Regulations [3].

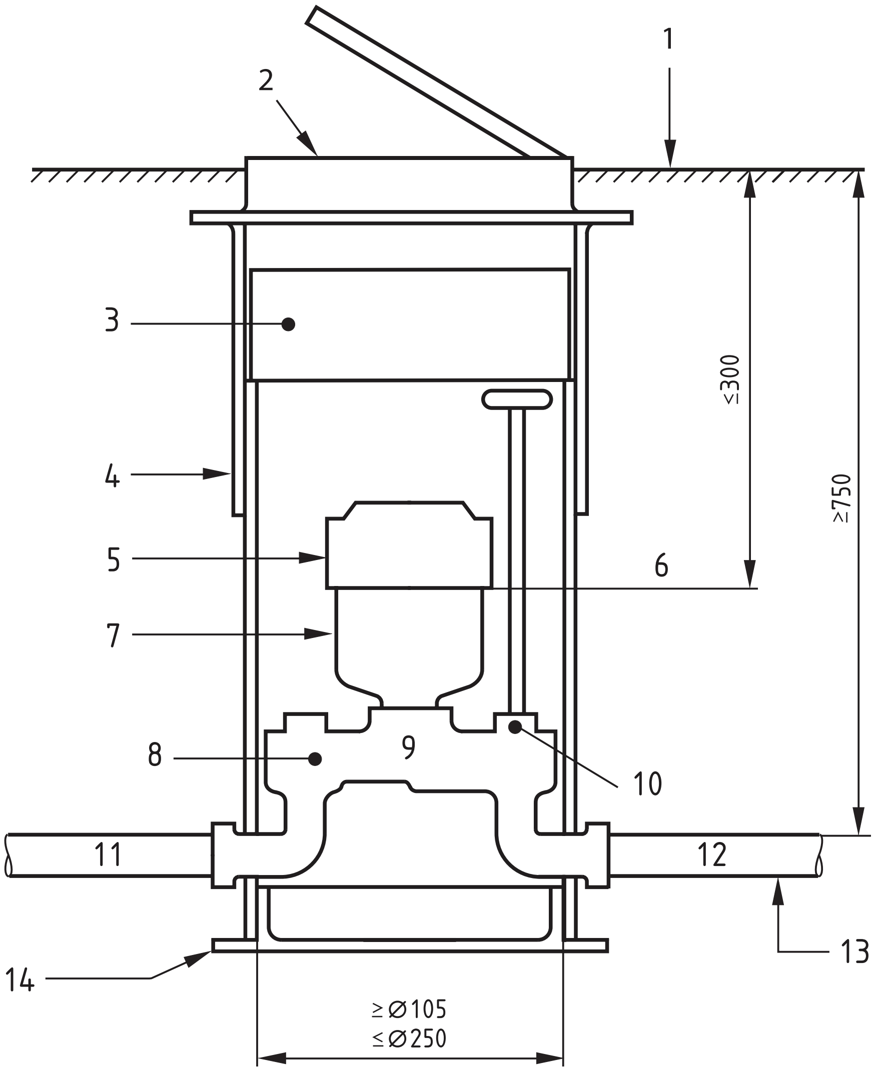
4.3.19 External meters

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

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.

The clear opening of the surface box should be the same as the internal dimensions of the chamber, see Figure 5.

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



Key

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

4.3.20 Internal meters

Where access to a meter is restricted, a remote readout device may be installed if the water supplier agrees.

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

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

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 in accordance with **4.3.35** 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

Hot water storage and distribution should be as recommended in the HSE's *Approved Code of Practice L8, Legionnaires' disease – The control of Legionella bacteria in water systems* [N1] (see also **4.3.32.2**).

In particular, the whole water content of the calorifier, including that at the base, should be heated to a temperature of 60 °C for one hour every day.

The water temperatures and delivery times recommended in the HSE's *Approved Code of Practice L8, Legionnaires' disease – The control of Legionella bacteria in water systems* [N1] might not be achievable where hot water is provided by instantaneous water heaters or combination boilers. However, the Legionella risk is considered to be acceptable provided that all of the following conditions are met:

- the cold supply is directly from the supply pipe and under mains pressure;
- the volume of cold water pipework subject to heat gain (i.e. generally above ground pipework) is less than 1.0 L; and
- the volume of pipework from each hot water outlet to the heat source is less than 1.5 L.

NOTE The HSE's guidance note "HSG 220, Health and Safety in Care Homes" [22] refers to scalding protection.

4.3.23 Storage type hot water systems

A summary of the main differences between vented and unvented systems is as follows.

a) Vented systems: vented domestic 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. 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. In addition, an energy cut-out or relief system should be incorporated to minimize the consequences of a malfunction.

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. 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.

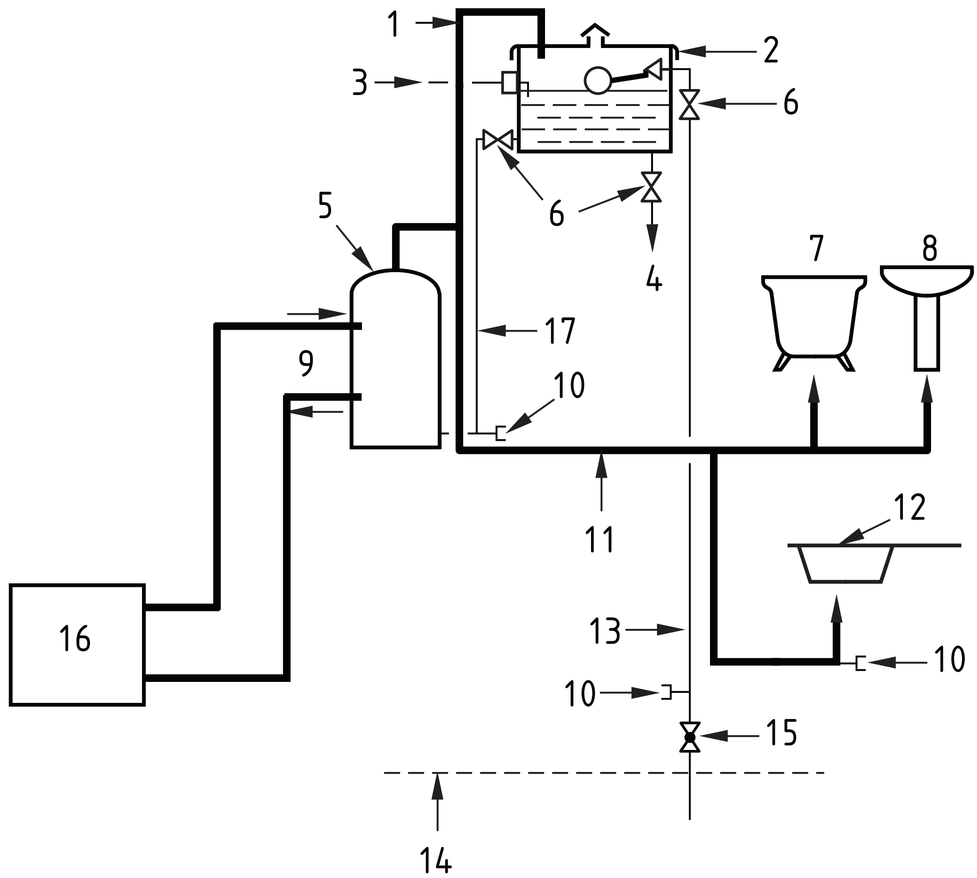
   4) The safety aspects of unvented, storage type hot water systems are subject to the requirements of the Building Regulations [8].

Except for supplies to dual stream (biflow) 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 referred to for required operating pressure and temperature ranges.

4.3.24 Direct and indirect systems

This British Standard includes direct and indirect, vented and unvented systems. Figure 6, Figure 7, Figure 8 and Figure 9 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.

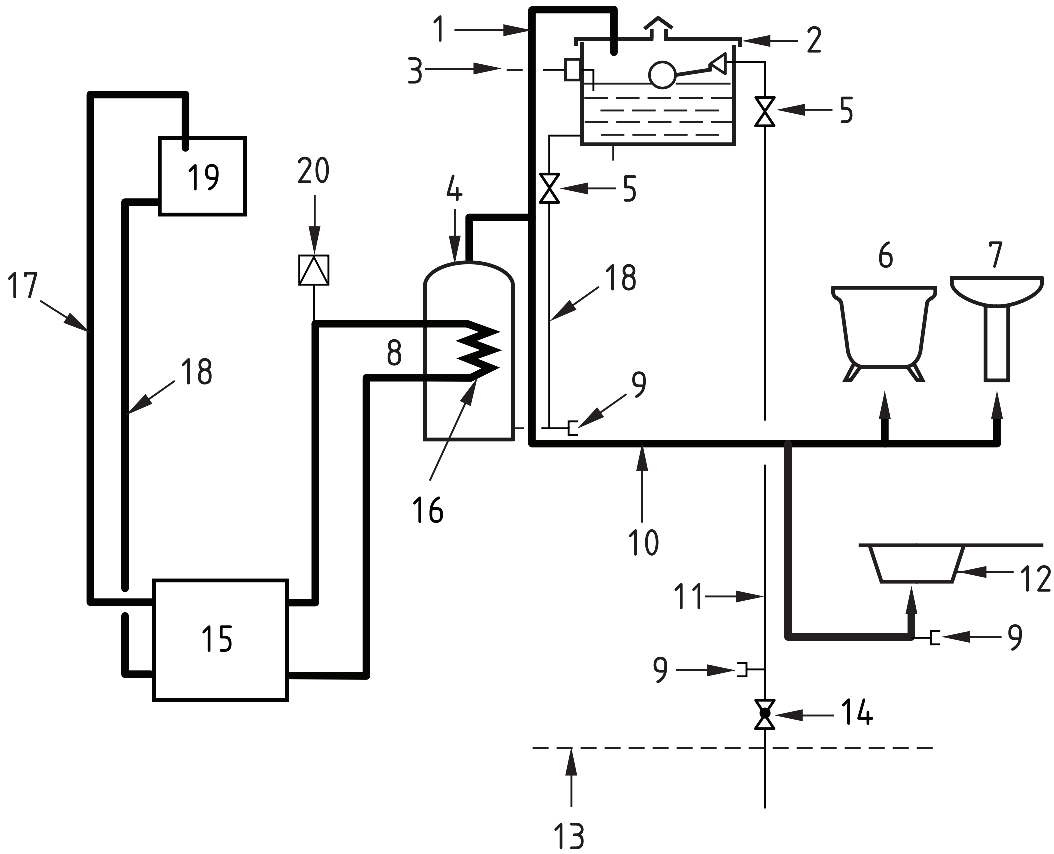
Figure 6 **Schematic example of a direct (vented) hot water system**



Key

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

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

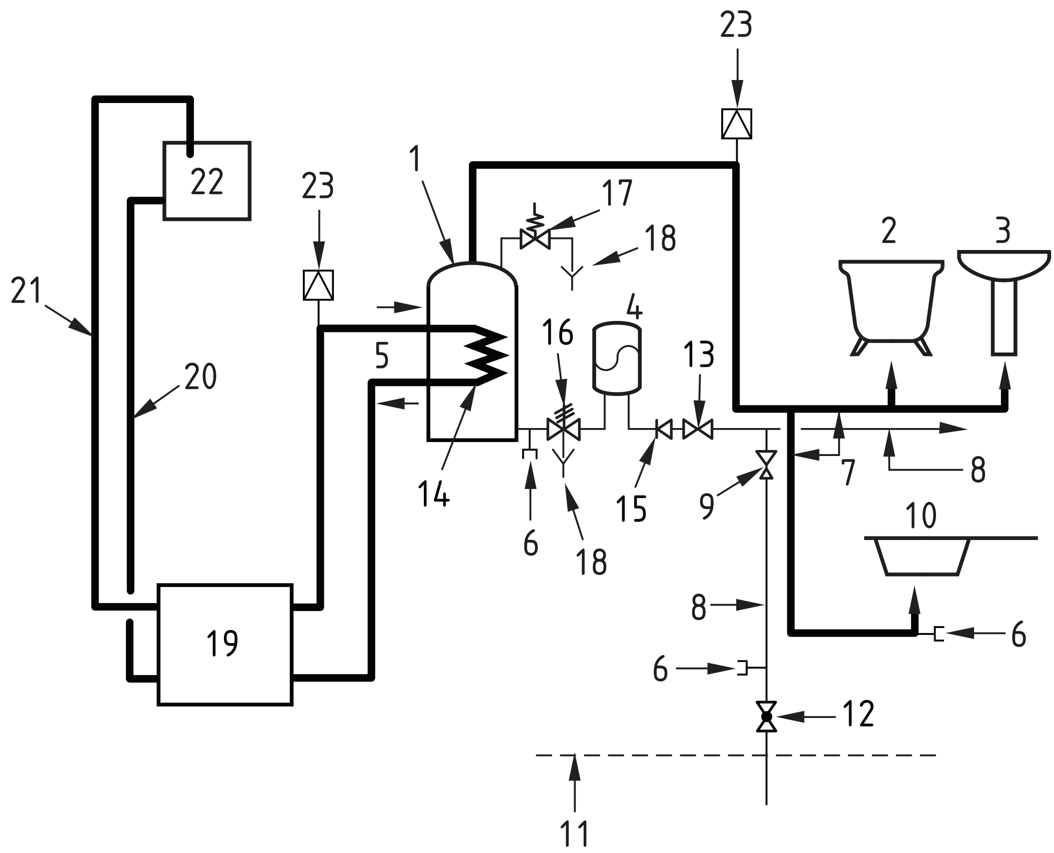


Key

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**

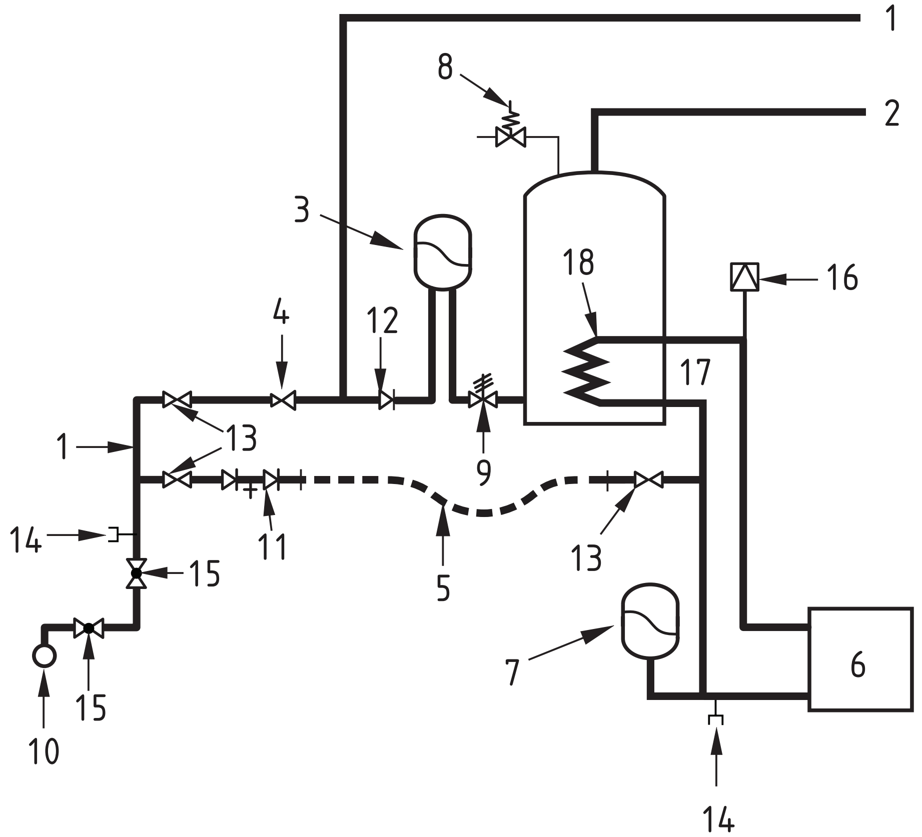


Key

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

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

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



Key

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

[A)] It is recommended to have a dosing and sampling point between the expansion relief valve and the heat source 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.

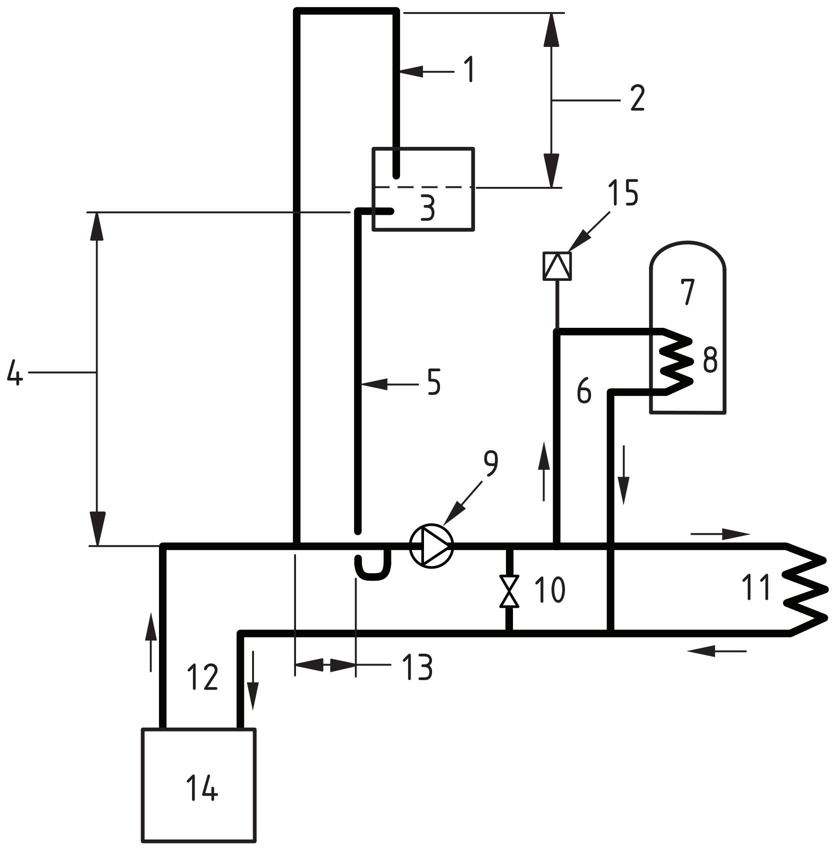
4.3.25 Vented primary circuits

For domestic installations the vent should be not less than 19 mm bore. 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.

Close coupled feed and vent should only be used on the recommendation of the boiler manufacturers and 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.

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.

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.

4.3.26 Sealed primary circuits

Pipes sizes in sealed primary circuits should conform to the relevant recommendations for vented primary circuits in **4.2.26**. 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.

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 **4.3.27** to **4.3.30** and **4.3.32**.

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** to **4.3.30** and **4.3.32** and should conform to the relevant standards from BS 6280, BS 6283-2, BS 6283-4, BS EN 1490, BS EN 1491, BS EN 13076, BS EN 13077, BS EN 13959, BS EN 14451 and BS EN 14623.

4.3.28 Energy control and safety devices

The Building Regulations [8] 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 vented systems, the vent acts as one safety device.

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.

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.

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.

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

4.3.29 Pressure control

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.

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).

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

a) allowing expansion water to travel back along the feed pipe, provided that heated water cannot reach any communication pipe or branch feeding a cold water outlet. Where such reverse flow is impeded by a stopvalve with a loose washer plate, this valve should be replaced by a valve with a fixed washer plate, or a no less effective valve; or

b) providing an expansion vessel conforming to BS 6144, or an integral air 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. This expansion vessel or integral air space should be sized in accordance with the volume of water heated so that the pressure is limited to the maximum working pressure for the system.

4.3.30 Maintenance of water level

The hot water delivery connection should be located at the top of the hot water cylinder in conjunction with a suitably located vent, or, for some unvented systems, an anti-vacuum valve. Where hot water is delivered through a secondary circulating system, the hot water supply or distributing pipe should be arranged to be from the top of the vessel, or as near thereto as practicable, and always above any primary flow connection.

NOTE Unintentional draining of a hot water system is dangerous as it might expose temperature controls, impairing their operation, or the heating surfaces of the heater, which then becomes overheated. Where heating elements and controls are situated in the upper part of a system, they are correspondingly more vulnerable to a fall in water level.

4.3.31 Pipe sizing

Simultaneous use of appliances can reduce flow rates, potentially below design values. It is important that 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, therefore for reasons of economy, it is usual to provide for a demand less than the total demand of all appliances being in use at the same time.

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.

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 four hours filling time may be assumed.

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.

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 can be found in BS 6465-3.

Table 5 **Design flow rates to outlet fitting and appliances** A), B)

Outlet fitting or appliance	Rate of flow L/s	
	Design rate	**Minimum rate**
WC cistern (to fill in two minutes)	0.13	0.05
WC flushing trough (per WC served) C)	0.15	0.10
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)	0.50	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 figures 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 sought.

C) WC flushing troughs are recommended where anticipated use of WCs is more frequent than once per minute.

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

4.3.32 Contamination

4.3.32.1 Prevention of contact of water with unsuitable materials

The Water Fittings Regulations [7] 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 to prevent backflow is installed.

In areas of contaminated ground, approved copper 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* [17].

If a fluid (other than water) is used in any type of heating primary circuit which transfers heat to water for domestic use, or if an additive is used in water in such a circuit, the liquid or additive should be non-toxic and non-corrosive. In larger building systems, water quality might require biocides for microbiological control that are not non-toxic. Building systems should be checked for crossover leaks at least annually.

Where non-potable water systems, e.g. rainwater harvesting systems, are used, checks should be carried out that 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 the WRAS, *IGN 9-02-05 Marking & Identification of Pipework for Water Reuse Systems* [23]).

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

To prevent the contamination of the system with Legionella, measures should be taken in the design, installation and operation of hot and cold water systems. Where possible, these should include the avoidance of:

- stagnation of water in pipes, cisterns and other storage vessels;
- water temperatures within the range of 20 °C to 45 °C;
- use of materials with the greatest potential to harbour or provide nutrients for bacteria and other organisms; and

  NOTE WRAS approved materials are recommended.
- installation of fittings where aerosol formation can occur.

Legionella pneumophilia is the bacteria that causes Legionnaires' disease. People catch Legionnaires' disease by inhaling droplets of water, suspended in the air, which contain the bacteria. To determine the likelihood of any Legionella related problems, a risk assessment should be undertaken, for guidance see BS 8580.

Good practice is assumed if the recommendations contained in the HSE's *Approved Code of Practice L8, Legionnaires' disease – The control of Legionella bacteria in water systems* [N1] are followed.

To reduce the risk of colonization of a water system the temperature of cold water in pipes and cisterns should reach below 20 °C in less than two minutes; hot water should be stored and distributed at a temperature of not less than 60 °C with a temperature at the discharge point of 50 °C after one minute.

Hot and cold water pipework should be as short as practicable, especially where it only serves infrequently used taps and fittings.

The Water Supply (Water Quality) Regulations [2] contains requirements for the use of braided or flexible hoses in contact with drinking water.

4.3.33 Backflow prevention

4.3.33.1 General

Avoidance of backflow can be achieved by good system design and the provision of suitable backflow prevention arrangements and devices, the type of which depends on 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 [7].

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.

To enable buckets and similar utensils to be filled, the outlet of the kitchen tap should be not less than 275 mm above the bottom of the sink.

For further guidance, see the WRAS *Water Regulations Guide* [9] for detailed information on backflow protection or consult the local water supplier.

4.3.33.2 Secondary or zone backflow protection

Backflow protection should be in accordance with BS EN 1717. The local water supplier can provide advice on the level of backflow protection that should be installed. Further information is available from the WRAS, *IGN 9-04-05, Report of the Expert Group on the Risk of Contamination of the Public Water Supply by Backflow* [24].

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.

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.

4.3.34 Protection of water pipes and fittings

4.3.34.1 General

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; and

d) thermal stresses.

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 **4.3.35**. Where pipes rise from the ground, the thermal insulation should extend to the depth below ground stated in **4.3.35**.

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

i) thermal insulation;

ii) trace heating tapes; or

iii) local heating; and

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

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.

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

To prevent freezing of water services in buildings, 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 of water pipes and fittings (trace heating) or heating their immediate surroundings (local heating) might be sufficient.

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*, G4.3 [9]). 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.

In addition to thermal protection, pipework and fittings should also be protected from their surroundings. This might be physical protection in the form of a casing or other measures applying either above or below ground.

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

1) external locations above ground;
2) unheated spaces;
3) positioning near a window, air brick or other ventilator, external door, or any other place where cold draughts can occur; and
4) a chase or duct formed in an external wall.

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

4.3.34.2 Underground pipes

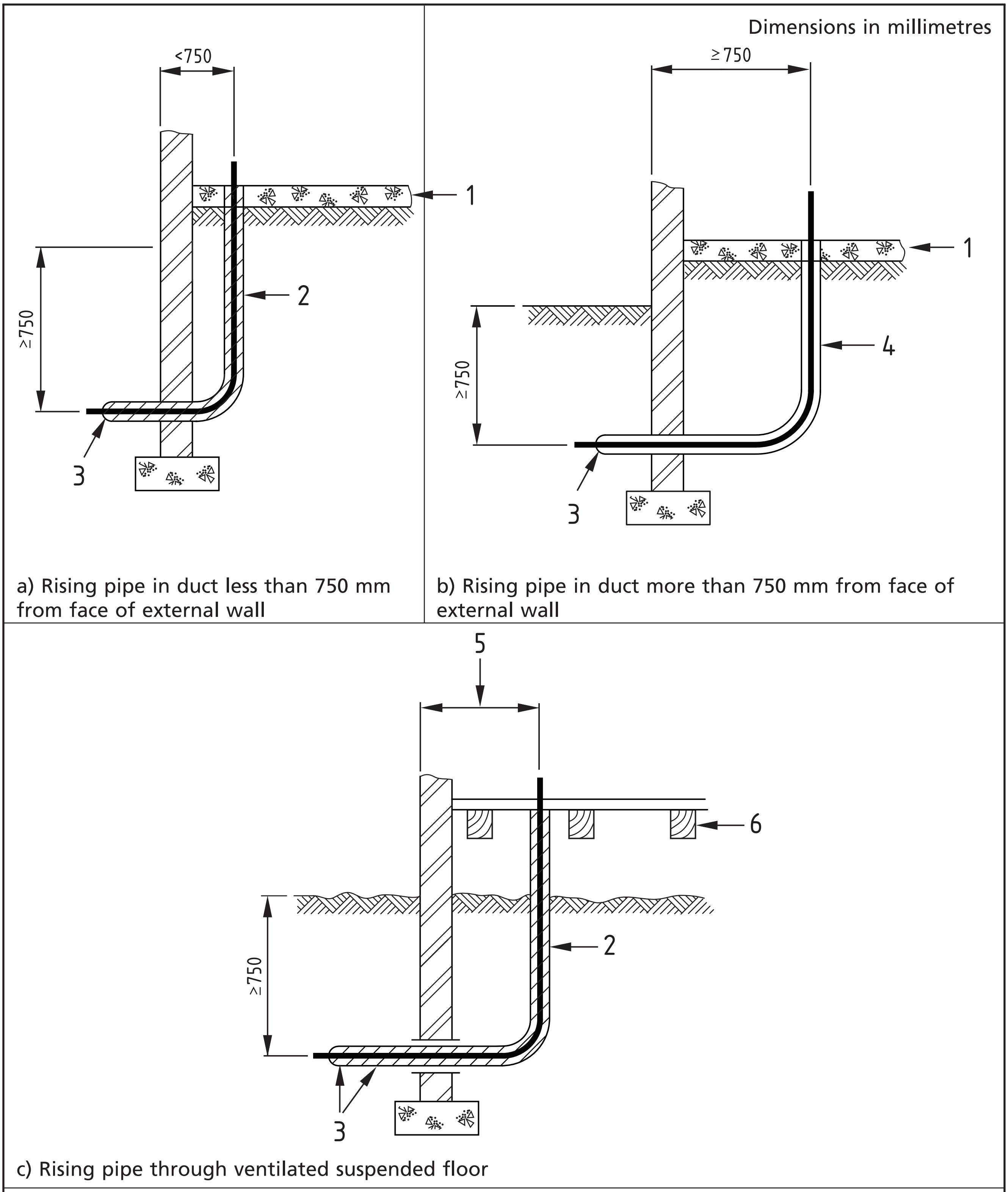
Pipes laid underground outside buildings should be laid at a depth sufficient to give protection against freezing, which should be no less than 0.75 m but no greater than 1.35 m. Where this cannot be achieved, the water supplier should be consulted. Where the depth of cover is less than 0.75 m, thermal insulation should be in accordance with **4.3.35** or with that agreed with the water supplier (see Figure 11).

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

4.3.34.3 Pipes entering buildings

Where pipes rise from below the ground, waterproof thermal insulation should extend to at least 0.75 m below the ground, in accordance with **4.3.35** (see Figure 11, **4.3.39** and **5.2.1.10**).

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



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.

4.3.34.4 Pipes and fittings inside buildings

Pipes and fittings should be thermally insulated in accordance with **4.3.35**. Thermal insulation should be provided on the top and sides of any cistern.

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.

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

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 **4.3.35**).

4.3.35 Thermal insulation

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

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%.

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.

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)

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

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.

Pipes passing through areas with no heating, such as basements, garages, roofspaces, etc., should have greater levels of protection.

Further advice on thermal insulation is given in the WRAS *Water Regulations Guide* [9] and can be obtained from manufacturers. There are also thermal calculation tools available, e.g. WRAS.

4.3.36 Local and trace heating

Electric trace heating should conform to BS EN 62395-1 and BS EN 60079-30-1, with electrical installation in accordance with BS 7671.

Any trace heating provided for the protection of any pipes or fittings should be additional to, and not in substitution for, insulation recommendations in **4.3.34** to **4.3.37**.

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.

Where trace heating is provided, it should be fitted before the insulation is applied.

4.3.37 Drainage of system to prevent frost damage

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

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.

Unless the stopvalve is installed within a normally heated building, it should be protected against freezing in accordance with **4.3.34** to **4.3.36**.

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 **4.3.34** to **4.3.37**.

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.

4.3.38 Accessibility of pipes and water fittings

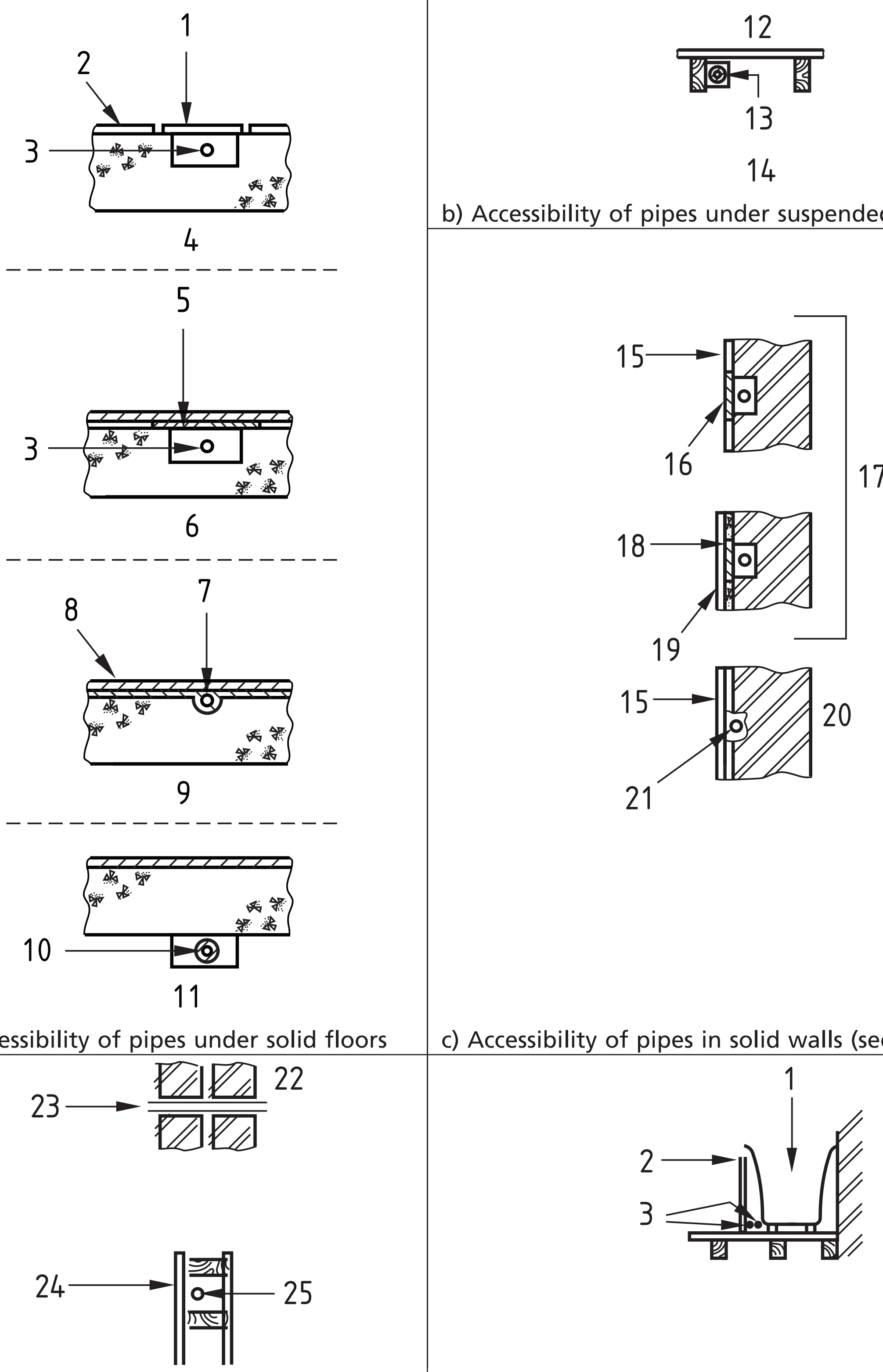
The following factors should be assessed (see Figure 12).

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 increase or decrease in capital or maintenance costs arising from the provision of improved accessibility: ease of forming ducts or chases, changes to pipe runs, ease of provision of removable access panels or covers and availability of multi-service walkways or crawlways in which water pipes might be installed.

c) 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**



a) Accessibility of pipes under solid floors

b) Accessibility of pipes under suspended floors

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

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

e) Accessibility of pipes behind bath panels

Figure 12 **Accessibility of pipework**

Key

1 Removable cover (recommended practice)
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 Pipe in screed or purpose-made chase
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 few pipes can be withdrawn for inspection
12 Ground floor
13 Pipe thermally insulated
14 Boards removable at intervals of not more than two metres and at every joint for inspection of whole length of pipe
15 Surface finish
16 Removable cover over purpose-made duct
17 For pipes fixed on the external face of an external walls, thermally insulate the pipes
18 Wood or metal cover
19 Plaster or tiling
20 Internal wall
21 Pipe in chase
22 Cavity wall
23 Pipe in duct and thermally insulated
24 Plaster board and studding wall (internal)
25 Pipe run within wall
26 Bath
27 Correct position for pipes [B)]

[A)] Except for the topmost arrangement, no pipes should be laid within a cavity.

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

NOTE For Figure 12c), this is only permitted in an internal wall and if pipe can be capped off or isolated if a leak becomes apparent.

4.3.39 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.

4.3.40 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.

4.3.41 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.

4.3.42 Cisterns

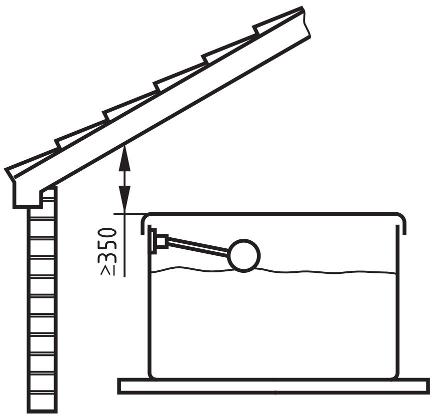
Every cistern should be placed and equipped so that the interior can be inspected and cleansed and the float operated valve can be maintained, see Figure 13. A clear space of not less than 350 mm should be provided between the top of the cistern and any ceiling or other obstruction above the cistern.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

Cistern into which a vent pipe terminates should be supported throughout the whole of its base on a flat level platform capable of supporting the weight of the cistern when full to its brim. The platform should be extended beyond the outside edges of the cistern by at least 150 mm. This advice should also be followed where a metal or plastics cistern is replaced by one of larger dimensions.

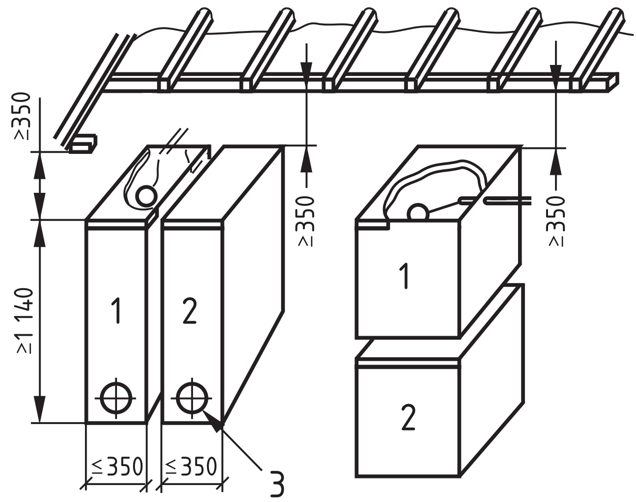
Concealed cisterns, e.g. WC and urinal flushing cisterns, should be accessible for repair/maintenance.

Figure 13 **Clear space needed above cisterns**

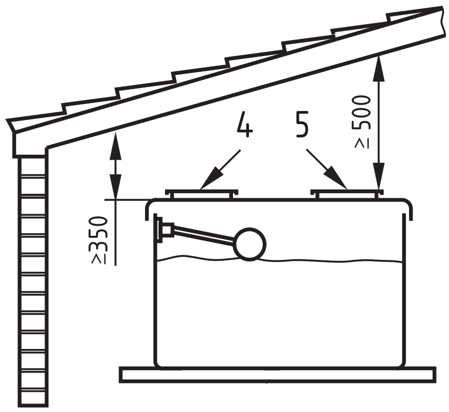
Dimensions in millimetres



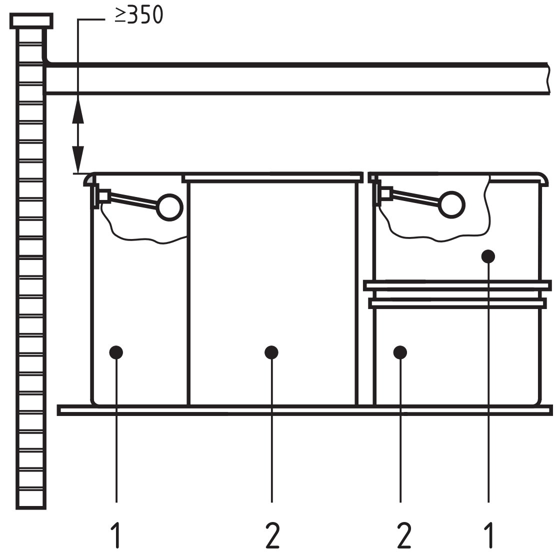
a) Conventionally shaped cistern up to 1 000 L



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.

4.3.43 Water economy

Attention is drawn to the Water Fittings Regulations [7] for the arrangement of WC flushing and the Building Regulations [8] for requirements on water efficiency.

The discharge of the flushing apparatus should be according to the design of the pan. Arbitrary reduction in the flush is not recommended.

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

4.3.44 Urinal flushing

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

4.3.45 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 an equally effective closure, except where the water supply is only from a fitting incapable of supplying water to a washing trough or basin at a rate exceeding 3.6 L/min per appliance, where it is fitted with self-closing taps, or where the appliance is for medical, dental or veterinary use and is intended for use with an unplugged waste.

4.3.46 Spray taps

Spray taps can save as much as 50% in both water consumption and fuel. The spray is only for hand rinsing; spray taps should not be used in situations where there might be heavy fouling of basins by grease and dirt. Without regular attention, the spray head can become blocked over a period of time with any quality of water, but more particularly with hard water. Self-cleansing velocities can rarely be satisfactorily achieved, particularly in long discharge pipes, so drain blockage due to a build up of grease and soap residue can occur, especially in soft water areas. Particularly good performances have been reported from areas with water in the range of 100 mg/L to 135 mg/L total hardness.

Aerators should conform to BS EN 246. Although aerators are intended for the purpose of improving the flow pattern, they can also reduce consumption by reducing the flow. However, aerators do have a minimum operating pressure, the value of which should be provided by the manufacturer.

Where spray taps are installed in an existing building as part of a refurbishment or water saving initiative, existing storage and pipe sizing should be assessed with regards to stratification and stagnation, which might have an impact on the proliferation of Legionella (see the HSE's *Approved Code of Practice L8, Legionnaires' disease – The control of Legionella bacteria in water systems* [N1]).

Any enhanced risk of aerosol formation in spray taps should be assessed and the system designed accordingly.

4.3.47 Energy conservation: pipework and hot water storage

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.

All pipes forming part of a primary or secondary circulation system for supplying domestic hot water and all pipes supplying hot water to a tap or other outlet that is longer than two times the pipe diameter, should be thermally insulated in accordance with BS 5422 or so that the energy loss under normal operating conditions at no time exceeds the values given in Table 9.

Table 9 **Maximum permitted rates of energy loss from pipes**

Outside diameter of pipe [A)] mm	Maximum energy loss W/m^2
10	675
20	400
30	280
40	220
50 and above	175

[A)] For intermediate values of pipe diameter, the corresponding maximum energy loss is found by interpolation.

Where 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.

Reducing the quantity and temperature of hot water heated and/or stored to meet recommendations produces energy savings in addition to those achieved by thermal insulation and controls. Storage vessels should therefore be sized to meet recommendations 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.

4.3.48 Scale control

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 the efficiency of the heater is impaired. Tests have shown that this can reduce the heater efficiency by up to 30%.

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.

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, continuous dosing or physical water conditioner.

4.3.49 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 12 L/min 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 should also be considered.

4.3.50 Bending of pipes

Rippling or excessive throating, and restricting the diameter of pipes when forming bends should be avoided.

Where appropriate, purpose-designed equipment should be used.

4.3.51 Above ground pipework

Adaptor couplings are available for jointing different materials covering 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.

4.3.52 Below ground pipework

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 **4.2.2**).

Service connections to cast iron pipes should be made by drilling and tapping the pipe and screwing in a copper alloy union ferrule.

When making service connections to unplasticized PVC pipes, a saddle should be fixed round the larger pipe and a ferrule screwed into the saddle. Installers should observe 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.

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

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.

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.

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

Additional guidance on below ground pipework can be found in BS EN 805.

4.3.53 Location of pipes and valves

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.

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

4.3.54 Identification

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 fire fighting purposes should be clearly and indelibly marked to distinguish them from each other and from every other pipe in the building.

The Water Fittings Regulations [7] 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.

For further guidance, see WRAS *IGN 9-02-05, Marking & Identification of Pipework for Water Reuse Systems* [23] [9].

4.3.55 Inspection

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

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

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.

Unvented hot water storage installations, if not installed by a member of a Competent Persons Scheme, should be notified to the Building Control Body to verify that they conform to Building Regulations [8] (see **4.2.1**).

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.

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, 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.

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.

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 [7].

A person registered with a water industry approved Competent Persons Scheme in accordance with the Water Fittings Regulations [7] can self-certify that the installation conforms to the Water Fittings Regulations [7].

4.3.56 Connection to water supply system

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.

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 detailed in the specification.

[9] Free to download from www.wras.co.uk

4.3.57 Compatability

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

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.

4.3.58 Thermal insulation

Any sub-standard insulation, damage to thermal insulation or fire stopping revealed during inspection should be rectified. Trace heating should also be checked for continuity.

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

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 performance of the system impact on water quality.

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 [4] and the overriding duty 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 breathing in the dust. This may be achieved by the use of damping down and using hand rather than power tools. If in doubt, guidance should be sought from the Health and Safety Executive.

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

Further details on workmanship on building sites may be obtained from BS 8000-15.

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

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

Any tube 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

When making a capillary joint, the mating faces of the tube 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.

The ends of annealed tubes should always be re-rounded.

The type of fitting and jointing methods used should be in accordance with Table 10, using tin/copper alloy number 23 or number 24, or tin/silver alloy number 28 or number 29, conforming to BS EN 29453.

Table 10 **Jointing of copper tube and stainless steel tube**

Tube	**Fitting conforming to BS EN 1254-2**			**Other methods**			
	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 in Table 1 of BS EN 1057:2006 [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 in Table 1 of BS EN 1057:2006	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Hard copper tube conforming to designation R290 in Table 1 of BS EN 1057:2006	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.

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 [7] 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; sparing use on the spigot is recommended to avoid the flux entering the bore.

5.1.3.1.2 Capillary brazed joints

Brazed joints, either using capillary type joints formed by special tools or using 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 tubes 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)

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

Non-manipulative types of compression joint do not require any working of the tube 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 tube 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 tube 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.

5.1.3.1.6 Push fittings

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

5.1.3.1.7 Press/crimp fittings

No special recommendations.

5.1.3.2 Steel pipes

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

Screwed joints in steel piping should be made with screwed socket joints using wrought-iron, steel or malleable cast-iron fittings. A thread filler should be used. Hemp should not be used in conjunction with any jointing paste. 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 [10)].

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.

[10)] Obsolescent.

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 10).

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.

5.1.3.3.4 Press/crimp fittings

No special recommendations.

5.1.3.4 Unplasticized PVC pipes

5.1.3.4.1 Mechanical joints

Mechanical joints in unplasticized PVC piping of nominal diameter DN2 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.

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 4346-3 recommended by the pipe manufacturer. The dimensions of the spigots and sockets should conform to BS 4346 (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 joint should be wrapped with an approved protective material.

5.1.3.5 Polybutylene pipes

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

5.1.3.6 Polyethylene pipes

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 fitting's manufacturer instructs otherwise.

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 carefully followed.

Polyethylene piping should not be jointed by solvent cement welding.

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

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 fitting's manufacturer instructs otherwise.

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 carefully followed.

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.

5.1.3.8 ABS pipes

5.1.3.8.1 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.

5.1.3.8.2 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.

5.1.3.8.3 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, BS 5392-1 or BS EN ISO 15493, as applicable.

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

5.1.3.8.4 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 joint should be wrapped with an approved protective material.

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

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 done by introducing changes of direction to avoid long straight runs or by fitting proprietary expansion joints.

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

Notching and boring of structural timbers is covered in the Building Regulations, Part A [8], by reference to BS EN 1995-1-1.

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

The rules for notching and drilling of solid timber joists, see Figure 14 and the following paragraph, do not apply to proprietary wood engineered joists or to metal web joists; manufacturer's product and design literature should be consulted.

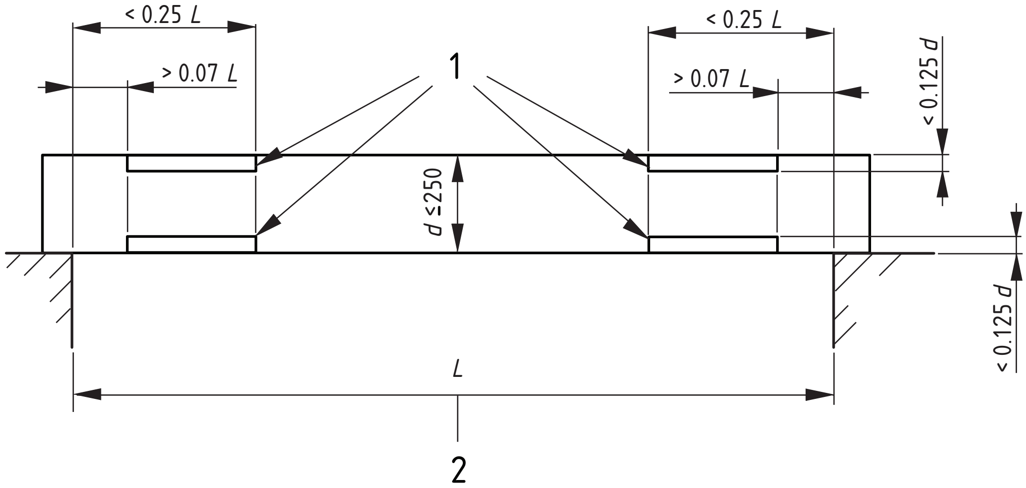
For structural solid timber joists, notches and holes should be as small as necessary to receive pipes. Notches should be U-shaped and formed by parallel cuts to previously drilled pilot holes. It is essential that structural members are not weakened by indiscriminate notching and drilling. In this respect, 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.

The sizing of structural timber members is covered by the Building Regulations [8], by reference to BS EN 1995-1-1 and, for certain solid timber joist members, by reference to BS 8103-3.

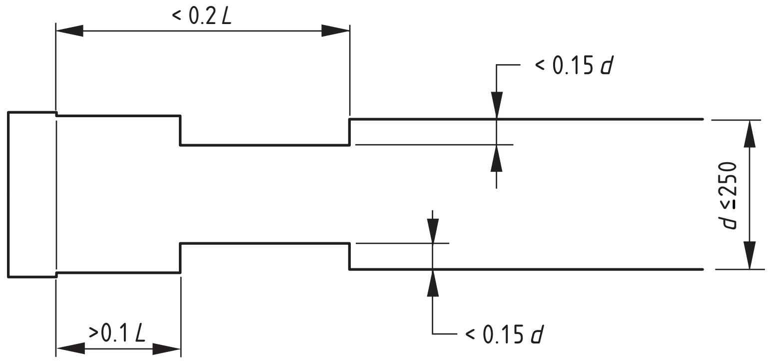
To prevent accidental damage or injury when inserting pipework below suspended floors, a visual inspection should be carried out beforehand to identify the position of any electrical cables, junction boxes and ancillary equipment.

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.

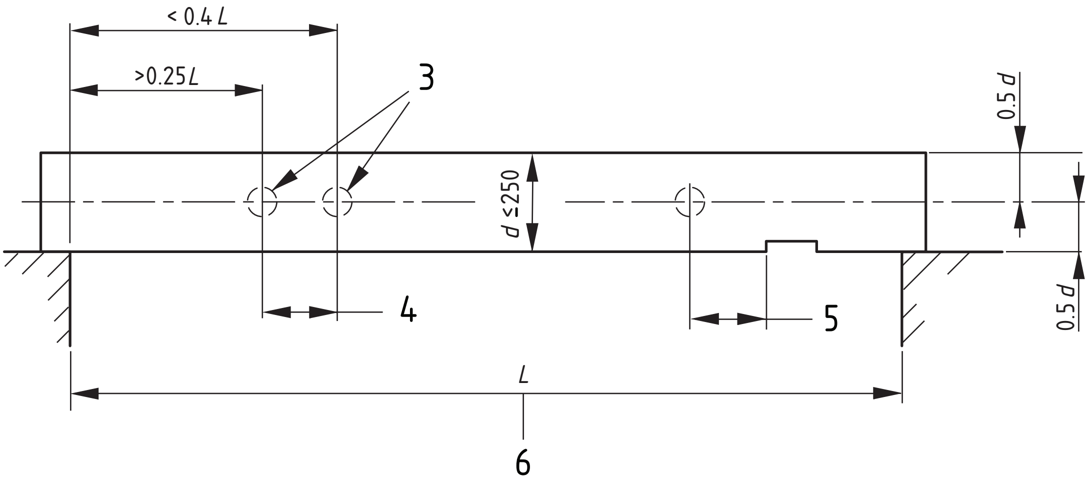
Figure 14 **Recommended positions of notching and drilling of solid timber floor joists**



a) Limits for notching (see Note 1)



b) Alternative limits for notching (see Note 1)



c) Limits for drilling (see Note 2)

Figure 14 **Recommended positions of notching and drilling of solid timber floor joists**

Key

1 Positions within which notching can occur, either on top or bottom, without a design check

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

3 Holes not exceeding 0.25 *d* diameter may be positioned on the centre line between 0.25 *L* and 0.4 *L* from a support without a design check

4 Not closer than 3× diameter

5 No hole to be closer than 100 mm to any notch (and vice versa)

6 Clear span

NOTE 1 This alternative notching can occur at both ends, either on top or bottom but not top and bottom together at one end, without a design check.

NOTE 2 The holes permitted on the centre line can occur as well as a notch on the top or bottom.

NOTE 3 For calculation, if d is greater than 250 mm then it is deemed to be 250 mm.

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

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.

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

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

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.

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

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.

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

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.

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

5.2.1.5 Hydrocarbon permeation risk

Water fittings laid in ground subject to spillage of hydrocarbons, such as oil, petrol or creosote, should be resistant to and/or protected from deterioration by exposure to such contaminants.

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* [17].

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

Ripe 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:

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

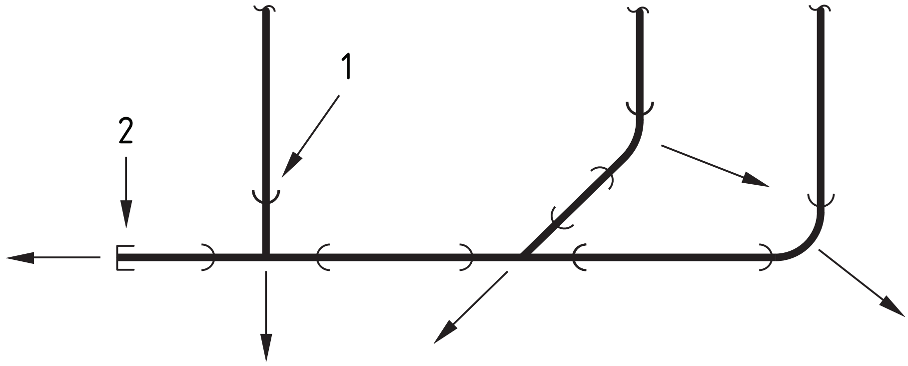
$$T_{\mathrm{radial}} = AP_{\sin}\frac{\theta}{2}$$

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);
- θ is the angle of deviation of bend.

Alternatively, when standard fittings are used, the thrusts should be calculated by multiplying the values given in Table 11 by the test pressure (in bar).

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" [25], by kind permission of CIPHE.

Table 11 **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

Thrust blocks for the restraint of pipelines should have adequate bearing area to resist the thrust, calculated using the data given in Table 12 or from measuring soil bearing capacity for horizontal thrusts made on site.

Table 12 **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

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, allowance being made for settlement.

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 to avoid contamination of the supply pipe should be taken 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

Underground pipes entering a building should do so at the level given in **4.3.34.4** (see also **4.3.38** and **4.3.39**).

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 **4.3.34.3** and Figure 11).

5.2.2 Electrical bonding

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.

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

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

Earthing recommendations are given in BS 7430.

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

Electrical installation requirements are given in BS 7671.

5.2.3 Flushing and disinfection

5.2.3.1 Flushing

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 wholesome 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. Additionally, the process removes any excess of flux, which can cause corrosion of copper pipes if left in place under conditions of low or no flow.

Larger pipes, e.g. pipes with an ID greater than 50 mm, or where contamination is suspected, should be disinfected after flushing.

5.2.3.2 Pre-disinfection flushing

At the time of construction and before the disinfection it may be necessary to leave the water in the system. Where this is the case, a regular regime of flushing should be undertaken at every outlet twice weekly. This counteracts the effect of stagnation at exposed copper surfaces, which can lead to corrosion and the onset of blue water syndrome. Depending on the quality of the local water over time, deposit of calcium salts are laid on the copper surfaces, which might negate the effects of localized corrosion.

This process is not a substitute for a full system disinfection before occupancy.

5.2.3.3 Disinfection

The timing of the disinfection process affects the water quality management of a building. Where precautions are not taken, biofilms re-colonize tanks, cisterns and pipework shortly after disinfection. The speed of recolonization depends on:

- the temperature and microbiological quality of the incoming supply water;
- the materials of construction of the tanks, cisterns and distribution system;
- the influence of temperature at specific points in the distribution system;
- the residual disinfectant concentrations retained in the distribution system on completion of the disinfection process; and
- the frequency of use of outlets.

NOTE Even materials fully compliant with Water Fittings Regulations [7] support the formation of biofilm to some extent. Different materials support differing thickness and growth rates relative to flow rate and temperature.

Where practicable, system disinfection should not be carried out until immediately before occupation. Disinfection should be carried out not more than 30 days before the start of occupancy. Once disinfection has been carried out, the system should be flushed weekly to maintain a flow of water. The design of the flushing programme should be in accordance with the HSE's *Approved Code of Practice L8, Legionnaires' disease – The control of Legionella bacteria in water systems* [N1].

Where more than 30 days elapse between the completion of system disinfection and the start of occupancy, routine flushing should be carried out to mimic occupancy. Where this flushing does not take place, the building should be representatively sampled and assessed for microbiological quality and evidence of excessive accumulation. The following tests should be carried out:

- total viable counts (TVC) measured at 22 °C;
- TVC measured at 37 °C;
- Coliform bacteria;
- Pseudomonas aeruginosa;
- Legionella (species); and
- disinfection residuals (taken concurrently with the microbiological samples).

Where the results indicate that the system has deteriorated with an increase in microbiological counts, e.g. TVC results in excess of a 2 log difference above that found in incoming mains water, corrective action should be taken.

Where Pseudomonas aeruginosa or Coliform bacteria are present, the sampling point should be flushed and retested. If positive results persist, investigation into the cause should be extended with a view to repeating the disinfection process.

Where Legionella is identified during this exercise, disinfection should be repeated.

5.2.3.4 Residual disinfection

After the disinfection process, a residual free chlorine concentration should be retained to delay the onset of biofilm formation in the system before normal use is allowed. The residual should conform to the following criteria where possible.

a) The average residual chlorine for the building across all the representative sampling points should be between 0.3 mg/L and 0.1 mg/L free chlorine.

b) Between 1% and 10% of the samples should be between 1 mg/L and 2 mg/L free chlorine.

c) The maximum residual free chlorine concentration acceptable is 2 mg/L, which should not occur in more than 1% of the distribution samples.

d) The extremities of the distribution system benefit the most from retained free chlorine residuals above 1 mg/L.

e) Cisterns should be left with a residual free chlorine concentration of 2 mg/L.

Achieving these proportions precisely might not be possible under all circumstances. Therefore acceptance of the retained residual free chlorine should be left to the professional judgement of the responsible person at the time of completion.

5.2.3.5 Disinfection

COMMENTARY ON ***5.2.3.5***

Flushing and disinfection are not a substitute for a high degree of cleanliness during installation (see also ***5.2.1.4****).*

For single dwellings and minor extensions or alterations in any premises, flushing is all that is normally recommended, unless contamination is suspected.

After flushing, systems should be disinfected in accordance with **5.2.3.6** to **5.2.3.8** in the following situations:

a) in new installations (except private dwellings occupied by a single family);

b) where major extensions or alterations have been carried out;

c) where underground pipework has been installed (except where localized repairs only have been carried out or junctions have been inserted [see **5.2.3.7**]);

d) where it is suspected that contamination might have occurred, e.g. fouling by sewage, drainage, animals or physical entry by site personnel for interior inspection, painting or repairs; and

e) where a system has not been in regular use and not regularly flushed.

Where any pipework under mains pressure or upstream of any backflow prevention device within the installation is to be disinfected, the water supplier should be informed. Chemicals used for disinfection of drinking water installations should be appropriate for public drinking water systems and in accordance with section 2.1 of Annex 2 of the Drinking Water Inspectorate's *List of Approved Products for use in Public Water Supply in the United Kingdom* [26] [11)]. The listing of a specific relevant standard for a particular disinfectant does not imply that this disinfectant is suitable or recommended for the proposed use; fitness for purpose of the chosen disinfectant should be ensured, including its effectiveness in controlling microorganisms in the proposed application.

[11)] www.dwi.gov.uk

NOTE Attention is drawn to the Water Industry Act [5] for information on contacting the relevant authority before water used to disinfect an installation is discharged into a sewer.

Where water is to be discharged into a water course or into a drain leading to the same, consent to discharge should be obtained from the appropriate authority, i.e. the Environment Agency in England and Wales, the Scottish Environmental Protection Agency in Scotland and the Department of the Environment for Northern Ireland in Northern Ireland. The sequence of disinfection should be water mains, service pipes, cisterns and the internal distribution system.

5.2.3.6 Cisterns with internal coatings

Because high chlorine concentrations and other disinfectants can adversely affect new coatings in cisterns and release chlorinated or other compounds into the water, the coating should be thoroughly cured before disinfection takes place and 50 mg/L chlorine concentration or the manufacturer's recommendation for alternative approved disinfectants should not be exceeded.

All cisterns storing water for domestic purposes should be made from or lined with material that is approved for contact with drinking water in the WRAS *Water fittings and materials directory* [27] and or supporting documentation demonstrating conformity to BS 6920 (all parts).

5.2.3.7 Localized repairs

Junctions or fittings for a localized repair inserted into an existing external pipeline should be disinfected by immersion in a solution of sodium hypochlorite containing 200 mg/L of available chlorine.

5.2.3.8 Safety

Systems, or parts of systems, should not be used during the disinfection procedure and all outlets should be marked with "DISINFECTION IN PROGRESS, DO NOT USE".

To avoid the generation of toxic fumes, no other chemicals, e.g. toilet cleansers, should be added to the water until disinfection is complete. All building users should be informed of the disinfection before it takes place. This includes those not normally in attendance during working hours, i.e. cleaners and security guards.

5.2.3.9 Disinfection procedure

5.2.3.9.1 General

The system to be disinfected should be thoroughly flushed before commencing the disinfection procedure.

For supply pipes (including unvented hot water systems off the supply pipe) after flushing, disinfectant solution should be injected through a properly installed injection point at the upstream end of the supply pipe until the disinfectant solution discharged at the downstream end of the pipeline is equal to the initial concentration; the contact period then commences.

Disinfection should be carried out via a temporary connection incorporating the appropriate backflow prevention.

5.2.3.9.2 Methods using chlorine as a disinfectant

5.2.3.9.2.1 Chlorine dioxide

Once vessels have been mechanically cleaned internally and externally, they should be disinfected by making full contact of the inner surfaces using wholesome cold water containing 21.0 mg/L chlorine dioxide (ClO_2) (see Figure 16 and Figure 17, which illustrate the more likely practical times and concentrations obtained using the equation Contact time (h) = 300/free chlorine (mg/L) graphically, which can be used as a "look-up chart" for practical application; see also BS EN 12671).

NOTE Chlorine dioxide has the advantage of being effective against biofilms.

Figure 16 **Initial free chlorine concentration and contact period for tank disinfection (see Table 13, columns 1 and 2)**

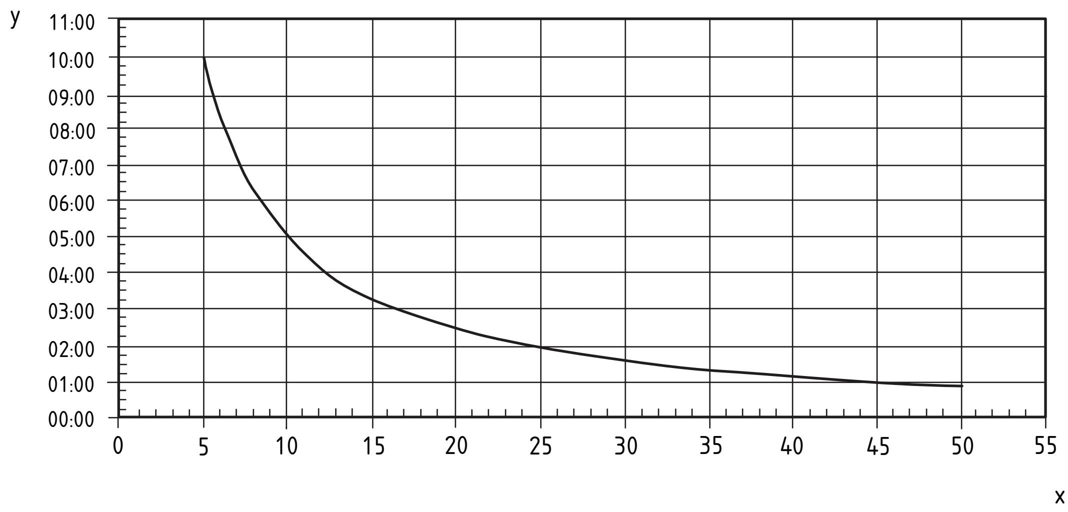
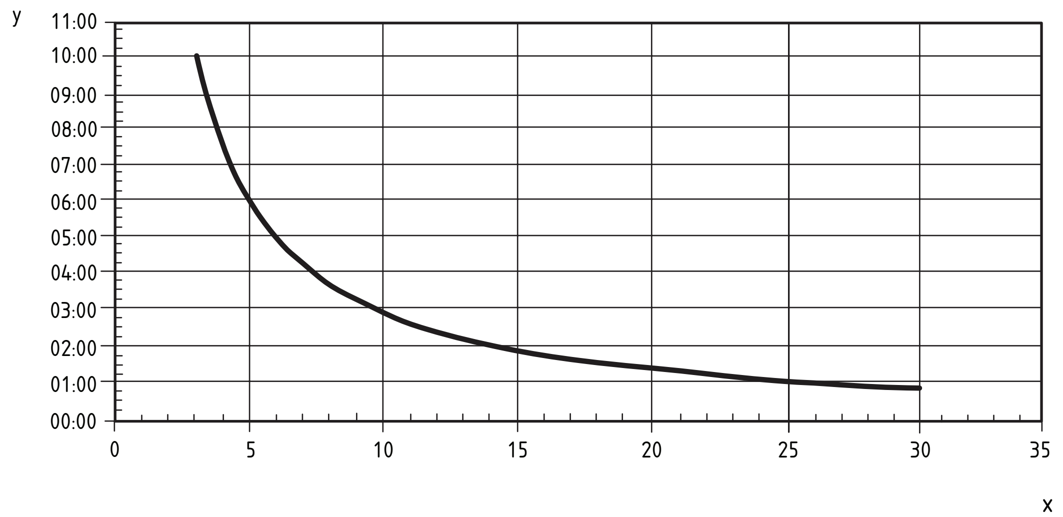


Figure 17 **Minimum residual free chlorine after contact period (see Table 13, column 3)**



NOTE Minimum residual free chlorine measured at the end of the contact period.

5.2.3.9.2.2 Free chlorine soaking

When disinfecting pillow tanks, chlorine dioxide solution should be introduced into the vessel to separate both top and bottom surfaces of the tank, while ensuring contact of the sides and agitating the surfaces by moving the solution inside the tank (walking in circles on top of the tank is a very effective method).

Another regularly used contact disinfectant is water containing up to 50 mg/L of free chlorine for the appropriate time given in Table 13 (see also Figure 16 and Figure 17). This disinfectant medium is satisfactory, but is less effective in stripping biofilm and, over time, proves more difficult to obtain a satisfactory microbiological test result.

NOTE Table 13 was constructed using data from the equation:
Contact time (h) = 300/free chlorine (mg/L).

Table 13 **Chlorine contact period** [A)]

1	2	3
Initial free chlorine concentration mg/L	**Contact period** h:min	**Minimum residual free chlorine measured at the end of the contact period** mg/L
3.1	16:00 [B)]	1.9
5	10:00	3
10	05:00	6
15	03:20	9
20	02:30	12
25	02:00	15
30	01:40	18
40	01:15	24
50 [C)]	01:00	30

A) If the residual free chlorine measured at the end of the contact period is less than the values in Table 13, this indicates an excessive chlorine demand and poor cleaning beforehand. Where this is the case, the disinfection process should be repeated. After the allotted contact period, the loss of free chlorine should not exceed 40%.

B) Contact periods of greater than 16 h prove impractical under most circumstances when vessels are required for use; this equates to a minimum practical residual free chlorine concentration of 1.9 mg/L.

C) 50 mg/L chlorine concentration should not be exceeded to avoid corrosion risks to copper.

NOTE 1 The information in Table 13 is reproduced using the disinfection criteria in BS 6700:1997, ***3.1.10.4.1*** *(superseded).*

NOTE 2 The contact period commences when the entire volume, up to overflow concentration, is full of disinfectant solution at the required initial concentration.

5.2.3.9.3 Supplementary disinfection dosing

If the building system is designed to operate with the support of supplementary disinfection equipment, or if such equipment is retrofitted to an existing building, the designers and specifies of such equipment should consider:

a) the water storage capacity in the building with particular reference to the water age;

b) the concentration and type of residual disinfectant present in the supply water;

c) the natural disinfectant demand of the water;

d) the inherent quality factors attributable to the supply water that might affect the performance of the disinfectant to be added to the system;

e) the synergistic and additive effects of inherent supply disinfectant residuals and their effects on those to be added to the system;

f) the half-life of the disinfectant material to be added to the system; and

NOTE This is important for the maintenance of the minimum dose during periods of building inactivity, e.g. overnight, at weekends.

g) the effects of changes in water temperature on the efficacy of the disinfectant to be applied.

Suitable backflow protection should be incorporated upstream of the injection point.

Disinfectants do not remain stable and unchanged over the entire storage period under all circumstances of use and occupancy. Water softeners, different materials of system construction and the process by which cisterns are filled all affect the disinfectant residual achieved. These variables should be considered in the dosing regime design.

5.2.3.9.4 Location of dosing equipment

Dosing equipment should be located at points in the system where the most effective deployment of disinfectant can be achieved. Where designing supplementary disinfectant regimes, the minimum effective dose should be achievable over the minimum of a 24-hour period. Additionally, the minimum concentration should be sustained during the designed water storage period at full occupancy of a building.

At the time of building or plant commissioning, it should be demonstrated that effective doses can be maintained over the longest period of predicted building inactivity proportionate to its functionality, e.g. a hospital might demonstrate active occupancy over a weekend, an office block where water age increases over those predicted for occupancy during a working day.

At the time of commissioning, a building-wide sampling plan should be drafted and a structured monitoring exercise carried out to demonstrate the efficacy of the equipment.

Contractual variations may be necessary to accommodate for modification or refits if the building cannot be effectively tested due to low or no occupancy at the time of commissioning of dosing equipment.

5.2.3.9.5 Sampling

Samples should be:

- appropriate for the specified purpose, i.e. microbiological assessment, chemical analysis or on-site testing;
- sufficient in number to be fully representative of the distribution system, sub-branches, tanks and cisterns as well as the condition to be evaluated, e.g. completion of a cleaning process, efficacy of distribution of disinfectant; and
- taken at a frequency which is representative of the time series to be demonstrated, e.g. taking into account the growth rate of the organism when designing the monitoring scheme to check for potential microbiological colonization.

For further guidance on sampling, see BS EN ISO 5667-3, BS ISO 5667-5, BS EN ISO 19458, BS 7592 and BS 6068-6.3.

Where alternative temporary supplies are used during construction, or at other necessary times of deployment, sampling should be conducted in accordance with BS ISO 5667-21.

Where testing for disinfectant materials, appropriately calibrated test kits should be used at the point of sampling. Test kits should be:

- within the operable shelf life as specified by the manufacturer;
- capable of providing results within the recommended control range of the substance being measured; and
- assessed and the results documented before use to determine the consequences of any interfering substances, which should be understood by the operator.

Field test kits should be used in accordance with BS 1427.

Where temporary water supplies have been used for system filling at the time of construction or for supplementary provision when mains water is not available, the supply should also be monitored in accordance with BS 8551.

5.2.3.9.6 Sampling plan

Sampling is a necessary part of water quality management in buildings and distribution systems. All sampling exercises should:

a) routinely assess compliance or efficacy and/or efficiency of a process, e.g. disinfection, thermal performance; and

b) determine change in water quality, both intended, e.g. addition of new items of equipment such as a water softener, and unintended, e.g. infestation of Legionella bacteria.

Both types of assessment should have separate sampling plans prepared. Sampling plans should be able to provide sufficient information to satisfy the data user's requirements by establishing compliance with required specifications and/or identifying the cause of changes in water quality. Sampling plans may need to be periodically varied to achieve this.

Sampling is important for the protection of public health as well as regulatory and contractual compliance; a responsible person should be appointed to oversee sampling at the time of construction as well as during the operational use of a water system. To ensure the sampling results are used effectively, a sampling plan should be prepared for agreement before the operations begin.

Sampling plans should be prepared in accordance with BS EN ISO 5667-1 and BS 6068-6.1.

The sampling plan should contain agreed sample locations identified on a schematic and documented in a list which forms the basis for assessment of:

a) the adequate distribution of disinfection materials at the time of initial application;

b) the efficacy of disinfection demand within the system after the allotted contact time. In particular, the plan should be sufficient to demonstrate, with adequate samples, that there has not been excessive disinfection demand; and

c) there being no inherent surviving population of any resident microbiological population represented by:

   1) total viable counts (TVC) measured at 22°C;

   2) TVC measured at 37°C;

   3) Coliform bacteria; and

   4) Pseudomonas aeruginosa.

5.2.3.9.7 Sampling and monitoring quality assurance

Regular sampling practice audits should be carried out to ensure that a responsible person can verify the cleaning process or monitoring programme as part of a building water safety plan (see the WHO's *Water safety in buildings* [28]). Water quality sampling practice should be audited in accordance with BS 8550.

5.2.3.9.8 Water management log book

On completion of the disinfection process the following documentation should be made available for use in the water management logbook at the time of occupancy:

a) a certificate of approval of the sampling plan signed by the responsible person.

b) certification of acknowledgement of the efficacy of disinfection (chlorine demand is not excessive); and

c) certification that there is adequate residual disinfection available on completion of the cleaning process. This documentation should also recognize that there is no excess residual disinfectant above the recommended values.

Where the certification is part of a handover procedure, a nominated responsible person from all parties involved should indicate approval of completion.

A portfolio of supporting information should be provided for the water management logbook. This should contain, as a minimum:

- copies of all operator/supervisor field notes and instructions for cleaning and disinfection;
- copies of all field records of on-site tests;
- copies of custody documents and laboratory scheduling communications;
- records of flushing volumes;
- a copy of any sampling audits carried out together with notes of corrective action taken to mitigate any non-conformity;
- records of the free chlorine residuals achieved at the time of certification for the disinfection process;
- copies of material safety sheets for the disinfectants used; and
- any other relevant documentation which might provide assistance in the ongoing management or assessment of water quality in the system.

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

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

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

NOTE For single dwellings, the responsibility for maintenance is normally the householders. This includes identifying and correcting leakages and any discharges from overflow pipes or regular discharges from any valves.

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.

The services of a competent person qualified to carry out the work should be obtained to carry out maintenance and repairs. Competence includes the appropriate skills and knowledge of the relevant statutory requirements relating to water supply.

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

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**.

These checks should be carried out during 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 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

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

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

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

Periodic chemical and bacteriological 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.

Disinfection of the water system should be undertaken;

a) for both the hot and cold water system, as described in **5.2.3**; 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* [N1]).

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

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.

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 they 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 (all parts) as suitable for use in contact with drinking water. 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.

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.

Measures should be taken in accordance with **4.3.32.2** to prevent the colonization of the system with Legionella and Pseudomonas bacteria.

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

Self-closing taps, WCs with drop valves, flap valves or internal overflow arrangements, and flushing urinals should be monitored particularly closely. 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 detect.

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

The meter or meters 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

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.

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, see the HSE's *Approved Code of Practice L8, Legionnaires' disease – The control of Legionella bacteria in water systems* [N1].

Gland packings on taps should be tightened or renewed as necessary to prevent any leakage while not impeding the normal operation of the fitting. Stopvalves should be operated at least once per year to ensure free movement of working parts.

Any stiffness or leakage through the gland should be prevented by lubrication, adjustment or replacement of gland packings or seals. If there is any indication of leakage past the seating, the valve should be rewashered, reseated or replaced as necessary. If there is any indication that the waterway is blocked, the valve should be dismantled, cleared and restored to good working order or replaced.

All materials used should be suitable for contact with wholesome water.

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

Where necessary, meters (other than the water supplier's meters) should be removed for cleaning and renewal of worn parts, and recalibration.

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.

NOTE Discharge from warning pipes is generally associated with float valves.

Where a pressure gauge is fitted downstream of a pressure control valve, its reading should be checked twice monthly and any changes investigated. In addition checks should be carried out for accuracy and, where necessary, recalibrated or replaced.

6.2.3 Ducts

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

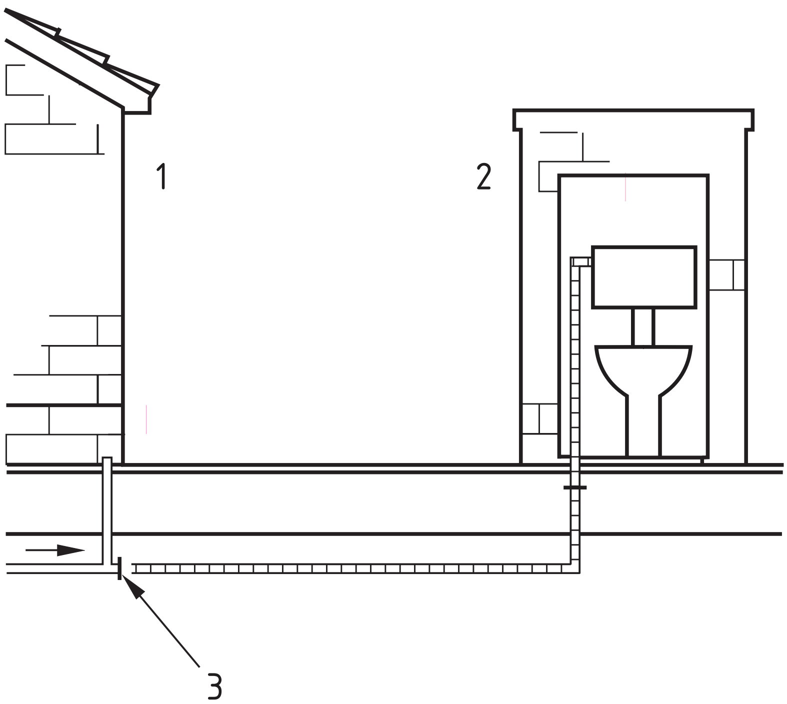
All access points should be checked to ensure that they have not been obstructed. Inspections should be made twice monthly to detect any vermin and determine the need for disinfestation. Crawlways and subways should be inspected at intervals not exceeding six months. They should be checked for leakage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

6.2.4 Disconnection of unused pipes and fittings

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 18).

It is undesirable and can be dangerous to have lengths of pipework containing stagnant water connected to the service installation. The Water Fittings Regulations [7] prescribe a maximum period of 60 days during which water fittings may be disconnected for repair or renewal without disconnecting the pipework supplying them with water.

Figure 18 **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 (normative) 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.

Booster pumps can cause excessive aeration; although this does not cause deterioration of water quality, the turbid appearance of aerated water can cause concern amongst consumers.

The provision of sampling taps on outlets from booster pumps is desirable. The following systems are given as examples:

a) indirect boosting to storage cistern;

b) indirect boosting with pressure vessel;

c) direct boosting; and

d) direct boosting to header and duplicate storage cisterns.

A.2 Indirect boosting to storage cistern

Where the water supplier insists on a break cistern being incorporated in the installation, the pumps should be fitted to the outlet from the break cistern. The effective capacity of the break cistern should be decided after consideration of the total water storage requirements and its location within the building, but should be not less than 15 min of pump output. The cistern should not be oversized as this could result in stagnation of the water.

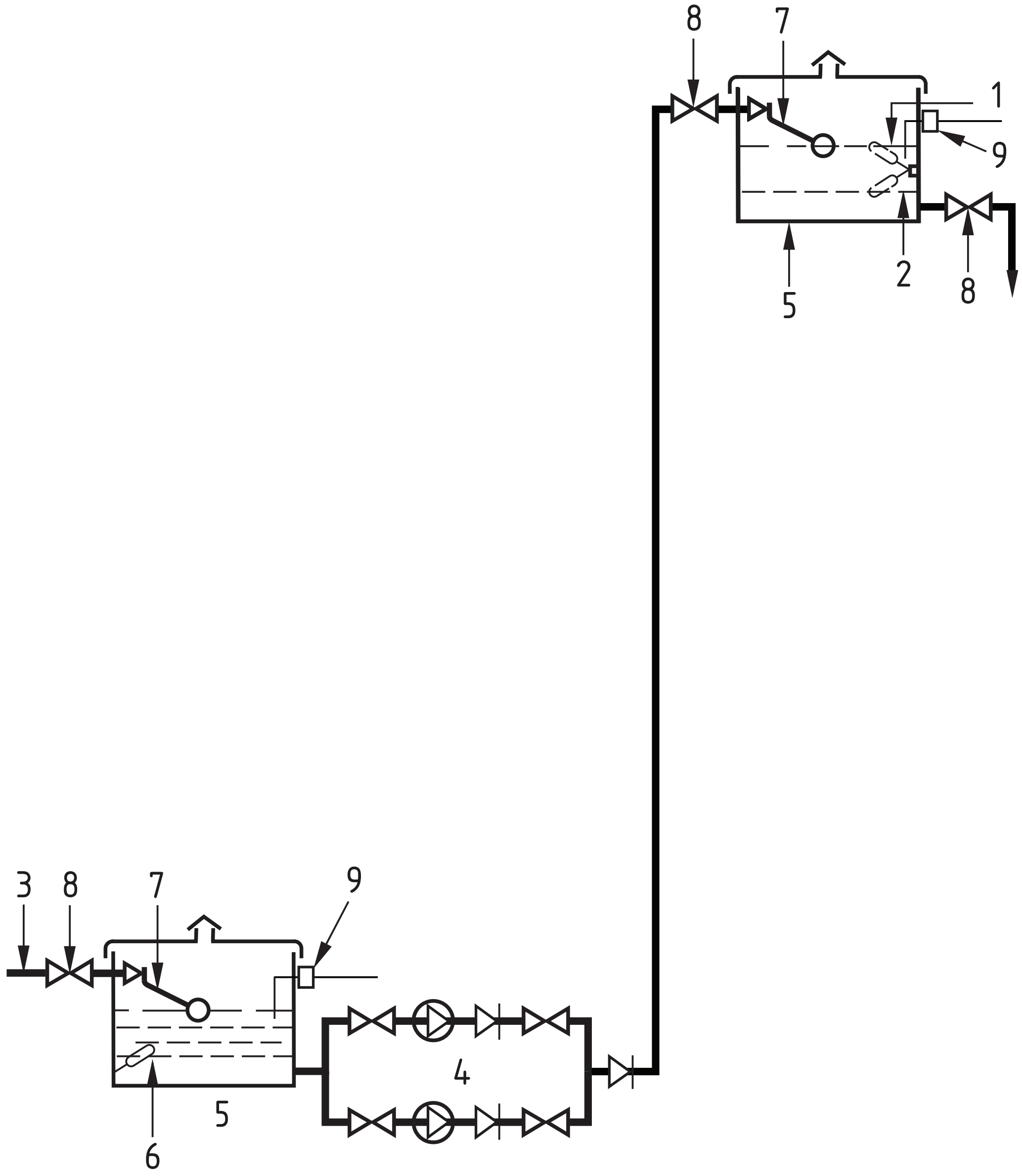
The water level in the storage cistern or cisterns is controlled by water level switches controlling the pumps. When the water level drops to a predetermined value, the pumps start and are switched off when the water level reaches a point approximately 50 mm below the float operated valve shut-off level. Additionally, a water level switch should be positioned in the break cistern to cut out the pumps when the level of water in the break cistern drops to approximately 225 mm above the pump suction connection. This ensures that the pumps do not run dry (see Figure A.1).

A.3 Indirect boosting with pressure vessel

In buildings where a boosted supply serves a number of delivery points or storage cisterns at various levels, e.g. in flats, it might not be practicable to control the pumps by means of a number of level switches.

An alternative method of control is by use of 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.1 **Indirect boosting from break cistern to storage cistern**



Key

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

NOTE Figure A.1 does not show any additional backflow prevention devices that might be recommended in accordance with ***4.3.32*** *to* ***4.3.33****.*

Figure A.2 **Indirect boosting with pressure vessel**

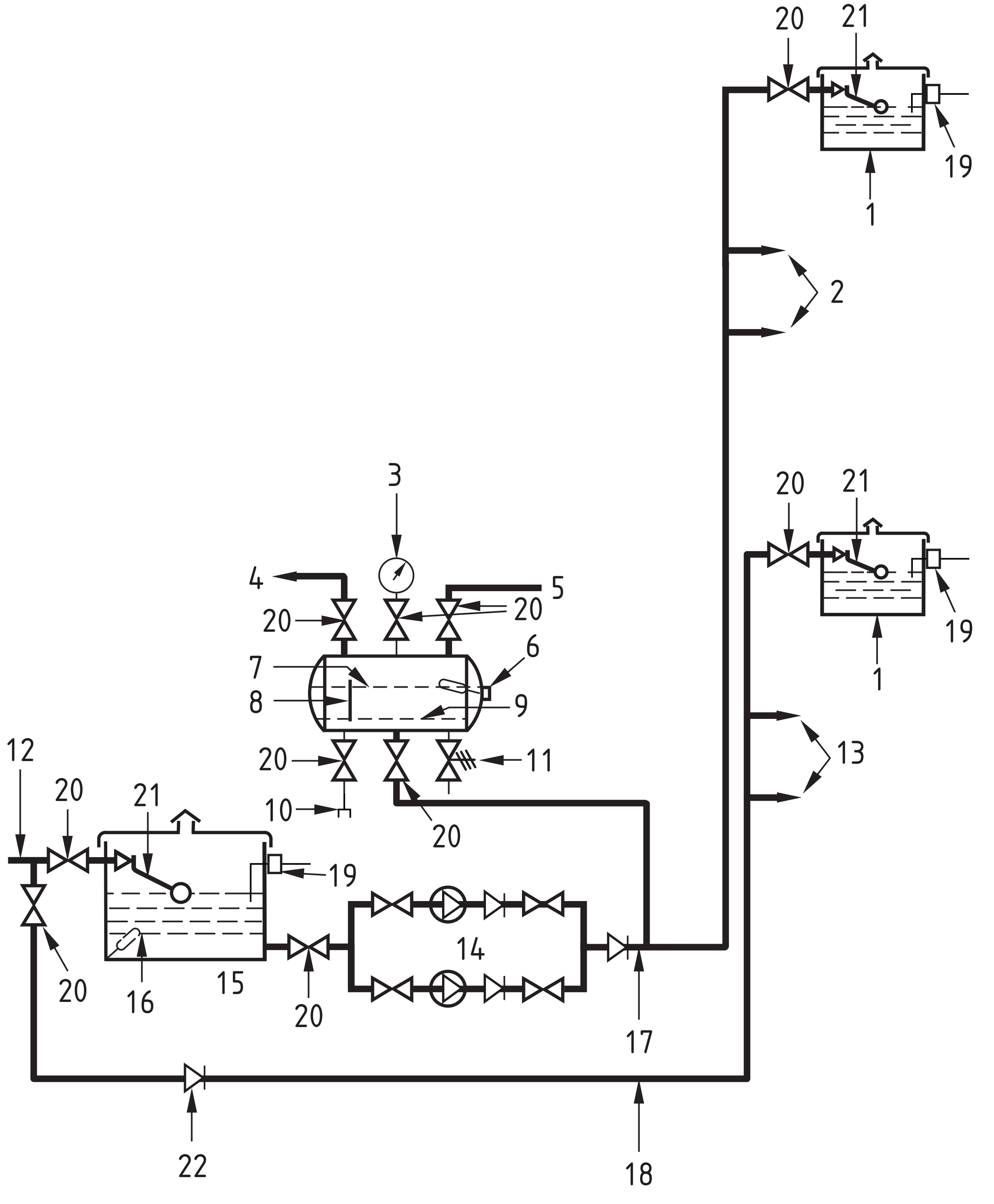


Figure A.2 **Indirect boosting with pressure vessel**

Key

1 Storage cisterns in flats
2 Drinking water supplies to sink taps in flats taken from boosted supply pipe
3 Pressure gauge
4 To pressure switches
5 Air line from compressor
6 Level switch
7 Stop pumping (to pressure vessel)
8 Sight gauge
9 Start pumping
10 Draining valve
11 Pressure relief valve
12 Supply pipe
13 Drinking water supplies to sink taps in flats taken from unboosted supply pipe where mains pressure is sufficient
14 Duplicate pumping set
15 Break cistern
16 Stop pumping (from break cistern)
17 Boosted supply pipe
18 Unboosted supply
19 Warning pipe
20 Servicing valve
21 Float operated valve
22 Check valve

NOTE Figure A.2 does not show any additional backflow prevention devices that might be recommended in accordance with ***4.3.32*** *to* ***4.3.33****.*

A.4 Direct boosting

Where the water supplier has given written permission beforehand, pumps are connected to the incoming supply pipe to enable the pressure head to be increased (see Figure A.3).

A.5 Direct boosting with drinking water header

Where required, the provision of supply drinking water points at high level when the pump is not running can be achieved by a pipe arrangement of limited capacity called a header (see Figure A.4). Level switches should be provided to control the filling of the cold water storage cisterns for non-drinking water. Excessive pressures should not be 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:

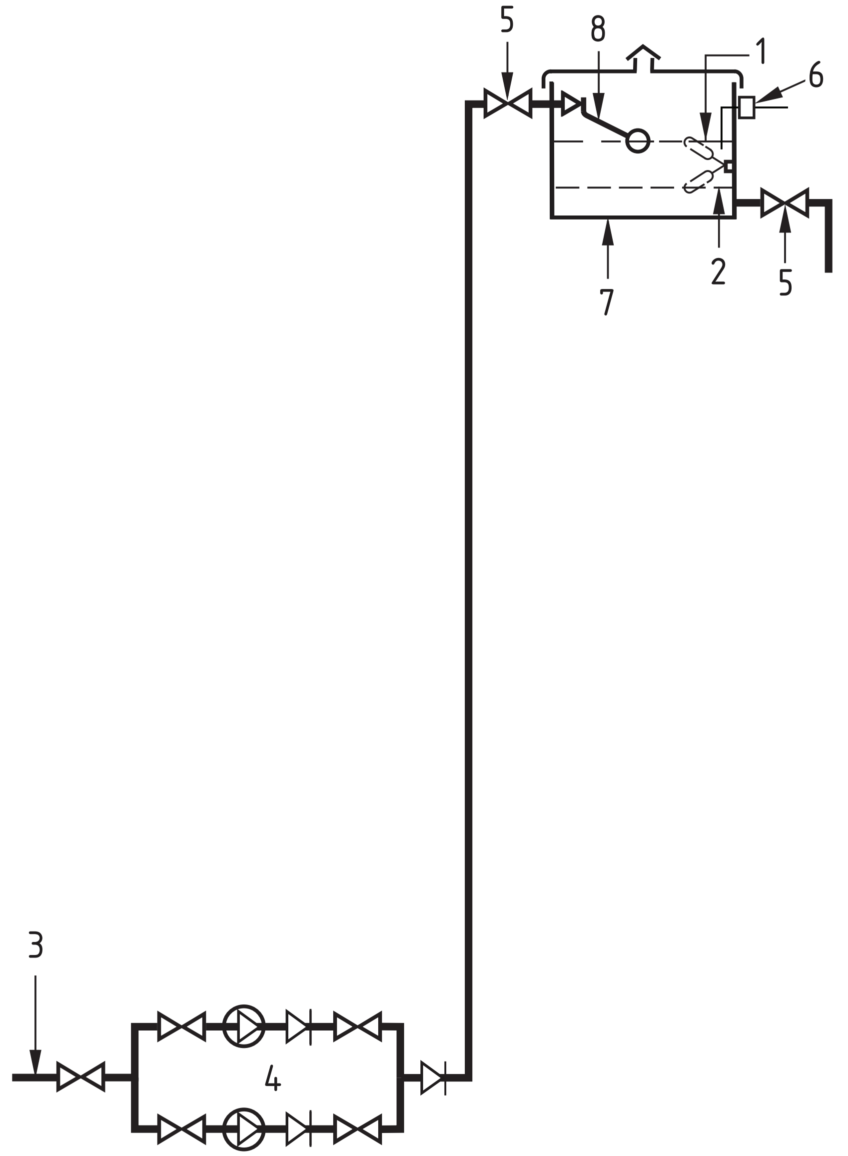
- by the emptying of, or drop in level of, the water in the header; and
- by the fall of the level of water in one of the storage cisterns.

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

A.6 Pumps and equipment

Electrically-driven centrifugal pumping plant is normally used. The pumps should be supplied by an alternative electricity supply in the event of mains failure. Pumps should be installed in duplicate and used alternately. They should be sized so that each pump is capable of overcoming the static lift plus the friction losses in the pipework and valves. All pipework connections to and from pumps should be adequately supported and anchored against thrust to avoid stress on pump casings and to ensure proper alignment.

Figure A.3 **Direct boosting**



Key

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

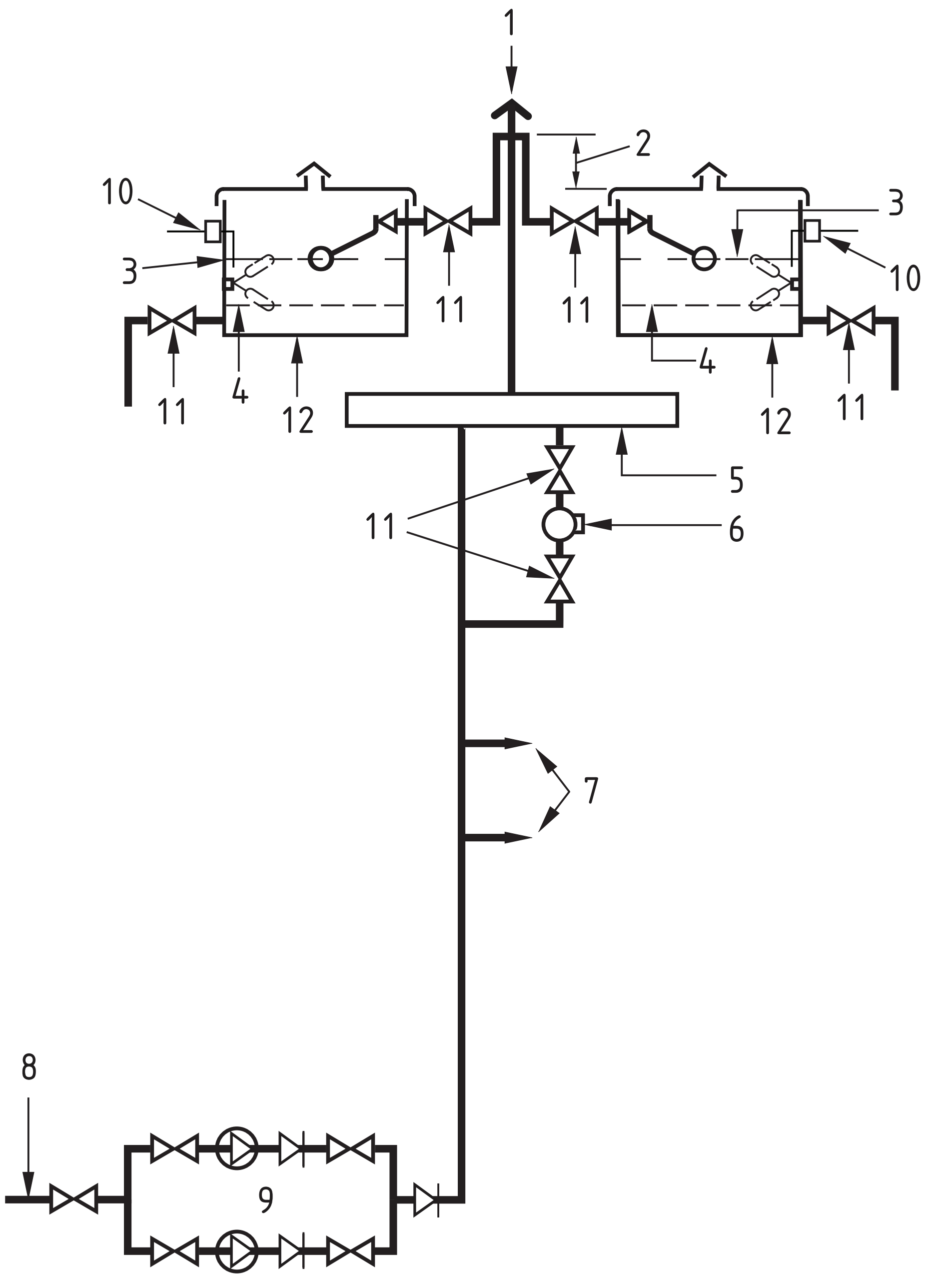
*NOTE Figure A.3 does not show any additional backflow prevention devices that might be recommended in accordance with **4.3.32** to **4.3.33**.*

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 should be 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 should oversee the proper execution of the scheme and the owner/occupier should arrange for regular maintenance and inspection of the pumps and plant.

Figure A.4 **Direct boosting with header and duplicate storage cisterns**



Key

1	Automatic air inlet valve	7	Drinking water supplies to sink taps in flats taken from boosted supply pipe
2	Upstand	8	Supply pipe
3	Stop pumping	9	Duplicate pumping set
4	Start pumping	10	Warning pipe
5	Drinking water header	11	Servicing valve
6	Pipeline level switch	12	Cold water storage cistern

*NOTE 1 Figure A.4 does not show any additional backflow prevention devices that might be recommended in accordance with **4.3.32** to **4.3.33**.*

NOTE 2 Warning pipe to cold water storage cistern not shown.

All work and inspections carried out should be recorded in a suitable log book, which should be kept in the plant room.

NOTE Attention is drawn to the Health and Safety at Work etc. Act 1974 [6] with respect to the inspection of pumps and plant.

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

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

$$M = \frac{(VT)}{(14.3P)}$$

where:

V	is the volume of water heated (L);
T	is the temperature rise (°C);
P	is the rate of heat input to water (kW).

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

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 a simple approximation by taking an average value for *P* is usually sufficient. An indirect cylinder conforming to BS 1566-1 accepts heat inputs up to approximately 15 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.

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

Examples of application:

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 the recommendation 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 since 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:

$$\left(\frac{60-3500}{V}\right)+\left(\frac{1072.5}{V}\right)=40\text{ (or more)}$$

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 given in Table B.1.

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

Heat input to water kW	**Minimum storage capacity** 1	
	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.

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