ENGINEERING STANDARD

FOR

BUILDING PIPING

(HOT AND COLD)

CONTENTS :

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1. SCOPE

This Engineering Standard gives recommendations on the design of services supplying water for domestic use within buildings and their curtilages (excluding generation of heat i.e., boiler house). It covers the system of pipes, fittings and connected appliances installed to supply any building, whether domestic or industrial, with water for ablutionary, cleaning, sanitary, culinary, drinking and domestic laundry purposes.

The pipe sizing methods, avoiding wasteful oversizing, are given with recommendations for prevention of bursting, preservation of water quality, frost precautions and ease of maintenance.

This Standard deals only with low temperature systems; it does not cover systems that are designed to operate with steam or high temperature hot water.

2. REFERENCES

In this Standard, the following standards and publications are referred to, and to the extent specified herein, form a part of this Standard.

BSI (BRITISH STANDARDS INSTITUTION)

BS 6700-1987	"Design, Installation, Testing and Maintenance of Services Supplying Water for Domestic Use Within Buildings and their Curtilages"
BS 4118	"Glossary of Sanitation Terms"
DIN 1988 Part 3	"Drinking Water Supply Systems Pipe Sizing (DVGW Code of Practice)"

ANSI/ASME (AMERICAN NATIONAL STANDARDS INSTITUTE/AMERICAN SOCIETY OF MECHANICAL ENGINEERS)

ANSI/ASME	"A 112.26.1 M-1984 Water Hammer Arresters"

3. DEFINITIONS AND TERMINOLOGY

3.1 Air Gap

The physical break (air gap) measured vertically between the water inlet or feed pipe to an appliance and the water in the appliance.

3.2 Air Chamber, Waterlogged

An air chamber which has lost sufficient air to impair its efficiency.

3.3 Calorifier

A type of indirect hot water cylinder containing a tubular primary heater.

3.4 Chase

A recess that is cut or preformed and designed to accommodate water pipes and fittings which can be accessible by removal of a cover or covers.

3.5 Cylinder

A closed cylindrical vessel capable of storing water under mains pressure.

3.6 Direct Heating System

A hot water supply system in which the water supplied to the draw-off points is heated by a primary source of heat such as gas, electricity, etc.

3.7 Dead Leg

A length of water pipe leading to a draw-off point and not forming part of a circuit.

3.8 Indirect Heating System

A hot water supply system in which the water supplied to the draw-off points is heated by means of a heat exchanger, calorifier or an indirect cylinder.

3.9 Duct (Pipe Duct)

An enclosure designed to accommodate water pipes and fittings and other services if required and 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.

3.10 Faucet

In the United States of America, means "tap". In England means "cock".

3.11 Pipe Fitting

A component fitted to a pipe for jointing, connecting or changing the direction or bore of a pipe.

3.12 Potential Head (Position Head)

The vertical height to the surface of water at a given point above a datum.

3.13 Friction Head (Friction Loss)

Loss of head due to friction i.e. the reduction in head which takes place when water flows from one point to another.

3.14 Velocity Head

The vertical height through which a fall under the influence of gravity alone would give the water a velocity equal to its actual velocity.

3.15 Primary Circuit

A circuit in which water circulates between a boiler and a hot water storage vessel.

3.16 Secondary Circuit

A circuit in which water circulates in distributing pipes (supply return pipes) from and back to a hot water storage vessel (double shell hot water tank).

3.17 Water Hammer Arrester, Engineered

A manufactured device, other than an air chamber or calculated air chamber, containing a permanently sealed cushion of gas or air, designed to provide protection against excessive shock pressure without maintenance.

3.18 Servicing Valve

A valve intended to facilitate maintenance or servicing of a water fitting or appliance (known as "pissoire" in Iran).

4. UNITS

This Standard is based on International System of Units (SI), except where otherwise is specified.

5. GENERAL DESIGN CONSIDERATIONS

5.1 Initial Procedures

5.1.1 Preliminary investigations

The following factors shall be taken into consideration in the design:

a) The water supplier’s requirements; where the water is to be supplied by a public water supplier all the byelaws and any other lawful requirements of that undertaker have to be complied with. Byelaws apply whenever the work involves either a new service or the modification or disconnection of existing services:

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

c) The location of the available supply;

d) The quality, quantity and pressure required;

e) The cold water storage capacity required; if water shall be supplied to cold water taps indirectly i.e. from a cold water storage cistern. See Clause 6.2.2.

f) The likelihood of ground subsidence due to adjacent constructional activities or any other reason;

g) The likelihood of contamination of the site.

5.1.2 Supply of water from a statutory water undertaker

All the byelaws and any other lawful requirements of that undertaker have to be sought and complied with. The said undertaker including the owner may require or give the consumer the option of supply through a meter, in which case an agreement will have to be entered into by the consumer. The supplier may require to know the size of the pipe on which the meter is to be connected, the estimated maximum demand in litres per second and the estimated quarterly or annual consumption in litres or cubic meters.

5.2 Sound Engineering

5.2.1 General

The installation of water distribution lines and fittings to draw-off points shall be designed to avoid waste, undue consumption, misuse and contamination and to ensure continued compliance with the byelaws throughout its useful life without an uneconomic maintenance requirement.

The design of the system should include provision not only for the appliances connected to it but also where reasonable, practicable and economic to do so, for additional appliances that are likely to be installed in the future, such as water softeners (in hard water areas), water meters, etc.

The two systems of pipe laying are:

a) Conventional system of pipe laying to draw-off points-Rigid pipes

In this system of water supply or distribution, the cold and hot pipe-lines in each storey that are branched from riser or return pipes consist of different sized pipe lengths complete with fittings (tees, elbows, bends, plugs etc.) that supply water to the taps of required sanitary units along the distribution pipework in the shortest route possible with due consideration to the accessibility of the pipes for repair and maintenance in case of leakages. The pipes used, in this system of water supply, are usually of rigid kind.

b) New systems of water supply to draw-off points-Flexible pipes

In the last two decades high strength flexible cross linked plastic pipes in pressure services have been used successfully which might be included in future revision of the IPS Standard.

5.2.2 Extensions

Where a water service branch or main pipe has to be extended during future phases of a project, allowance should be made in the initial design of the water pipes with due knowledge of the water supplier authorities.

5.2.3 Choice of pipe laying system and material

The following factors shall be taken into account in selecting the pipe laying system and materials used in a water service: (See also Clause 5.2.1)

a) cost;
b) effect on water quality;
c) internal and external corrosion;

d) compatibility of different materials;
e) aging, fatigue and temperature effects;
f) mechanical properties;
g) durability.

5.2.4 Contamination of the site

If there is any indication that contamination of the ground has occurred, an investigation shall be made to ascertain any residual contamination which may adversely affect buried pipes or fittings. Such indications should be sought from the local authority, the site owner or the water supplier.

5.2.5 External pipework

External pipework shall be installed such that it is unlikely to be damaged by frost or traffic loads and vibration.

The normal minimum depth for protection against frost damage for underground pipework is 0.75 m. This may have to be increased to avoid frost damage, obstructions and/or damage from traffic, to a maximum of 1.35 m. (See Clause 9 for details on frost protection.)

Outside pipework should be located above ground only in exceptional circumstances.

It should be lagged with waterproof insulation material in accordance with 9.4 and provision should be made for draining off all water from such lengths of pipe in frosty weather through a draw-off point, which should not be buried in the ground or so placed that its outlet is in danger of being flooded.

The following recommendations should be carried out where practicable.

a) No pipework should be laid under surfaced footpaths or drives.
b) The underground service pipe should be laid at right angles to the main.
c) The underground service pipe should be laid in approximately straight lines to facilitate location for repairs but with slight deviations to allow for minor ground movements. Where access for repair or replacement may be difficult, consideration should be given to the provision of some form of duct or sleeve.

5.2.6 Accessibility of water pipes and fittings

Apart form the minimum degree of accessibility that may be required by the water supplier authority, the designer of a water supply system should consider the advantages and disadvantages of arranging the pipework so that it is freely accessible for repair and maintenance (e.g. by not screeding over a cover).

5.2.6.1 Rigid pipes

a) Pipes passing through walls and floors

- No pipe shall be installed in the cavity of an external cavity wall. Where a pipe passes through any wall or floor, there shall be adequate provision for movement of the pipe relative to the wall or floor, by the use of a sleeve properly bonded into the wall or floor or by other no less suitable means.

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

- Where a pipe passes into a building it shall be arranged so as to accommodate differential movement and shall be accessible for withdrawal and replacement. Where a sleeve is used for this purpose, it shall be capable of resisting external loading and shall be sealed at each end.

The diameter of the sleeve and the radius of any bends therein shall be such as to permit the ready insertion and withdrawal of the pipe.

- No sleeve intended for carrying a water pipe shall contain within it any other pipe or cable.

b) Pipes in walls, floors and ceilings

- No rigid pipe or pipe joint in or under a building shall be embedded in any wall or solid floor or in any material below a solid floor at ground level except when adequate recesses are provided.

- Pipe and pipe joints enclosed in a purpose-made chase in any external wall or located under a floor at ground level that has basement or enclosed within a purpose-made false ceiling, or duct under any solid floor shall, where necessary, be wrapped, plastics coated or otherwise protected from freezing in accordance with 10.4, corrosion and thermal movement.

- No pipe or pipe joint shall be located under any surface finished floor, at ground floor level, that has no basement unless every pipe and pipe joint is accessible for examination.

- Where access panels are formed in the wooden floor panels of chipboard or plywood, the structural stability of the building shall not be affected.

- All pipes laid in ducts shall be adequately supported by clipping.

c) Underground stopvalves

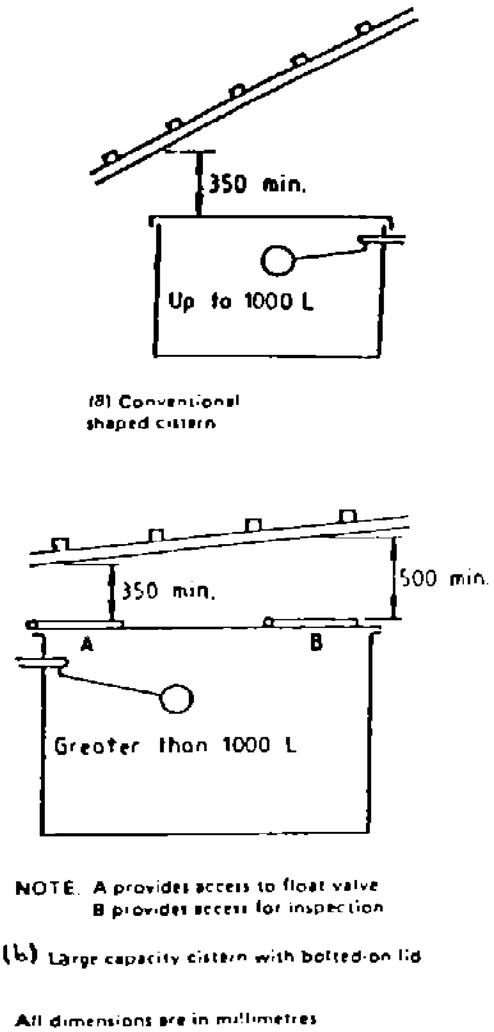
Stopvalves installed on an underground pipe shall be enclosed within a pipe guard or chamber under a surface box of the correct grade for the traffic loading relevant to the location (see IPS-M-CE-345).

d) Accessibility of above ground valves

Every valve shall be so placed that it is readily accessible for examination, maintenance and operation by the means by which it is designed to be operated. Any covers shall be fixed by removable fastenings.

e) Cisterns (see also 6.2.2)

Every storage cistern if provided in the system shall be so placed and equipped that the interior thereof can be inspected and cleansed and the float-operated valve can be maintained, as in Fig. 1. For this purpose a clear space of not less than 350 mm shall be provided between the top of the cistern and any ceiling or other obstruction above the cistern.



CLEAR SPACE NEEDED ABOVE STORAGE CISTERNS
Fig. 1

f) Backflow prevention devices

Every backflow prevention device shall be installed so that it is accessible for examination, repair or replacement.

5.2.7 Prevention of noise and vibration-water hammer arresters

The supply or distribution pipework within a building should be so designed and installed that the flow noises and impulsive noises (water hammer) are prevented or reduced to such an extent as not to cause annoyance for the occupants of the building.

5.3 Pumping

The energy demand for boosting water pressure in a building by pumping amounts to about 0.02 kW.h/m^3 per metre lift.

5.4 Adequacy of Consultation and Technical Documents

5.4.1 Liaison and consultation

From an early stage in the design process of the water distribution system, the necessary liaisons and consultations shall take place with the designer of the building, the building owner or his agent, the water supplier and all other public and private utilities, local authorities, landowners and others involved.

Proper completion and timely submission of notices and applications shall be made to avoid delays.

Whenever other services* are in close proximity to the water service pipes, any byelaws, regulations and requirements of all undertakers concerned shall be ascertained.

Where it is necessary to open the ground for pipe laying or other works, the necessary notices, drawings, documents and applications for consent shall be lodged with the public utility undertakers, landowners and any other interested parties as early as possible, with an aim to obtain written excavation permits.

5.4.2 Technical documents

The installer should be provided with working drawings of the water services showing clearly the precise location of all pipe runs, indicating the method of ducting to be employed where appropriate, the location and full description of all appliances, valves and all other fittings, methods of fixing, protection and all other information which may be required to enable him to construct the work satisfactorily.

The drawings or an accompanying specification should set out clearly any precautions to be taken against frost, corrosion, bursting, expansion and contraction, contamination, noise, damage due to earth movement or any other damage, any consultation required with other public utilities or subcontractors and any notice to be served before or during the execution of the work.

Where possible, the point of entry of the water service should be arranged to facilitate the equipotential bonding of incoming metallic services to the main electrical earth terminal as near as is practical to their point of entry into the premises.

6. COLD WATER SERVICES

6.1 Type of Supply System

6.1.1 Systems in dwellings

Water shall be supplied to cold taps either directly form the mains via the service pipe or indirectly from a cold water storage cistern. The method of supply may be affected by the requirements of the water supplier and these shall be ascertained before proceeding with the design and installation of a water service.

*** In addition to gas, electricity and telephone, these could include amongst others oil pipelines, television relay cables, district heating systems and drainage connections.**

The main factors that should be considered when choosing a cold water supply system are as follows:

a) Characteristics of supply via a storage cistern:

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

2) additional protection of the mains from contamination;

3) 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;

4) a constant low pressure which reduces risk of leakage and rate of leakage and which is suitable for mixer fittings in conjunction with low pressure (vented) hot water supply, but the pressure available is usually insufficient for some types of taps and may not be sufficient for showering;

5) increased risk of frost damage;

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

7) need to ensure that the cistern is continuously protected against the ingress of any contaminant and need to replace the cistern, usually at infrequent intervals.

b) Characteristics of supply direct from mains:

1) smaller pipes may be used in most cases;

2) high pressure supply more suitable for instantaneous type shower heaters, hose taps and for mixer fitting used in conjunction with a high pressure (unvented) hot water supply;

3) more expensive dual-flow mixer fittings required if used in conjunction with a low pressure (vented) hot water supply.

The type of water supply system and its characteristics prescribed in Clause 5.1.1(a) can be advantageous in isolated dwellings far-away from cities with no public water supply e.g. company houses at pumping stations along the route of oil and gas transmission lines, or office buildings within small plants that should provide water supply of their own.

In such cases water conservation and storage is very important, hence the factors involved are more favorable for supply of water to the taps via a cold water storage cistern.

Similarly the type of water supply system and its characteristics prescribed in Clause 6.1.1(b) is advantageous for single dwellings and apartment houses built within cities that have public water supply networks with adequate pressure.

In such circumstances, depending on the available pressure in the mains, supply of cold water to draw-off points through service lines taken directly form the mains of the public water supply networks is recommended.

6.1.2 Preferred system of water supply to draw-off points within company owned plants and residential houses when supply of water is owner’s responsibility.

For cold water supply to draw-off points within company owned plants and housing complexes of single dwellings or apartment buildings with moderate heights it is recommended to have central high level water tanks and distribution networks from which servicing distribution lines shall supply water directly to the taps at controllable and more or less constant and moderate pressures, thus preventing unnecessary wastage of water.

Notes:

1) For design guidances of distribution networks See IPS-E-CE-340.

2) For water reservoirs and elevated tanks refer to IPS-G-CE-420.

6.2 Water Supply Piping and Components

Hydraulic design of water distribution network within buildings is fully discussed under Clause 8 (pipe sizing). But there are many engineering recommendations, that for preparation and construction of working drawings of pipework and components, these engineering guidances need to be addressed prior to sizing of pipes.

6.2.1 Supply and distributing pipes

No drinking water point shall be installed at the end of a long pipe where only small volumes of water are drawn-off. 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 a high demand.

- Where cold water pipes pass through areas of relatively high dew point, e.g. habitable rooms, they shall be insulated to prevent condensation forming on them.

- Pipe runs to cold water taps within buildings shall not follow the routes of space heating or hot water pipes or pass through heated areas such as airing cupboards or, where local proximity is unavoidable, the hot and cold pipes shall be insulated form each other.

- Pipe runs within buildings should not be laid exactly horizontal but to a slight fall to reduce the risk of air locks forming. For a similar reason, pipes should be laid clear of obstructions such as joists and doorways to avoid local undulations.

- Overflow and warning pipes shall be made of rigid, corrosion resistant material; no flexible hose shall be connected to or form part of any overflow or warning pipe. When a single overflow pipe is fitted its bore shall be greater than that of the inlet pipe to the cistern and in no case shall any warning pipe be less than 19 mm internal diameter.

- Every cistern of capacity* up to 1000 L shall be fitted with a warning pipe, and no other overflow pipe.

- Cisterns of capacity exceeding 1000 L shall be fitted with one or more overflow pipes. For capacities of 5000 to 10,000 L, lowest overflow pipe shall be a warning pipe.

  For capacities greater than 10,000 L, either the lowest overflow pipe shall be a warning pipe or a device shall be fitted that gives an audible or visual alarm when the water reaches the level overflowing and which acts independently of the normal service inlet control valve.

- No warning or overflow pipes shall rise in level outside the cistern.

  Every warning pipe shall discharge water immediately the water in the cistern reaches the overflowing level and shall discharge in a conspicuous position, preferably outside the building where this is appropriate.

- All distributing pipes from cisterns shall be connected so that the lowest point of the outlet is not less than 30 mm above the bottom of the cistern. This is to impede the passage of sediment into the pipework.

*** (If filled to the level at which water just starts to flow through any overflow pipe).**

6.2.2 Storage cisterns

6.2.2.1 General

- Storage cisterns or thanks for domestic purposes, if provided, shall not impart taste, color, odor or toxicity to the water, nor promote or foster microbial growth under the conditions where the tank is installed (see Clause 8).

- Any cistern from which water for domestic purposes may be drawn shall be:

a) a watertight vessel having a tightly fitting, but not airtight, and rigid access cover of materials not likely to fragment nor to contaminate any condensate which may form on its underside, that will exclude insects, securely fixed in position;

b) where necessary, lined or coated with a material suitable for use in contact with potable water;

c) where necessary, insulated against heat and frost;

d) supplied from a service pipe from the water supplier's mains or from a pump drawing water from a cistern which is also a watertight closed vessel similarly equipped and supplied as above;

e) when of capacity greater that 1000 L, so constructed that the interior can be readily inspected and cleaned, and the inlet control valve adjusted and maintained without having to remove the cover or the whole of any cover which is in two or more parts;

f) the cover should accommodate any vent or expansion pipes in closely-fitting, purpose-made holes or sleeves.

- The material of a cistern shall be corrosion resisting or shall be coated internally with corrosion resisting material. The cistern shall be designed to have sufficient strength to perform its function without undue deformation. The lid or cover shall be made of materials compatible with those of the cistern.

- The cistern shall be supported on a firm level base capable of withstanding the weight of the cistern when filled with water to the rim. Every plastics cistern shall be supported on a flat rigid platform fully supporting the bottom of the cistern over the whole of its area.

- Except for interconnected cisterns arranged to store water at the same level, every pipe supplying water to a cistern shall be fitted with a float-operated valve or some other equally effective device to control the inflow of water and maintain it at the required level.

The inlet control device shall be suitable for the particular application, bearing in mind the supply pressure and the temperature of the water in the cistern. The float-operated valves shall comply with relevant Clauses of IPS-M-CE-345.

- Every float-operated valve shall be securely fixed to the cistern it supplies and where necessary braced to prevent the thrust of the float causing the valve to move and so affect the water level at which it shuts off. This water level shall be at least 25 mm below the lowest point of the warning pipe connection or, if no warning pipe is fitted, at least 50 mm below the lowest point of the lowest overflow pipe connection.

6.2.2.2 Cistern capacity

- In designing the storage cistern capacity account shall be taken of the pattern of water use in the premises concerned and, where possible to assess, the likely frequency and duration of breakdown in supply from the water supplier's mains.

For example, a water supplier may be providing water within its statutory requirements but, nevertheless, the pressure may be so low over such periods of the day as to warrant increased storage capacity to ensure that there is an adequate reserve for all purposes in the building.

Table 1 given recommendations for storage capacities related to various types of use but these are to be regarded as a guide only. The water supplier should be consulted regarding any particular requirements it may have in this matter.

TABLE 1 - RECOMMENDED MINIMUM STORAGE OF COLD WATER FOR DOMESTIC PURPOSES

TYPE OF BUILDING OR OCCUPATION	MINIMUM STORAGE (L)
HOSTEL	90 PER BED SPACE
HOTEL	200 PER BED SPACE
OFFICE PREMISES:	
WITH CANTEEN FACILITIES	45 PER EMPLOYEE
WITHOUT CANTEEN FACILITIES	40 PER EMPLOYEE
RESTAURANT	7 PER MEAL
DAY SCHOOL: NURSERY	15 PER PUPIL
PRIMARY	
SECONDARY	20 PER PUPIL
TECHNICAL	
BOARDING SCHOOL	90 PER PUPIL
CHILDREN'S HOME OR RESIDENTIAL NURSERY	135 PER BED SPACE
NURSE'S HOME	120 PER BED SPACE
NURSING OR CONVALESCENT HOME	135 PER BED SPACE

In small houses it is usual for storage cisterns supplying only cold water fittings to have a capacity of 100 L to 150 L, and double this capacity if supplying all water outlets, hot and cold. In larger houses a total storage capacity of 100 L per bedroom is recommended.

In a hospital it is important to ensure that storage is adequate to meet the particular demands of the facilities provided. For example, a convalescent home may not require the same amount of water as a fully equipped teaching hospital. It is usual to calculate storage capacity on the basis of so much per bed space. The same philosophy should be applied to setting storage requirements in various types of hotels.

6.2.3 Valves-All kinds

6.2.3.1 Stopvalves fitted to service pipes below or above ground shall comply with the relevant clauses of IPS-M-CE-345.

The stopvalve components of fittings incorporating stopvalves shall comply with the requirements for stopvalves.

When a stopvalve is installed on an underground pipe it shall be enclosed in a pipe guard under a surface box.

- In every building or part of a building to which a separately chargeable supply of water is provided and in all premises occupied as a dwelling, whether or not separately charged for a supply of water, a stopvalve shall be provided that controls the whole of the supply to the premises concerned without shutting off the supply to any other premises. This stopvalve shall, so far as is 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.

- In addition, where a common supply or distributing pipe provides water to two or more premises, it shall be fitted with a stopvalve that controls the water supply to all of the premises supplied by that pipe. This stopvalve shall be installed either inside or outside the building in a position to which every occupier of premises supplied has access.

- A stopvalve shall 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 shall 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.

- In addition to the above requirements, it is often advantageous where a building is divided into separately occupied parts, for the supply to each part to 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.

The principle on which these requirements and recommendations are based 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. Any occupier should be able to drain down his supply to avoid frost damage and to shut off his own supply or a supply in unoccupied premises which is causing damage or nuisance by means of a stopvalve under his control or to which he has ready access.

6.2.3.2 Servicing valves

- Servicing valves shall be provided and located in positions so as to enable the flow of water to individual or groups of appliances to be controlled and to limit the inconvenience caused by interruption of supply during repairs. This is of particular importance in large buildings.

- A servicing valve shall either comply with the requirements for stopvalves specified in 6.2.3.1 or shall be capable of withstanding a static pressure 1.5 times the maximum pressure it will be subjected to in use, and be leak-tight when closed against the latter pressure.

- A servicing valve shall be fitted upstream of, and as close as practicable to, every float-operated valve connected to a supply pipe.

Every pipe taking water from a cistern of capacity exceeding 18 L shall be fitted with a servicing valve near the cistern.

- A siatic water closets, apart from water supply to flush tanks or self closing taps, should have a hot and cold water mixer fitting with servicing valves and a flexible metal hose for the purpose of ablution. The hot and cold servicing valves shall be fitted upstream of every such mixer fitting and flexible draw-off point ("shelang or aftabei").

- If bidets are not provided adjacent to European W.C.s, a flexible metal hose of the kind mentioned above shall be provided next to each European W.C.

6.2.4 Revenue meter installations

It is usual for the installation of the meter on the incoming supply to a premises for revenue charging purposes to be supplied by the water supplier and sited by agreement between the consumer and the water supplier. However, if supply of water to dwellings be the responsibility of the "owner", but there be the likelihood of such services to be rendered by a third party in future, the owner should install such water meter that is acceptable to local water authority who would be the future undertaker. The water meter laid close to servicing or incoming stop valve should be as per IPS-D-CE-190.

- The revenue 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 communication pipe.

  In the case of flats (apartments) or shops in multiple occupation, apart from the main revenue water meter at the boundary of the premises, internal and additional water meters may be installed by the occupants of the premises for controlling and payment of the water consumption fee for each flat, shop etc. in accordance with water meter readings of each consumer.

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

6.2.5 Bounding

No water pipe shall be used as an electrode for earthing purposes, but all metal water pipes shall be bonded to the electrical installation main earth terminal as near as possible to the point of entry into the building.

A suitable conductor shall be installed for bonding between inlet and outlet pipework connections to water meters, water authority stopvalves or other water conveying components in a metal water supply pipe to ensure equipotential bonding. This applies to any pipework temporarily disconnected for the purpose of removing such components for replacement or maintenance.

For dwellings a bond of at least 6 mm^2 cross section shall be connected prior to attaching the pipework which remains in place following installation.

These arrangements are necessary on both internal and external water meter installations for protection of the installer against electrical fault and for maintenance of the earth connection.

7. HOT WATER SERVICES

7.1 General Principles

The hot water service shall be designed to provide, so far as is practicable, hot water at the locations, in the quantities and at the temperatures required by the user at the least overall cost, taking account of installation, maintenance and fuel costs.

7.2 Choice of System

Initially a choice shall be made between water heating by one or more instantaneous heaters, a hot water storage system, and a water-jacketed tube type heater. This choice shall be made bearing in mind the objectives expressed in 7.1 and the characteristics of the different systems.

Dependant on the available source of energy the method for generation of hot water and space heating of living quarters should be chosen with due consideration of least overall cost and simplicity of operation.

For preferred heat generation systems and any diagramatic illustration refer to IPS-E-AR-100.

8. PIPE SIZING-GENERAL

The sizes of the pipes and fittings used in a cold or hot water service shall be such as will provide an adequate rate of delivery of water without recourse to wasteful oversizing.

One of the important items that must be determined before any part of the water piping system can be sized is the probable rate of flow in any particular section of piping.

The rate of flow in the service line, risers and main branches, however, is rarely equal to the sum of the rates of flow of all connected fixtures. In fact, the probability that every fixture in a large group will be in use at the same time is so remote that it would be very poor engineering practice to design the piping to take care of such simultaneous flow.

The demand load in building water supply systems cannot be determined exactly and is not readily standardized. The two main problems to be considered are:

1) the satisfactory supply of water for a given fixture and
2) the number of fixtures that are assumed to be in use at the same time.

Apart from the above considerations, the minimum satisfactory flow at each draw-off point depends greatly on the consumer, his living standard, his professional needs, family size, garden requirements and similar factors. Depending on these factors, the per capita water consumption for domestic use usually varies between 90 to 360 L/day. Type of dwelling also has considerable influence on water consumption. The recommended method of pipe sizing is given hereunder.

8.1 Method of Pipe Sizing Calculation

(Based on the recognized B.S. Standard 6700)

The distribution pipe system of buildings shall be sized so that the design flow rates given in Table 2 will be available at each outlet for most of the time.

TABLE 2 - DESIGN FLOW RATES

OUTLET FITTING	RATE OF FLOW (L/s)
WC FLUSHING CISTERN FLOAT-OPERATED VALVE	0.10
WC FLUSHING THROUGH FLOAT-OPERATED VALVE	0.15 PER WC SERVED
SPRAY TAP OR SPRAY MIXER TAP	0.04 PER TAP
WASH BASIN TAP	0.15 HOT OR COLD
BIDET	0.15 HOT OR COLD
BATH TAP OF NOMINAL SIZE ¾"	0.30 HOT OR COLD
BATH TAP OF NOMINAL SIZE 1"	0.60 HOT OR COLD
SHOWER HEAD	0.10 HOT OR COLD
SINK TAP OF NOMINAL SIZE ½"	0.20 HOT OR COLD
SINK TAP OF NOMINAL SIZE ¾"	0.30 HOT OR COLD
SINK TAP OF NOMINAL SIZE 1"	0.60 HOT OR COLD

Notes:

1) Clothes and dishwashing machines in individual dwellings can normally be satisfactorily supplied by a sink tap of nominal size ½" but manufacturer's instructions should be checked.

2) WC flushing throughs are advisable where anticipated use of WCs is more frequent than once per minute.

3) Mixer fittings or combination tap assemblies deliver less flow than two separate taps, but the difference can normally be disregarded for pipe sizing.

4) The rate of flow will vary according to the type of shower head fitted and the manufacturer should be consulted regarding the recommended discharge rate.

In addition the pipes and fittings shall be sized so that the water velocity in any pipe does not exceed those given in Table 3.

TABLE 3 - MAXIMUM ALLOWABLE WATER VELOCITIES IN PIPEWORK

WATER TEMPERATURE °C	MAXIMUM WATER VELOCITY m/s
10	3.0
50	3.0
70	2.5
90	2.0

Note:

These maxima do not apply to small bore connections of limited length supplied as parts of taps, etc.

The subject of maximum water velocities is currently under investigation and the velocities specified will be amended if the results of this investigation so require.

When the supply system to draw-off points is indirect which needs installation of storage cisterns [see 6.1.1 (a)], the design flow rates to storage cisterns shall be determined by dividing the cistern capacity by the filling time. Where individual houses or flats are supplied from individual minimal sized storage cisterns (see 6.2.2.2), filling time shall be less than 1 h.

Note:

For larger installations filling times can be 4 h or more depending upon usage.

8.1.1 Determination of flow rates

8.1.1.1 Assessment of probable demand

In most buildings it rarely happens that all the appliances installed are in simultaneous use. For reasons of economy therefore, the simultaneous demand which is less than the possible maximum should be assessed. This simultaneous demand can be estimated either by application of probability theory using loading units or from data derived by observation and experience of similar installations.

8.1.1.2 Loading units

Loading units are factors taking into account the flow rate at the appliance, the length of time in use and the frequency of use. The number of each type of appliance fed by the pipe run concerned is multiplied by its loading unit as given in Table 4 and the results added together to obtain a figure for the total loading units. By use of Fig. 2 this total of loading units is converted into the total simultaneous demand for that group of appliances, as a design flow rate in litres per second. For most practical purposes the same loading units can be adopted for both hot and cold outlets. Table 4 is based on normal domestic usage and customary (or statutory) provision of appliances.

8.1.2 Head losses in pipes, fittings and valves

8.1.2.1 Pipes

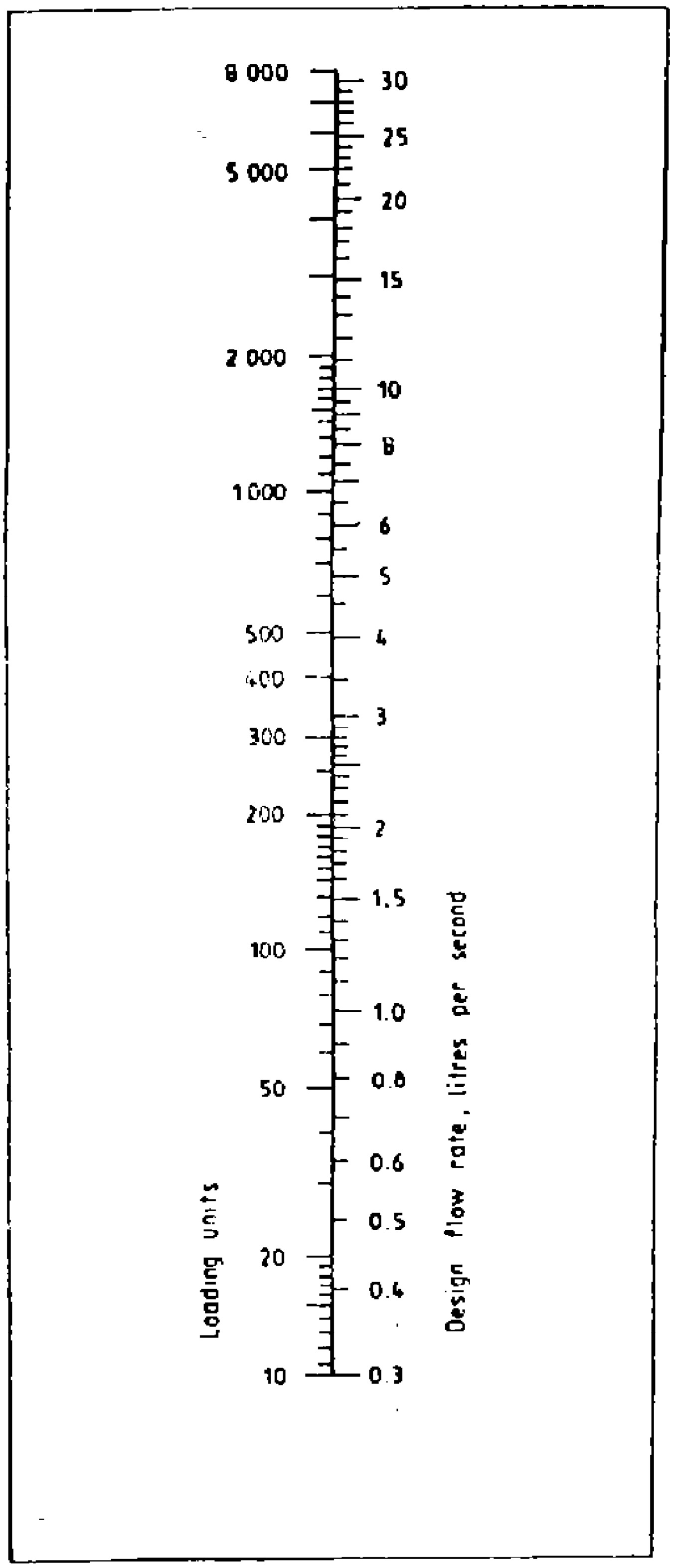
The rate of flow of water through a pipe depends upon the length and bore diameter, the roughness of the surface and the pressure drop (head loss) along the pipe.

8.1.2.2 Pipe fittings

The loss of head through pipe fittings (elbows and tees) should be expressed as the loss of head through an equivalent length of pipe as set out in Table 5.

8.1.2.3 Valves

The loss of head through stopvalves and check valves is relatively large. These losses are expressed as the loss of head through an equivalent length of pipe as in Table 5 and added to the actual length.



CONVERSION OF LOADING UNITS TO DESIGN FLOW RATE
Fig. 2

TABLE 4 - LOADING UNITS (HOT OR COLD SUPPLY)

APPLIANCES	LOADING UNITS
WC FLUSHING CISTERN (9 L)	2
WASH BASIN	1½ TO 3
BATH TAP OF NOMINAL SIZE ¾"	10
BATH TAP OF NOMINAL SIZE 1"	22
SHOWER	3
SINK TAP OF NOMINAL SIZE ½"	3
SINK TAP OF NOMINAL SIZE ¾"	5

Notes:

1) WC flushing cisterns with single or dual flush control have the same loading unit.

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

3) Clothes washing machines and dishwashing machines in individual dwellings can be assessed as sinks fitted with taps of nominal size ½".

4) Outlet fittings for industrial purposes or requiring high peak demands to be met should be taken into account by adding 100% of their flow rate to the design flow rate for other appliances obtained by using loading units.

TABLE 5 - EQUIVALENT PIPE LENGTHS (COPPER, PLASTICS AND STAINLESS STEEL)

BORE OF PIPE mm	EQUIVALENT PIPE LENGTH			
	ELBOW m	TEE m	STOP VALVE m	CHECK VALVE m
12	0.5	0.6	4.0	2.5
20	0.8	1.0	7.0	4.3
25	1.0	1.5	10.0	5.6
32	1.4	2.0	13.0	6.0
40	1.7	2.5	16.0	7.9
50	2.3	3.5	22.0	11.5
65	3.0	4.5	—	—
73	3.4	5.8	34.0	—

Notes:

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

2) In some systems special fittings with significant head losses are used. For information on head losses in these fittings, reference should be made to the manufacturers of such fittings.

3) Where it is proposed and permitted to use galvanized steel pipes in a small installation, the calculations for pipe sizing, for all practical purposes, may be based on the data given in this table for equivalent nominal sizes of smooth bore pipes.

8.1.2.4 Meters

If there is a meter in the pipeline, the loss of head through the meter at design flow should be deducted from the available head. The amount of such loss can be obtained from the meter manufacturer or from the water supplier.

8.1.2.5 Taps

The residual head available at each tap should be at least equal to the loss of head through the tap at the design flow rate. Alternatively, the loss of head may be expressed as an equivalent length of pipe. Head losses and equivalent lengths of pipe or taps are given in Table 6.

8.1.2.6 Float-operated valves

The nominal size of a float-operated valve, the diameter of its orifice and the size of float required are all dependent on the residual head of water available at the inlet to the valve and flow required.

Where non-standard float valves are used, the data relating the flow rate to the head of water available at the inlet should be obtained from the manufacturer.

TABLE 6 - TYPICAL LOSS OF HEAD THROUGH TAPS AND EQUIVALENT PIPE LENGTHS

TAP	FLOW RATE L/s	LOSS OF HEAD m	EQUIVALENT PIPE LENGTH
NOMINAL SIZE ½"	0.15	0.5	3.7
NOMINAL SIZE ½"	0.20	0.8	3.7
NOMINAL SIZE ¾"	0.30	0.8	11.8
NOMINAL SIZE 1"	0.60	1.5	22.0

***Head losses for stated flow rates are typical only and may vary with taps of different manufacture.**

8.1.3 Available head

8.1.3.1 Storage cistern supplied systems

The initial available head should normally be measured from the outlet of a cistern, unless the supply is sufficient to allow a depth of half the cistern or 0.5 m (whichever is less) to be assumed. Each pipe length between pipe junctions should be sized on a trial-and-error basis, starting with the first pipe length from the cistern. The residual head at the end of each pipe length should be calculated taking account of head losses in pipework, fittings and valves. If a residual head is arrived at that is negative or less than the head absorbed by the outlet or tap, or if an impractical pipe size is indicated, the diameter of the preceding pipes should be adjusted and the procedure repeated (see 8.1.4.5).

8.1.3.2 Mains pressure supplied systems

The minimum pressure in the main at the time of peak demand should be obtained from the water supplier (see 5.1.1) and if there is any doubt about this pressure being obtainable in the future a suitable factor should be applied.

8.1.4 Method of determination of pipe size

8.1.4.1 General

The principle underlying the design of a water supply system is the same whether the cold and hot water supplies to sanitary appliances are obtained from a storage cistern or direct from a main service pipe. Friction losses in the pipes may be determined by the general theory of roughness, but this has too many variables for normal design purposes.

8.1.4.2 Calculation diagrams

An approximate isometric or similar projection of the scheme should be drawn. This drawing should be to scale to facilitate measurement of pipe lengths and levels unless the data can be obtained otherwise. The possibility of future extensions or additions to the scheme should be considered at this stage. Each pipe junction and fitting should be numbered for calculation purposes and pipes referenced by their terminal junctions and fittings.

9. FROST PRECAUTIONS

9.1 General

Precautions against frost shall be taken to reduce the risk of interruption of supply, waste, leakage, damage and bursting.

9.2 Location of Pipes, Fittings and Appliances

As far as possible, the layout of the water service shall be planned to avoid the following locations:

a) external situations above ground;

b) an unheated part of the roof space or attic;

c) an unheated cellar or basement;

d) any other unheated part of the building, unheated stairwells or lift shafts or any outhouse or garage;

e) positions near a window, airbrick or other ventilator, external door or any other place where cold draughts are likely to occur;

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

If it is not possible to avoid these locations, then the requirements of 9.3 and 9.4 apply.

9.3 Protection of Water Pipes and Fittings

9.3.1 Underground pipes

Where practicable, pipes outside buildings shall be laid underground at a depth sufficient to give protection against freezing (see also 5.2.6).

The total depth of cover of the pipe should be a minimum of 750 mm. This has been found sufficient in most parts of the country but where local experience is otherwise, a greater depth of cover should be given up to a maximum of 1350 mm.

The minimum cover should be maintained everywhere along the pipe; any shallow places may result in freezing starting at that point and then extending along the pipe.

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

If at any point it is impracticable to maintain the minimum cover, the pipe shall be insulated in accordance with 9.4.

9.3.2 Pipes entering buildings [see also 5.2.6.1 (a)]

Where practicable, every underground pipe entering or leaving a building shall do so at the depth below the outside ground surface specified in 9.3.1. Where a pipe enters a building it shall be accommodated in a sleeve that has previously been solidly built-in and the space between the pipe and the sleeve shall be filled with non-hardening, non-cracking water-resistant material (mastic) for a minimum length of 150 mm at both ends to prevent the passage of water, gas or vermin.

Any pipe or part of a pipe which lies above the depths quoted in 9.3.1 shall be insulated in accordance with 9.4.

Whatever its position relative to an external wall, a pipe passing through the air space under a suspended floor, an unheated cellar or a garage shall be continuously insulated not only where it is within the air, but also within the ground to the depth stated in 9.3.1.

9.3.3 Pipes and fittings above ground outside buildings

Where the placing of pipes and fittings above ground outside buildings is unavoidable, these pipes and fittings shall be protected by insulation having a weatherproof finish, in accordance with 9.4.

9.3.4 Pipes and fittings inside buildings

Where it is impracticable to avoid flxing pipes or fittings in the locations given in 9.2, those pipes and fittings shall be insulated in accordance with 9.4.

The whole length of the pipe run so fixed shall be insulated in accordance with 9.4 and at no position shall the thickness of insulation between the pipe and the air in the roof space be less than that given in Table 7. Where pipes are positioned in the immediate vicinity of pitched roof space ventilation openings, the insulation thickness shall be that specified for outdoor installations.

Insulation shall be provided all over any cistern in an unheated roof space.

TABLE 7 - MINIMUM THICKNESS OF THERMAL INSULATING MATERIAL TO DELAY FREEZING FOR FROST PROTECTION

NOMINAL OUTSIDE DIAMETER OF PIPE (mm)	THERMAL CONDUCTIVITY OF INSULATING MATERIAL NOT EXCEEDING:							
	0.035 W/(m.K)	0.04 W/(m.K)	0.055 W/(m.K)	0.07 W/(m.K)	0.035 W/(m.K)	0.04 W/(m.K)	0.055 W/(m.K)	0.07 W/(m.K)
	INDOOR INSTALLATIONS (mm)				OUTDOOR INSTALLATIONS (mm)			
UPTO AND INCLUDING 15	22	32	50	89	27	38	63	100
OVER 15 UPTO AND INCLUDING 22	22	32	50	75	27	38	63	100
OVER 22 UPTO AND INCLUDING 42	22	32	50	75	27	38	63	89
OVER 42 UPTO AND INCLUDING 54	16	25	44	63	19	32	50	75
OVER 54 UPTO AND INCLUDING 76.1	13	25	32	50	16	25	44	63
OVER 76.1 AND FLAT SURFACES	13	19	25	38	16	25	32	50

Notes:

1) This table lists the thermal conductivity value with an air temperature of 0°C and the minimum thickness of insulating material that will afford worth while protection against freezing during normal occupation of buildings.

2) Storage cisterns and pipework in roof spaces are considered as indoor installations except where otherwise specified in 9.3.4.

3) Pipework in the air space beneath a suspended ground floor or in a detached garage should be protected as outdoor installations.

9.4 Insulation

Any pipes or fittings that during frosty wheather are likely to freeze shall be adequately thermally insulated.

The minimum thicknesses of thermal insulating materials used for the protection of water pipes and fittings shall be as shown in Table 7. When fixing pipes and fittings that are to be insulated, room shall be allowed for the required thickness of material to be applied.

Thermal insulating materials shall be applied in accordance with the manufacturer's recommendations. They shall be kept dry before, during and after application, except for water which may be required for the purpose of mixing.

Suitable materials commonly used within the range of thermal conductivity shown in Table 7 are given in Table 8. Simply wrapping the pipe in lagging felt will not provide the standard of insulation called for in Table 7. The standard of insulation required to restrict heat loss from a hot water pipe may be insufficient for frost protection.

Unless the insulation material used is itself sufficiently impermeable to water vapor, a vapor barrier with a permenance not exceeding 0.05 g/(s-MN) should be applied on the outside surface of the insulation and protected against damage if necessary.

TABLE 8 - EXAMPLES OF INSULATING MATERIALS

THERMAL CONDUCTIVITY W/(m.K)	MATERIAL
LESS THAN 0.035	POLYURETHANE FOAM FOAMED OR EXPANDED PLASTICS INCLUDING RIGID AND FLEXIBLE PREFORMED PIPE INSULATION OF THESE MATERIALS
0.04 TO 0.055	CORCKBOARD
0.055 TO 0.07	EXFOLIATED VERMICULITE (LOOSE FILL)