ENGINEERING STANDARD

FOR

BUILDING PIPING

(HOT AND COLD)

ORIGINAL EDITION

JAN. 1996

This standard specification is reviewed and updated by the relevant technical committee on Jan. 2003(1) and May 2012(2). The approved modifications are included in the present issue of IPS.

FOREWORD

The Iranian Petroleum Standards (IPS) reflect the views of the Iranian Ministry of Petroleum and are intended for use in the oil and gas production facilities, oil refineries, chemical and petrochemical plants, gas handling and processing installations and other such facilities.

IPS are based on internationally acceptable standards and include selections from the items stipulated in the referenced standards. They are also supplemented by additional requirements and/or modifications based on the experience acquired by the Iranian Petroleum Industry and the local market availability. The options which are not specified in the text of the standards are itemized in data sheet/s, so that, the user can select his appropriate preferences therein.

The IPS standards are therefore expected to be sufficiently flexible so that the users can adapt these standards to their requirements. However, they may not cover every requirement of each project. For such cases, an addendum to IPS Standard shall be prepared by the user which elaborates the particular requirements of the user. This addendum together with the relevant IPS shall form the job specification for the specific project or work.

The IPS is reviewed and up-dated approximately every five years. Each standards are subject to amendment or withdrawal, if required, thus the latest edition of IPS shall be applicable

The users of IPS are therefore requested to send their views and comments, including any addendum prepared for particular cases to the following address. These comments and recommendations will be reviewed by the relevant technical committee and in case of approval will be incorporated in the next revision of the standard.

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GENERAL DEFINITIONS

Throughout this Standard the following definitions shall apply.

COMPANY :

Refers to one of the related and/or affiliated companies of the Iranian Ministry of Petroleum such as National Iranian Oil Company, National Iranian Gas Company, National Petrochemical Company and National Iranian Oil Refinery And Distribution Company.

PURCHASER :

Means the “Company" where this standard is a part of direct purchaser order by the “Company”, and the “Contractor” where this Standard is a part of contract document.

VENDOR AND SUPPLIER:

Refers to firm or person who will supply and/or fabricate the equipment or material.

CONTRACTOR:

Refers to the persons, firm or company whose tender has been accepted by the company.

EXECUTOR :

Executor is the party which carries out all or part of construction and/or commissioning for the project.

INSPECTOR :

The Inspector referred to in this Standard is a person/persons or a body appointed in writing by the company for the inspection of fabrication and installation work.

SHALL:

Is used where a provision is mandatory.

SHOULD:

Is used where a provision is advisory only.

WILL:

Is normally used in connection with the action by the “Company” rather than by a contractor, supplier or vendor.

MAY:

Is used where a provision is completely discretionary.

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1. SCOPE

This Engineering Standard gives the minimum requirement and recommendations on the design of services supplying water (hot and cold) 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.

Note 1:

This standard specification is reviewed and updated by the relevant technical committee on Jan. 2003. The approved modifications by T.C. were sent to IPS users as amendment No. 1 by circular No 200 on Jan. 2003. These modifications are included in the present issue of IPS.

Note 2:

This standard specification is reviewed and updated by the relevant technical committee on May 2012. The approved modifications by T.C. were sent to IPS users as amendment No. 2 by circular No 369 on May 2012. These modifications are included in the present issue of IPS.

2. REFERENCES

Throughout this Standard the following dated and undated standards/codes are referred to. These referenced documents shall, to the extent specified herein, form a part of this standard. For dated references, the edition cited applies. The applicability of changes in dated references that occur after the cited date shall be mutually agreed upon by the Company and the Vendor. For undated references, the latest edition of the referenced documents (including any supplements and amendments) applies.

BSI (BRITISH STANDARDS INSTITUTION)

BS 6700-2006+A1:2009	"Design, Installation, Testing and Maintenance of Services Supplying Water for Domestic Use Within Buildings and their Curtilages"

IPS (IRANIAN PETROLEUM STANDARDS)

IPS-E-GN-100	"Engineering Standard for Units"

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).

3.19 Domestic Hot Water System

Hot water supply system for ablution culinary and cleansing putposes only.

3.20 Hot Water System

Installation of pipes and associated components in which water is heated and distributed for heating or hot water supply.

3.21 Water Services

Services for supplying water to individual premises.

4. UNITS

This Standard is based on International System of Units (SI), as per IPS-E-GN-100 except where otherwise specified.

5. DESIGN CONSIDERATIONS

5.1 Initial Procedures

5.1.1 Preliminary investigations

The following factors shall 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 due to mining activities or any other reason;
g) The likelihood of contamination of the site;
h) Transient or surge pressures that might arise during the operation of the system.

5.1.2 Design

The installation shall be designed to avoid waste, undue consumption, misuse contamination and erroneous measurement.

The installation shall be designed to avoid the trapping of air during filling and the formation of air locks during operation.

For more information refer to BS 6700: 2006 + A1: 2009.

6. COLD WATER SERVICES

6.1 General

6.1.1 Where required, drinking water shall be provided directly from the supply pipe. So far as is reasonably practical the temperature of water within cold water pipes shall not exceed 20 °C (although it is recognized that mains water can rise to 25 ºC in the summer months) and adequate measures shall be taken to ensure that this temperature is not exceeded.

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

6.1.2 Type of system

The type of systems are:

a) Direct supply from water main
b) Supply via a storage cisterm
c) Dewelling
d) Pump system

For recommandation of storage capacities related to various types of use see table 1.

TABLE 1 - RECOMMENDED MINIMUM STORAGE OF COLD WATER FOR DOMESTIC PURPOSES (HOT AND COLD OUTLETS)

Type of building or occupation	Minimum storage litres
Hostel	90 per bed space
Hotel	200 per bed space
Office premises:	
with canteen facilities	40 per employee
with canteen facilities	40 per employee
Restaurant	7 per meal
Day school:	
Nursery } Primary	15 per pupil
Secondary } Technical	20 per pupil
Children.s home or residential nursery	135 per bed space
Nursing or convalescent home	135 per bed space
Children.s home or residential nursery	135 per bed space
Nursing or convalescent home	135 per bed space
Note: Direct supply is preferred for the supply of drinking water.	

For more information refer to BS 6700:2006+A1:2009.

7. HOT WATER SERVICES

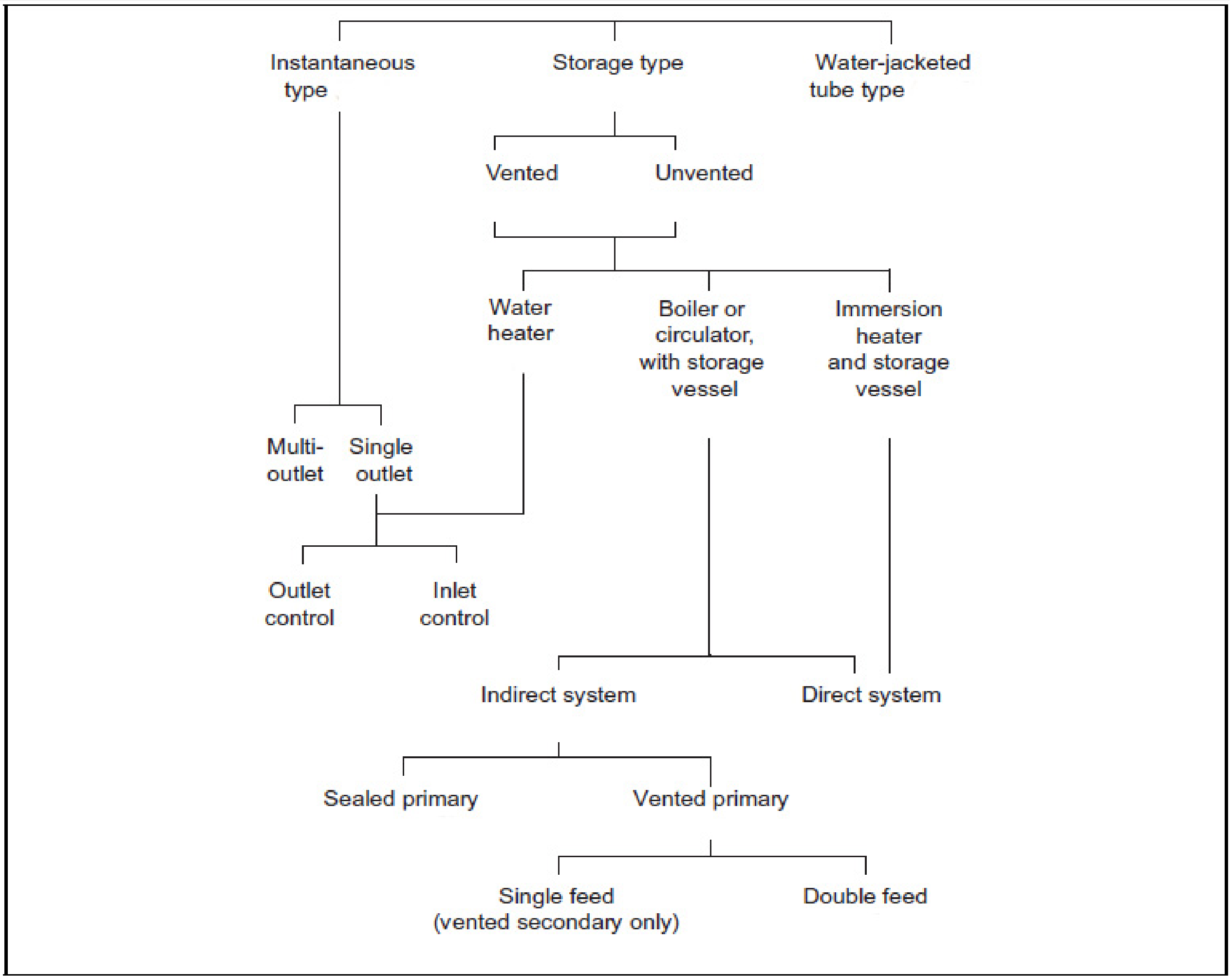
7.1 General Principles

The hot water service shall be designed to provide hot water at the point of use, in the quantities and at the temperatures required by the user.

7.2 Choice of System

Where the user requirements are not specified, and in particular where the user is not known, e.g. in speculative housing developments, an assessment of user needs shall be made on the basis of the size and type of building, experience and convention.

Where a dwelling has only one bathroom it shall be assumed that immediately after filling a bath, some hot water will be required for kitchen use, but a second bath will not be required within 20 min to 30 min. Where a dwelling has two or more bathrooms, it shall be assumed that all the installed baths will be filled in succession and that hot water will immediately be required for kitchen use (see Figure 1).



CHOICE OF HOT WATER SYSTEM

Fig. 1

8. PIPE SIZING

The system shall be designed and installed so that the design flow rates given in Table 2 shall be available at each outlet and any group of outlets where the total demand does not exceed 0.3 l/s, when only that outlet or group of outlets are open. When simultaneous discharge occurs the rate of flow of water at any outlet in use shall be not less than the minimum rate given in Table 2.
The pipes and fittings shall be sized so that the maximum velocity does not exceed 3.0 m/s. This maximum shall not apply to small bore connections of limited length supplied as parts of combination tap assemblies.

The design flow rates to storage cisterns shall be determined by dividing the cistern's capacity by the required filling time. Where single dwellings are supplied from individual minimal sized storage cisterns, filling time shall be less than one hour.

TABLE 2 - DESIGN FLOW RATES

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) (see Note 2)	0.15	0.10
Urinal cistern (each position served)	0.004	0.002
Washbasin	0.15	0.10
Handbasin (pillar taps)	0.10	0.07
Handbasin (spray or spray mixer taps)	0.05	0.03
Bidet	0.20	0.10
Bath (G ¾)	0.30	0.20
Bath (G 1)	0.60	0.40
Shower head (see Note 3)	0.20	0.10
Kitchen sink (G ½)	0.20	0.10
Kitchen sink (G ¾)	0.30	0.20
Kitchen sink (G ¾)	0.60	0.40
Washing machine	0.20	0.15
Dish-washing machine (see Note 1)	0.15	0.10
Pressure flushing valves for WCs or urinals	1.5 max.	1.2 min.
Urinal flushing cistern	0.3 max.	0.15 min.

Note 1: The manufacturer should be consulted for required flow rates to washing and dish-washing machines for other than single dwellings.
Note 2: WC flushing troughs are recommended where anticipated use of WCs is more frequent than once per minute.
Note 3: The rate of flow required to shower heads will depend on the type fitted and the advice of the shower manufacturer should be sought.

For more information refer to BS 6700: 2006 + A1: 2009.

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.

8.2.1 Determination of flow rates

8.2.1.1 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.

8.2.1.2 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.

8.2.2 Head losses in pipes, fittings and valves

8.2.2.1 Pipes

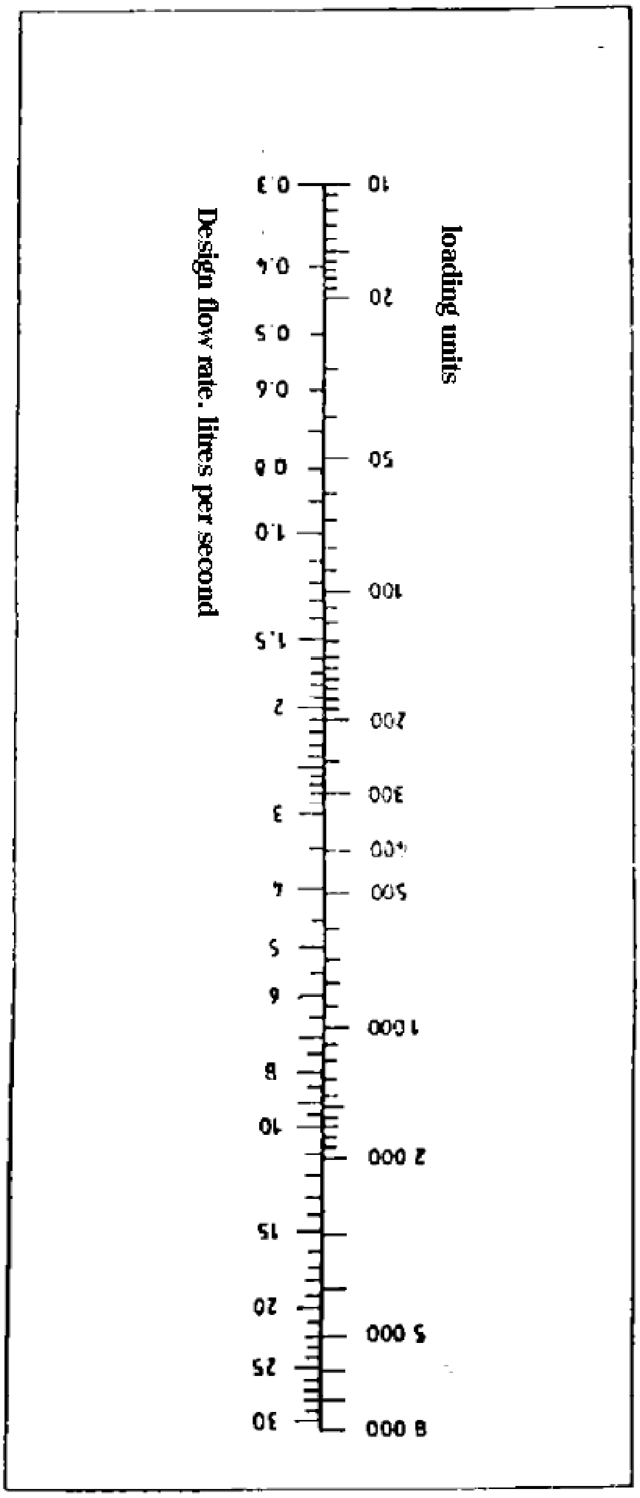
The rate of flow of water through a pipe depends upon the length and bore diameter, the roughness of the surface and the pressure drop (head loss) along the pipe.

8.2.2.2 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.

8.2.2.3 Valves

The loss of head through stop valves 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 LOADING UNITS	2
FLUSHING CISTERN (9 L)	1½ TO 3
WASH BASIN	10
BATH TAP OF NOMINAL SIZE ¾"	22
BATH TAP OF NOMINAL SIZE 1"	3
SHOWER	3
SINK TAP OF NOMINAL SIZE ½"	5
SINK TAP OF NOMINAL SIZE ¾"	

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.

8.2.2.4 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.

8.2.2.5 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.

8.2.2.6 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.**

8.2.3 Available head

8.2.3.1 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.

8.2.3.2 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.

8.2.4 Method of determination of pipe size

8.2.4.1 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.

8.2.4.2 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 shall be applied.

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 5.2.5).

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

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, noncracking water-resistant material (mastic) for a minimum length of 150 mm at both ends to prevent the passage of water, gas or vermin. (see also 5.2.6.1 (a))
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 0.020	RIGID PHENOLIC FOAM
0.021 TO 0.035	POLYURETHANE FOAM
	CORCKBOARD
0.04 TO 0.055	EXFOLIATED
0.055 TO 0.07	VERMICULITE (LOOSE FILL)