



भारतीय मानक ब्यूरो BUREAU OF INDIAN STANDARDS

MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG, NEW DELHI 110002
Phone: + 91 11 23230131, 23233375, 23239402 Extn 4402; Fax: + 91 11 23235529

व्यापक परिचालन मसौदा

हमारा संदर्भ : सीईडी/46 :टी-19

11 नवंबर 2015

तकनीकी समिति :राष्ट्रीय भवन निर्माण संहिता विषय समिति,सीईडी 46

प्राप्तकर्ता :

- 1 सिविल इंजीनियरी विभाग परिषद् के सभी सदस्य
- 2 राष्ट्रीय भवन निर्माण संहिता विषय समिति, सीईडी 46 व नल-साजी सेवाओं के लिए पैनल, सीईडी 46:P17 के सभी सदस्य
- 3 रुचि रखने वाले अन्य निकाय ।

महोदय/महोदया,

निम्नलिखित मसौदा संलग्न है:

प्रलेख संख्या	शीर्षक
सीईडी 46(8058)WC	राष्ट्रीय भवन निर्माण संहिता का मसौदा: भाग 9 नल-साजी सेवाएं, अनुभाग 1 जल आपूर्ति [SP7(भाग9/अनुभाग 1) का तीसरा पुनरीक्षण]

कृपया इस मसौदे का अवलोकन करें और अपनी सम्मतियों यह बताते हुए भेजें कि यदि यह मसौदा भारत की राष्ट्रीय भवन निर्माण संहिता के भाग के रूप में प्रकाशित हो तो इस पर अमल करने में आपके व्यवसाय अथवा कारोबार में क्या कठिनाइयाँ आ सकती हैं ।

सम्मतियों भेजने की अंतिम तिथि :**11 दिसंबर 2015**

यदि कोई सम्मति हो तो कृपया अधोहस्ताक्षरी को उपरिलिखित पते पर संलग्न फॉर्मेट में भेजें । हो सके तो कृपया अपनी सम्मतियों ई-मेल द्वारा sanjaypant@bis.org.in पर भेजें ।

यदि कोई सम्मति प्राप्त नहीं होती है अथवा सम्मति में केवल भाषा सम्बन्धी त्रुटि हुई तो उपरोक्त प्रलेखों को यथावत अंतिम रूप दे दिया जाएगा । यदि सम्मति तकनीकी प्रकृति की हुई तो विषय समितिके अध्यक्ष के परामर्श से अथवा उनकी इच्छा पर आगे की कार्यवाही के लिए विषय समिति को भेजे जाने के बाद प्रलेख को अंतिम रूप दे दिया जाएगा ।

यह प्रलेख भारतीय मानक ब्यूरो की वेबसाइट www.bis.org.in पर भी उपलब्ध है ।

धन्यवाद ।

भवदीय,

ह0

(बी.के. सिन्हा)

प्रमुख (सिविल इंजीनियरी)

संलग्न: उपरिलिखित



भारतीय मानक ब्यूरो BUREAU OF INDIAN STANDARDS

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Phone: + 91 11 23230131, 23233375, 23239402 Extn 4402; Fax: + 91 11 23235529

DRAFT IN WIDE CIRCULATION

DOCUMENT DESPATCH ADVICE

Reference	Date
CED 46/T-19	11 November 2015

TECHNICAL COMMITTEE:

NATIONAL BUILDING CODE SECTIONAL COMMITTEE, CED 46

ADDRESSED TO:

1. All Members of Civil Engineering Division Council, CEDC
2. All Members of National Building Code Sectional Committee, CED 46 and Panel for Plumbing Services, CED 46:P17
3. All other interests.

Dear Sir/Madam,

Please find enclosed the following draft:

Doc. No.	Title
CED 46 (8058)WC	Draft National Building Code of India: Part 9 Plumbing Services, Section 1 Water Supply [Third Revision of SP 7(Part 9/Section 1)]

Kindly examine the draft and forward your views stating any difficulties which you are likely to experience in your business or profession if this is finally adopted as Part of the National Building Code of India.

Last Date for comments: **11 December 2015.**

Comments if any, may please be made in the format as attached, and mailed to the undersigned at the above address. You are requested to send your comments preferably through e-mail to sanjaypant@bis.org.in.

In case no comments are received or comments received are of editorial nature, you may kindly permit us to presume your approval for the above document as finalized. However, in case of comments of technical nature are received then it may be finalized either in consultation with the Chairman, Sectional Committee or referred to the Sectional Committee for further necessary action if so desired by the Chairman, Sectional Committee.

This document is also hosted on BIS website www.bis.org.in.

Thanking you,

Yours faithfully,

Sd/-

(B. K. Sinha)
Head (Civil Engg)

Encl: as above

FORMAT FOR SENDING COMMENTS ON THE DOCUMENT

[Please use A4 size sheet of paper only and type within fields indicated. Comments on each clause/sub-clause/ table/figure, etc, be stated on a fresh row. Information/comments should include reasons for comments, technical references and suggestions for modified wordings of the clause. **Comments through e-mail in MS WORD format to sanjaypant@bis.org.in shall be appreciated.**]

Doc. No.: CED 46(8058)WC BIS Letter Ref: CED 46/T-19 Dated: 11 November 2015

Title: NATIONAL BUILDING CODE OF INDIA: Part 9 'Plumbing Services, Section 1 Water Supply' [*Third Revision of SP 7 (Part 9/Sec 1)*]

Name of the Commentator or Organization: _____

Clause No. with Para No. or Table No. or Figure No. commented (as applicable)	Comments/Modified Wordings	Justification for the Proposed Change

Draft NATIONAL BUILDING CODE OF INDIA

**PART 9 PLUMBING SERVICES
(INCLUDING SOLID WASTE MANAGEMENT)**

Section 1 Water Supply

[Third Revision of SP 7 (Part 9/ Section 1)]

BUREAU OF INDIAN STANDARDS

C O N T E N T S

FOREWORD

- 1 SCOPE
- 2 TERMINOLOGY
- 3 GENERAL
- 4 WATER SUPPLY

ANNEX A APPLICATION FORM FOR TEMPORARY/PERMANENT
SUPPLY OF WATER/FOR ADDITIONS AND/OR
ALTERATIONS FOR SUPPLY OF WATER

ANNEX B FORM FOR LICENCED PLUMBER'S COMPLETION
CERTIFICATE

ANNEX C FORM FOR DETAILED DESCRIPTION OF WORK AND
SPECIFICATION OF MATERIALS

ANNEX D FORM FOR LICENSED PLUMBER'S COMPLETION
CERTIFICATE

ANNEX E NOMOGRAM OF HAZEN AND WILLIAM'S EQUATION

LIST OF STANDARDS

IMPORTANT EXPLANTORY NOTE FOR USERS OF THE CODE

In this Part of the Code, where reference is made to 'good practice' in relation to design, constructional procedures or other related information, and where reference is made to 'accepted standard' in relation to material specification, testing, or other related information, the Indian Standards listed at the end of this Part may be used as a guide to the interpretation.

At the time of publication, the editions indicated in the standards were valid. All standards are subject to revision and parties to agreements based on this Part are encouraged to investigate the possibility of applying the most recent editions of the standards.

In the list of standards given at the end of this part, the number appearing in the first column indicates the number of the reference in this Part. For example:

- a) Good practice [9-1(7)] refers to the Indian Standard given at serial number (7) of the above list given at the end of this Section 1 of Part 9, that is IS 3114 : 1994 ' Code of practice for laying of cast iron pipes (*second revision*)'.
- b) Accepted standard [9-1(8)] refers to the Indian Standard given at serial number (8) of the above list given at the end of this Section 1 of Part 9, that is IS 782:1978 ' Specification for caulking lead (*third revision*)'.

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Draft NATIONAL BUILDING CODE OF INDIA:

PART 9 PLUMBING SERVICES (INCLUDING SOLID WASTE MANAGEMENT)

Section 1 Water Supply

[*Third Revision* of SP 7(Part 9/Section 1)]

ICS: 01.120; 91.040.01

National Building Code Sectional Committee, CED 46	Last Date for Comments: 11 December 2015
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National Building Code Sectional Committee, CED 46

FOREWORD

This Section covers the requirements of water supply. The water supply provisions covered in this section encompass the requirements of water supply, plumbing connected to public water supply, design of water supply systems, principles of conveyance and distribution of water within the premises, hot water supply system, inspection and maintenance of water supply systems. It also covers design of water supply systems in high altitudes and/or sub-zero temperature regions.

In the first version of the Code formulated in 1970, three separate sections of Part 9 Plumbing Services were brought out, namely, Section 1 Water supply, Section 2 Drainage and sanitation, and Section 3 Gas supply. These sections were subsequently revised in 1983. The major changes incorporated in the first revision in Section 1 Water supply, were:

- a) Rationalization of definitions and addition of definitions for more terms.
- b) Universal pipe friction diagram and nomogram of Hazen and Willam's equation were added for discharge computation, deleting the discharge curves based on Chezy's formula.
- c) A detailed clause giving guidance on the design of water supply system for multistoried buildings was introduced.
- d) In regard to storage tanks for flushing, the requirements were modified to indicate that no separate storage need be provided for flushing and domestic purposes for health reasons and a single storage tank may be provided.
- e) Provisions relating to domestic hot water supply installations were modified/amplified.

- f) A detailed clause covering recommendations to be considered while planning and designing water supply systems peculiar to high altitude and/or sub-zero temperature regions of the country, were introduced.
- g) Requirements relating to inspection, testing and maintenance applicable to hot water supply system were added.

As a result of experience gained in implementation of 1983 version of the Code and feedback received as well as revision of some of the standards based on which this section was prepared, a need to revise this section was felt. The last revision was therefore prepared to take care of these. In the last revision, the erstwhile two sections were merged and a combined and comprehensive section, namely Section 1 Water supply, drainage and sanitation (including solid waste management), was brought out. Gas supply was brought out as Section 2. Following significant changes were incorporated in the last revision of Section 1 on Water supply, drainage and sanitation, in respect to water supply:

- a) Provision of water supply requirement was modified.
- b) A new clause on water supply for other purposes was added.
- c) A new clause on quality of water was added which also includes a sub clause on waste water reclamation.
- d) The provision regarding storage of water was modified and guidelines for calculating storage capacity was introduced.
- e) In design of distribution system provisions for discharge computation was modified to include designed consumer pipes based on fixtures unit also taking into account probable simultaneous demand instead of earlier computation based on Reynold's Number.
- f) An alternate option of variable speed drive pumping system to hydro pneumatic system was introduced.
- g) A new clause on backflow prevention was added.
- h) Provision for suitability of galvanized mild steel tanks on the basis of pH of the water was added.
- j) Types of hot water heater was extended.
- k) Restructuring of the section was done to make it more user friendly.

The last revision also incorporated for the first time the provisions on solid waste management.

In this revision to comprehensively address the various and distinct features related to the plumbing aspects and solid waste management, this Part 9 Plumbing Services has been rearranged as follows:

Section 1 Water Supply
Section 2 Drainage and Sanitation
Section 3 Solid Waste Management
Section 4 Gas Supply

Further, in this revision of the Section 1, the following significant changes/modifications have been incorporated:

- a) Provisions on water supply requirements for buildings have been related to the estimated occupancy in the chosen type of building (clause 4.1).
- b) The Table 1 on water requirements for buildings other than residences has been updated with respect to type of buildings and it now also includes domestic and flushing requirements.
- c) Water demand for landscaping purposes has been included (clause 4.1.5.2).
- d) Requirements related to treatment of waste water and usage of recycled waste water have been included (clause 4.3.1.3).
- e) Materials used for storage water tanks have been updated (clause 4.4.3).
- f) Provisions related to quantity of water to be stored have been updated (clause 4.4.10).
- g) List of materials used to manufacture pipes has been updated (clause 4.5.2).
- h) General requirements for design of distribution systems have been included (clause 4.6.1).
- j) Table 3 on fixture unit for different types of fixtures has been updated with inclusion of kitchen dishwasher.
- k) Table 5 on probable simultaneous demand has been updated with demand values included for 1, 5 and 10 fixture units.
- m) The maximum flow rate and flush volumes have been included (clause 4.6.3.3).
- n) Provisions related to inadequate and excessive water pressure have been included (clause 4.6.5).
- p) Guidance on water hammer effects have been included (clause 4.6.6).
- q) Provisions related to zoning of distribution systems have been included (clause 4.7.5).
- r) Hot water supply systems have been included under the existing clause on hot water supply installations (clause 4.13.4.1).
- s) Detailed provisions related to swimming pools have been included (clause 4.18).
- t) Guidance on allowance for expansion of water pipes have been included (clause 4.19).
- u) A new clause on colour coding for different types of water pipes has been included (clause 4.20)
- v) Certain terminologies have been included and some have been updated based on the above mentioned changes in the draft.
- w) Cross-referred standards have been updated.

This Section is largely based on the following Indian Standards.

IS 1172:1993	Code of basic requirements for water supply, drainage and sanitation (<i>fourth revision</i>)
IS 2065:1983	Code of practice for water supply in buildings (<i>second revision</i>)
IS 6295:1986	Code of practice for water supply and drainage in high altitudes and or sub-zero temperature regions (<i>first revision</i>)
IS 7558:1974	Code of practice for domestic hot water installations
IS 12183(Part 1) :1987	Code of practice for plumbing in multi-storeyed buildings : Part 1 Water supply

A reference to SP 35:1987 'Handbook on Water Supply and Drainage' may be useful, from where also, assistance has been derived.

All standards, whether given herein above or cross-referred to in the main text of this section, are subject to revision. The parties to agreement based on this section are encouraged to investigate the possibility of applying the most recent editions of the standards.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2:1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this Section.

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Draft NATIONAL BUILDING CODE OF INDIA:

PART 9 PLUMBING SERVICES (INCLUDING SOLID WASTE MANAGEMENT)

Section 1 Water Supply

[*Third Revision of SP 7(Part 9/Section 1)*]

ICS: 01.120; 91.040.01

**National Building Code
Sectional Committee, CED 46**

Last Date for Comments:
11 December 2015

1 SCOPE

1.1 The Section covers the basic requirements of water supply for residential, business and other types of buildings, including traffic terminal stations. This Section also deals with general requirements of plumbing connected to public water supply and design of water supply systems along with general guidelines about expansion in piping systems and Swimming pools.

1.1.1 This Section does not take into consideration the requirements of water supply for industrial plants and processes, which have to be provided for separately. It also does not provide the requirements of water supply for other purposes, such as fire fighting, and street cleaning.

2 TERMINOLOGY

2.1 For the purpose of this section, the following definitions shall apply in addition to the definitions given in accepted standards [9-1(1)].

2.1.1 *Access Panel* – Removable panel mounted in a frame, normally secured with screws and mounted in a wall or ceiling, to provide access to concealed appurtenances or items which may require maintenance.

2.1.2 *Air Gap* – The distance between the lowest point of a water inlet or feed pipe to an appliance and the spill-over level (or the overflowing level) of the appliance.

2.1.3 *Air Valve* – A valve that releases air from a pipeline automatically without loss of water, or introduce air into a line automatically if the internal pressure becomes less than that of the atmosphere.

2.1.4 Authority Having Jurisdiction – The Authority which has been created by a statute and which for the purpose of administering the Code/Part may authorize a committee or an official to act on its behalf; hereinafter called the ‘Authority’.

2.1.5 Available Head – The head of water available at the point of consideration due to mains’ pressure or overhead tank or any other source of pressure.

2.1.6 Air Admittance Valve – One way valves designed to allow air to enter drainage system when negative pressure develops in the system. The purpose is to provide a method of allowing air to enter the drainage system for prevention of siphonage of traps.

2.1.7 Air Break – Physical separation which may be a low inlet into the indirect waste receptor from the fixture or device indirectly connected.

2.1.8 Air Gap, Water distribution – Unobstructed vertical distance through the free atmosphere between the lowest opening from any pipe or faucet conveying potable water to flood level of any tank or fixture.

2.1.9 Barrel – This portion of a pipe in which the diameter and wall thickness remain uniform throughout.

2.1.10 Base – The lowest portion or lowest point of a stack of vertical pipe.

2.1.11 Bath Room Group – Group of fixtures consisting of water closet, lavatories and other fittings with a floor drain located together.

2.1.12 Bedding – The material on which the pipe is laid and which provides support for the pipe. Bedding can be concrete, granular material or the prepared trench bottom.

2.1.13 Chair – A bed of concrete or other suitable material on the trench floor to provide a support for the pipes at intervals.

2.1.14 Channel – The open waterway through which sewage, storm water or other liquid wastes flow at the invert of a manhole or an inspection chamber.

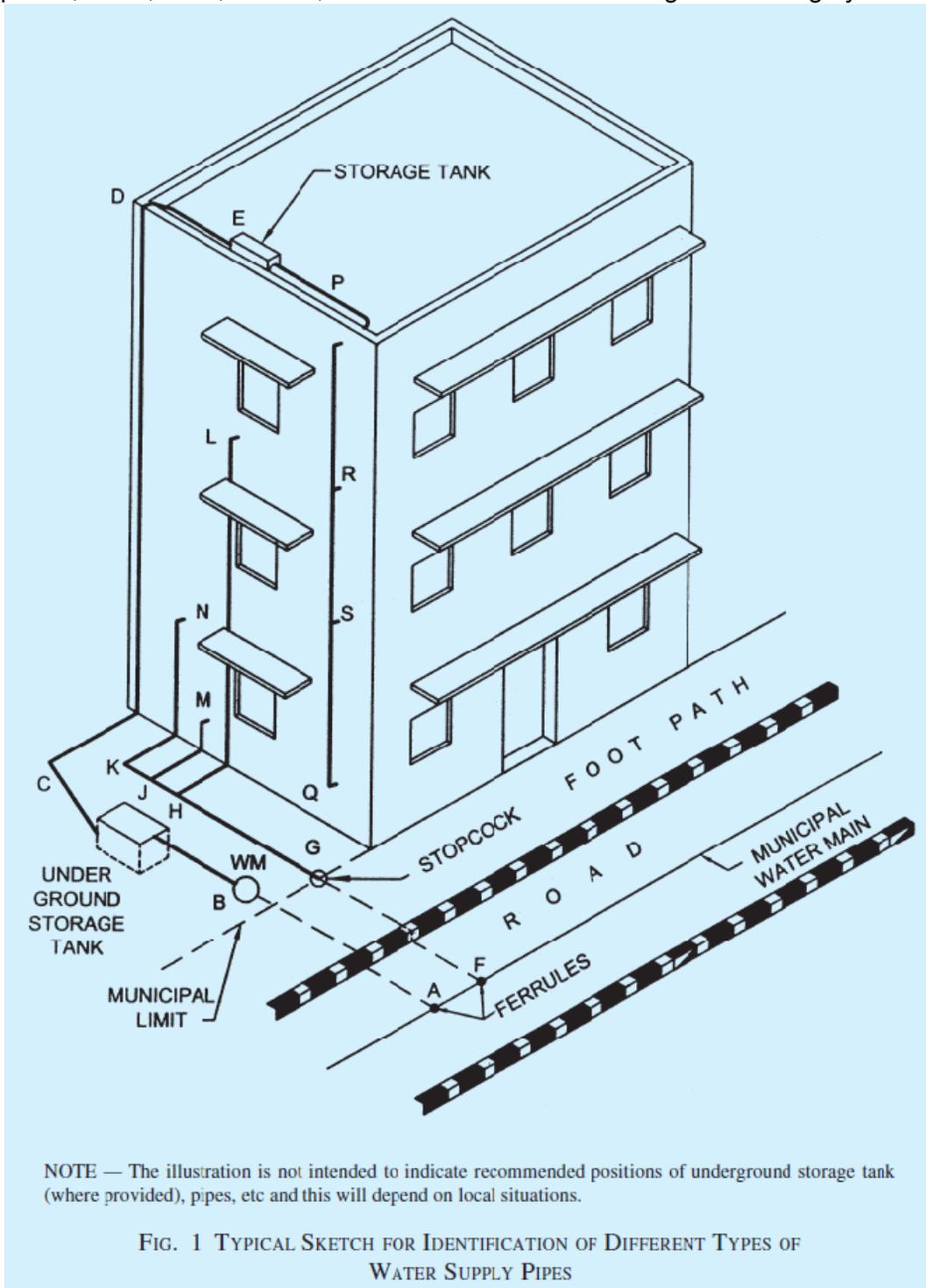
2.1.15 Communication Pipe – That part of a service pipe which vests in the water undertakes. It starts at the water main and terminate at a point which differs according to the circumstances of the case.

2.1.16 Consumer – Any person who uses or is supplied water or on whose application such water is supplied by the Authority.

2.1.17 Consumer’s Pipe – The portion of service pipe used for supply of water and which is not the property of the Authority (see Fig. 1).

2.1.18 Contamination – *Contamination* of water is the term used to describe hazardous materials of any kind that are polluting a source of water. This could

include both biological and chemical substances and the water source may be ponds, lakes, seas, oceans, or reservoirs used for drinking and bathing by humans.



2.1.19 Cover

- a) A removable plate for permitting access to a pipe, fitting, vessel or appliance.

- b) The vertical distance between the top of the barrel of a buried pipe or other construction and the surface of the ground.

2.1.20 Cross-Connection – A connection between two normally independent pipelines which permits flow from either pipeline into the other.

2.1.21 Effective Opening – The minimum cross-sectional area at the point of water supply, measured or expressed in terms of :

- a) the diameter of a circle; and
- b) the diameter of a circle of equivalent cross-sectional area, if the opening is not circular.

2.1.22 Feed Cistern – A storage vessel used for supplying cold water to a hot water apparatus, cylinder or tanks.

2.1.23 Fittings – Fittings shall mean coupling, flange, branch, bend, tees, elbows, unions, waste with plug, P or S trap with vent, stop ferrule, stop tap, bib tap, pillar tap, globe tap, ball valve, cistern storage tank, baths, water-closets, boiler, geyser, pumping set with motor and accessories, meter, hydrant, valve and any other article used in connection with water supply, drainage and sanitation.

2.1.24 Fixture Unit – A quantity in terms of which the load producing effects on the plumbing system of different kinds of plumbing fixtures is expressed on some arbitrarily chosen scale.

2.1.25 Float Operated Valve – Ball valves or ball taps and equilibrium valves operated by means of a float.

2.1.26 Flushing Cistern – A cistern provided with a device for rapidly discharging the contained water and used in connection with a sanitary appliance for the purpose of cleaning the appliance and carrying away its contents into a drain.

NOTE – The nominal size of a cistern is the quantity of water discharged per flush.

2.1.27 Flushometer Tank – Tank integrated with an air accumulator vessel that is designed to discharge a predetermined quantity of water to fixtures for flushing purposes.

2.1.28 Formation – The finished level of the excavation at the bottom of a trench or heading prepared to receive the permanent work.

2.1.29 Frost Line – The line joining the points of greatest depths below ground level up to which the moisture in the soil freezes.

2.1.30 General Washing Place – A washing place provided with necessary sanitary arrangement and common to more than one tenement.

2.1.31 Geyser – An apparatus for heating water with supply control on the inlet side and delivering it from an outlet.

2.1.32 Haunching – Outward sloping concrete support to the sides of a pipe or channel above the concrete bedding.

2.1.33 Heel Rest Bend or Duck-Foot Bend – A bend, having a foot formed integrally in its base, used to receive a vertical pipe.

2.1.34 High Altitudes – Elevations higher than 1 500 m above mean sea level (MSL).

2.1.35 Highway Authority – The public body in which is vested, or which is the owner of, a highway repairable by the inhabitants collectively; otherwise the body or persons responsible for the upkeep of the highway.

2.1.36 Horizontal Pipe – Any pipe of fitting which makes an angle of more than 45° with the vertical.

2.1.37 Hot Water Tank – A vessel for storing hot water under pressure greater than atmospheric pressure.

2.1.38 Hydro Pneumatic Systems – Water supply pumping system which operates automatically in conjunction with pump(s), pressure vessel and pressure switch.

2.1.39 Inlet Fittings – An arrangement of connecting the internal waste branch pipe from wash basin, sinks & shower drains to the main deep seal trap with the help of hopper extension.

2.1.40 Insanitary – Condition that is contrary to sanitary principles or is injurious to health.

2.1.41 Interceptor – A device designed and installed so as to separate and retain deleterious, hazardous or undesirable matter from normal wastes and permit normal sewage or liquid wastes to discharge into the disposal terminal by gravity.

2.1.42 Interceptor Manhole or Interceptor Chamber – A manhole incorporating an intercepting trap and providing means of access thereto.

2.1.43 Invert – The lowest point of the internal surface of a pipe or channel at any cross section.

2.1.44 Junction Pipe – A pipe incorporating one or more branches.

2.1.45 Lagging – Thermal insulation on pipes.

2.1.46 Licensed Plumber – A person licensed under the provisions of this Code.

2.1.47 Offset – A pipe fitting used to connect two pipes whose axes are parallel but not in line.

2.1.48 Period of Supply – The period of the day or night during which water supply is made available to the consumer.

2.1.49 *Pipe Work* – Any installation of piping with its fittings.

2.1.50 *Plumbing*

- a) The pipes, fixtures and other apparatus inside a building for bringing in the water supply and removing the liquid and water borne wastes.
- b) The installation of the foregoing pipes, fixtures and other apparatus.

2.1.51 *Plumbing System* – The plumbing system shall include the water supply and distribution pipes; plumbing fittings and traps; soil, waste, vent pipes and anti-siphonage pipes; building drains and building sewers including their respective connections, devices and appurtenances within the property lines of the premises; and water-treating or water-using equipment.

2.1.52 *Potable Water* – Water which is satisfactory for drinking, culinary and domestic purposes and meets the requirements of the Authority.

2.1.53 *Premises* – Premises shall include passages, buildings and lands of any tenure, whether open or enclosed, whether built on or not, and whether public or private in respect of which a water rate or charge is payable to the Authority or for which an application is made for supply of water.

2.1.54 *Pressure balancing Valve* – Mixing valve that senses incoming hot and cold water pressures and compensates for fluctuations.

2.1.55 *Residual Head* – The head available at any particular point in the distribution system.

2.1.56 *Saddle* – A purpose made fitting, so shaped as to fit over a hole cut in a sewer or drain used to form connections.

2.1.57 *Service Pipe* – Pipe that runs between the distribution main in the street and the riser in case of a multi-storied building or the water meter in the case of an individual house and is subject to water pressure from such main.

2.1.58 *Static Pressure* - The Pressure existing without any flow.

2.1.59 *Residual Pressure* - The pressure available at the fixture after allowance is made for pressure drop due to friction loss & head in the system during maximum demand periods.

2.1.60 *Stop-Cock* – A cock fitted in a pipe line for controlling the flow of water.

2.1.61 *Stop Tap* – Stop tap includes stop-cock, stop valve or any other device for stopping the flow of water in a line or system of pipes at will.

2.1.62 *Storage Tank* – A container used for storage of water which is connected to the water main or tube-well by means of supply pipe.

- 2.1.63** *Sub-Soil Water* – Water occurring naturally in the subsoil.
- 2.1.64** *Sub-Soil Water Drain*
- a) A drain intended to collect and carry away subsoil *water*.
 - b) A drain intended to disperse into the subsoil from a septic tank.
- 2.1.65** *Sub-Zero Temperature Regions* – Regions where temperatures fall below 0°C and freezing conditions occur.
- 2.1.66** *Sullage* – See **2.1.83**.
- 2.1.67** *Supply Pipe* – So much of any service pipe as is not a communication pipe.
- 2.1.68** *Supports* – Hangers and anchors or devices for supporting and securing pipe and fittings to walls, ceilings, floors or structural members.
- 2.1.69** *Surface Water* – Natural water from the ground surface, paved areas and roofs.
- 2.1.70** *Surface Water Drain* – A drain conveying surface water including storm water.
- 2.1.71** *Systems of Drainage*
- a) *Combined System* – A system in which foul water (sewage) and surface water are conveyed by the same sewers and drains.
 - b) *Separate System* – A system in which foul water (sewage) and surface water are conveyed by the separate sewers and drains.
 - c) *Partially Separate System* – A modification of the separate system in which part of the surface water is conveyed by the foul (sanitary) sewers and drains.
- 2.1.72** *Thermostatic/Pressure balancing valve*: Mixing valve that senses outlet temperature and incoming hot and cold water pressure and compensates for fluctuations for stabilization.
- 2.1.73** *Trade Effluent* – Any liquid either with or without particles of matter in suspension which is wholly or in part produced in the course of any trade or industry, at trade premise. It includes farm wastes but does not include domestic sewage.
- 2.1.74** *Trap* – A fittings or device so designed and constructed as to provide, when properly vented, a liquid seal which will prevent the back passage of air without materially affecting the flow of sewage or waste water through it.
- 2.1.75** *Vertical Pipe* – Any pipe or *fitting* which is installed in a vertical position or which makes an angle or not more than 45° with the vertical.

2.1.76 *Vent Stack/Vent Pipe* – A vertical vent pipe installed primarily for the purpose of providing circulation of air to and from any part of the drainage system. It also protects trap seals from excessive pressure fluctuation.

2.1.77 *Vent System* – A pipe or pipes installed to provide a flow of air to or from a drainage system or to provide a circulation of air within such system to protect trap seals from siphonage and back-pressure.

2.1.78 *Warning Pipe* – An overflow pipe so fixed that its outlet, whether inside or outside a building, is in a conspicuous position where the discharge of any water therefrom can be readily seen.

2.1.79 *Wash-Out Valve* – A device located at the bottom of the tank for the purpose of draining a tank for cleaning, maintenance, etc.

2.1.80 *Waste Appliance* – A sanitary appliance for the collection and discharge of water after use for ablutionary, culinary and other domestic purposes.

2.1.81 *Waste Pipe* – In plumbing, any pipe that receives the discharge of any fixtures, except water-closets or similar fixtures and conveys the same to the house drain or soil or waste stack. When such pipe does not connect directly with a house drain or soil stack, it is called an indirect waste pipe.

2.1.82 *Waste-Water (Sullage)* – The discharge from wash basins, sinks and similar appliances, which does not contain human or animal excreta.

2.1.83 *Water hammer Arrestor* – Device designed to provide protection against hydraulic shock in the building water supply system.

2.1.84 *Water Main (Street Main)* – A pipe laid by the water undertakers for the purpose of giving a general supply of water as distinct from a supply to individual consumers and includes any apparatus used in connection with such a pipe.

2.1.85 *Water Outlet* – A water outlet, as used in connection with the water distributing system, is the discharge opening for the water (a) to a fitting; (b) to atmospheric pressure (except into an open tank which is part of the water supply system); and (c) to any water-operated device or equipment requiring water to operate.

2.1.86 *Water Seal* – The water in a trap, which acts as a barrier to the passage of air through the trap.

2.1.87 *Water Supply System* – Water supply system of a building or premises consists of the water service pipe, the water distribution pipes, and the necessary connecting pipes, fittings, control valves, and all appurtenances in or adjacent to the building or premises.

2.1.88 *Waterworks* – Waterworks for public water supply include a lake, river, spring, well, pump with or without motor and accessories, reservoir, cistern, tank,

duct whether covered or open, sluice, water main, pipe, culvert, engine and any machinery, land, building or a thing used for storage, treatment and supply of water.

2.2 The following terminologies relate to Swimming pools only:

2.2.1 *Appurtenance* – An accessory facility or feature at a swimming pool, such as a diving board, slide, wading pool, plunge pool, spray pool.

2.2.2 *Attendant* – A person at least 16 years of age, stationed at the top of a water slide and responsible for ensuring safe use of the slide.

2.2.3 *Bather Load* – The maximum number of persons that may be allowed in the pool area at one time without creating undue health or safety hazards.

2.2.4 *Deep Area* – An area of a swimming pool in which the water depth exceeds five feet.

2.2.5 *Driving Pool* – A pool designed and intended for use exclusively for diving.

2.2.6 *Drop Slide* – A slide with an exit angle exceeding 11 degrees measure downward from the horizontal.

2.2.7 *Inlet* – An opening or fitting through which filtered water enters the pool.

2.2.8 *Main Drain* – The outlet or outlets in the floor of the pool.

2.2.9 *Make-up Water* – The water added to a pool to replace that which is lost.

2.2.10 *Manager/Operator* – The person or entity responsible for the actual daily operation, or for the supervision of the operation, of a swimming pool or bathing beach.

2.2.11 *Pool* – A swimming pool or other recreational water basin utilized in conjunction with or as an appurtenance to a swimming pool.

NOTE: The term does not refer to spas and therapy pools not designed or intended for swimming or to basins for individual use that are drained after each use.

2.2.12 *Pool Depth* – The vertical distance between the pool floor and the water level.

2.2.13 *Shallow Area* – An area in a swimming pool, in which the water depth does not exceed 1.5 m at any point.

2.2.14 *Skimmer* – A mechanical device connected to the recirculation piping which is used to skim the pool surface.

2.2.15 *Transition Point* – A location in a shallow area of a swimming pool where an area, having a floor slope of no more than 300 mm vertical in 3.65 m horizontal, adjoins an area where the floor slope exceeds one in 12.

2.2.16 *Turnover Period* – The time required to recirculate a volume of water

equivalent to the water volume of the pool through the filtration system.

2.2.17 *Wading Pool* – A pool having a maximum water depth not exceeding 76 cm.

2.2.18 *Water Level* – The level of the overflow lip of a perimeter overflow system or the mid-level of surge weirs, if present, or the mid-level of the skimmer operating range.

2.2.19 *Zero-Depth Edge* – That portion of the perimeter of a zero-depth pool where the pool floor intersects the pool water surface.

2.2.20 *Zero-Depth Pool* – A swimming pool where the pool floor intersects the water surface along a portion of its perimeter.

3 GENERAL

3.1 Basic Principles

3.1.1 Potable Water

All premises intended for human habitation, occupancy, or use shall be provided with supply of potable water. This water supply shall not be connected with unsafe water resources, nor shall it be subject to the hazards of backflow.

3.1.2 Water Provision

Plumbing fixtures, devices and appurtenances shall be provided with water in sufficient volume and at pressures adequate to enable them to function properly and without undue noise under normal conditions of use.

There should be at least a residual head of 0.018 N/mm² at the consumer's tap.

NOTE – The residual head shall be taken at the highest/farthest outlets in the building.

3.1.3 Water Conservation

Plumbing system shall be designed, installed and adjusted to use the optimum quantity of water consistent with proper performance and cleaning.

3.1.4 Safety Devices

Plumbing system shall be designed and installed with safety devices to safeguard against dangers from contamination, explosion, overheating, etc.

3.1.5 Plumbing Fixtures

It is recommended that each family dwelling unit should have at least one water closet, one lavatory, one kitchen wash place or a sink, and one bathing wash place or shower to meet the basic requirements of sanitation and personal hygiene.

3.1.6 *Drainage System*

The drainage system shall be designed, installed and maintained to guard against fouling, deposit of solids and clogging and with adequate cleanouts so arranged that the pipes may be readily cleaned.

3.1.7 *Materials and Workmanship*

The plumbing system shall have durable material, free from defective workmanship and so designed and installed as to give satisfactory service for its reasonable expected life.

3.1.8 *Fixture Traps and Vent Pipes*

Each fixture directly connected to the drainage system shall be equipped with a liquid seal trap. Trap seals shall be maintained to prevent sewer gas, other potentially dangerous or noxious fumes, or vermin from entering the building. Further, the drainage system shall be designed to provide an adequate circulation of air in all pipes with no danger of siphonage, aspiration, or forcing of trap seals under conditions of ordinary use by providing vent pipes throughout the system.

3.1.9 *Foul Air Exhaust*

Each vent terminal shall extend to the outer air and be so installed as to minimize the possibilities of clogging and the return of foul air to the building, as it conveys potentially noxious or explosive gases to the outside atmosphere. All vent pipes shall be provided with a cowl.

3.1.10 *Testing*

The plumbing system shall be subjected to required tests to effectively disclose all leaks and defects in the work or the material.

3.1.11 *Exclusion from Plumbing System*

No substance that will clog or accentuate clogging of pipes, produce explosive mixtures, destroy the pipes or their joints, or interfere unduly with the sewage-disposal process shall be allowed to enter the drainage system.

3.1.12 *Light and Ventilation*

Wherever water closet or similar fixture shall be located in a room or compartment, it should be properly lighted and ventilated.

3.1.13 *Maintenance*

Plumbing systems shall be maintained in a safe and serviceable condition.

3.1.14 *Accessibility*

All plumbing fixtures shall be so installed with regard to spacing as to be accessible for their intended use and for cleaning. All doors, windows and any other device needing access within the toilet shall be so located that they have proper access.

3.1.15 *Fixture for Disabled*

Special toilet fixtures shall be provided for the disabled with required fixtures and devices.

3.1.16 *Structural Safety*

Plumbing system shall be installed with due regard to preservation of the structural members and prevention of damage to walls and other surfaces.

3.2 Water Supply Connection

3.2.1 *Application for Obtaining Supply Connection*

Every consumer, requiring a new supply of water or any extension or alteration to the existing supply shall apply in writing in the prescribed form (see Annex A) to the Authority.

3.2.2 *Bulk Supply*

In the case of large housing colonies or where new services are so situated that it will be necessary for the Authority to lay new mains or extend an existing main, full information about the proposed housing scheme shall be furnished to the Authority; information shall also be given regarding their phased requirements of water supply with full justification. Such information shall include site plans, showing the layout of roads, footpaths, building and boundaries and indicating thereon the finished line and level of the roads or footpaths and water supply lines and appurtenances.

3.2.3 *Completion Certificate*

On completion of the plumbing work for the water supply system, the licensed plumber shall give a completion certificate in the prescribed form (see Annex B) to the Authority for getting the water connection from the mains. The certificate detailing the description of work of the plumbing shall be as per the prescribed form (see Annex C).

3.3 Licensing/Registration of Plumbers

3.3.1 *Execution of Work*

The work which is required to be carried out under the provisions of this section, shall be executed only by a licensed plumber under the control of the Authority and shall be responsible to carry out all lawful directions given by the Authority. No

individual shall engage in the business of plumbing unless so licensed under the provisions of this section.

3.3.1.1 No individual, firm, partnership or corporation shall engage in the business of installing, repairing or altering plumbing unless the plumbing work performed in the course of such business is under the direct supervision of a licensed plumber.

3.3.2 *Examination and Certification*

The Authority shall establish standards and procedure for the qualification, examination and licensing of plumbers and shall issue licences to such persons who meet the qualifications thereof and successfully pass the examination.

3.3.3 For guidelines for registration of plumbers including the minimum standards for qualifications for the grant of licences, reference may be made to good practice [9-1(2)].

3.3.4 *Completion Certificate*

On completion of the plumbing work for the water supply system, the licensed plumber shall give a completion certificate in the prescribed form (see Annex D) to the Authority for getting the water connection from the mains.

4 WATER SUPPLY

4.1 Water Supply Requirements for Buildings

The total quantity of water per day is estimated based on the proposed occupancy and activities catered. Designer has to identify all the possible sources for augmenting the shortfall in water supply. The analysis of available water is done to decide the treatment for consumption and treatment process depends on the quality of water and the purpose for which it is used.

Population requirements for residential buildings shall be as below:

<i>Residential buildings</i>	<i>Population Requirements</i>
1BHK	4
2 BHK	5
3 BHK	6
4 BHK including support staff	7
5 BHK including support staff	7

For commercial buildings, the occupant load shall be determined as indicated below:

- Offices : 1 person per 10 sq. m of floor area;
- Schools : Strength of school plus teaching & non-teaching staff;
- Hostels : Number of beds + 4.5 * (wardens residence) + staff;
- Hotels : Number of beds + staff + requirement of restaurant seats;

Hospitals : Number of beds + staff + visitors [generally population density (includes visitors + staff + attendants) per bed in secondary care hospital is 5, tertiary care is 7 and quaternary care is 9].

NOTE - However, when there are contradictions on the population requirements specified between the relevant Indian Standard and this NBC, it is advised to follow the provisions in the latest of these two publications.

4.1.1 Water Supply for Residences

A minimum of 70 to 100 litres per head per day may be considered adequate for domestic needs of urban communities, apart from non domestic needs as flushing requirements (which varies based on type of building occupancy). As a general rule the following rates per capita per day may be considered minimum for domestic and non domestic needs:

- 1) For communities with population up to 20000
 - a) water supply through stand post 40 lphd (*Min*)
 - b) water supply through house service connection 70 to 100 lphd
- 2) For communities with population 20000 to 100000 together with full flushing system 100 to 150 lphd
- 3) For communities with population above 100000 together with full flushing system 150 to 200 lphd

NOTE – The value of water supply given as 150 to 200 litres per head per day may be reduced to 135 litres per head per day for houses for Medium Income Group (MIG) and Lower Income Groups (LIG) and Economically Weaker Section of Society (EWS), depending upon prevailing conditions.

4.1.1.1 Out of the 150 to 200 litres per head per day, 45 litres per head per day may be taken for flushing requirements and the remaining quantity for other domestic purposes.

4.1.2 Water Supply for Buildings other than Residences

Minimum requirements for water supply for buildings other than residences shall be in accordance with Table 1.

Table 1 Water Requirements for Buildings Other than Residences
(Clause 4.1.2)

Sl. No	Type of Building	Domestic per Day, litres	Flushing per Day, litres	Total Consumption per Day, litres
(1)	(2)	(3)	(4)	(5)
i)	Factories where bath rooms are required to be provided	30 per head	15 per head	45 per head
ii)	Factories where no bath rooms are required to be provided	20 per head	10 per head	30 per head
iii)	Hospital (excluding laundry and Kitchen) :			
	a) Number of beds not exceeding 100	a) 230 per head	a) 110 per head	a) 340 per head
	b) Number of beds exceeding 100	b) 300 per head	b) 150 per head	b) 450 per head
iv)	Nurses' homes and medical quarters	90 per head	45 per head	135 per head
v)	Hostels	90 per head	45 per head	135 per head
vi)	Hotel (up to 3 star) excluding laundry, kitchen, staff & water bodies.	120 per head	60 per head	180 per head
vii)	Hotel (4 Star & above) excluding laundry, kitchen, staff & water bodies.	260 per head	60 per head	320 per head
viii)	Offices	25 per head	20 per head	45 per head
ix)	Restaurants & Food Court including water requirement for kitchen	60 per seat	15 per seat	70 per seat
x)	Cinemas, Concert halls & theatres and Multiplex	5 per seat	10 per seat	15 per seat
xi)	Schools			
	a) Day schools	a) 30 per head	a) 15 per head	a) 45 per head
	b) Boarding schools	b) 90 per head	b) 45 per head	b) 135 per head
xii)	Shopping and Retail (Mall)			
xiii)	Staff	25 per head	20 per head	45 per head
xiv)	Visitors	5 per seat	10 per seat	15 per head
xv)	Airports	50 per head	20 per head	70 per head

NOTE – For calculating water demand for visitors, consumption of 15 litres per head per day may be taken.

The water demand for the lab facilities cannot be fixed as it will depend on actual requirements based on functional point of view.

4.1.3 Water Supply Requirements of Traffic Terminal Stations

The water supply requirements of traffic terminal stations (railway stations, bus stations, harbours, airports, etc) include provisions for waiting rooms and waiting halls. They do not, however, include requirements for retiring rooms. Requirements of water supply for traffic terminal stations shall be according to Table 2.

Table 2 Water Supply Requirements for Traffic Terminal Stations
(Clause 4.1.3)

Sl No.	Nature of Station/Terminal	Where Bathing Facilities are Provided litres/capita	Where Bathing Facilities are not Provided litres/capita
(1)	(2)	(3)	(4)
i)	Intermediate stations (excluding mail and express stops)	45	25
ii)	Junction stations and intermediate stations where mail or express stoppage is provided	70	45
iii)	Terminal stations	45	45
iv)	International and domestic airports	70	70

NOTES

- 1 The number of persons shall be determined by average number of passengers handled by the station daily; due consideration may be given to the staff and vendors likely to use facilities.
- 2 Consideration should be given for seasonal average peak requirements.

4.1.4 Water Supply for Fire Fighting Purposes

4.1.4.1 The Authority shall make provision to meet the water supply requirements for fire fighting in the city/area, depending on the population density and types of occupancy.

4.1.4.2 Provision shall be made by the owner of the building for water supply requirements for fire fighting purposes within the building, depending upon the height and occupancy of the building, in conformity with the requirements laid down in Part 4 'Fire and Life Safety'.

4.1.4.3 The requirements regarding water supply in storage tanks, capacity of fire pumps, arrangements of wet riser-cum-downcomer and wet riser installations for buildings above 15 m in height, depending upon the occupancy use, shall be in accordance with Part 5 'Fire and Life Safety'.

4.1.5 *Water Supply for Other Purposes*

4.1.5.1 Water supply in many buildings is also required for many other applications other than domestic use, which shall be identified in the initial stages of planning so as to provide the requisite water quantity, storage capacity and pressure as required for each application. In such instances information about the water use and the quality required may be obtained from the users. Some typical uses other than domestic use and fire fighting purposes are air conditioning and air washing, swimming pools and water bodies and gardening.

4.1.5.2 The water demand for landscaping purposes is generally taken as 6 to 8 litres/m²/day for lawns. For shrubs and trees the above value can be reduced considerably.

4.2 Water Sources and Quality

4.2.1 *Sources of Water*

The origin of all sources of water is rainfall. Water can be collected as it falls as rain before it reaches the ground; or as surface water when it flows over the ground or is pooled in lakes or ponds; or as ground water when it percolates into the ground and flows or collects as ground water; or from the sea into which it finally flows.

4.2.2 The water supplied shall be free from pathogenic organisms, clear, free from undesirable taste and odour, neither corrosive nor scale forming and free from minerals which could produce undesirable physiological effects. The quality of water to be used for drinking shall be as per good practices [9-1(3)].

4.2.3 For purposes other than drinking, water if supplied separately, shall be absolutely safe from bacteriological contamination so as to ensure that there is no danger to the health of the users due to such contaminants.

4.2.4 *Waste Water Reclamation*

Treated sewage or other waste water of the community may be utilized for non-domestic purposes such as water for cooling, flushing, lawns, parks, fire fighting and for certain industrial purposes after giving the necessary treatment to suit the nature of the use. This supply system shall be allowed in residences only if proper provision is made to avoid any cross connection of this treated waste water with domestic water supply system.

4.2.5 Whenever a building is used after long intervals, the water quality of the stored water shall be checked so as to ensure that the water is safe for use as per water quality requirements specified in this Code.

4.3 Estimate of Demand Load

4.3.1 Estimates of total water supply requirements for buildings shall be based on the occupant load consistent with the provisions of **4.1**.

4.3.1.1 For residential buildings, the requirements of water shall be based on the actual number of occupants; where this information is not available, the number of occupants for each residential unit may be based on a family of five. For assessing the population in other occupants, reference may be made to Part 4 'Fire and Life Safety'.

4.3.1.2 In making assessment of water supply requirements of large complexes, the future occupant load shall be kept in view. Use may be made of the following methods for estimating future requirements:

- a) demographic method of population projection,
- b) arithmetic progression method,
- c) geometrical progression method,
- d) method of varying increment or incremental increase,
- e) logistic method,
- f) graphical projection method, and
- g) graphical comparison method.

4.3.1.3 Waste water is generated by residential, institutional, commercial and industrial establishments. It includes household waste liquid from toilets, baths, showers, kitchens and sinks that is disposed of via sewers. Waste water treatment is the process of removing contaminants from wastewater, including household sewage and runoff (effluents). It includes physical, chemical, and biological processes to remove physical, chemical and biological contaminants. Treatment of waste water and usage of recycled waste water shall be done to make it usable for appropriate applications. The objective is to produce an environmentally safe fluid waste stream (or treated effluent) and a solid waste (or treated sludge) suitable for disposal or reuse.

Separation and draining of household waste into grey water and black water is becoming more common with grey water being permitted to be used for watering plants or recycled for flushing toilets. Waste water collection and treatment is typically subject to local, state and central regulations. Treatment depends on the characteristics of influent sewage and the treatment requirements that are needed for treating the same. Waste water treatment generally involves the following three stages:

- a) Primary treatment consists of temporarily holding the sewage for settlement of heavy solids at the bottom while oil, grease and lighter solids float to the surface.
- b) Secondary treatment removes dissolved and suspended biological matter.
- c) Tertiary treatment is more than primary and secondary treatment in order to allow rejection into a highly sensitive or fragile ecosystem.

Recycled waste water may be used for flushing, landscaping and for HVAC purposes.

4.4 Storage of Water

4.4.1 In a building, provision is required to be made for storage of water for the following reasons :

- a) to provide against interruptions of the supply caused by repairs to mains, etc;
- b) to reduce the maximum rate of demand on the mains;
- c) to tide over periods of intermittent supply; and
- d) to maintain a storage for the fire fighting requirement of the building

4.4.2 The water may be stored either in overhead tanks (OHT) and/or underground tanks (UGT).

4.4.3 *Materials Used*

Reservoirs and tanks for the reception and storage of water shall be constructed of reinforced concrete, brick masonry, ferrocement, mild steel, stainless steel, plastic or glass reinforced panels.

4.4.3.1 Tanks made of steel may be of welded, riveted or pressed construction. The metal shall be galvanized coated externally with a good quality anti-corrosive weather-resisting paint. Lead-based paint shall not be used in the tank. Lead-lined tanks shall not be used. Rectangular pressed steel tanks shall conform to good practice [9-1(4)].

4.4.4 Each tank shall be provided with the following :

- a) *Manholes* – Adequate number of manholes for access and repair. The manholes shall be made of corrosion resistant material (for example, cast iron, reinforced cement concrete, steel fibre reinforced concrete, galvanized steel, high density polyethylene, fibre glass reinforced plastic or such other materials acceptable to the Authority. Manholes shall be provided with locking arrangement to avoid misuse and tampering.
- b) *Catch Rings and Ladders* – Tanks higher than 900 mm deep shall be provided with corrosion resistant catch rings, steps or ladders according to the depth to enable a person to reach the bottom of the tank.
- c) *Overflow Pipe* – Each tank shall be provided with an overflow pipe terminating above the ground/terrace level to act as a 'Warning Pipe' to indicate overflow conditions. The size of the overflow pipe shall be adequate to accept the flow. Normally the overflow pipe size shall be one size higher than the inlet pipe. When the inlet pipe diameter is large, two or more overflow pipes of equivalent cross section may be provided.
- d) *Vent Pipes* – Tanks larger than 5000 litres capacity shall be provided with vent pipes to prevent development pressure in the tank which might result in NO FLOW condition or inward collapse of the tank.
- e) *Scour Pipe* – Each tank shall be provided with a scour pipe with an accessible valve for emptying the tank.
- f) *Connection of Overflow and Scour Pipe* – Under no circumstances tank overflow and scour pipe shall be connected to any drain, gully trap or

manhole to prevent back flow and contamination of the water. All such connections shall be discharged over a grating with an air gap of 50 mm. All overflow and vent pipes shall be provided with a mosquito proof brass grating to prevent ingress of mosquito, vermin and other insects.

- g) The top slab of the tank shall be suitably sloped away from its centre for proper drainage of the rainwater.
- h) Tanks on terraces and above ground shall be supported by appropriate structural members so as to transfer the load of the tank and the water directly on the structural members of the building.

4.4.5 Every storage tank shall be easily accessible and placed in such a position as to enable thorough inspection and cleaning to be carried out. If the storage capacity required is more than 5000 litres, it is advantageous to arrange it in a series of tanks so interconnected that each tank can be isolated for cleaning and inspection without interfering with the supply of water. In large storage tanks, the outlet shall be at the end opposite the inlet to avoid stagnation of the water.

4.4.6 The outlet pipe shall be fixed 50 mm to 75 mm above the bottom of the tank and fitted with a strainer, preferably of brass.

4.4.7 In the case of underground storage tanks, the design of the tank shall be such as to provide for the draining of the tank when necessary and water shall not be allowed to collect around the tank. The tank shall be perfectly water-proof and shall be provided with a cement concrete cover, having a manhole opening, with a properly fitting hinged cast iron cover on a leak-proof cast iron frame.

The underground tanks should not be located in low lying areas or near any public or private sewer, septic tank, leaching pool or soakage pit to prevent any contamination. The overflow of the tank should be well above (preferably 600 mm) the external surface level and terminate as a warning pipe with a mosquito proof grating. Care shall be taken to prevent backflow of local surface water into the tank in case of local flooding. Otherwise the overflow shall be terminated in a more safer manner as per the site conditions. For tanks with atleast one side exposed to a basement, it is safer to discharge the overflow into the basement level.

The tank top slab shall also be designed to carry the load due to fire tender movement where anticipated as in the case of an extended basement.

There should be no common wall between the tanks storing safe water and tanks storing water from unsafe sources.

4.4.8 In case of overhead tanks, bottom of the tanks shall be placed clear off the terrace slab such that the elevation difference between the outlet pipe of the tank and the highest fixture at the top floor of the building is minimum 2 m, which shall also prevent leakage into the structural slab. In tall buildings, the top of the tank shall be provided with the safe ladder or staircase. The top slab shall be provided with railing or a parapet wall.

4.4.9 For jointing steel pipe to a storage tank, the end of the pipe shall be screwed, passed through a hole in the tank and secured by backnuts, both inside and outside.

The pipe end shall be flush with the face of the inside backnut. For jointing copper pipe to steel or copper tank, a connector of non-ferrous material shall be used. The connector shall have a shoulder to bear on the outside of the tank and shall be secured by a backnut inside.

4.4.10 The quantity of water to be stored shall be calculated taking into account the following factors:

- a) hours of supply at sufficiently high pressure to fill up the overhead storage tanks;
- b) frequency of replenishment of overhead tanks, during the 24 hours;
- c) rate and regularity of supply; and
- d) consequences of exhausting storage particularly in case of public buildings like hospitals.

In case of intermittent water supply, the following guidelines may be adopted for calculation of capacity:

- 1) In case of plotted development, where the supply is from main OHT, the capacity of individual OHT may be taken as half a day requirement.
- 2) In case of all the other buildings (Apartments, Hotels, Hospitals, and Commercial), the capacity of UGT and OHT may be taken as one and half days and half a day requirement.
- 3) General practice, however is 2 days per day demand, which varies based on system design and water availability per day by municipal or other sources.
- 4) Also, the final capacities of the underground water tanks for domestic purpose will depend as per regulations of the local authorities.

For additional requirement of water storage for fire fighting purposes, reference may be made to Part 4 'Fire and Life Safety'.

NOTE – General guidelines for calculation of capacity of these storage tanks are as follows:

- a) In case only OHT is provided, it may be taken as 33.3 to 50 percent of one day's requirement;
- b) In case only UGT is provided, it may be taken as 50 to 150 percent of one day's requirement; and
- c) In case combined storage is provided, it may be taken as 66.6 percent UGT and 33.4 percent OHT of one day's requirement.

4.4.11 When only one communication pipe is provided for water supply to a building, it is not necessary to have separate storage for flushing and sanitary purposes for health reasons. In such cases when only one storage tank has been provided, tapping of water may be done at two different levels (the lower tapping for flushing) so that a part of the water will be exclusively available for flushing purposes.

4.5 Materials, Fittings and Appliances

4.5.1 Standards for Materials, Fittings and Appliances

All materials, water fittings and appliances shall conform to Part 5 'Building Materials'.

4.5.2 Materials for Pipes

Pipes may be of any of the following materials:

- a) cast iron, vertically cast or centrifugally (spun) cast,
- b) steel (internally lined or coated with bitumen or a bituminous composition, and out-coated with cement concrete or mortar, where necessary),
- c) reinforced concrete,
- d) prestressed concrete,
- e) galvanized mild steel tubes,
- f) copper,
- g) brass,
- h) wrought iron,
- j) asbestos cement,
- k) polyethylene,
- m) unplasticized PVC,
- n) chlorinated PVC, or
- p) stainless steel.
- q) PPR
- r) Composite pipes (PE-Al-PE)
- s) HDPE
- t) PEX

4.5.2.1 The material chosen shall be resistant to corrosion, both inside and outside or shall be suitably protected against corrosion.

4.5.2.2 Polyethylene and unplasticized PVC pipes shall not be installed near hot water pipes or near any other heat sources. For temperature limitations in the use of polyethylene and unplasticized PVC pipes to convey water, reference may be made to good practice [9-1(5)].

4.6 Design of Distribution Systems

4.6.1 General

- a) All buildings shall conform to the general requirements given in **3.1**.
- b) The peak factor for calculation of flows may generally be adopted in design as 2 to 3.
- c) The residual head at consumer's tap for gravity and pumping system shall be 0.50 kg/cm^2 and 1.0 kg/cm^2 respectively.
- d) The pressure required may be maintained based on fixtures and its technical data sheet.

4.6.2 Rate of Flow

One of the important items that needs to be determined before the sizes of pipes and fittings for any part of the water piping system may be decided upon, is the rate of

flow in the service pipe which, in turn depends upon the number of hours for which the supply is available at sufficiently high pressure. If the number of hours for which the supply is available is less, there will be large number of fittings in use simultaneously and the rate of flow will be correspondingly large.

The data required for determining the size of the communication and service pipes are:

- a) the maximum rate of discharge required;
- b) the length of the pipe; and
- c) the head loss by friction in pipes, fittings and meters.

4.6.3 Discharge Computation

4.6.3.1 Design of consumer's pipes based on fixture units

The design of the consumers' pipes or the supply pipe to the fixtures is based on:

- a) the number and kind of fixtures installed;
- b) the fixture unit flow rate; and
- c) the probable simultaneous use of these fixtures.

The rates at which water is desirably drawn into different types of fixtures are known. These rates become whole numbers of small size when they are expressed in fixture unit.

The fixture units for different sanitary appliances or groups of appliances are given in Table 3 and Table 4.

4.6.3.2 Probable simultaneous demand

The possibility that all water supply taps in any system in domestic and commercial use will draw water at the same time is extremely remote. Designing the water mains for the gross flow will result in bigger and uneconomical pipe mains and is not necessary. A probability study made by Hunter suggests the relationship shown in Fig. 2 and Table 5. In the absence of similar studies in India, the curves based on Hunter's study may be followed. In making use of these curves, special allowances are made as follows:

- a) Demands for service sinks are ignored in calculating the total fixture demand.
- b) Demands of supply outlets such as hose connections and air conditioners through which water flows more or less continuously over a considerable length of time shall be added to the probable flow rather than the fixture demand.
- c) Fixtures supplied with both hot and cold water exert reduced demands upon main hot water and cold water branches (not fixture branches).

**Table 3 Fixture Unit for Different Types of Fixtures
With Inlet Pipe Diameter
(Clause 4.6.3.1)**

SI No	Type of Fixture	Fixture Unit FU as Load Factor	Minimum Normal Size of Fixture Branch, mm
(1)	(2)	(3)	(4)
i)	Ablution tap	1	15
ii)	Bath tub supply by spout <i>(A shower head over a bath tub does not increase the load)</i>	3	15
iii)	Shower stall domestic	2	15
iv)	Shower in groups per head	3	15
v)	Wash Basin domestic use	1	15
vi)	Wash Basin Public Use	2	15
vii)	Wash Basin Surgical	2	15
viii)	Scrub Station in hospitals per outlet	3	15
ix)	Drinking water fountain /water cooler	0.5	15
x)	Water closet with cistern (single/double flush)	4	15
xi)	Water Closet with flush or magic eye operated valve	8	25/32
xii)	Urinals with auto flushing cisterns	4	15/20
xiii)	Urinals with flush or magic eye operated Valve	2	15/20
xiv)	Kitchen sink (domestic use)	2	15/20
xv)	Washing machine	3	15/20
xvi)	Kitchen Dish washer	1.5	15

**Table 4 Fixture Unit for Different Types of Fixtures
Based on Pipe or Trap Diameter
(Clause 4.6.3.1)**

SI No.	Drain or Trap outlet diameter mm	Fixture Unit FU
1	32 or smaller	1
2	40	2
3	50	3
4	65	4
5	75	5
6	100	6

NOTE - Before using the above figures check the actual flow from the outlets of special equipment for example, small period high discharges for example, from washing machines, boiler blow downs, filter backwash and water tank emptying operations

Table 5 Probable Simultaneous Demand
(Clause 4.6.3.2)

No. of Fixture Units (1)	System with Flush Tanks Demand (Based on Fixture Units)		System with Flush Valves Demand (After Hunter)	
	Unit rate of Flow ¹⁾ (2)	Flow in Litre per Minute (3)	Unit rate of Flow ¹⁾ (4)	Flow in Litre per Minute (5)
1	0	–	0	–
5	0.7	18.9	–	–
10	1.2	30.3	3.5	102.0
20	2.0	56.6	4.7	133.1
40	3.3	93.4	6.3	178.4
60	4.3	121.8	7.4	209.5
80	5.1	144.4	8.3	235.0
100	5.7	161.4	9.1	257.7
120	6.4	181.2	9.8	277.5
140	7.1	201.0	10.4	294.5
160	7.6	215.2	11.0	311.5
180	8.2	232.2	11.6	328.5
200	8.6	243.5	12.3	348.3
220	9.2	260.5	12.7	359.6
240	9.6	271.8	13.1	370.9
300	11.4	322.8	14.7	416.2
400	14.0	396.4	17.0	481.4
500	16.7	472.9	19	538.0
600	19.4	549.3	21.1	597.5
700	21.4	606.0	23.0	651.3
800	24.1	682.4	24.5	693.7
900	26.1	739.0	26.1	739.0
1000	28.1	795.7	28.1	795.7
1500	36.1	1022.2	36.1	1022.2
2000	43.9	1243.1	43.9	1243.1
2500	51.1	1446.9	51.1	1446.9
3000	57.8	1636.7	57.8	1636.7

¹⁾ Unit rate of flow = Effective fixture units

NOTE – In respect of fixture units more than 3000, the unit rate of flow shall be extrapolated by developing an equation between fixture units and unit rate of flow

4.6.3.3 The maximum flow rate and flush volumes shall be as below:

<i>Plumbing fixtures/ Fittings</i>	<i>Maximum flow rate</i>
Water closets	6 litres /flush
Urinals	3.8 litres/flush
Lavatory, Metered faucet (Public)	1 litre/use
Lavatory, Faucet (Private)	8 litres/min at 0.55 kg/cm ²
Sink, faucet	8 litres/min at 0.55 kg/ cm ²
Bidet, Hand held spray	8 litres/min at 0.55 kg/ cm ²
Shower head	10 litres/min at 0.55 kg/ cm ²

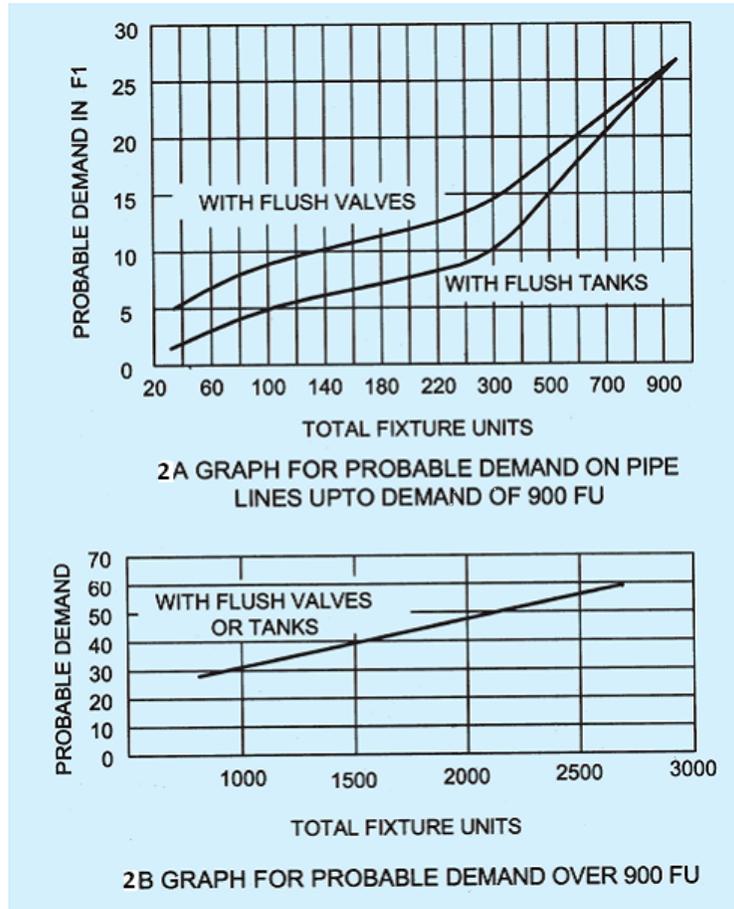


FIG. 2 GRAPH FOR PROBABLE DEMAND

4.6.4 Pipe Size Computation

Commercially available standard sizes of pipes are only to be used against the sizes arrived at by actual design. Therefore, several empirical formulae are used, even though they give less accurate results. The Hazen and William's formula and the charts based on the same may be used without any risk of inaccuracy in view of the fact that the pipes normally to be used for water supply are of smaller sizes. Nomogram of Hazen and William's equation has been provided in Annex E.

4.6.5 Inadequate and Excessive Water Pressure

The requirements shall be as follows:

- a) *Inadequate water pressure* – A minimum water pressure of 1.0 kg/cm² shall be ensured in the distribution system. For dual piping, a minimum pressure of 0.5 kg/cm² for flushing cisterns and 1.0 kg/cm² for flush valves respectively is required.
- b) *Excessive water pressure* – Whenever pressure exceeds 4.0 kg/cm², the distribution system will not be able to withstand the same and this may result in bursting of pipes. During these periods, pressure reducing valves shall be installed for reduction of pressure.

4.6.6 Water Hammer Effects

Water hammer is recognised by the noise that is heard when valves are shut off. This occurs when flow of moving water is suddenly stopped due to closure of valve. Water hammer arrestors may be used to absorb high pressures resulting from sudden closure of valves.

4.7 Distribution Systems in Multi-Storeyed Buildings

4.7.1 There are four basic methods of distribution of water to a multi-storied buildings.

- a) Direct supply from mains to ablutionary taps and kitchen with WCs and urinals supplied by overhead tanks.
- b) Direct Pumping Systems
- c) Hydro-pneumatic Systems
- d) Overhead Tanks Distribution

4.7.2 Direct Supply System

This system is adopted when adequate pressure is available round the clock at the topmost floor. With limited pressure available in most city mains, water from direct supply is normally not available above two or three floors. For details of this system, reference may be made to good practice [9-1(6)] may be referred.

4.7.3 Direct Pumping

4.7.3.1 Water is pumped directly into the distribution system without the aid of any overhead tank, except for flushing purposes. The pumps are controlled by a pressure switch installed on the line. Normally a jockey pump of smaller capacity installed which meets the demand of water during low consumption and the main pump starts when the demand is greater. The start and stop operations are accomplished by a set of pressure switches are installed directly on the line. In some installation, a timer switch is installed to restrict the operating cycle of the pump.

4.7.3.2 Direct pumping systems are suitable for buildings where a certain amount of constant use of water is always occurring. These buildings are all centrally air-conditioned buildings for which a constant make up supply for air-conditioning cooling towers is required.

4.7.3.3 The system depends on a constant and reliable supply of power. Any failure in the power system would result in a breakdown in the water supply system.

4.7.3.4 The system eliminates the requirements of overhead tanks for domestic purposes (except for flushing) and requires minimum space (see Fig. 3).

4.7.4 Hydro-pneumatic Systems

4.7.4.1 Hydro-pneumatic System is a variation of direct pumping system. An air-tight pressure vessel is installed on the line to regulate the operation of the pumps. The vessel capacity shall be based on the cut-in and cut-out pressure of the pumping system depending upon allowable start/stops of the pumping system. As pumps operate, the incoming water is the vessel, compresses the air on top. When a predetermined pressure is reached in the vessel, a pressure switch installed on the vessel switches off the pumps. As water is drawn into the system, pressure falls into the vessel starting the pump at preset pressure. The air in the pressure tank slowly reduces the volume due to dissolution in water and leakages from pipe lines. An air compressor is also necessary to feed air into the vessel so as to maintain the required air-water ratio. The system shall have reliable power supply to avoid breakdown in the water supply.

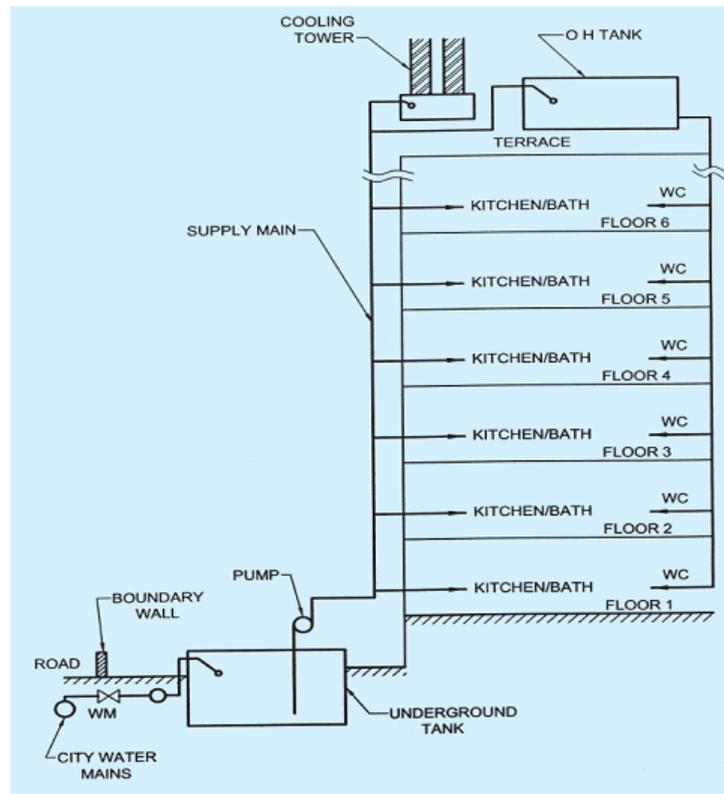


FIG. 3 DIRECT PUMPING SYSTEM APPLICABLE WHERE THERE IS CONTINUOUS DEMAND ON SYSTEM

4.7.4.2 There is an alternate option of providing variable speed drive pumping system where a pump with a large variation in its pressure-discharge and speed of the pump is efficiently used to deliver water at rates of flow as required by the system by changing its speed by a varying its with the assistance of an electronic device which will reduce the rate of flow from speed of the motor from 960 rpm to 3000 rpm. With this arrangement the same pump is able to deliver water as required at different times of the day. The system consumes energy in proportion to the work done and save considerable amount of power as compared to the fixed speed pumps used conventionally.

4.7.4.3 Hydro-pneumatic system generally eliminates the need for an over head tank and may supply water at a much higher pressure than available from overhead tanks particularly on the upper floors, resulting in even distribution of water at all floors (see Fig. 4).

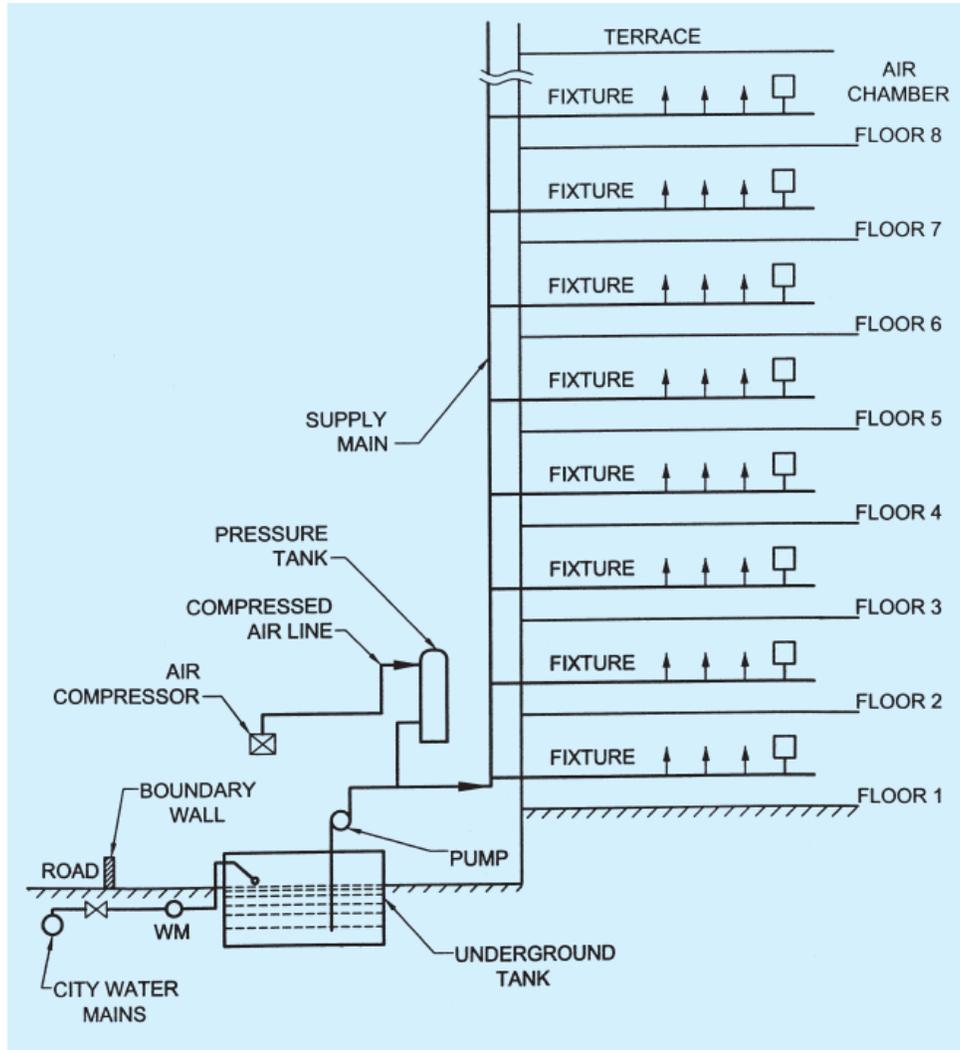


FIG. 4 HYDRO-PNEUMATIC SYSTEM

4.7.4.4 *Overhead Tank Distribution*

4.7.4.4.1 This is the most common of the distribution systems adopted by various type of buildings.

4.7.4.4.2 The system comprises pumping water to one or more overhead tanks placed at the top most location of the hydraulic zone.

4.7.4.4.3 Water collected in the overhead tank is distributed to the various parts of the building by a set of pipes located generally on the terrace.

4.7.4.4 Distribution is accomplished by providing down takes to various fixtures (see Fig. 5).

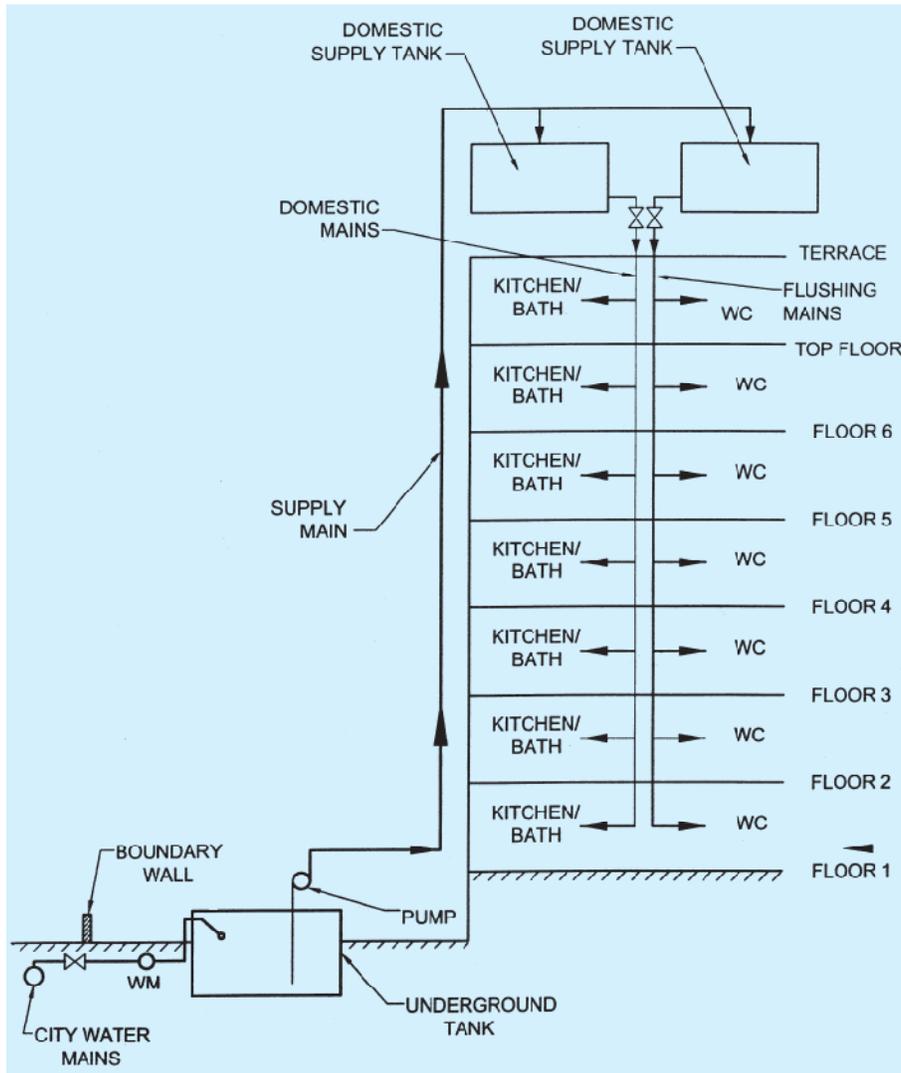


FIG. 5 OVERHEAD TANK DISTRIBUTION

4.7.5 Zoning of Distribution Systems

The zoning shall be undertaken as follows:

- The minimum number of floors that is considered based on pressure requirements for a down take pipe is generally 6 to 7.
- In respect of gravity systems, zoning of distribution system would be adopted after 7 floors.
- For hydro-pneumatic systems, zoning would be 7 to 8 floors. The supply is through hydro-pneumatic vessel fitted with accessories.
- Pressure reducing valves are provided in gravity systems as and when the pressure exceeds 4.0 kg/cm^2 .

- e) The minimum pressure requirement for shower and for WC with flush valve would be 1 kg/cm².

4.8 General Requirements for Pipe Work

4.8.1 Mains

The following principles shall apply for the mains:

- a) Service mains shall be of adequate size to give the required rate of flow.
- b) The mains shall be divided into sections by the provisions of sluice valves and other valves so that water may be shut off for repairs.
- c) To avoid dead ends, the mains shall be arranged in a grid formation or in a network.
- d) Where dead ends are unavoidable, a hydrant shall be provided to act as a wash-out.
- e) The wash-out valve shall not discharge directly into a drain or sewer, or into a manhole or chamber directly connected to it; an effectively trapped chamber shall be interposed, into which the wash-out shall discharge.
- f) Air valves shall be provided at all summits, and wash-out at low points between summits.
- g) Mains need not be laid at unvarying gradients, but may follow the general contour of the ground. They shall, however, fall continuously towards the wash-out and rise towards the air valves. The gradient shall be such that there shall always be a positive pressure at every point under working conditions.
- h) The cover for the mains shall be at least 900 mm under roadways and 750 mm in the case of footpaths. This cover shall be measured from the top of the pipe to the surface of the ground.
- j) The mains shall be located sufficiently away from other service lines like electric and telegraph cables to ensure safety and where the mains cannot be located away from such lines, suitable protective measures shall be accorded to the mains.

4.8.2 Communication Pipes

- a) Every premises that is supplied with water by the Authority shall have its own separate communication pipe. In the case of a group or block of premises belonging to the same owner the same communication pipe may supply water to more than one premises with the prior permission of the Authority.
- b) The communication pipe between the water main and the stop-cock at the boundary of the premises shall be laid by the Authority.
- c) Connections up to 50 mm diameter may be made on the water main by means of screwed ferrules, provided the size of the connections does not exceed one third the size of the water main. In all other cases, the connection shall be made by a T-branch off the water main.
- d) As far as practicable, the communication pipe and the underground service pipe shall be laid at right angles to the main and in approximately straight lines to facilitate location for repairs. It is also recommended that

the communication pipe be laid in a pipe in pipe sleeve of larger dia. Made of non corrosive material to protect the communication pipe.

- e) Every communication pipe shall have a stop-cock and meter inserted in it. The waterway of each such fitting shall not be less than the internal sectional area of the communication pipe and the fittings shall be located within the premises at a conspicuous place accessible to the Authority which shall have exclusive control over it.

4.8.3 Consumer Pipes

- a) No consumer pipe shall be laid in the premises to connect the communication pipe without the approval of the Authority.
- b) The consumer pipe within the premises shall be laid underground with a suitable cover to safeguard against damage from traffic and extremes of weather.
- c) To control the branch pipe to each separately occupied part of a building supplied by a common service pipe, a stop tap shall be fixed to minimize the interruption of the supply during repairs. All such stop valves shall be fixed in accessible positions and properly protected. To supply water for drinking or for culinary purposes, direct taps shall be provided on the branch pipes connected directly to the consumer pipe. In the case of multi-storied buildings, downtake taps shall be supplied from overhead tanks.
- d) Pumps shall not be allowed on the service pipe, as they cause a drop in pressure on the suction side, thereby affecting the supply to the adjoining properties. In cases where pumping is required, a properly protected storage tank of adequate capacity shall be provided to feed the pump.
- e) No direct boosting (by booster pumps) shall be allowed from the service pipes (communication and consumer pipes).
- f) Consumer pipes shall be so designed and constructed as to avoid air-locks. Draining taps shall be provided at the lowest points from which the piping shall rise continuously to draw-off taps.
- g) Consumer pipes shall be so designed as to reduce the production and transmission of noise as much as possible.
- h) Consumer pipes in roof spaces and unventilated air spaces under floors or in basements shall be protected against corrosion.
- j) Consumer pipes shall be so located that they are not unduly exposed to accidental damage and shall be fixed in such positions as to facilitate cleaning and avoid accumulations of dirt.
- k) All consumer pipes shall be so laid as to permit expansion and contraction or other movements.

4.8.4 Prohibited Connections

- a) A service pipe shall not be connected into any distribution pipe; such connection may permit the backflow of water from a cistern into the service pipe, in certain circumstances, with consequent danger of contamination and depletion of storage capacity. It might also result in pipes and fittings being subjected to a pressure higher than that for which they are designed, and in flooding from overflowing cisterns.

- b) No pipe for conveyance or in connection with water supplied by the Authority shall communicate with any other receptacle used or capable of being used for conveyance other than water supplied by the Authority.
- c) Where storage tanks are provided, no person shall connect or be permitted to connect any service pipe with any distributing pipe.
- d) No service or supply pipe shall be connected directly to any water-closet or a urinal. All such supplies shall be from flushing cisterns which shall be supplied from storage tank.
- e) No service or supply pipe shall be connected directly to any hot water system or to any other apparatus used for heating other than through a feed cistern thereof.

4.9 Jointing of Pipes

4.9.1 *Cast Iron Pipes*

Jointing may be done by any of the following methods:

- a) spigot and socket joints, or
- b) flanged joints.

in accordance with good practice [9-1(7)]. The lead shall conform to the accepted standards [9-1(8)].

4.9.2 *Steel Pipes*

Plain-ended steel pipes may be jointed by welding. Electrically welded steel pipes shall be jointed in accordance with good practice [9-1(9)].

4.9.3 *Wrought Iron and Steel Screwed Pipes*

Screwed wrought iron or steel piping may be jointed with screwed and socketed joints. Care shall be taken to remove any burr from the end of the pipes after screwing. A jointing compound approved by the Authority and containing no red lead composition shall be used. Screwed wrought iron or steel piping may also be jointed with screwed flanges.

4.9.4 *Asbestos Cement Pipes*

Asbestos cement pipes may be jointed in accordance with good practice [9-1(10)].

4.9.5 *Copper Pipes*

Copper pipes shall be jointed by internal solder ring joint, end-brazing joint or by use of compression fitting. The flux used shall be non-toxic and the solder used shall be lead free. The use of dezincification fittings shall be made in case of jointing of copper pipe and steel pipe.

4.9.6 *Concrete Pipes*

Concrete pipes shall be jointed in accordance with good practice [9-1(11)].

4.9.7 Polyethylene and Unplasticized PVC Pipes

Polyethylene and unplasticized PVC pipes shall be jointed in accordance with good practice [9-1(12)].

4.10 Backflow Prevention

4.10.1 The installation shall be such that water delivered is not liable to become contaminated or that contamination of the public water supply does not occur.

4.10.2 The various types of piping and mechanical devices acceptable for backflow protection are:

- a) Barometric loop
- b) Air gap
- c) Atmosphere vacuum breaker
- d) Pressure vacuum breaker
- e) Double check valve
- f) Reduced pressure backflow device

4.10.3 The installation shall not adversely affect drinking water:

- a) by materials in contact with the water being unsuitable for the purpose;
- b) as a result of backflow of water from water fittings, or water using appliances into pipework connected to mains or to other fittings and appliances;
- c) by cross-connection between pipes conveying water supplied by the water undertaker with pipes conveying water from some other source; and
- d) by stagnation, particularly at high temperatures.

4.10.4 No pump or similar apparatus, the purpose of which is to increase the pressure in or rate of flow from a supply pipe or any fitting or appliance connected to a supply pipe, shall be connected unless the prior written permission of the water supplier has been obtained in each instance.

The use of such a pump or similar apparatus is likely to lead to pressure reduction in the upstream pipe work which, if significant, increase the risk of backflow from other fittings.

4.10.5 The water shall not come in contact with unsuitable materials of construction.

4.10.6 No pipe or fitting shall be laid in, on or through land fill, refuse, an ash pit, sewer, drain, cesspool or refuse chute, or any manhole connected with them.

4.10.7 No pipe susceptible to deterioration by contact with any substance shall be laid or installed in a place where such deterioration is likely to occur. No pipe that is

permeable to any contaminant shall be laid or installed in any position where permeation is likely to occur.

4.10.8 If a liquid (other than water) is used in any type of heating primary circuit, which transfers heat to water for domestic use, the liquid shall be non-toxic and non-corrosive.

4.10.9 A backflow prevention device shall be arranged or connected at or as near as practicable to each point of delivery and use of water. Appliances with built-in backflow prevention shall be capable of passing the test. All backflow prevention devices shall be installed so that they are accessible for examination, repair or replacement. Such devices shall be capable of being tested periodically by the Authority to ensure that the device is functioning efficiently and no backflow is occurring at any time.

4.11 Conveyance and Distribution of Water Within the Premises

4.11.1 *Basic Principles*

Wholesome water supply provided for drinking and culinary purposes shall not be liable to contamination from any less satisfactory water. There shall, therefore, be no cross-connection whatsoever between the distribution system for wholesome water and any pipe or fitting containing unwholesome water, or water liable to contamination, or of uncertain quality, or water which has been used for any other purpose. The provision of reflux or non-return valves or closed and sealed stop valves shall not be construed as a permissible substitute for complete absence of cross-connection.

4.11.2 The design of the pipe work shall be such that there is no possibility of backflow towards the source of supply from any cistern or appliance, whether by siphonage or otherwise. Reflux non-return valves shall not be relied upon to prevent such backflow.

4.11.3 Where a supply of less satisfactory water than wholesome water becomes inevitable as an alternative or is required to be mixed with the latter, it shall be delivered only into a cistern and by a pipe or fitting discharging into the air gap at a height above the top edge of the cistern equal to twice its nominal bore and in no case less than 150 mm. It is necessary to maintain a definite air gap in all appliances or taps used in water-closets.

4.11.4 All pipe work shall be so designed, laid or fixed and maintained as to remain completely water-tight, thereby avoiding wastage, damage to property and the risk of contamination.

4.11.5 No water supply line shall be laid or fixed so as to pass into or through any sewer, scour outlet or drain or any manhole connected therewith nor through any ash pit or manure pit or any material of such nature that is likely to cause undue deterioration of the pipe, except where it is unavoidable.

4.11.5.1 Where the laying of any pipe through corrosive soil or previous material is unavoidable, the piping shall be properly protected from contact with such soil or material by being carried through an exterior cast iron tube or by some other suitable means as approved by the Authority. Any existing piping or fitting laid or fixed, which does not comply with the above requirements, shall be removed immediately by the consumer and relaid by him in conformity with the above requirements and to the satisfaction of the Authority.

4.11.5.2 Where lines have to be laid in close proximity to electric cables or in corrosive soils, adequate precautions/protection should be taken to avoid corrosion.

4.11.6 Underground piping shall be laid at such a depth that it is unlikely to be damaged by frost or traffic loads and vibrations. It shall not be laid in ground liable to subsidence, but where such ground cannot be avoided, special precautions shall be taken to avoid damage to the piping. Where piping has to be laid across recently disturbed ground, the ground shall be thoroughly consolidated so as to provide a continuous and even support.

4.11.7 In designing and planning the layout of the pipe work, due attention shall be given to the maximum rate of discharge required, economy in labour and materials, protection against damage and corrosion, water hammer, protection from frost, if required, and to avoidance of airlocks, noise transmission and unsightly arrangement.

4.11.8 To reduce frictional losses, piping shall be as smooth as possible inside. Methods of jointing shall be such as to avoid internal roughness and projection at the joints, whether of the jointing materials or otherwise.

4.11.9 Change in diameter and in direction shall preferably be gradual rather than abrupt to avoid undue loss of head. No bend or curve in piping shall be made which is likely to materially diminish or alter the cross-section.

4.11.10 No boiler for generating steam or closed boilers of any description or any machinery shall be supplied direct from a service or supply pipe. Every such boiler or machinery shall be supplied from a feed cistern.

4.12 Laying of Mains and Pipes on Site

4.12.1 The mains and pipes on site shall be laid in accordance with good practice [9-1(13)].

4.12.2 *Excavation and Refilling*

The bottoms of the trench excavations shall be so prepared that the barrels of the pipes, when laid, are well bedded for their whole length on a firm surface and are true to line and gradient. In the refilling of trenches, the pipes shall be surrounded with fine selected material, well rammed so as to resist subsequent movement of the pipes. No stones shall be in contact with the pipes; when resting on rock, the pipes

shall be bedded on fine-selected material or (especially where there is a steep gradient) on a layer of concrete.

4.12.2.1 The pipes shall be carefully cleared of all foreign matter before being laid.

4.12.3 *Laying Underground Mains*

Where there is a gradient, pipe laying shall proceed in 'uphill' direction to facilitate joint making.

4.12.3.1 Anchor blocks shall be provided to withstand the hydraulic thrust.

4.12.4 Iron surface boxes shall be provided to give access to valves and hydrants and shall be supported on concrete or brickwork which shall not be allowed to rest on pipes.

4.12.5 *Laying Service Pipes*

4.12.5.1 Service pipes shall be connected to the mains by means of right-hand screw down ferrule or T-branches. The ferrules shall conform to accepted standards [9-1(14)].

4.12.5.2 Precaution against contamination of the mains shall be taken when making a connection and, where risk exists, the main shall be subsequently disinfected. The underground water service pipe and the building sewer or drain shall be kept at a sufficient distance apart so as to prevent contamination of water. Water service pipes or any underground water pipes shall not be run or laid in the same trench as the drainage pipe. Where this is unavoidable, the following conditions shall be fulfilled:

- a) The bottom of the water service pipe, at all points, shall be at least 300 mm above the top of the sewer line at its highest point.
- b) The water service pipe shall be placed on a solid shelf excavated on one side of the common trench.
- c) The number of joints in the service pipe shall be kept to a minimum.
- d) The materials and joints of sewer and water service pipe shall be installed in such a manner and shall possess such necessary strength and durability as to prevent the escape of solids, liquids and gases there from under all known adverse conditions, such as corrosion strains due to temperature changes, settlement, vibrations and superimposed loads.

4.12.5.3 The service pipe shall pass into or beneath the buildings at a depth of not less than 750 mm below the outside ground level and, at its point of entry through the structure, it shall be accommodated in a sleeve which shall have previously been solidly built into the wall of the structure. The space between the pipe and the sleeve shall be filled with bituminous or other suitable material for a minimum length of 150 mm at both ends.

4.12.6 Pipes Laid through Ducts, Chases, Notches or Holes

Ducts or chases in walls for piping shall be provided during the building of the walls. If they are cut into existing walls, they shall be finished sufficiently smooth and large enough for fixing the piping.

4.12.6.1 Piping laid in notches or holes shall not be subjected to external pressure.

4.12.7 Lagging of Pipes

Where lagged piping outside buildings is attached to walls, it shall be entirely covered all round with water-proof and fire insulating material and shall not be in direct contact with the wall. Where it passes through a wall, the lagging shall be continued throughout the thickness of the wall.

4.13 Hot Water Supply Installations

4.13.1 Design Consideration

4.13.1.1 General

In electric water heating practice for domestic purposes, the accepted method is to use storage heaters in which water is steadily heated up to a predetermined temperature and stored until required for use. The heating by electricity of a large quantity of water, such as water required for a hot bath, within the time normally taken to run the water into the bath, requires a heater of too high a rating to be practicable in normal domestic premises.

4.13.1.2 In modern hotels and apartment blocks and service apartments, centralized storage and distribution systems are adopted, where other energy sources such as oil, gas, solar panels, etc, may be used for the generation of hot water as these options prove more economical and convenient in heating large volumes of water for storage.

4.13.1.3 When water supplied to the buildings contain dissolved salts resulting in hardness of water, measures such as installation of water softening plants etc shall be taken to avoid formation of scales in the hot water installations.

4.13.2 Storage Temperature

4.13.2.1 The design of hot water supply system and its appliances shall be based on the temperatures at which water is normally required for the various uses, namely:

Scalding	65°C
Sink	60°C
Hot bath	43°C as run, for use at 41°C
Warm bath	37°C
Tepid bath	29.5°C

4.13.2.2 In order to minimize the danger of scalding, precipitation of scale from hard water, standing heat losses, risk of steam formation and the possibility of damage to porcelain or other fittings and to surface finishes, a storage temperature of 60°C is recommended. If storage capacity is limited, a higher temperature up to 65°C may be adopted when soft water is used.

4.13.3 Storage Capacity

The size of the storage vessel is governed by the maximum short time demand of the domestic premises. Depending on local conditions this shall be 50 l to 75 l at 60°C in a dwelling with a bath tub and 25 l at 60°C for a shower or a tap (for bucket supply). The capacity of the storage vessel shall not be less than 20 percent in excess of the required maximum short time demand. In larger houses where a single hot water heater is intended to supply hot water to more than one bathroom or kitchen or both, the maximum short time demand shall be estimated and the capacity decided accordingly. Small electric or gas storage heaters of 15 l to 25 l capacity may be used to supply one or two points of draw off depending on the use of hot water. Values of volume of hot water required for a bath, when cold water is mixed with it are given in Table 6.

Table 6 Volume of Hot Water Required For a Bath When Cold Water is Mixed with It
(Clause 4.13.3)

Storage temperature, °C	75	70	65	60	55	50
Percentage of Hot water required	51	55	60	66	73	82.5
Quantity of hot water in litres required for a 115 litre bath	59	63	69	76	84	95

NOTE – Hot bath temperature at 41°C and cold water at about 5 to 55°C

4.13.4 Rate of Flow

With storage type installation, the recommended minimum rates of flow for different types of fixtures are given in Table 7.

Table 7 Rate of Hot Water Flow
(Clause 4.13.4)

SI No.	Fixtures	Rate of Flow litres/min
(1)	(2)	(3)
i)	Bath tub	22.5
ii)	Kitchen sink	18
iii)	Wash basin	7
iv)	Shower (spray type)	7

4.13.4.1 Hot water supply systems

Identification of water supply system is critical for safe functioning and protection of occupants. The first step is correct labelling of various water systems in the building. The requirements of identification/labelling shall be adhered on every installation where different water systems are provided.

While designing centralised hot water systems in major projects, the following points should be considered:

- a) Fuel to be used
- b) Location and dimension of boiler house and calorifier chambers
- c) Location and dimension of fuel storage tank
- d) Means of ash disposal (in case of solid fuel)
- e) Location and dimension of chimney
- f) Location of cold water points
- g) Drainage facilities during emptying
- h) Quality of water supply
- j) Provision for air combustion and ventilation

In laying hot water piping systems, the pressures of hot and cold water should be made equal at each fixture, especially where mixing faucets are to be used. Otherwise, there would be imbalance of pressure where one pressure would be more than the other. These conditions should be avoided by proper design of the system.

Return circulation systems are recommended for energy conservation and user comfort.

In the inverted systems, hot water heaters and tanks are located at the highest point of water supply system and supply and return risers below the level of hot water source.

Environmental and consumer requirements should be considered when planning the installation of a solar hot water system. Factors affecting the performance of a system and decisions about how the system should be installed, include:

- 1) the climate zone of the site and possibility of:
 - i) shading
 - ii) frost and freezing
 - iii) wind
 - iv) dust
 - v) hail
 - vi) corrosion and scaling
- 2) the ambient air temperature
- 3) the cold water temperature
- 4) the availability of space and pitch of a suitable north-facing roof
- 5) the presence and location of an existing hot water service
- 6) the available energy sources (for example, gas or electricity)
- 7) the householder's hot water usage
- 8) the householder's budget.

4.13.5 Design of Storage Vessel

Storage tanks shall be oblong or cylindrical in shape and shall be installed, preferably with the long side vertical in order to assist the effective stratification or 'layering' of hot or cold water. The ratio of height to width or diameter shall not be less than 2:1. An inlet baffle should preferably be fitted near the cold inflow pipe in order to spread the incoming cold water.

4.13.6 Materials for Storage Vessel and Pipes

4.13.6.1 Under no circumstances shall ungalvanized (black) mild steel pipes and fittings, such as sockets, bushes, etc, be used in any part of a hot water installation, including the cold feed pipe and the vent pipe. Materials resistant to the chemical action of water supplied shall be used in construction of vessels and pipes. Each installation shall be restricted to one type of metal only, such as all copper or all galvanized mild steel. When water supplied is known to have appreciable salt content, galvanized iron vessels and pipes shall not be used. However, it is advisable to avoid use of lead pipes in making connection to wash basins. Where required it is also advisable to use vessels lined internally with glass, stainless steel, etc.

4.13.6.2 In general tinned copper and other metals such as monel metal etc are suitable for most types of water. The suitability of galvanized mild steel for storage tanks depends upon the pH value of the water and the extent of its temporary hardness. For values of pH 7.2 or less, galvanized mild steel should not be used. For values of pH 7.3 and above, galvanized mild steel may be used provided the corresponding temporary hardness is not lower than those given below:

<i>pH Value</i>	<i>Minimum Temporary Hardness Required (mg/l)</i>
7.3	210
7.4	150
7.5	140
7.6	110
7.7	90
7.8	80
7.9 – 8.5	70

4.13.7 Location of Storage Vessel

The loss of heat increases in proportion to the length of pipe between the storage vessel and the hot water outlet since each time the water is drawn, the pipe fills with hot water which then cools. The storage vessel shall therefore be so placed that the pipe runs to the most frequently used outlets are as short as possible.

4.13.8 Immersion Heater Installation

4.13.8.1 If a domestic storage vessel is to be adopted to electric heating by the provision of an immersion heater and thermostat, the following precautions shall be observed:

- a) *Location of immersion heaters* – The immersion heater shall be mounted with its axis horizontal, except in the case of the circulation type which is normally mounted with its axis approximately vertical.
- b) In a tank with a flat bottom, a space of not less than 75 mm below the immersion heater and 50 mm below the cold feed connection shall be provided to allow for accumulation of sludge and scale, where it will not affect the working of the immersion heater.
- c) In a cylindrical storage vessel with inwardly dished bottom, the inlet pipe shall be so arranged that the incoming cold water is not deflected directly into the hot water zone. The lowest point of the immersion heater shall be 25 mm above the centre line of the cold feed inlet, which, in turn, is usually 100 mm above the cylinder rim.
- d) *Location of thermostat* – Where the thermostat does not form an integral part of the immersion heater, it shall be mounted with its axis horizontal, at least 50 mm away from and not lower than the immersion heater.
- e) *Dual heater installations* – If desired, the principle of the dual heater may be adopted. In this case, one heater and its thermostat shall be installed at a low level as indicated in (b) and (c). The second heater and its thermostat shall be similarly disposed in the upper half of the cylinder at a level depending on the reserve of hot water desired for ordinary domestic use. The bottom heater shall be under separate switch control.
- f) *Clearance around storage vessel* – Adequate clearance shall be provided between the tank and the cupboard, door or walls to allow convenient insertion and adjustment of the immersion heater and thermostat and to give space for thermal insulation.

4.13.8.2 *Rating of Immersion Heaters*

The rating of an immersion heater shall be determined according to the following factors:

- a) proposed hot water storage capacity (the maximum with cold water as indicated in **4.13.3** shall be taken into account),
- b) rate of utilization (draw off frequency),
- c) permissible recovery period, and
- d) inlet water temperature.

For details regarding rated input of water, refer to good practice [9-1(15)].

4.13.9 *Thermal Insulation*

The hot water storage vessel and pipes shall be adequately insulated wherever necessary to minimize heat loss. The whole external surface of the storage vessel including the cover to the handhole, shall be provided with a covering equivalent to not less than 75 mm thickness of thermal insulating material having a conductivity of not more than $0.05 \text{ W}/(\text{m}^2 \cdot ^\circ\text{C})/\text{mm}$ at mean temperature of 50°C .

4.13.10 *Cold Water Supply to Heaters*

4.13.10.1 A storage water heater (pressure type) shall be fed from a cold water storage tank and under no circumstances connected directly to the water main, except the type which incorporates a feed tank with ball valves and overflow pipe arrangement (cistern type heaters) or non-pressure type heaters.

4.13.10.2 *Storage cisterns*

4.13.10.2.1 The storage capacity of a cold water tank shall be at least twice the capacity of the hot water heater. The capacity of the storage tank may, however, be 1.5 times when the number of heaters connected to one common tank exceeds 10.

4.13.10.2.2 The storage tank for supply of cold water to hot water heaters shall be separate, if practicable. In the case of a common tank which also supplies cold water to the fixtures, this cold water supply connection shall be so arranged that 50 percent of the net capacity, worked out as in **4.13.10.2.1**, shall be available for supply to the hot water heaters.

4.13.10.2.3 In the case of multistoried buildings where a common overhead tank over the stair/lift well is generally installed, it is advisable to have one or more local tanks for supply to the hot water heaters. This arrangement shall help in reducing the length of the vent pipes (see Fig. 6).

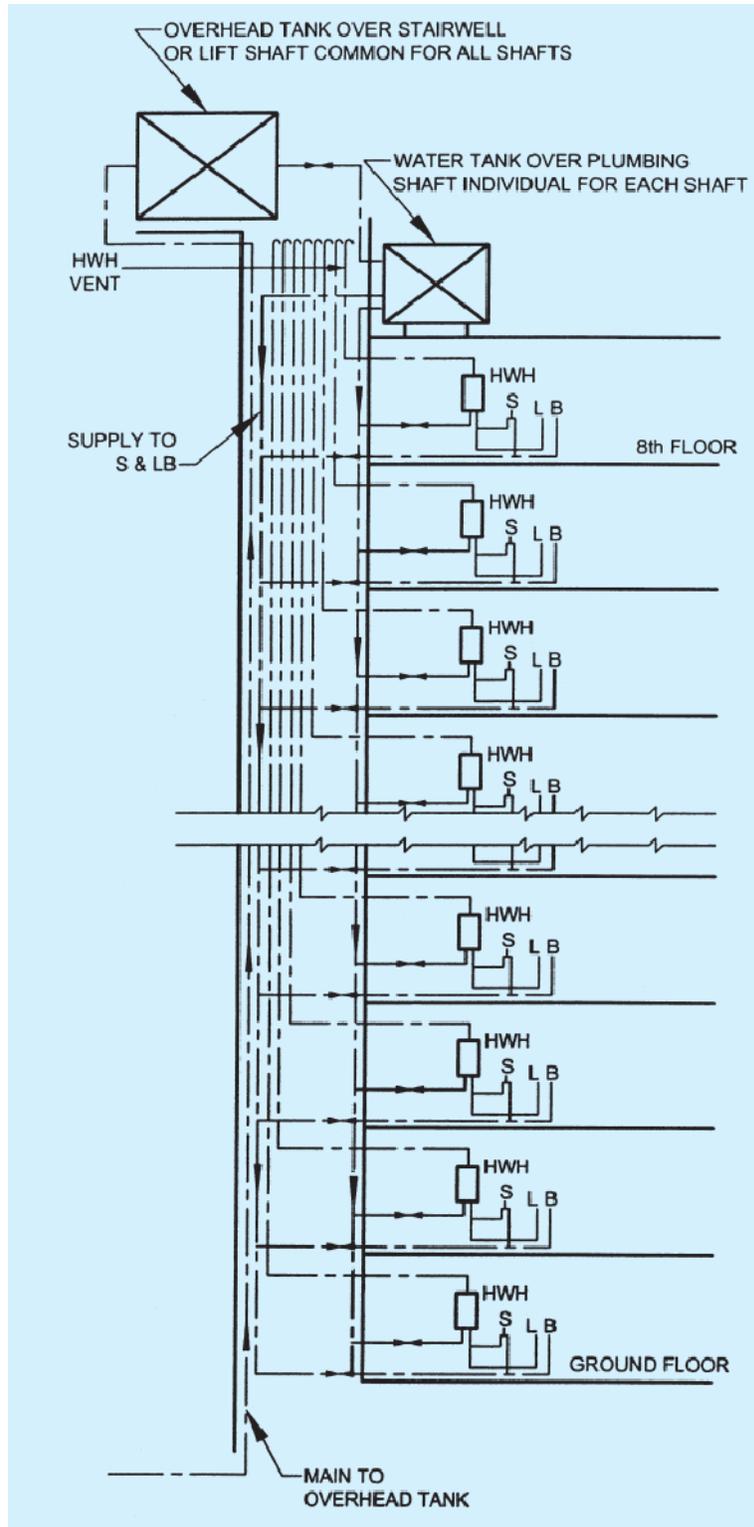


FIG. 6 INSTALLATION FOR 8-STOURED BUILDING

4.13.10.2.4 In tall multistoried buildings where the static pressure increases with the height, the total static pressure on the hot water heaters on the lowest floor shall not exceed the rated working pressure of the hot water heater installed. Should the

height of the building so require, additional tanks shall be provided on the intermediate floors to restrict the static head to permissible limits (see Fig. 7).

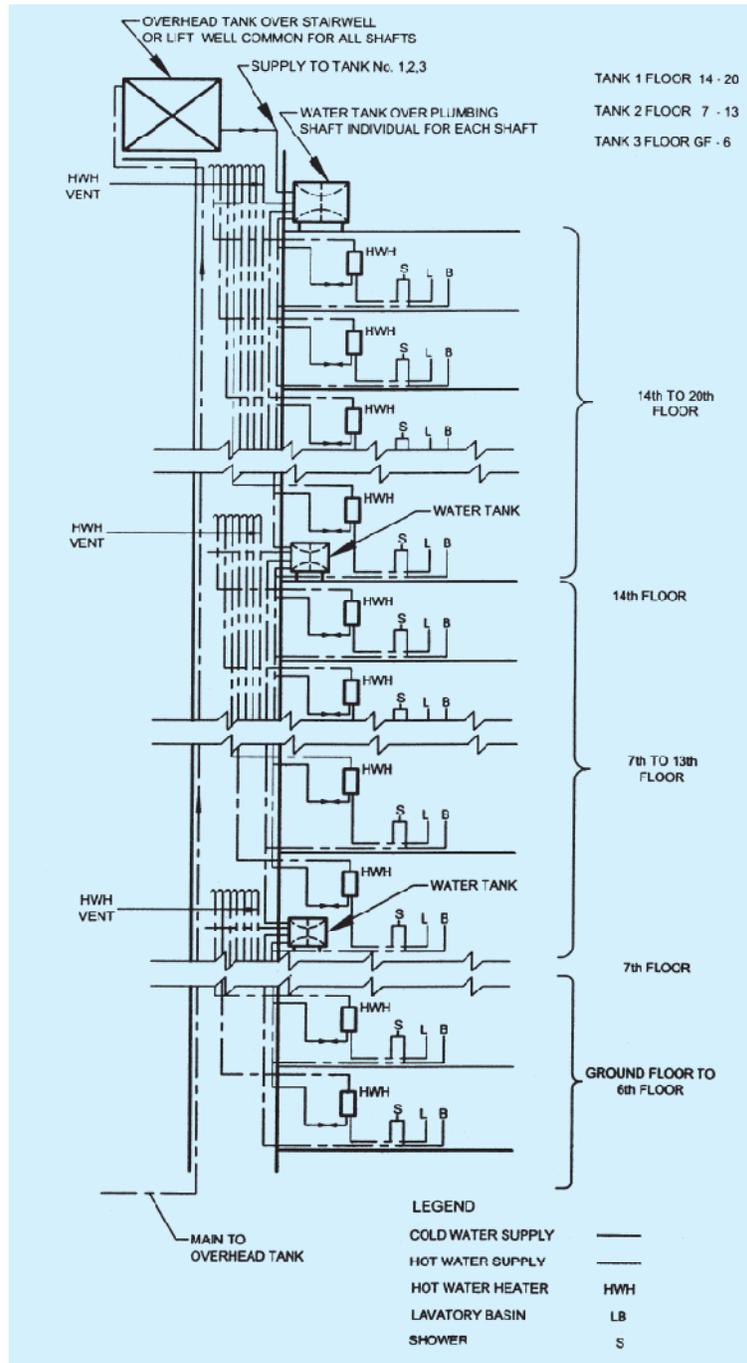


FIG. 7 INSTALLATION FOR 20-STOREYED BUILDING

4.13.10.2.5 As an alternative to the arrangements stated in **4.13.10.2.3** and **4.13.10.2.4** an individual storage tank in each flat may be provided for supply to hot water heaters (see Fig. 8).

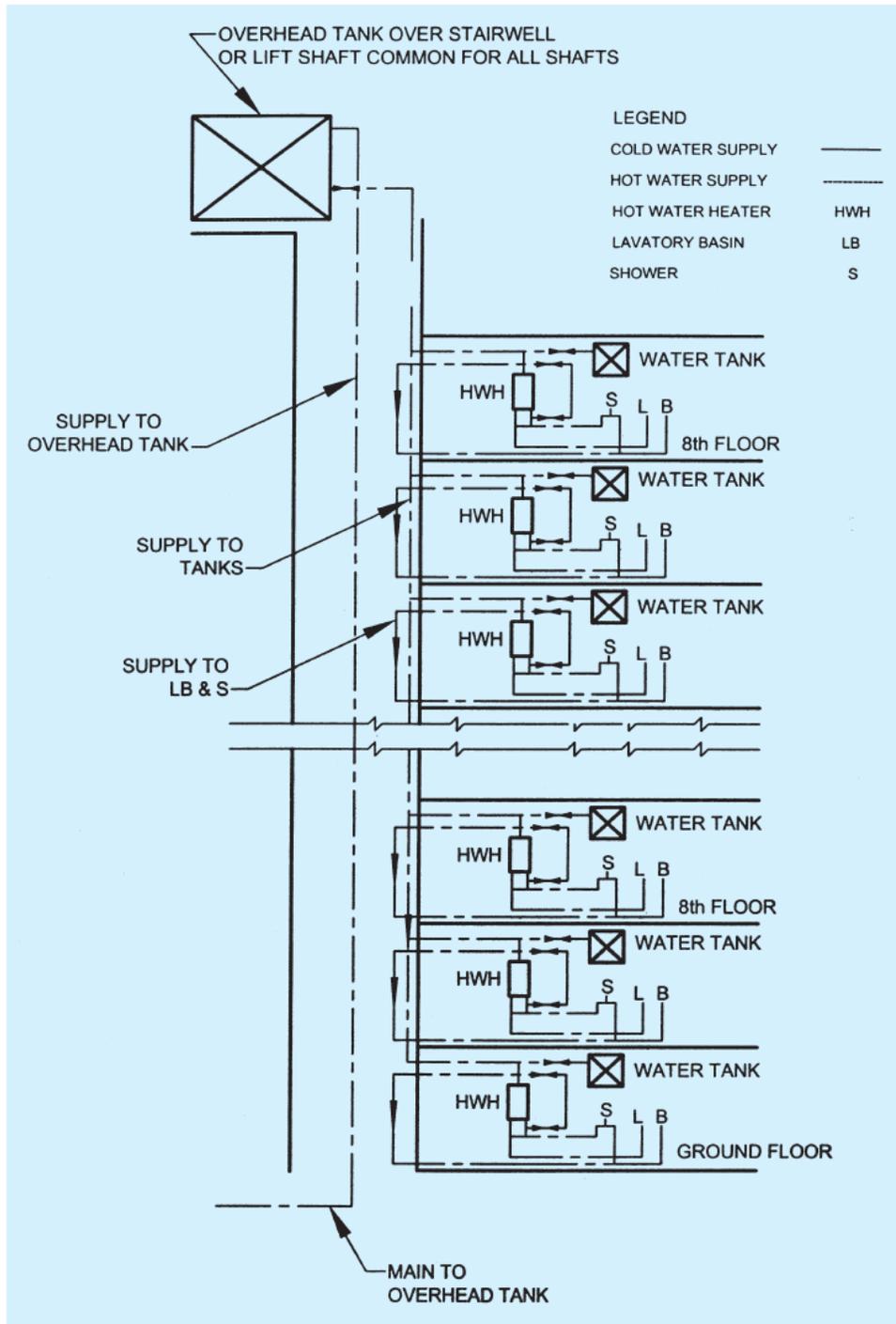


FIG. 8 INSTALLATION FOR 8-STOREYED BUILDING WITH INDIVIDUAL WATER TANKS

4.13.11 Cold Water Feed

4.13.11.1 The feed pipe connecting cold water tank with the hot water heater shall not be of less than 20 mm bore and it shall leave the cold water tank at a point not less than 50 mm above the bottom of the tank and shall connect into the hot water

heater near its bottom. The feed pipe shall not deliver cold water to any other connection, but into the hot water cylinders only.

4.13.11.2 In the case of multistoried buildings, a common cold water feed pipe may be installed, but each hot water heater shall be provided with a check valve (horizontal type check valve shall be preferred to vertical type for easy maintenance).

4.13.11.3 Care shall be taken in installing the piping to prevent air locks in the piping and negative pressure in the hot water heater. Cold water feedpipe shall not be cross connected with any other source of supply under pressure (see Fig. 8).

4.13.12 *Hot Water Piping*

4.13.12.1 *Expansion pipe or vent pipe*

4.13.12.1.1 Each non pressure type hot water heater or cylinder shall be provided with a vent pipe of not less than 20 mm bore. The vent pipe shall rise above the water line of the cold water tank by at least 150 mm plus 10 mm for every 300 mm height of the water line above the bottom of the heater. The vent shall discharge at a level higher than the cold water tank and preferably in the cold water tank supplying the hot water heaters. Care shall be taken to ensure that any accidental discharge from the vent does not hurt or scald any passerby or persons in the vicinity.

4.13.12.1.2 The vent pipe shall be connected to the highest point of the heater vessel and it shall not project downwards inside it, as otherwise air may be trapped inside, resulting in surging and consequent noises.

4.13.12.1.3 At no point, after leaving the vessel, shall the vent pipe dip below the level of its connection with the vessel.

4.13.12.1.4 A vent pipe may, however, be used for supply of hot water to any point between the cold water tank and the hot water heaters.

4.13.12.1.5 The vent pipe shall not be provided with any valve or check valves.

4.13.12.2 *Hot water heaters*

4.13.12.2.1 The common hot water delivery pipe shall leave the hot water heater near its top and shall be of not less than 20 mm bore generally, not less than 25 mm bore if hot water taps are installed on the same floor as that on which the hot water heater is situated.

4.13.12.2.2 Hot water taps shall be of such design as would cause the minimum friction. Alternatively, oversized tap may be provided, such as a 20 mm tap on a 15 mm pipe.

4.13.12.2.3 The hot water distributing system shall be so designed as to ensure that the time lag between opening of the draw-off taps and discharge of hot water is reduced to the minimum to avoid wastage of an undue amount of water which may have cooled while standing in the pipes when the taps are closed. With this end in

view, a secondary circulation system with flow and return pipes from the hot water tank shall be used where justified. Whether such a system is used or not, the length of pipe to a hot water draw-off tap, measured along the pipe from the tap to the hot water tank or the secondary circulation pipe, shall not exceed the lengths given in Table 8.

Table 8 Maximum Permissible Lengths of Hot Water Draw-off Pipes
(Clause 4.13.12.2.3)

SI No. (1)	Largest Internal Diameter of Pipe (2)	Length (3)
i)	Not exceeding 20 mm	12
ii)	Exceeding 20 mm but not exceeding 25 mm	7.5
iii)	Exceeding 25 mm	3.0

NOTE – In the case of a composite pipe of different diameters, the largest diameter is to be taken into consideration for the purpose of this table.

4.13.12.2.4 Wherever mixing of hot and cold water is done by a mixing fitting, that is, hot and cold stop-cocks deliver to a common outlet of mixed water (that is, showers, basin or bath supply fittings), the pressure in the cold and hot water systems shall be equal. This can be achieved by connecting the cold water supply from an overhead tank at the same static height as the overhead tank supplying cold water to the hot water heaters. In case this is not possible, hot and cold water should be supplied to the fixtures by separate supply taps.

4.13.13 *Types of Hot Water Heaters*

The various types of water heaters used for preparation of hot water are as follows:

- a) *Electric Storage Heaters* :
 - 1) Non –pressure or open outlet type,
 - 2) Pressure type,
 - 3) Cistern type, and
 - 4) Dual heater type.
- b) *Gas Water Heaters* :
 - 1) Instantaneous type, and
 - 2) Storage type.
- c) *Solar Heating Systems* :
 - 1) Independent roof mounted heating units, and
 - 2) Centrally banked heated system.
- d) *Central Hot Water System*
 - 1) Oil Fired
 - 2) Gas Fired

4.13.13.1 The quality and construction of the different types of hot water heaters shall be in accordance with good practice [9-1(16)].

4.13.13.2 Typical arrangement of water heater is shown in Fig. 9.

4.13.13.3 Requirements in regard to inspection and maintenance of hot water supply installations shall be in accordance with **4.14.1** to **4.14.4**.

4.14 Inspection and Testing

4.14.1 *Testing of Mains before Commencing Work*

All pipes, fittings and appliances shall be inspected, before delivery at the site to see whether they conform to accepted standards. All pipes and fittings shall be inspected and tested by the manufacturers at their factory and shall comply with the requirements of this section. They shall be tested hydraulically under a pressure equal to twice this maximum permissible working pressure or under such greater pressure as may be specified. The pipes and fittings shall be inspected on site before laying and shall be sounded to disclose cracks. Any defective items shall be clearly marked as rejected and forthwith removed from the site.

4.14.2 *Testing of Mains after Laying*

After laying and jointing, the main shall be slowly and carefully charged with water by providing a 25 mm inlet with a stop-cock, so that all air is expelled from the main. The main is then allowed to stand full of water for a few days if time permits, and then tested under pressure. The test pressure shall be 0.5 N/mm^2 or double the maximum working pressure, whichever is greater. The pressure shall be applied by means of a manually operated test pump, or, in the case of long mains or mains of a large diameter, by a power-driven test pump, provided the pump is not left unattended. In either case, due precaution shall be taken to ensure that the required test pressure is not exceeded. Pressure gauges shall be accurate and shall preferably have been recalibrated before the test. The pump having been stopped, the test pressure shall maintain itself without measurable loss for at least 5 min. The mains shall be tested in sections as the work of laying proceeds; it is an advantage to have the joints exposed for inspection during the testing. The open end of the main may be temporarily closed for testing under moderate pressure by fitting a water-tight expanding plug of which several types are available. The end of the main and the plug shall be secured by struts or otherwise, to resist the end thrust of the water pressure in the mains.

4.14.2.1 If the section of the main tested terminates into a sluice valve, the wedge of the valve shall not be used to retain the water; instead the valve shall be temporarily fitted with a blank flange, or, in the case of a socketed valve, with a plug, and the wedge placed in the open position while testing. End support shall be given as in **4.14.2**.

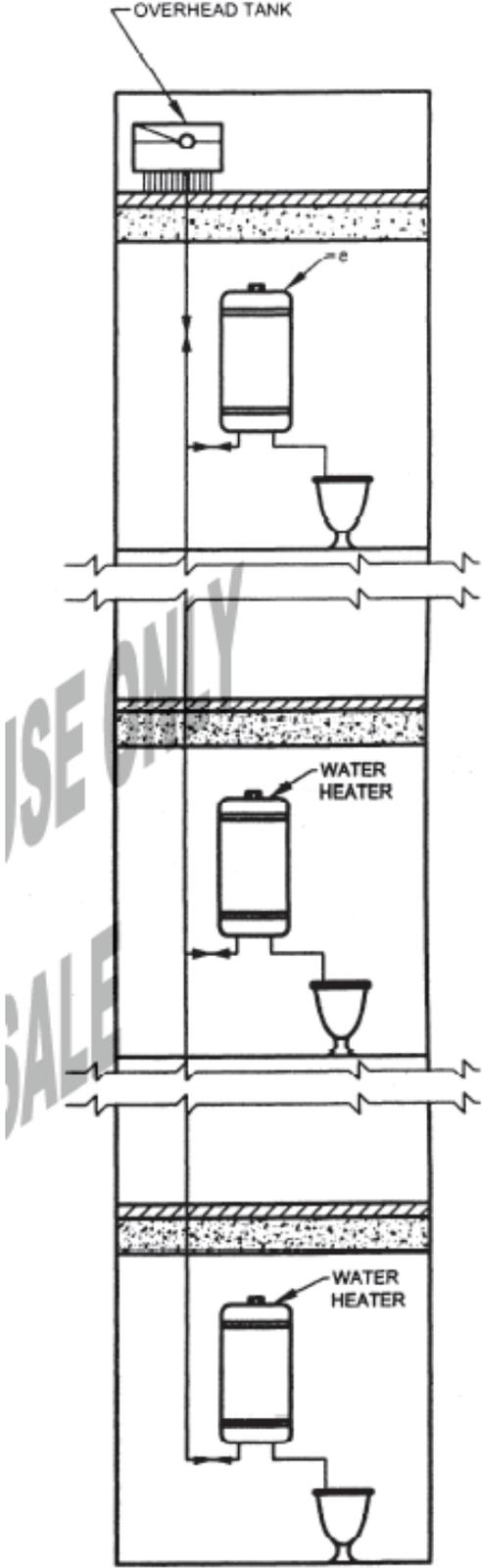


FIG. 9 NON-PRESSURE TYPE INSTALLATION OF HEATERS

4.14.3 *Testing of Service Pipes and Fittings*

When the service pipe is complete, it shall be slowly and carefully charged with water, allowing all air to escape, care being taken to avoid all shock or water hammer. The service pipe shall then be inspected under working conditions of pressure and flow. When all draw-offs taps are closed, the service pipe shall be absolutely water-tight. All piping, fittings and appliances shall be checked for satisfactory support, and protection from damage, corrosion and frost. Because of the possibility of damage in transit, cisterns shall be re-tested for water-tightness on arrival at the site, before fixing.

4.14.4 In addition to the provisions given in **4.14.1**, provisions given in **4.14.4.1** to **4.14.4.3** shall also apply to hot water supply installations in regard to inspection and testing.

4.14.4.1 *Testing of the system after installation*

After the hot water system, including the hot water heaters, has been installed, it shall be carefully charged with water, so that all air is expelled from the system. The entire system shall then be hydraulically tested to a pressure of 0.5 N/mm^2 or twice the working pressure, whichever is greater, for a period of at least half an hour after a steady state is reached. The entire installation shall then be inspected visually for leakages, and sweating. All defects found shall be rectified by removing and remaking the particular section. Caulking of threads, hammering and welding of leaking joints shall not be allowed.

4.14.4.2 *Hot water testing*

After the system has been proved water-tight, the hot water heaters shall be commissioned by connecting the same to the electrical supply. The system shall then be observed for leakage in pipes due to expansion or overheating. The temperature of water at outlets shall be recorded. The thermostats of the appliances shall be checked and adjusted to temperatures specified in **4.13.2.1**.

4.14.4.3 *Electrical connection*

For relevant provisions regarding general and safety requirements for household and similar electrical appliances, reference may be made to good practice [9-1(15)]. The metal work of the water heating appliances and installation other than current carrying parts shall be bonded and earthed in conformity with the good practice [9-1(15)]. It should be noted that screwing of an immersion heater into a tank or cylinder cannot be relied upon to effect a low resistance earth connection, a satisfactory separate earthing of heater should be effected.

4.15 **Cleaning and Disinfection of the Supply System**

4.15.1 All water mains communications pipes, service pipes and pipes used for distribution of water for domestic purposes shall be thoroughly and efficiently disinfected before being taken into use and also after every major repair. The method of disinfection shall be subject to the approval of the Authority. The pipes

shall also be periodically cleaned at intervals, depending upon the quality of water, communication pipes and the storage cisterns shall be thoroughly cleaned at least once every year in order to remove any suspended impurities that may have settled in the pipes or the tanks.

4.15.2 *Disinfection of Storage Tanks and Downtake Distribution Pipes*

The storage tanks and pipes shall first be filled with water and thoroughly flushed out. The storage tank shall then be filled with water again and a disinfecting chemical containing chlorine added gradually while the tanks are being filled, to ensure thorough mixing. Sufficient quantities of chemicals shall be used to give the water a dose of 50 parts of chlorine to one million parts of water. If ordinary bleaching powder is used, the proportions will be 150 g of powder to 1000 litres of water. The powder shall be mixed with water to a creamy consistency before being added to the water in the storage tank. When the storage tank is full, the supply shall be stopped and all the taps on the distributing pipes opened successively working progressively away from the storage tank. Each tap shall be closed when the water discharged begins to smell of chlorine. The storage tank shall then be topped up with water from the supply pipe and with more disinfecting chemical in the recommended proportions. The storage tank and pipes shall then remain charged for at least 3 h. Finally, the tank and pipes shall be thoroughly flushed out before any water is used for domestic purposes.

4.16 Water Supply Systems in High Altitudes and/or Subzero Temperature Regions

4.16.1 *Selection and Source*

In general, the site selected for a water source shall be such as to minimize the length of transmission line so as to reduce the inspection and upkeep. Attempt shall be made, where feasible, to locate the source near the discharge of waste heat, such as of power plants provided it does not affect the potability of water.

4.16.2 *Pumping Installation*

Pump and pumping machinery shall be housed inside well-insulated chambers. Where necessary, arrangements shall be made for heating the inside of pump houses. Pump houses, as far as possible, should be built directly above the water intake structures.

4.16.3 *Protection of Storage Water and Treatment*

Where ambient temperatures are so low as to cause danger of freezing, proper housing, insulation and protection shall be provided for all processes and equipment. If necessary, means shall be provided for proper heating of the enclosure.

4.16.4 *Transmission and Distribution*

Freezing of the buried pipe may be avoided primarily by laying the pipe below the level of the frost line; well consolidated bedding of clean earth or sand, under,

around or over the pipe should be provided. For the efficient operation and design of transmission and distribution work, the available heat in the water shall be economically utilized and controlled. If the heat which is naturally present in water is made equate to satisfy heat losses from the system, the water shall be warmed. Where economically feasible, certain faucets on the distribution system may be kept in a slightly dripping condition so as to keep the fluid in motion and thus prevent is freezing. If found unsuitable for drinking purposes, such water may be used for heating purposes. Heat losses shall be reduced by insulation, if necessary. Any material that will catch, absorb or hold moisture shall not be used for insulation purposes. Adequate number of break pressure water tanks and air release valves shall be provided in the distribution system.

NOTE – The level of frost line is generally found to be between 0.9 m and 1.2 m below ground level in the northern regions of India, wherever freezing occurs.

4.16.4.1 *Materials for pipes*

Distribution pipes shall be made of any of the following materials conforming to Part 5 'Building Materials' :

- a) high density polyethylene pipes,
- b) asbestos cement pipes,
- c) galvanized iron pipes,
- d) cast iron pipes, and
- e) unplasticized PVC pipes (where it is laid before frost line).

4.16.4.2 *Materials for insulation of pipes*

The normal practice in India is to surround the pipe with straw, grass or jute wrapped over with gunny and painted with bitumen; alternatively, other materials, like 85 percent magnesia, glasswool, etc, may also be used.

4.16.4.3 *Distribution methods*

Distribution by barrels or tank trucks shall be employed, where the water requirements are temporary and small. Utmost care shall be exercised for preventing the water from being contaminated by maintaining a residual of disinfecting agent at all times. Hoses, pails and the tank shall be kept free from dust and filth during all period of operation. Where winter temperatures are low, making frost penetration depths greater during the winter, and where adequate facilities for heating the water in the distribution system do not exist, the use of tank trucks or barrels for delivery of water shall be considered only for cold weather; during the warm weather, piping system for seasonal use may be supplemented.

4.16.4.4 In the conventional distribution system involving the use of a network of pipelines requiring no auxiliary heat, it is essential that the pipelines are buried well below the frost line. Adequate facilities for draining the pipelines shall be provided where there is a danger of frost.

4.16.4.5 *House service connections*

House service connections shall be kept operative by the use of adequate insulation at exposed places extending below the frost line. Fig. 7 shows a typical arrangement for providing insulation for house service connections.

4.16.5 For detailed information on planning and designing water supply system peculiar to high altitudes and/or sub-zero temperature regions of the country, reference may be made to good practice [9-1(17)].

4.17 Guidelines to Maintenance

4.17.1 Storage tanks shall be regularly inspected and shall be cleaned out periodically, if necessary. Tanks showing signs of corrosion shall be emptied, thoroughly wire brushed to remove loose material (but not scraped), cleaned and coated with suitable bituminous compositions or other suitable anti-corrosive material not liable to impart taste or odour or otherwise contaminate the water. Before cleaning the cistern, the outlets shall be plugged to prevent debris from entering the pipes. Tanks shall be examined for metal wastage and water tightness after cleaning.

4.17.2 Record drawings showing pipe layout and valve positions shall be kept up to date and inspection undertaken to ensure that any maintenance work has not introduced cross-connections or any other undesirable feature. Any addition or alterations to the systems shall be duly recorded from time to time.

4.17.3 Any temporary attachment fixed to a tap or outlet shall never be left in such a position that back-siphonage of polluted water may occur into the supply system.

4.17.4 All valves shall periodically be operated to maintain free movement of the working parts.

4.17.5 All taps and ball valves shall be watertight, glands shall be made good, washers shall be replaced and the mechanism of spring operated taps and ball valves shall be repaired where required.

4.17.6 All overflow pipes shall be examined and kept free from obstructions.

4.17.7 The electrical installation shall be checked for earth continuity and any defects or deficiencies corrected in the case of hot water supply installations.

4.18 Swimming Pools

4.18.1 *General*

4.18.1.1 Swimming pools shall be of three types namely:

<i>Type</i>	<i>Characteristic</i>
Fill and draw	Clear water of potable quality is retained till it becomes turbid or unfit for use. Thereafter, the pool is drained, cleaned and refilled with clear water.
Flow through	Clear water of hygienic quality flows continuously. This type requires more water for replenishment and so cautious decision of usage of such pools be made.
Recirculating	Use the same pool water again and again, pumped continuously from the pool. Only a small amount of makeup water is required for the water lost in operation and evaporation

4.18.1.2 Turnover rate – It is the amount of time it would take for the volume of the pool to pass through the filtration system one time. Turnover rate is measured in hours and is expressed as:

$$\text{Turnover rate in hours} = (\text{Pool volume in gallons} / \text{Flow in GPM})$$

Typical turnover rates for the following pools are

<i>Type of Pool</i>	<i>Turnover rate, in hours</i>
Swimming Pool	6
Wading Pool	1
Spa	1/2

4.18.1.3 Swimming pool user load

The maximum load for the pool shall be:

- a) For pool depth up to 1 m : 2.2 m² surface area per user
- b) For pool depth up to 1.5 m : 2.7 m² surface area per user
- c) For pool depth more than 1.5 m : 4.0 m² surface area per user

4.18.1.4 Recommended dimensions of the swimming pools shall be:

- a) Half sized Olympic pools : 25 m (length) x 12 to 13 m (width) x 1.8 m (depth)
- b) Full size Olympic pools : 50 m (length) x 25 m (wide) X 2 m (depth)
- c) Diving depth : 3.5 m for 1 m spring board; and 5 m for a 10 m platform
- d) Maximum depth : 1.2 m
- e) Ladders : 2 treads for 1.2 m depth; 3 treads for 1.2 m to 1.5 m depth; and

4.18.2.6 Pool walls

Where the pool depth is 1 m or less, pool walls shall be vertical to the floor and the junction of the wall with the floor shall consist of a cove with a radius not exceeding 150 mm. Where the pool depth exceeds 1 m, pool walls shall meet one of the following criteria:

- a) The wall shall be vertical for a distance of at least 1.5 m below the water level, below which the wall may angle to the floor; or
- b) The wall shall be vertical for a distance of at least 1 m below the water level, below which the wall shall form a curve to the floor. The curve shall be tangent to the pool wall.

4.18.2.7 Water depth

Water depth at the shallow end of the swimming pool should be around 1 m. The beginner's area of the pool shall be visually set apart from, but may be adjoined to the shallow area and shall not adjoin to the deep area.

4.18.2.8 Walkways and deck areas

Pools shall be completely surrounded by a deck that is at least 1.2 m in width and extends completely around and adjacent to the pool. There shall be no obstructions or interruptions of the pool deck within the 1.2 m adjacent to the pool other than necessary structural supports, or appurtenances such as diving boards, slides, perimeter overflow systems, or handrails. A clear, unobstructed walkway at least 1.1 m in width shall be maintained at such obstructions or interruptions.

Structural supports located within the minimum required deck width or within 1.2 m of the swimming pool shall be no closer than 3 m apart measured parallel to the adjacent perimeter of the pool, with the dimension of any single support in a plane parallel to the adjacent pool perimeter no greater than 1 m and the sum of all such support dimensions no greater than 10 percent of the pool perimeter.

The deck between two adjacent swimming pools shall be at least 2.5 m wide. All decks and walkways shall have an unobstructed overhead clearance of at least 2 m.

Synthetic material which meets the following criteria may be installed for deck coverings:

- a) Non-fibrous and allows drainage such that it will not remain wet or retain moisture;
- b) Inert and will not support bacterial or fungal growth;
- c) Durable;
- d) Cleanable; and
- e) Provides a slip-resistant finish.

The decks and walkways shall have a paved surface. The surface of the pool deck and other surfaces used for foot contact, such as gratings of perimeter overflow systems, shall be slip-resistant.

The outer perimeter of the deck for outdoor pools shall be at least 10 cm higher than the surrounding ground surface except where access is provided to adjacent turf areas.

4.18.2.9 *Starting platforms*

Starting Platforms may be from 0.50 m to 0.75 m above the surface of water. The maximum height of the platform above the water shall be 0.75 m where the water depth is 1.2 m or greater and 0.50 m when the water depth is less than 1.2 m. The surface area of each platform shall be 0.5 m x 0.5 m with a maximum slope of not more than 10 degree. Surface of each block shall be covered with non-slip material and with back stroke hand grip facility.

4.18.3 *Electrical Installation*

4.18.3.1 *Lighting*

Artificial lighting shall be provided at all indoor pools and at all outdoor pools that are open for use after sunset in accordance with one of the following:

- a) Underwater lighting of at least 8.35 lumens or 5.5 W per square metre of pool water surface area, located to provide illumination of the entire pool floor; plus area lighting of at least 10 lumens or 6.6 W per square metre of deck area.
- b) If underwater lights are not provided, at least 33.5 lumens or 2.2 W per square metre of pool water surface area and deck area.

Where portable electric vacuum cleaning equipment is used, electrical receptacles with ground-fault circuit interrupter protection shall be provided. Separation between receptacles shall be a maximum of 30 m. All receptacles installed in the swimming pool area shall have waterproof covers and ground-fault circuit interrupter protection. Lighting controls should not be accessible to the public.

4.18.3.2 *Ventilation*

Adequate ventilation shall be provided in facilities to prevent objectionable odor.

4.18.3.3 *Shower and bathroom*

Separate shower, dressing booth and sanitary facilities shall be provided for each gender. This may not be applicable for schools and other institutional use where a pool may be open to one gender at a time. The rooms should be well lit, drained, ventilated, and of good construction, using impervious materials. They should be developed and planned to ensure maintenance of good sanitation throughout the building at all times. Floors should have a slip-resistant surface and sufficiently smooth to ensure ease in cleaning.

4.18.4 Water Treatment System

4.18.4.1 General

A water treatment system shall be provided to filter, chemically balance and disinfect the swimming pool water. The system shall be so designed for the recirculation flow rate that turnover period shall not exceed 8 h in case of diving pool, 2 h for wading pool and 6 h for other pools.

4.18.4.2 Hair and lint strainer

A hair and lint strainer shall be installed on the suction side of the pump except on vacuum filter systems. The strainer basket shall be easily removable. Valves shall be installed to allow the flow to be shut off during cleaning, switching baskets or inspection.

4.18.4.3 Inlets

Inlets for filtered water shall be located and directed suitably to produce uniform circulation of water to facilitate the maintenance of a uniform disinfectant residual throughout the entire pool without the existence of dead spots, and to produce surface flow patterns that effectively assist skimming.

4.18.4.4 Outlets

Pools shall be provided with a main drain at the deepest point. The main drain shall be connected to the recirculation system. Openings shall be covered by grating which cannot be removed without the use of tools. Openings of the grating shall be at least four times the area of the main drain pipe or have an open area. The maximum width of grate openings shall be 3.5 cm. Main drains and all other suction outlets installed in the pool shall be designed to prevent bather entrapment.

4.18.4.5 Make-up water

Make-up water shall be added through a fixed air gap of at least 15 cm to the pool, surge tank, vacuum filter tank, or other receptacle. When make-up water is added directly to the pool, the fill-spout should be located under a low diving board or immediately adjacent to a ladder rail, grab rail, or fixed lifeguard chair.

4.18.4.6 Filtration

The design filtration rate in the particular application in which the filter is utilized shall not exceed the maximum design filtration rate for which the filter was installed. Wash or backwash water from diatomaceous earth filters shall be passed through a separation tank designed for removal of suspended diatomaceous earth and solids, prior to disposal.

4.18.4.7 Disinfection

The pool water shall be continuously disinfected by suitable disinfecting agent that imparts easily measured residual. Gaseous chlorine, chlorine compounds, bromine compounds or other bactericidal agents should be used to maintain the quality parameters of water.

4.18.5 Water Quality

4.18.5.1 Disinfectant residual

Where chlorine is used as a disinfectant, the chlorine residual shall be maintained between 1.0 and 4.0 ppm. as free chlorine residual. A free chlorine residual of at least 2.0 ppm. shall be maintained when the pool water temperature exceeds 30 °C.

Where bromine is used as a disinfectant, a bromine residual shall be maintained between 2.0 and 8.0 ppm. as total bromine. A bromine residual of at least 4.0 ppm. shall be maintained when the pool water temperature exceeds 30 °C.

Where chlorinated cyanurates are used, the cyanuric acid concentration shall not exceed 100 ppm.

Where silver/copper or copper ion generators are used, the concentration of copper shall not exceed 1.3 ppm. and the concentration of silver shall not exceed 0.05 ppm.

Where ozone is used, the ambient air ozone concentration shall be less than 0.1 ppm. at all times either in the vicinity of the ozonator or at the pool water surface.

For all other physical, chemical and bacteriological parameters, the quality of water used in swimming pools in continuous circulation type shall conform to good practices [9-1(19)].

4.19 Allowance for Expansion

4.19.1 The allowances for expansion of the water pipes are recommended as below:

- a) All pipes should be installed at ambient temperature. Pipes carrying hot fluids such as water or steam operate at higher temperatures.
- b) It follows that they expand, especially in length, with an increase from ambient to working temperatures. This will create stress upon certain areas within the distribution system, such as pipe joints, which, in the extreme, could cause fracture.
- c) The pipe work system shall be sufficiently flexible to accommodate the movements of the components as they expand. In many cases, the flexibility of the pipe work system, due to the length of the pipe and number of bends and supports, means that no undue stresses are imposed. In other installations, however, it will be necessary to incorporate some means of achieving this required flexibility.

- d) The expansion fitting is one method of accommodating expansion. These fittings are placed within a line and are designed to accommodate the expansion without the total length of the line changing. They are commonly called expansion bellows, due to the bellows construction of the expansion sleeve.
- e) Other expansion fittings can be made from the pipe work itself. This can be a cheaper way to solve the problem, but more space is needed to accommodate the pipe.

4.19.2 Full Loop

- a) This is simply one complete turn of the pipe and, on steam pipe work, should preferably be fitted in a horizontal rather than a vertical position to prevent condensate accumulating on the upstream side.
- b) The downstream side passes below the upstream side and great care shall be taken that it is not fitted wrong way round, as condensate can accumulate in the bottom. When full loops are to be fitted in a confined space, care shall be taken to specify that wrong-handed loops are not supplied.
- c) The full loop does not produce a force in opposition to the expanding pipe work as in some other types, but with steam pressure inside the loop, there is a slight tendency to unwind, which puts an additional stress on the flanges.

4.20 Colour Codes for Different types of Water Pipes

The following colour codes are recommended for pipes, {see also accepted standard [9-1(20)]}:

<i>Particulars</i>	<i>Ground colour</i>	<i>First colour band</i>	<i>Second colour band</i>
Cooling water	Sea green	French blue	
Boiler feed water	Sea green	Gulf red	
Condensate water	Sea green	Light brown	
Drinking	Sea green	French blue	Signal red
Treated	Sea green	Light orange	
Fire water	Fire red	Crimson red	
Water with central heating below 60 °C	Sea Green	Canary Yellow	
Water with central heating between 60 to 100 °C	Sea Green	Dark violet	
Water with central heating above 100 °C	Sea Green	Dark Violet	Signal red
Cold water from storage tanks	Sea green	French blue	Canary yellow

Domestic, hot water	Sea green	Light grey	
Hydraulic power water	Sea green	Black	
Untreated Sea/river water	Sea green	white	
Filtered water	Sea green	Light brown	
Soft water	Sea green	Light brown	Signal red
Warm water	Sea green	Light grey	Canary yellow
Chilled water	Sea green	Black	Canary yellow
Sprinkler & Hydrant water	Sea green	White	Signal red
Waste water	Sea green	Canary yellow	Signal red

ANNEX A
(Clause 3.1.1)

**APPLICATION FORM FOR TEMPORARY/PERMANENT SUPPLY
OF WATER/FOR ADDITIONS AND/OR ALTERATIONS FOR
SUPPLY OF WATER**

I/Wehereby make application to the* for the temporary/permanent supply of water for the following additions and/or alterations to the water supply requirements and water fittings at the premises..... Ward No.Street No.Road/Street known asfor the purpose described below and agreed to pay such charges as the Authority may from time to time be entitled to make and to conform to all their byelaws and regulations.....licensed plumber, has been instructed by me/us to carry out the plumbing work.

Description of the premises:.....
Address :.....
Purpose for which water is required.....

.....

The connection/connections taken by me/us for temporary use, shall not be used by me/us for permanent supply unless such a permission is granted to me/us in writing by the Authority.

I/We hereby undertake to give the*..... due notice of any additions or alterations to the above mentioned supply which I/we may desire to make.

My/Our requirements of water supply are as under :

- a) I/We request that one connection be granted for the whole of the premises.
- b) I/We request that separate connections may be granted for each floor and I/we undertake to pay the cost of the separate connections.
- c) My/Our probable requirements for trade purpose arelitres per day and for domestic purposes are.....litres per day.
- d) Our existing supply islitres per day. Our additional requirement of supply islitres per day.
- e) The details as regards proposed additions and alterations in fittings are as follows :
.....
.....

Signature of the licensed plumber.....
Name and address of the licensed
Plumber.....

Signature of the applicant.....
Name and address of the
Applicant

Date

Date

NOTES

- 1 Please strike out whatever is not applicable.
- 2 The application should be signed by the owner of the premises or his constituted attorney and shall be countersigned by the licensed plumber.

* Insert here the name of the Authority

ANNEX B
(Clause 3.2.3)

FORM FOR LICENCED PLUMBER'S COMPLETION CERTIFICATE

Certified that I/we have completed the plumbing work of water connection No..... for the premises as detailed below. This may be inspected and connection given.

Ward No..... Road/Street.....
Locality.....
Block No..... House No.....
Existing water connection No. (if any).....
Owned by.....
Owner's address.....
Applicant's name..... son of.....
Address.....
Situation.....
Size of main.....on..... Street
Where main is situated.....
Size of service pipe.....
Size of ferrule.....
No. of taps..... No. of closets.....
No. of other fittings and appliances.....
Road cutting and repairing fee

Paid Rs.....(Receipt No.....dated.....) (receipt enclosed)

Dated Signature of licensed plumber.....
Name and address of the licensed plumber
.....

The Authority's Report

Certified that the communication and distribution pipes and all water fittings have been laid, applied and executed in accordance with the provisions of bye-laws, and satisfactory arrangements have been made for draining off waste water.

Connection will be made on.....

Date..... The Authority.....

ANNEX C
(Clause 3.3.3.2)

**FORM FOR DETAILED DESCRIPTION OF WORK
AND SPECIFICATION OF MATERIALS**

- 1) Separation of rain-water and foul water.....
- 2) Rain-water drains, curbs and points of discharge.....
- 3) Rain-water gutters, pipes or spouts where discharging.....
- 4) Open-full-water drains, materials, sizes, curbs and other means places,
verandahs, latrines
- 5) Silt-catcher and grating, size and position.....
- 6) Drains.....
 - a) Main sewage drains : Fall
Size.....
 - b) Branch drains : Fall
Size.....
 - c) Materials.....
 - d) Method of jointing.....
- 7) Bedding of pipes :
 - a) Method of bedding.....
 - b) Thickness and width of beds of concrete.....
 - c) Thickness of concrete round pipes.....
- 8) Protection of drain laid under wall.....
- 9) Traps, description and interceptor :
 - a) Lavatory waste pipes.....
 - b) Bath waste pipes.....
 - c) Sink.....
 - d) Gully-traps.....
 - e) Water-closet traps.....
 - f) Grease traps.....
 - g) Slop sink.....
 - h) Urinal.....
 - j) Others.....

- 10) Manholes and inspection chambers :
 - a) Thickness of walls.....
 - b) Description of bricks.....
 - c) Description of rendering.....
 - d) Description of invert channels.....
 - e) Depth of chambers.....
 - f) Size and description of cover and manner of fixing.....

- 11) Ventilation of drain :
 - a) Position – Height above nearest ground level.....
 - b) Outlet shaft position of terminal at top.....

- 12) Soil pipe, waste pipe and ventilating pipe connections :
 - a) Lead and iron pipes.....
 - b) Lead pipe of trap with cast iron pipe.....
 - c) Stoneware pipe or trap with lead pipe.....
 - d) Lead soil pipe or trap with stoneware pipe or trap.....
 - e) Cast iron pipe with stoneware drain.....
 - f) Stoneware trap with cast iron soil pipe.....

- 13) Ventilation of water-closet trap sink, lavatory and other traps material and supports.

- 14) Water-closets (apartments):
 - a) i) At or above ground level.....
 - ii) Approached from.....
 - iii) Floor material.....
 - iv) Floor fall towards door.....
 - v) Size of window opening in wall made to open.....
 - vi) Position of same.....
 - vii) Means of constant ventilation.....
 - viii) Position of same.....

 - b) Water-closet apparatus :
 - i) Description of pan, basin, etc.....
Kind.....
 - ii) Flushing cistern.....
 - iii) Material of flushing pipe.....
 - iv) Internal diameter.....
 - v) Union with basin.....

- 15) Sanitary fittings, water storage tank, etc :
 - a) Number and description of sanitary fittings in room and rooms in which they are to be installed.....

- b) Capacity and position of water storage tanks.....
 - c) Size and number of draw off taps and whether taken off storage tanks or direct from main supply.....
 - d) Details of draw off taps, that is, whether they are of plain screw down pattern or 'waste not' and description of any other sanitary work to be carried out not included under above headings.....
- 16) Depth of sewer below surface of street.....
- 17) Level of invert of house drain at point of junction :
- a) with sewer.....
 - b) Level of invert of sewer at point of junction with house drain.....
 - c) Distance of nearest manhole on sewer from the point at which the drain leaves the premises.....
- 18) Schedule of pipes :

<i>Description of pipe/drain</i>	<i>Materials</i>	<i>Diameter</i>	<i>Weight</i>	<i>Method of Jointing</i>
a) Subsoil drains				
b) Main sewage drains				
c) Branch sewage drains				
d) Soil pipes				
e) Ventilating pipes other than soil pipes				
f) Waste pipes				
g) Rain-water pipes				
h) Anti-syphon pipes				

Signature of the licensed plumber.....
 Name and address of the licensed plumber.....

 Date.....

ANNEX D
(Clause 3.3.5)

FORM FOR LICENSED PLUMBER'S COMPLETION CERTIFICATE

Certified that I/we have completed the plumbing work of drainage and sanitation system for the premises as detailed below. This may be inspected, approved and connection given.

Ward No.....

Street.....

Locality.....

Block No.....

House No.....

Details of work.....
.....
.....

The work was sanctioned by the Authority*
vide
.....

Signature of the owner	Signature of the licensed plumber
Name and address.....	Name and address
.....

Date.....

The Authority's Report

Certified that the plumbing work of drainage and sanitation system for the premises, have been laid, applied, executed in accordance with Part 9 Plumbing services, Section 1 Water supply, drainage and sanitation of the Code.

Drainage Connection to the main sewer will be made on.....

Date..... The Authority.....

* Insert the name of the Authority

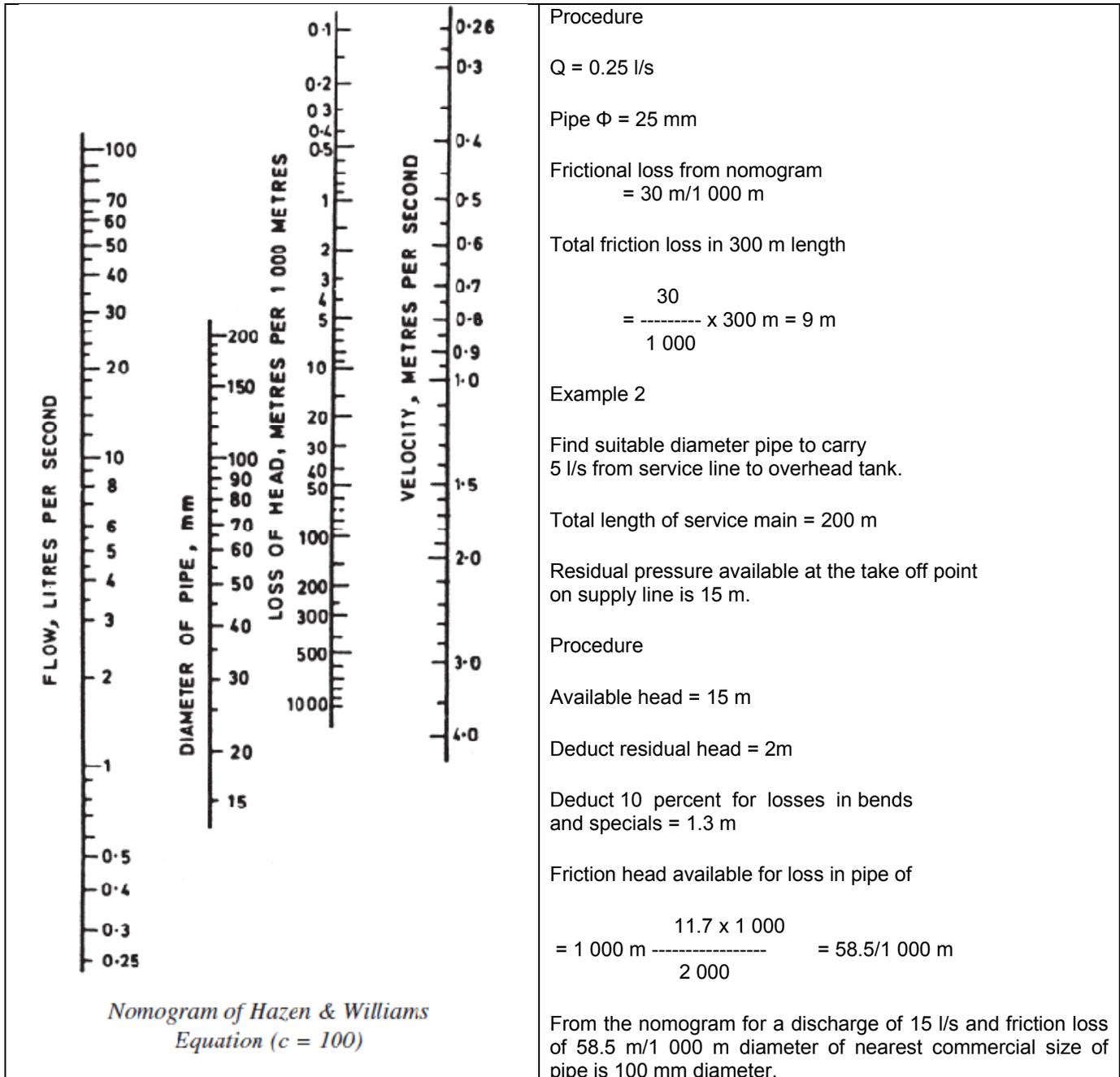
ANNEX E
(Clause 4.6.4)

NOMOGRAM OF HAZEN AND WILLIAM'S EQUATION

E-1 Examples of the use of nomogram are given below :

Example 1

Find the total friction loss in 25 mm Φ G.I. Pipe discharging 0.25l/s in a total length of 300 m.



Procedure

Q = 0.25 l/s

Pipe Φ = 25 mm

Frictional loss from nomogram
= 30 m/1 000 m

Total friction loss in 300 m length

$$= \frac{30}{1000} \times 300 \text{ m} = 9 \text{ m}$$

Example 2

Find suitable diameter pipe to carry 5 l/s from service line to overhead tank.

Total length of service main = 200 m

Residual pressure available at the take off point on supply line is 15 m.

Procedure

Available head = 15 m

Deduct residual head = 2m

Deduct 10 percent for losses in bends and specials = 1.3 m

Friction head available for loss in pipe of

$$= 1000 \text{ m} \frac{11.7 \times 1000}{2000} = 58.5/1000 \text{ m}$$

From the nomogram for a discharge of 15 l/s and friction loss of 58.5 m/1 000 m diameter of nearest commercial size of pipe is 100 mm diameter.

LIST OF STANDARDS

The following list records those standards which are acceptable as 'good practice' and 'accepted standards' in the fulfillment of the requirements of the code. The latest version of a standard shall be adopted at the time of enforcement of the code. The standards listed may be used by the Authority as a guide in conformance with the requirements of the referred clauses in the code.

(1)	IS 10446 : 1983	Glossary of terms relating to water supply and sanitation
(2)	IS 11208:1985	Guidelines for registration of plumbers
(3)	IS 10500:2012	Drinking water — Specification (<i>second revision</i>)
(4)	IS 2041:2009	Steel plates for pressure vessels used at moderate and low temperature — Specification (<i>third revision</i>)
	IS 804:1967	Specification for rectangular pressed steel tanks (<i>first revision</i>)
(5)	IS 4984:1995	Specification for high density polyethylene pipes for potable water supplies (<i>fourth revision</i>)
	IS 4985:2000	Specification for unplasticized PVC pipes for potable water supplies (<i>third revision</i>)
(6)	IS 2065:1983	Code of practice for water supply in buildings (<i>second revision</i>)
(7)	IS 3114:1994	Code of practice for laying of cast iron pipes (<i>second revision</i>)
(8)	IS 782:1978	Specification for caulking lead (<i>third revision</i>)
(9)	IS 5822:1994	Code of practice for laying of welded steel pipes for water supply (<i>second revision</i>)
(10)	IS 6530:1972	Code of practice for laying of asbestos cement pressure pipes
(11)	IS 783:1985	Code of practice for laying of concrete pipes (<i>first revision</i>)
(12)	IS 7634	Plastics pipes selection, handling, storage and installation for potable water supplies — Code of practice:
	(Part 2): 2012	Part 2 Laying and jointing of polyethylene (PE) pipes (<i>first revision</i>)
	(Part 3): 2003	Part 3 Laying and jointing of UPVC pipes (<i>first revision</i>)
(13)	IS 783:1985	Code of practice for laying of concrete pipes (<i>first revision</i>)
	IS 3114:1994	Code of practice for laying of cast iron pipes (<i>second revision</i>)
	IS 5822:1994	Code of practice for laying of welded steel pipes for water supply (<i>second revision</i>)
	IS 6530:1972	Code of practice for laying of asbestos cement pressure pipes

	IS 7634	Plastics pipes selection, handling, storage and installation for potable water supplies — Code of practice:
	(Part 2): 2012	Part 2 Laying and jointing of polyethylene (PE) pipes (<i>first revision</i>)
	(Part 3): 2003	Part 3 Laying and jointing of UPVC pipes (<i>first revision</i>)
(14)	IS 2692:1989	Specification for ferrules for water services (<i>second revision</i>)
(15)	IS 302(Part 1): 2008	Safety of household and similar electrical appliances: Part 1 General requirements (<i>sixth revision</i>)
	IS 2082:1993	Stationary storage type electric water heaters (<i>third revision</i>)
(16)	IS 7558:1974	Code of practice for domestic hot water installations
(17)	IS 6295:1986	Code of practice for water supply and drainage in high altitudes and/or sub-zero temperature regions (<i>first revision</i>)
(18)	IS 6494:1988	Code of practice for water-proofing of underground water reservoirs and swimming pools (<i>first revision</i>)
(19)	IS 3328 : 1993	Quality tolerances for water for swimming pools
(20)	IS 2379 : 1990	Colour code for identification of pipe lines