Chapter 5
WATER SUPPLY

5.1 PURPOSE AND SCOPE

5.1.1

The purpose of this chapter of the Code is to provide minimum standards for the design, installation and maintenance of water supply and distribution system within a building and its premises.

5.1.2

The regulations of this chapter also provide guidelines for water requirements for different classes of buildings according to their occupancy classification.

5.1.3

The provisions stated herein do not cover the requirements of water supply for industrial plants and process, municipal uses, viz. street washing, street hydrant, etc.

5.2 TERMINOLOGY

This section provides an alphabetical list of the terms used in and applicable to this chapter of the Code. In case of any conflict or contradiction between a definition given in this section and that in Part 1, the meaning provided in this section shall govern for interpretation of the provisions of this chapter.

Accessible: When applied to a fixture, appliance or equipment shall mean having access thereto, but which may require the removal of an access panel or similar obstruction; "readily accessible" shall mean direct access without the necessity of removing any panel, door or similar obstruction.

Air gap: The unobstructed vertical distance through the free atmosphere between the lowest opening from any pipe or faucet supplying water to tank, plumbing fixture or other device and the flood level rim of the receptacle.

Available Head : The head of water available at the point of consideration due to mains' pressure or storage tank or any other source of pressure.

Back Siphonage: The flowing back of used, contaminated, or polluted water from a plumbing fixture or vessel into a water supply pipe due to a reduced pressure in such a pipe (see Backflow).

Backflow: The flow of water or other liquids, mixtures or substances into the distribution pipes of a potable water supply from any source other than its intended source.

Backflow Connection or condition: Any arrangement whereby backflow can occur.

Backflow Preventer: A device or means to prevent backflow.

Ball Cock: A water supply valve, opened or closed by means of a float or similar device, used to supply water to a tank forming an approved air gap or vacuum breaker and acting as an antisiphon device. Also known as FLOAT OPERATED VALVE.

Bedpan Washer and Sterilizer: A fixture designed to wash bedpans and to flush the contents into the sanitary drainage system and located adjacent to a water closet or clinical sink. Such fixtures can also be provided for disinfecting utensils by scalding with steam or hot water.

BRANCH: Any part of the piping system other than a riser or main.

BRANCH CONNECTOR: A connector between water main and branch pipes by T, Y, T-Y, double Y, and V branches according to their respective shapes.

Building Supply: The water supply pipe carrying potable water from the water meter or other source of water supply to a building or other point of use or distribution on the lot.

Contamination : A general term meaning the introduction into the potable water supply of chemicals, wastes or sewage which will render the water unfit for its intended purpose.

Critical LEVEL: The level at which the vacuum breaker may be submerged before backflow occurs. When the critical level is not indicated on the vacuum breaker, the bottom of the device shall be considered as the critical level.

Cross-Connection : Any physical connection or arrangement between two otherwise separate piping systems, one of which contains potable water and the other either water of unknown or questionable safety or steam, gas, or chemical whereby there may be a flow from one system to the other, the direction of flow depending on the pressure differential between the two systems (See Backflow).

CYLINDER: A cylindrical closed vessel capable of containing water under pressure greater than the atmospheric pressure.

Developed LENGTH: Length of a pipe along the centerline of the pipe and fittings

Distribution PIPE: Any pipe conveying water from a storage tank/cistern or from a hot water apparatus supplied from a feed cistern under pressure from that cistern.

Effective OPENING: The minimum cross-sectional area at the point of water supply discharge measured or expressed in terms of - (1) diameter of a circle, (2) if the opening is not circular, the diameter of a circle of equivalent cross-sectional area. (This is also applicable to air gap.)

FAUCET: A valve end of a water pipe by means of which water can be drawn from or held within the pipe.

Feed CISTERN: A storage tank/cistern used for supplying cold water to a hot water apparatus.

FITTING: Anything fitted or fixed in connection with the supply, measurement, control, distribution, utilization or disposal of water. "Water fitting" includes pipes (other than mains), taps, cocks, valves, ferrules, meters, cisterns, baths, water closets, soil pans and other similar apparatus used in connection with the supply and use of water.

FIXTURE: See Plumbing Fixture.

Fixture BRANCH: A water supply pipe between the fixture supply pipe and the water distribution pipe.

Fixture SUPPLY: A water supply pipe connecting the fixture with the fixture branch.

Fixture Unit : A quantity in terms of which the load producing effects on the plumbing system of different kinds of plumbing fixtures are expressed on some arbitrary chosen scale.

Float Operated VALVE: See Ball Cock.

Flood Level RIM: The top edge of a receptacle from which water overflows.

Flush TANK: A tank located above water closets, urinals or similar fixtures for the purpose of flushing the usable portion of the fixture. Also known as FLUSHING CISTERN and FLUSHOMETER TANK.

FLUSH VALVE: See Flushometer Valve.

Flushing CISTERN: See Flush Tank.

Flushometer TANK: See Flush Tank.

Flushometer VALVE: A device located at the bottom of the tank, and which discharges a predetermined quantity of water to fixtures for flushing purposes and is closed by direct water pressure or other mechanical means. Also known as FLUSH VALVE.

Full FACILITIES: The modern plumbing facilities allowed to the occupants of modern dwellings or, of VIP hotels and accommodations.

ULL OPEN VALVE: A shutoff valve that in the full position has a straight through flow passageway with a diameter not less than one nominal pipe size smaller than nominal pipe size of the connecting pipe.

GEYSER: An apparatus for heating water with supply control on the inlet side and delivering it from an outlet.

GRADE: The slope or fall of a line of pipe with reference to a horizontal plane.

HANGERS: See Supports.

Horizontal PIPE: Any pipe or fitting which is installed in a horizontal position or which makes an angle less than 45 degrees with the horizontal.

Hot Water TANK: A vessel for storing hot water under pressure greater than the atmospheric pressure.

Individual Water SUPPLY: A supply other than an approved public water supply which serves one or more families.

LAGGING: The material used for thermal or acoustic insulation.

Liquid WASTE: The discharge from any fixture, appliance or appurtenance in connection with a plumbing system which does not receive fecal matter.

MAIN: The principal artery of the system, to which branches may be connected, for the purpose of water supply from a supply to individual consumers. Also known as WATER MAIN.

Mechanical Joint : A connection between pipes, fittings or pipes and fittings which is neither screwed, caulked, threaded, soldered, solvent cemented, brazed nor welded.

OFFSET: A combination of approved bends in a line of piping used to connect two pipes whose axes are parallel but not in line.

PLUMBING: The business, trade or work having to do with the installation, removal, alteration or repair of plumbing and drainage systems or part thereof.

Plumbing APPLIANCES: The plumbing fixtures whose operation or control can be dependent upon one or more energized components, such as motors, controls, heating elements, or pressure or temperature sensing elements.

Plumbing APPURTENANCE: A manufactured device or prefabricated assembly of component parts, which is an adjunct to the basic piping system and plumbing fixtures, performing some useful function in the operation, maintenance, servicing, economy or safety of the plumbing system.

Plumbing FIXTURE: A receptacle or device which is either permanently or temporarily connected to the water distribution system of the premises, and demands a supply of water there from, or discharges used water, waste materials or sewage either directly or indirectly to the drainage system of the premises, or requires both a water supply connection and a discharge to the drainage system of the premises. Also known as FIXTURE.

Plumbing System : A system of potable water supply and distribution pipes, plumbing fixtures and traps, soil waste and vent pipes, and sanitary and storm sewers and building drains including their respective connections, devices and a appurtenances within a building or premises.

Potable WATER: Water free from impurities which may cause diseases or harmful physiological effects and water which is satisfactory for drinking, culinary and domestic purposes.

Private/Private USE: Plumbing fixtures intended for the use of a family in residences, or for the restricted use of an individual in commercial establishments.

Quick closing VALVE: A valve or faucet that closes automatically when released manually or controlled by mechanical means for fast action closing.

Receptor : An approved plumbing fixture or device of such material, shape and capacity as to adequately receive the discharge from indirect waste pipes, so constructed and located as to be readily cleaned.

Residual HEAD: The head available at any particular point in the distribution system.

Restricted FACILITIES: The minimum plumbing facilities acceptable for the occupants of low income group.

RIM: An unobstructed open edge of a fixture.

RISER: A water supply pipe which extends vertically one full storey or more to convey water to branches or fixtures.

ROUGHING-IN: The installation of all parts of the plumbing system which can be completed prior to the installation of fixtures. This includes water supply, drainage, vent piping and necessary supports.

Service PIPE: The 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.

Slip JOINT: An adjustable tubing connection, consisting of a compression nut, a friction ring, and a compression washer, designed to fit a threaded adapter fitting, or a standard taper pipe thread.

Soldered JOINT: A joint obtained by the joining of metal parts with metallic mixtures of alloys which melt at a temperature below 427oC and above 149oC.

Stop VALVE: Any device (including a stopcock or stop tap) other than a draw off tap, for stopping at will the flow of water in a pipe.

Storage Cistern : A container, other than a flashing cistern, having a free water surface under atmospheric pressure and used for storage of water, and is connected to the water main or tube-well by means of supply pipe. Also known as STORAGE TANK.

STORAGE TANK: See STORAGE CISTERN.

Supports: Hangers and anchors or devices for supporting and securing pipe, fixture and equipment to walls, ceilings, floors or other structural members. Also known as HANGERS.

Tempered Water: The water ranging in temperature from 29oC up to 43oC.

Vacuum Breaker: A type of backflow preventer installed on openings subject to normal atmospheric pressure.

Vertical Pipe: Any pipe which is installed in a vertical position or which makes an angle of not more than 45 degrees with the vertical.

WARMING 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 there from can be readily seen.

Washout Valve: A device located at the bottom of the tank for the purpose of draining a tank for cleaning, maintenance, etc.

Water conditioning or Treating Device: A device which conditions or treats a water supply so as to change its chemical content or remove suspended solids by filtration.

Water Hammer Arrester: A device used to absorb the pressure surge (water hammer) which occurs when water flow is suddenly stopped in a water supply system.

Water Heater: Any heating device that heats potable water and supplies it to the potable hot water distribution system.

Water Line: A line marked inside a cistern to indicate the highest water level at which the ball valve should be adjusted to shut off.

WATER MAIN: See MAIN.

Water Outlet: A discharge opening through which water is supplied to a fixture, into the atmosphere (except into an open tank which is part of the water supply system), to a boiler or heating system, or to any devices or equipment requiring water to operate but which are not part of the plumbing system.

Water Supply System : A system consisting of building supply pipe, water distributing pipes, and necessary connecting pipes, fittings, control valves, and all appurtenances carrying or supplying potable water in or adjacent to the building or premises.

Welded Joints or Seam: Any joint or seam obtained by the joining of metal parts in the plastic molten state.

5.3 PERMIT FOR WATER CONNECTION

5.3.1 Requirement of Permit

No water supply system shall be installed in a new building until a permit for such work has been issued by the Authority. The addition or alteration of the existing water supply facilities in a building shall also require a permit for their installation.

5.3.1.1 Application for Permit (Obtaining Public Supply Connection)

Application for a permit for water supply system shall be made in writing by the licensed plumber and the owner or his appointed person(s) or agent on a prescribed form (Appendix- 8.5.A). The application shall accompany building drawings showing the water supply system with the following details:

(a) Site plans showing the location of water main.

(b) Typical floor plan(s) and elevations of the building with the position of different plumbing fixtures and piping.

(c) Materials, sizes and gradients (if any) of the proposed interconnecting piping system.

(d) Pipes (if any) conveying non potable water (for flushing water closets and urinals) shall be marked by distinctive (durable) yellow color.

(e) Design calculations of water requirement, indicating considerations of per capita water requirement and population.

5.3.1.2 Application of Permit for Bulk Water 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 there on the finished line and level of the roads or footpaths and water supply lines and appurtenances.

5.3.1.3 Application for Individual (Permission for DTW Installation) Water Supply

For private water supply facility in addition to public water main connection through installing own deep tube well, permission must be sought submitting application to water supply Authority in a prescribed form. Necessity for such connection indicating total water requirement should be mentioned.

5.3.2 Justification of Requirement

The design calculations for water supply system of high rise and public buildings shall be submitted along with the drawings mentioned in Section 5.3.1 above.

5.3.3 Permits and Approvals

The Building Official shall examine or cause to be examined the application for a permit and amendments thereto within 45 days from the day of receipt of such application. If the application does not conform to the provisions of this Code, it shall be rejected in writing, stating the reasons therefore. If the proposed work satisfies the provisions of this Code (Section 5.3.2 and 5.3.3), the Authority shall issue a nontransferable permit.

5.3.4 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 (Appendix- 8.5.B) to the Authority for getting the water connection from the mains.

5.4 LICENSING /REGISTRATION OF PLUMBERS

5.4.1 License Requirement

Plumbing work 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, partnership, corporation or firm shall engage in the business of installation, repair or alteration of water supply system without obtaining a license from the Authority.

5.4.2 Examination and Certification of Plumber

The Authority shall establish a plumbers selection and examination board. The board will determine:

a) The requirements of obtaining license, i.e.,
   - (i) minimum academic qualification
   - (ii) minimum practical vocational and other training
   - (iii) minimum years of experience
   - (iv) total volume of works done and

b) Finally, establish standards and procedures for examination of the applicants for license.

The Authority will issue license to such applicants who meet the qualifications thereof and successfully pass the examination conducted by the board.

5.4.3 Annulment of License

The license of a plumber may be annulled by the Authority, if it is proved that a plumbing work has been completed and certified by the licensed plumber violating the provisions of this Code and deliberately setting aside the approvals given in the permit or without receiving the permit from the Authority.

5.5 WATER SUPPLY REQUIREMENTS

5.5.1 General

5.5.1.1 Buildings equipped with plumbing fixtures and used for human occupancy or habitation shall be provided with the supply of cold potable water in the amounts specified in Section 5.5.2 to 5.5.4 and at the pressures specified in Section 5.10.4.2 and 5.10.4.3. Only potable water shall be accessible to the plumbing fixtures supplying water for drinking, bathing, culinary use and for the processing of food.

5.5.1.2 Non potable water may be used for flushing water closets and urinals provided such water shall not be accessible for drinking or such other purposes.

5.5.2 Water Requirement for Domestic Use

Water requirement for domestic purposes should be classified according to the socio-economic status, type of habitants, population of the area and public facilities present.

Socio -economic groups:

(a) High Income group - monthly Income > 1 lac taka
(b) Middle Income group - monthly Income > 30,000 - 1 lac
(c) low income group - monthly Income < 20,000 taka

Type of Habitants/Population

(a) City Corporation areas, big cities - Population > 0.5 million
(b) Small district towns, Upazilas and Urban growth centers- population > 0.1 million
(c) Village areas - population < 0.05 million

Water requirements for daily domestic use of a building shall be assessed on the basis of the one or a combination of the following two methods:

(a) Number of occupants according to their occupancy classification and their water requirements as specified in Table- 8.5.1(a). to Table- 8.5.1(d)
(b) Peak demand or maximum probable flow specified in Section P3 and P4 in the Appendix- 8.5.C.

Table- 8.5.1(a): Water Consumption for Domestic Purposes (Cities/Big District Towns) [In Residential Buildings]

Cat	Socio-economic group, Type of Building & Other Facilities	Water Consumption	
A	***Big Cities / City Corporation Area / Big District Towns (Population > 0.5 million)***	**Full Facility (lpcd)**	**Restricted Facility (lpcd)**
a	High income group:		
a1	Single Family Dwelling with Garden & Car washing	260	200
a2	Big Multi Family Apartment /Flat (> 2500 sft)	200	150
b	Middle income group:		
b1	Officer's Qrt./Colony & moderate Apartment (< 2000 sft)	180	135
b2	Small building/Staff Qrt. & small Apartment (< 1500 sft)	---	120
c	Low income group:		

c1	Junior staff Qrt. /flat (< 1000 sft) & temporary shade	---	80
c2	Stand post connection in the fringe area	---	65
c3	Common yard (stand post) connection in the fringe area	---	50
c4	Slum dwellers collection from road side public stand post	---	40

Table- 8.5.1(b): Water Requirement for Domestic Purposes (District Towns/Upazilas/Urban growth Centres) [In Residential Buildings]

Cat	Socio-economic group, Type of Building & Other Facilities	Water Consumption	
B	***Small District Towns/ Upajilas & Urban Growth Centre (Population > 0.1 million)***	**Full Facility (lpcd)**	**Restricted Facility (lpcd)**
a	Middle income group:		
a1	Single Family Dwelling with Garden	---	150
a2	Officer's Qrt./Colony & moderate Apartment (< 2000 sft)	---	135
a3	Small building/Staff Qrt. & small Apartment (< 1500 sft)	---	120
b	Low income group:		
b1	Junior staff Qrt. /flat (< 1000 sft) & temporary shade	---	80
b2	Private Stand post connection in the fringe area	---	65
b3	Common yard (stand post) connection in the fringe area	---	50
b4	Slum dwellers collection from road side public stand post	---	40

Table- 8.5.1(c): Water Requirement for Domestic Purposes (Village Areas and Small Communities) [In Residential Buildings]

Cat	Socio-economic group, Type of Building & Other Facilities	Water Consumption	
C	***Village Areas /Small Community* from hand tube well, dugwells , ponds & rivers (Non piped water supply system)**	**Full Facility (lpcd)**	**Restricted Facility (lpcd)**
a1	Private Source (Own Tubewell / dugwell & pond)	---	50 - 60
a2	Public Sources (Public TW/Dugwell/ other sources)	---	40 - 50

5.5.3 Water Requirement for Fire Fighting

5.5.3.1 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.

5.5.3.2 Provision shall be made by the owner of the building for water supply requirements for firefighting purposes within the building, depending upon the height and occupancy of the building, in conformity with the requirements laid down in Part 4 'Fire Protection'.

5.5.3.3 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 Section 4.2 of Part 4.

5.5.4 Water Requirement for Special Equipment

5.5.4.1 Water supply in many buildings is also required for many other applications other than domestic use, which must 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.

5.5.4.2 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. The water requirement for special equipment like air-conditioning or such others shall be based on the specification of the manufacturer.

Table 8.5.1(d): Domestic Water Requirements for Various others Occupancies and Facility Groups

Class of Occupancy	Occupancy Groups	For Full [a] Facilities (lpcd)	For Restricted Facilities (lpcd)
Occupancy A:	A1: Mess, Hostels, or Boarding House	135	70
Residential	A2: Minimum Standard Housing	-	70
	A3: Hotels or Lodging House (Per bed)	300	135
	A4: Hotel (up to 4 Star)	180	---
	A5: Hotels (up to 5 Star)	320	---
	A6: Gardening and Sprinkling		
	A7: Car Washing		
Occupancy B:	B1: Educational Facilities	70	45
Educational	B2: Preschool Facilities	50	35
Occupancy C:	C1: Institution for Children's Care	180	100
Institutional	C2: Custodian Institution for Capable	180	100
	C3: Custodian Institution for Incapable	120	70
	C4: Penal and Mental Institution	120	70
Occupancy D:	D1: Normal Medical Facilities/ Small Hospitals	340	225
Health Care	D2: Big Hospitals (Over 100 beds)	450	250
	D3: Emergency Medical Facilities	300	135
	D4: Nurses & Medical Quarters	250	135

Table 8.5.1(d) Cont.: Domestic Water Requirements for Various others Occupancies and Facility Groups

Class of Occupancy	Occupancy Groups	For Full [a] Facilities (lpcd)	For Restricted Facilities (lpcd)
Occupancy E:	E1: Large Assembly with Fixed Seats (per seat)	90	45
Assembly	E2: Small Assembly with Fixed Seats (per seat)	90	45
	E3: Large Assembly without Fixed Seats [b]	8	5
	E4: Small Assembly without Fixed Seats	8	5
	E5: Sports Facilities	8	5
Occupancy F:	F1: Offices	45	30
Business and	F2: Small Shops and Markets	45	30
Mercantile	F3: Large Shops and Markets	45	30
	F4: Garage and Petrol Stations	70	45
	F5: Essential Services	70	45
	F6: Restaurant	70	50
Occupancy G:	G1: Low Hazard Industries	40	25
Industrial	G2: Moderate Hazards Industries	40	25

Occupancy H: Storage	H1: Low Fire Risk Storage	10	6
	H2: Moderate Fire Risk Storage	10	6
Occupancy J: Hazardous	J1: Explosive Hazard Building	8	5
	J2: Chemical Hazard Building	8	5
Occupancy K[c] Miscellaneous	K1: Private Garage & Special Structure	8	5
	K2: Fences, Tanks and Towers	-	3

a For full facility in occupancy classifications A, B, C and D, the water requirement value includes 25% hot water.
b In the case of mosques, the water requirements given above shall be adequate for ablution and other uses of one devotee per prayer. The appropriate LPCD value may be calculated on this basis.
c Water requirement for occupancy K is shown as a provision for unknown visitors only.

5.6 ESTIMATION OF DEMAND LOAD

5.6.1

Estimates of total water supply requirements for buildings shall be based on the estimation of total present and predicted future population and per capita water requirement as mentioned in section 5.5.

5.6.2

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.

5.6.3

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 size around 5 (five). For assessing the population in other occupants, reference may be made to Part 4 'Fire Protection'.

5.6.4

To estimate office building occupancy, allow 7.4-9.3 sqm (80-100 sq ft) of floor space per person, depending on the type of office building, exclusive of elevator and stair space, corridors, or service areas.

5.6.5

To determine the present and future water requirement:

(a) Classify the total population based on the basis socio-economic status (Higher/middle/lower income group & slum dwellers)
(b) Determine per capita water requirement for different categories (types) of people for different type of domestic, recreational, and commercial uses.
(c) Multiply the population with per capita water consumption to determine the present and future water requirement.

5.7 WATER SOURCES AND QUALITY

5.7.1 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. Surface waters are physically and microbially contaminated and cannot be used without treatment, on the other hand ground water sources are chemically contaminated and treatment may be necessary in many cases.

5.7.2 Quality of Water

The quality of water to be used for drinking shall be maintained using WHO Water Safety Plan (WSP) and at least comply with the Bangladesh Standard (ECR, 1997) and WHO Guideline Values (2004) as presented in Table-5.Q1 of Appendix- 8.5.D. 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.

5.7.3 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.

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

5.8 WATER SUPPLY SYSTEM

Each floor or unit within the water supply system shall be provided with a control valve in addition to the main control valve at the entrance of the system. One of the following public water supply systems shall be adopted for distributing water to the plumbing fixtures within the building [Figures 8.5.C.2(a), 2(b) & 2(c) of Appendix- 8.5.C]

5.8.1 Direct Connection to Water Main

For continuous water supply system with sufficient pressure to feed all plumbing fixtures during peak demand period, the direct connection of water distribution system to the water mains may be adopted. However, direct pumping from the public water main should strictly be prohibited.

5.8.2 System Incorporating Balancing Roof Tank

For continuous water supply system with inadequate pressure only during peak demand hour or for intermittent water supply with sufficient pressure to feed balancing tank, a balancing roof tank shall be required to feed plumbing fixtures within the building. The connection to the balancing roof tank from the water main or from ground tank or from individual water sources shall be through a non-return valve.

5.8.3 System Incorporating Ground Tank

For water supply system with inadequate pressure to feed plumbing fixtures or balancing roof tank, the building premises shall have a ground (or underground) tank to store water. The water from the ground tank shall be boosted up to the roof tank to feed plumbing fixtures. The connection of water main to the ground tank shall be through a ball valve system. Installation of booster pump directly into the water main shall not be allowed. Since, this system cannot ensure protection against possible contamination (particularly during flood), disinfection system should be incorporated.

5.8.4 Individual Water Supply

In the absence of a public water supply system, or In case of need of additional supply of water, the building premises shall have individual water supply as specified in Section 5.23.1. The water from the sources (DTW) shall be boosted up to the roof storage tank to feed plumbing fixtures. The system shall be protected as specified in Section 5.13.3 to 5.23.7.

5.9 STORAGE OF WATER

5.9.1 Capacity of Storage Tank

5.9.1.1

The type and capacity of a storage tank shall be determined considering the following factors:

(a) The rate and regularity of supply;

(b) The frequency of replenishment of the storage tank during 24 hours;

(c) Building occupancy classification;

(d) Hours of supply of water at sufficiently high pressure to fill up the roof storage tank in absence of a ground (or underground) storage tank;

(e) The amount of water required for fire fighting and method of fire fighting system (Section 4.2, Part 4)

(f) The amount of water required by special equipment (Section 5.5.4).

5.9.1.2

The size and volume of a storage tank shall be calculated considering the following factors:

a) The amount of storage to be provided is a function of capacity of the distribution network, the location of the service storage, and the use to which it is to be put.

b) To compute the required equalizing or operating storage, a mass diagram or hydrograph indicating the hourly rate of consumption is required.

The procedure to be used in determining the needed storage volume follows:

a) Obtain a hydrograph of hourly demands for the maximum day, through a study of available records.

b) Tabulate the hourly demand data for the maximum day and draw a cumulative demand curve,

c) The required operating storage is found by comparing (maximum deviation) the cumulative demand curve (S - Shaped Curve) with cumulative pumping curve (Straight line) plotted on it..

c) The required capacity of a tank varies with the capacity and running time of the house or fill pumps, however, following procedure may be followed to determine the capacity of storage tanks and pump:

a) Capacity of Roof Tank = ½ x Total daily demand of water (m^3) + 1 hr. reserve (m^3) for firefighting requirement (for tall building). Therefore, two times filling of roof tank will meet the daily requirement.

b) Capacity of Delivery Pump = Peak hourly demand of water, lph. Therefore, daily pumping period would be around 7 - 8 hours (2-3 hours in the morning + 3 hours in the afternoon + 2 hours in the evening).

c) Capacity of Under Ground Reservoir = 1 x Total daily demand of water (m^3) + 1 hr. reserve (m^3) for firefighting (for tall building). For emergency requirement 2-3 days daily demand of water is sometimes stored.

5.9.2 Construction of Storage Tank

5.9.2.1 General

Storage tank shall be easily accessible for inspection and cleaning. The tank shall be provided with adequate size of valved drains at its lowest point in accordance with Table 8.5.2. The water supply inlet into the storage tank shall be at an elevation that is required for an air gap in an open tank with overflow (Section 5.18.6) or 100 mm

above the overflow whichever is greater. The diameter of overflow pipe shall not be less than the size shown in Table 8.5.3 for the specific discharge into storage tank. The storage tank shall be equipped with water tight and vermin and rodent proof cover. The tank shall be provided with return bend vent pipe with an open area not less than half the area of the riser (up feed or down feed). All openings (overflow pipe and vent pipe) shall be provided with corrosion resistant screens against the entrance of insects and vermin. There must be at least two compartments/units for alternative cleaning.

Table- 8.5.2: Sizes of Storage Tank Drainage Pipes

Tank Capacity (V) in Litres (ℓ)	Diameter of Drainage Pipe (mm)
V ≤ 2800	25
2800 < V ≤ 5500	38
5500 < V ≤ 11000	50
11000 < V ≤ 19000	63
19000 < V ≤ 28000	75
28000 <V	100

Table 8.5.3: Sizes of Overflow Pipes for Storage Tank

Maximum Discharge (Q) of Water Supply Pipe into Storage Tank (ℓ/min)	Diameter of Overflow Pipe (mm)
Q ≤ 190	50
190 < Q ≤ 570	63
570 < Q ≤ 760	75
760 < Q ≤ 1500	100
1500 < Q ≤ 2650	125
2650 < Q ≤ 3800	150
3800 < Q	200

5.9.2.2 Roof Storage Tank

The roof storage tank shall be constructed with prestressed or reinforced concrete or ferrocement or galvanized steel or of the material that will resist any action by the plain or chlorinated water. The tank shall be made of water tight without the use of putty. Tanks made of non-galvanized metal sheets shall be coated internally with a nontoxic material which does not impart a taste or odor. The metal storage tank shall be coated externally with a good quality anticorrosive weather resistant paint. The outlet of storage tank to the distribution system shall be at least 50 mm above the tank bottom.

To provide sufficient pressure, the bottom of the tank must be elevated sufficiently above the highest floor water fixtures.

Vent pipe should be provide to avoid any air lock and should be placed where the horizontal branch pipes connect the vertical down feed pipes (not adjacent to storage tank and at interconnection place between storage tank and distribution pipes).

5.9.2.3 Ground or Underground Storage Tank

The ground or underground storage tank shall be constructed of either prestressed or reinforced concrete or ferrocement. The tank shall be absolutely waterproof and have a water tight cast iron manhole cover suitable for inspection. The inside and outside of the tank may be coated with nontoxic and waterproof materials. The ground tank shall be placed at a location so as to avoid contamination by flood water or any other sources. Each compartment/units should be divided in two chambers with provision of sump for longer contact time with chlorine and easy cleaning

5.10 DESIGN OF DISTRIBUTION SYSTEM

5.10.1 Rate of Flow of Water

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 at peak demand period (Peak hourly demand of water)

$$= \frac{Total \quad daily \quad requiremen\,t \quad of \quad water}{Hours \quad of \quad water \quad consumptio\,n \quad (usually \quad 15-17\,hours)} \text{ X Peak Factor (usually 2.2)}$$

b) the length of the pipe; and

c) the head loss by friction in pipes, fittings and meters. For head loss calculation in piping system-

i) Determine the total length of pipe and calculate the equivalent Pipe Length (Head Loss from bend, gate valves, reducer etc.) from Tables 8.5.C2(a), C2(b) and C(c) of Appendix – 8.5.C.

ii) Assume the probable maximum velocity of flow (v) or tentative diameter of pipes (d),

considering maximum permissible head loss of 1.5 -1.6 m/ 100 m

For 13 mm and 50 mm diameter pipe: 0.30 - 0.60 m/sec

For 75 mm and 100 mm diameter pipe: 0.75 - 0.90 m/sec

For 150 mm and 200 mm diameter pipe: 1.15 - 1.30 m/sec

iii) Determination of total head loss (h_f) from Hazen William's Nomograph (Figure-8.5.C.4 of Appendix- 8.5.C) or friction loss formula, $h_f = \frac{4fLv^2}{2gd}$ where, f = friction loss factor, L = length of pipe, v = velocity of flow and d = diameter of pipe.

5.10.2 Discharge Computation

5.10.2.1

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 the following Table- 8.5.4

Table- 8.5.4: Fixture Unit for different Types of Fixtures with Inlet Pipe Diameter

Sl No.	Type of Fixture	Fixture Unit (FU) As Load Factor	Minimum Size of Fixture Branch, mm
1	Ablution Tap	1	15
2	Bath tub supply with spout	3	15
3	Shower Stall Domestic	2	15

Sl No.	Type of Fixture	Fixture Unit (FU) As Load Factor	Minimum Size of Fixture Branch, mm
4	Shower in Group per head	3	15
5	Wash Basin (Domestic Use)	1	15
6	Wash Basin (Public Use)	2	15
7	Wash Basin (Surgical)	2	15
8	Kitchen Sink (Domestic Use)	2	15/20
9	Washing Machine	3	15/20
10	Drinking Fountain	0.5	15

5.10.2.2 Probable Simultaneous Demand (Hunter Curve)

The possibility that all water supply taps in any system in domestic and commercial use will draw water at the same time are 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 as shown in Figure-8.5.C.1 of Appendix- 8.5.C, and may also be calculated from Table-8.5.5.

5.10.3 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 Figure-8.5.C.4 of Appendix- 8.5.C.

5.10.4 General Features of Distribution System Design

5.10.4.1

The water supply system shall be designed to supply minimum but requisite quantity of water to all fixtures, devices and appurtenances in every section of the building with adequate pressure. The design requirements of a water supply system are presented in Table 8.5.6.

5.10.4.2

For a down feed water distribution system (roof tank supply), static pressure due to gravity increases with increasing floor height (4.32 psi or 0.3 Bar per floor of 10 ft. height at non flow condition). Therefore, water distribution pipe in a building shall be maintained at a pressure so that none of their fittings shall are subject to a water head greater than 35 m (approximately 50 psi).

Table- 8.5.5: Probable Simultaneous Demand

No. of Fixture Units	System with Flush Tanks Demand (Based on Fixture Units)		System with Flush Valves Demand (After Hunter)	
	Unit Rate of Flow[1])	Flow in Litre per Minute	Unit Rate of Flow1)	Flow in Litre per Minute
(1)	(2)	(3)	(4)	(5)
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	19.0	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

[1] Unit rate of flow= Effective fixture units.

5.10.4.3

The distribution system shall be maintained at a pressure not less than those specified in Table 8.5.6 during peak demand period.

5.10.4.4

The minimum size of supply pipe for different fixtures shall be in accordance with Table 8.5.6. The fixture supply shall not terminate more than 0.76 m (2.5 ft) from the point of connection to the fixture. A reduced size flexible water connection pipe shall be used.

5.10.4.5

The water flow velocity in the distribution system shall be controlled to minimize the possibility of water hammer.

5.10.4.6

The design of water distribution system shall conform to approved engineering practices. An alternative guide to the design of a building water distribution system is also presented in Appendix 8.5.C.

Note : The sizing of water distribution piping within the building may be made either by considering the velocity of flow or by velocity of flow and pressure loss as governing parameters. The first method have limited application for one or two storey buildings provided the minimum available pressure is sufficient to operate the highest or most remote fixtures during peak demand period. The second method provides better estimate of pipe sizes for a water distribution system.

5.10.5 Design of Water Distribution Pump

The capacity of a water delivery pump can be calculated from the estimated maximum rate of flow (Q) of water in gpm, and total head (H = hs + hd + hf + hv) of supply of water in ft and using the following formula:

Break Horse Power, BHP = $\frac{H \ x \ Q}{3960}$ x Efficiency of pump in %.

Static head, hs is the total suction lift of water (sum of vertical distance between the underground reservoir and pump level and delivery head, hd is the vertical distance between the pump level and roof tank storage point.

Frictional head loss, hf can be determined for whole length (vertical and horizontal) of pipe flow using the procedures described in section 5.10.1(c).

Velocity head, hv = $\frac{v^2}{2g}$ where, v = velocity of flow of water at the discharge point in the roof tank.

5.11 WATER DISTRIBUTION IN TALL BUILDINGS

5.11.1 Distribution Methods

In tall buildings some of the fixtures at the lower level may be subject to excessive pressure. The sanitary appliances and fittings in tall buildings shall not be subject to a pressure of greater than 350 kPa. This shall be achieved by one or a combination of the following two methods :

a) Zoning Floors by Intermediate Tank : High rise buildings shall be zoned by providing intermed4ate tanks on different floors, each feeding a zone ranging from 5-6 storeys so that the plumbing fixtures are not subjected to excessive pressure. Distribution in each zone shall be through independent down-take pipes from intermediate tanks as shown in Figures 8.5.C.3(a), 8.5.C.3(b), 8.5.C.3(c) and 8.5.C.3(d) of Appendix- 8.5.C. The floors on which an intermediate tanks are located shall be fed from the story above it.

i) System Incorporating Intermediate Tanks Supplied by Storage Tank - Water required for the building shall be pumped from the underground tank to the storage tank. The intermediate tanks shall be fed from the storage tank through a separate down take pipe.

ii) System Incorporating Intermediate Tanks Supplied by Independent Pumps - Alternatively the intermediate tanks may be supplied from the underground tank through independent pumps

Table 8.5.6: Water Supply System Design Requirements

Fixture	Supply Control	Minimum Size of Supply Pipe (mm)	Required Flow Pressure (kPa)	Required Flow Rate (lpm)
Bathroom group	Flush tank	-	55	--
Bathroom group	Flushometer valve	-	55	--
Bathtub	Faucet	13	55	15.1
Clothes washer		13	55	--
Combination fixture	Faucet	13	55	--
Dishwashing machine		13	55	10.4
Drinking fountain	Faucet	13	55	2.8
Kitchen sink	Faucet	13	55	9.5
Laundry tray	Faucet	13	55	15.1
Wash basin	Faucet	19	55	--
Pedestal urinal	Flush tank	13	55	56.8
Pedestal urinal	Flushometer valve	19	100	56.8
Restaurant sink	Faucet	19	55	--
Service sink	Faucet	13	55	11.4
Shower head	Mixing valve	13	55	11.4
Water closet	Flush tank	19	55	11.4
Water closet	Flushometer tank	19	55	6.1
Water closet	Flushometer valve	25	100	132
For fixture not listed here but maximum		13	55	--
supply size requirement		19	55	--
		25	100	--

Note: 1 psi = 6.895 kPa (1 kPa = 0.145 psi), 1 gallon = 3.785 liter

b) **System Incorporating Pressure Reducing Valves:** The excessive pressures suffered by different fixtures shall be minimized by pressure reduction valves.

c) **Hydro-Pneumatic System:** This system may be adopted where the source is independent of public water supply system. In this system the supply shall be through a pneumatic pressure vessel fitted with accessories like non-return and pressure relief valves. The pump and compressor shall be automatically controlled through an electric control panel to provide air and water as and when needed.

5.11.2 Recirculation of Waste Water

Recirculation of cooling water and/or waste water from wash basin to the cistern of water closets and urinals in the lower floor may be provisioned only through a separate tank. No connection between the potable water supply line and the re-circulated waste water line shall be allowed with or without any non-reflex or non-return valves.

5.12 HOT WATER SUPPLY INSTALLATION

5.12.1 Hot Water Requirements

For a residential building, hot water may be supplied to all plumbing fixtures and equipment used for bathing, washing, cleansing, laundry and culinary purposes. For a nonresidential building, hot water may be supplied for bathing and washing purposes. Water requirement for hot water supply shall be in accordance with Section 5.5.

5.12.2 Storage Temperature

The design of hot water supply system may be based upon the following temperature requirement :

Scalding	68^{o}C
Hot bath	41^{o}C
Warm bath	37^{o}C
Tepid bath	30^{o}C
Sink	60^{o}C

5.12.3 Storage Capacity

The capacity of hot water vessel shall be based on the maximum short time demand of the premises.

5.12.4 Hot Water Heater

The hot water heater shall conform to the following standards : BS 758, BS 779, BS 843, BS 855, BS 1250, BS 2883 and those specified in Part 5 of this Code.

5.12.5 Cold Water Supply Connection to Water Heaters

The connection of cold water supply piping into water heater shall be made near its bottom. The minimum size of cold water supply piping shall be based on the probable hot water demand of different fixtures but not less than 25 mm. The supply pipe shall deliver cold water into hot water cylinder as follows:

a) The water heater (electric or gas) of less than 15 liters storage capacity may be directly connected to the water main through a non-return valve.

b) The storage heater of 20 to 70 liters capacity may be connected directly to the water main through a non-return valve and with an additional device that will prevent the siphonage of hot water back to the water main.

c) The enclosed water heater with storage capacity greater than 70 liters shall be fed from the storage tank. This water heater shall not be connected directly to the water main.

d) The water supply connection to an open vessel type water heater may be made with an air gap of at least 15 mm above the top edge of the water heater. Ball valve connection shall not be used to control the flow of water into this water heater.

5.12.6 Hot Water Distribution Piping

The connection of hot water distribution pipe to the hot water cylinder shall be at the top of the cylinder. The installation of piping shall be such as to avoid airlock. In case of hot water horizontal piping the gradient shall not be less than 1 in 250.

5.12.6.1

The procedure for sizing may be the same as that for cold water distribution system in Sec 5.10 but in no case shall the size be less than that specified in Table- 8.5.7.

Table- 8.5.7: Minimum Pipe Size for Hot Water Piping

Different Pipes	Minimum Diameter(mm)
The size of main distributing pipe that supplies hot water to the fixtures in the same storey of the hot water cylinder	25
The size of main distributing pipe that supplies hot water to the fixtures not in the same storey of hot water cylinder	19
Branch pipe supplying hot water to the bath tub or shower	19
Branch pipe supplying hot water to the sink	19
Branch pipe supplying hot water to the wash basin	19

5.12.6.2

The design consideration of hot water piping shall be such that hot water will appear quickly at the outlet of different fixtures. To improve the situation, a secondary circulation system with flow and return pipe from and to the hot water cylinder (Fig 8.5.1) may be adopted. The length of hot water distribution pipe measured along the pipe from the top of draw off tap to the hot water cylinder or the secondary circulation pipe shall not exceed the length prescribed in Table 8.5.8. The draw-off tap shall not be connected to the primary flow or return pipe.

Table- 8.5.8: Maximum Permissible Length of Hot Water Draw Off Pipe

Largest Internal Diameter (D) of Pipe	Length of Pipe (m)
D < 19 mm	12
20 mm <D < 25 mm	7.5
25 mm <D	3

5.12.7 Vent Pipe

The pressure type hot water heater shall be provided with a vent pipe of not less than 19 mm diameter. The vent pipe shall rise vertically above the water line of cold water tank by at least 150 mm plus 1 mm for every 30 mm height of waterline above the bottom of the water heater.

The vent pipe shall be connected to the top of the hot water cylinder. The vent pipe may be used to supply hot water to the point in between the cold water tank and the hot water cylinder. The vent pipe shall not be provided with any valve or check valves.

The termination of vent pipe shall be such as not to cause any accidental discharge to hurt or scald any passerby or person in the vicinity.

5.12.8 Capacity of Cold Water Storage Tank

The storage capacity of cold water cistern shall be at least equal to the size of hot water storage cylinder if the cold water cistern supplies water only to the hot water heater cylinder. This capacity shall be at least twice the capacity of hot water heater cylinder if the cold water storage tank also supplies water to the cold water draw off taps.

5.12.9 Safety Devices

The temperature relief valve or pressure relief valve or a combination of temperature and pressure relief valves shall be installed for the equipment for heating or storage of hot water. The temperature relief valve shall be set at a maximum temperature of 99^{o}C. The maximum pressure rating of water heater shall not be more than 1000 kPa. The temperature relief valve shall be placed directly above the cylinder it serves but in no case more than 75 mm away from the cylinder. The location of pressure relief valve shall be close to the equipment it serves. There shall be no valve connection in between a relief valve and the hot water cylinder it serves.

5.12.10 Wastes from Relief Valve

The outlet of pressure, temperature or such other valve shall not be directly connected to the drainage system.

5.12.11 Drain Cock

Adequate size of drain cock shall be provided with all storage tanks for their proper cleaning.

5.13 MATERIALS, FITTINGS & APPLIANCES

a) The materials and fittings for water supply and distribution pipe and for storage tank shall comply with the standards listed in Part 5 'Building Materials' and shall be in accordance with Section- 2.15 and those specified in this section.

b) The materials chosen shall be resistant to corrosion, both inside and outside or shall be suitably protected against corrosion and free from all toxic and harmful substances. Polyethylene and un-plasticized PVC pipes shall not be installed near hot water pipes or near any other heat source..

c) All jointing of pipes and fittings shall be done in accordance with acceptable standard practices.

5.13.1 Water Supply Service and Distribution Pipes

Water supply service and distribution pipes shall conform to the standards listed in Tables 8.5.9 and 8.5.10. The water supply pipes and tubing used outside the building or underground shall have a minimum working pressure of 1.1 MPa at 23^{O}C. In case of water supply exceeding 1.1 MPa pressure, the piping material shall have at least a rated working pressure equal to the highest available pressure. The hot water distribution piping shall have a minimum pressure of 550 kPa at 80^{O}C. Different types/classes of uPVC (Un-plasticized PVC pipes) are used both for service and internal distribution pipes as described in Table 8.5.11. However, Polyvinyl chloride (PVC) plastic pipes shall not be used exposed and unprotected as riser or water distribution pipe. Polythene or un-plasticized PVC pipes shall not be installed near the heaters or hot water piping. Lead pipes may be used only for flushing and overflow purposes in a water supply system.

5.13.2 Pipe Fittings

The pipe fittings shall be in accordance with the standards listed in Table 8.5.12 and those specified in Part 5.

5.13.3 Concrete, Prestressed or Ferrocement Structures

The properties of the materials used for storage tank or such other structures shall conform to the material standards specified in Part 5 of the Code.

Table- 8.5.9: Water Supply Service Pipe

Materials	Standards
Acrylonitrile butadiene styrene (ABS) plastic pipe	ASTM D1527, ASTM D2282
Brass pipe	ASTM B43
Cast iron water pipe	ASTM D377
Copper or Copper-alloy pipe	ASTM B42, ASTM B302
Copper or Copper-alloy tubing	ASTM B75, ASTM B88, ASTM B251, ASTM B447
Chlorinated polyvinyl chloride (CPVC) pipe	ASTM D2846, ASTM F441, ASTM F442
Galvanized steel pipe	ASTM A53
Polybutyline (PB) plastic pipe and tubing	ASTM D2662, ASTM D2666, ASTM D3309
Polyethyline (PE) plastic pipe and tubing	ASTM D2239, ASTM D2737
PVC plastic pipe	ASTM D1785, ASTM D2241, ASTM D2672

Table- 8.5.10: Water Distribution Pipe

Material	Standard
Brass pipe	ASTM B43
Copper or Copper-alloy pipe	ASTM B42, ASTM B302
Copper or Copper-alloy tubing	ASTM B75, ASTM B88, ASTM B251, ASTM B477
CPVC plastic pipe and tubing	ASTM D2846, ASTM F441, ASTM F442
Galvanized steel pipe	ASTM A53
PVC plastic pipe	ASTM D1785, ASTM D2241, ASTM D2672

5.14 GENERAL REQUIREMENT FOR PIPE WORK

5.14.1 Public Water Mains

The following principles shall apply for the mains:

a) Service mains shall be of adequate size to give the required rate of flow.

Table- 8.5.11(a): Working Pressure Range of Different Types of uPVC (Un-plasticized PVC) Pipes

Material	Type/Class	(Bar)	(kg/cm^2)
uPVC Pipe	Class – B	6.0	6.12
uPVC Pipe	Class – C	9.0	9.19
uPVC Pipe	Class – D	12.0	12.25
uPVC Pipe	Class – E	15.0	15.30

Table- 8.5.11 (b): Average Wall Thickness Class- E uPVC (Un-plasticized PVC) Pipes

Average Wall Thickness of Class- E Type uPVC Pipe			
3/8 inch (9.5 mm) Ø	**½ inch (13 mm) Ø**	**¾ inch (19 mm) Ø**	**1.0 inch (25 mm) Ø**
1.9 mm	2.1 mm	2.5 mm	2.7 mm

Table- 8.5.12: Pipe Fittings

Material	Standard
Asbestos cement	ISO 160, ISO 881, ISO 392
Cast iron	ASME B164, ASME B16.12
Copper or copper alloy	ASME B16.15, ASME B16.18, ASME B1622 ASME B16.23, ASME B16.26, ASME B16.29 ASME B16.32
Grey iron and ductile iron	AWWA C110, ISO 2531
Malleable iron	ASME B16.3
Plastic , uPVC	ASTM D2464, ASTM D2466, ASTM D2467 ASTM D2609, ASTM F409, ASTM F437, ASTM F438, ASTM F439
Steel	ASME B16.9, ASME B16.11, ASME B16.28

b) The mains shall be divided into sections by making loop system and with the provisions of sluice valves and other valves so that any part of water main may be shut off for repairs without affecting major part of pipe network

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.

i) 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.

5.14.2 Interconnection Pipes from Water Main

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 stopcock 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.

5.14.3 User/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, down-take 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.

i) 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.

j) All consumer pipes shall be so laid as to permit expansion and contraction or other movements.

5.14.4 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.

5.15 SAFE CONVEYANCE AND DISTRIBUTION OF WATER & PREVENTION OF BACKFLOW

5.15.1 Basic Principles

a) 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.

b) 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.

c) 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.

d) 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.

e) 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.

f) 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.

g) 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.

h) 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.

i) Undesigning 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.

j) 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.

k) 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.

l) 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.

5.15.2 Backflow Prevention

a) 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.

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

   i) Barometric loop,

   ii) Air gap,

   iii) Atmosphere vacuum breaker,

iv) Pressure vacuum breaker,

v) Double check valve, and

vi) Reduced pressure backflow device.

c) The installation shall not adversely affect drinking water:

i) by materials in contact with the water being unsuitable for the purpose;

ii) as a result of backflow of water from water fittings, or water using appliances into pipe work connected to mains or to other fittings and appliances;

iii) by cross-connection between pipes conveying water supplied by the water undertaker with pipes conveying water from some other source; and

iv) by stagnation, particularly at high temperatures.

d) 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.

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

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

g) 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.

h) 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 noncorrosive.

i) 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.

5.16 LAYING OF PIPES ON SITE

5.16.1 Excavation of Trenches and Refilling

a) 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.

b) 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.

c) 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.

d) The width of excavation trench shall be at least 0.4 m more than the outside diameter of the pipe.

e) The depth of ground cover shall be at least 0.9 m under roadway or 0.75 m under garden from the top surface of the pipe to the ground surface.

f) The bottom of the trench shall be carefully prepared so that the pipe will be bedded well for its entire length on firm surface.

5.16.2 Laying of Pipe

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

b) In sloping ground, the pipe laying shall proceed in upward direction. The pipe shall be provided with anchor blocks to withstand hydraulic pressure.

5.16.3 Laying of Pipe Through Ducts, Chases, Notches or Holes

Provisions for laying pipes in ducts or chase shall be made during the time of construction. When these will be cut into existing walls, they shall be large enough with smooth finishing for fixing the pipe and to accommodate thermal expansion. Piping subject to external pressure shall not be laid in notches or holes.

5.16.4 Lagged Piping

Lagged piping shall be entirely covered with waterproof and fire insulating materials before their attachment to the walls outside the building and shall be anchored with the wall keeping a gap in between the wall and the piping.

5.16.5 Jointing of Pipes

All joints and connections shall be gas tight and water tight for the pressure required by the test in accordance with Sec 5.22.2. The joints between different piping and fittings for water supply shall conform to the standards cited against them in Table 8.5.13. The requirements for the joints not specified in the table shall be subject to the approval of the Authority.

Table 8.5.13: Joints Between Different Piping and Fittings

Material	Standard
ABS plastic pipe and fittings	ASTM D2235, ASTM D2661, ASTM D3139, ASTM F628 ASME B1.20.1
Asbestos, cement pipe and fittings	ASTM D1869
Brass pipe and fittings	ASME B1.20.1
Cast iron pipe and fittings	ASTM C564
Copper and copper alloy pipe and fittings	ASTM B32, ASME B1.20.1
PVC plastic pipe and fittings	ASTM D2846, ASTM D3139, ASTM F493, ASME B1.20.1
Galvanized steel pipe and fittings	ASME B1.20.1
PB plastic pipe, tubing and fittings	ASTM D2657, ASTM D3140, ASTM D3309
PE plastic pipe, tubing and fittings	ASTM D2657
PVC plastic pipe and fittings	ASTM D2564, ASTM D2855, ASTM D3139, ASTM D3212, ASTM F402, ASTM F656, ASME B1.20.1

5.16.6 Special Care for Rat Proofing

The location and installation of water meter box shall be such as not to permit the entrance of rats into the building. The openings through walls, floors or ceilings for the installation of piping shall be closed by using proper collars to prevent the entrance of rats.

5.17 HANGERS AND SUPPORT

The piping system shall be installed with proper hangers and support to minimize undue strains and stresses. All fixtures and fittings shall be provided with hangers and support to secure them properly.

5.17.1 Galvanic action

Hangers, anchors and strapping materials shall be strong and ductile and shall not promote galvanic action.

5.17.2 Hanger Spacing

Vertical and horizontal piping shall be supported in accordance with Table 8.5.14.

Table 8.5.14: Hanger Spacing

Piping Material	Max. Horizontal Spacing (m)	Max. Vertical Spacing (m)
Galvanized steel pipe	3.5	4.5
Copper pipe or copper-alloy tubing > 38 mm diameter	3.5	3.0
Copper pipe or copper-alloy tubing < 38 mm diameter	2.0	3.0
PVC pipe and tubing	1.0	1.0
Aluminium tubing	3.0	4.5
Brass pipe	3.0	3.0

5.18 PROTECTION OF POTABLE WATER SUPPLY

5.18.1 Cross-connection

Potable water supply system shall be protected against non-potable water sources or wastes (solid, liquid or gases). There shall be no cross-connection between potable water distribution system and non-potable water distribution or waste disposal system.

5.18.2 Submerged outlet

From potable water supply system shall be avoided. Connection of potable water to boiler feed water system, or heating or cooling system shall be made through proper air gap.

5.18.3 Cooling water

Water used for cooling or for other purposes shall not be returned to the potable water supply system.

5.18.4 Back flow

Potable water supply system shall be protected against backflow either by air gap or by back flow preventor. Reflex non-return valve shall not be used for this purpose. Details have been explained in section 5.15.2.

5.18.5 Back flow Protections

The connection of potable water for health care plumbing fixtures shall be protected against backflow in accordance with Table 8.5.15.

5.18.6 Air Gap

The minimum air gaps for different water supply openings or outlet shall be at least 3 times the effective opening when they will be placed close to a wall. The minimum air gaps shall be at least 2 times the effective opening when they will be located away from a wall.

Table 8.5.15: Water Supply Protection for Hospital Fixtures

Fixtures	Protections Required
Aspirators	Vacuum breaker
Bedpan washer	Vacuum breaker
Boiling type sterilizer	Air gap
Exhaust condenser	Vacuum breaker
Flush floor drain	Vacuum breaker
House connection	Vacuum breaker
Pressure sterilizer	Vacuum breaker
Vacuum system (cleaning and fluid section)	Air gap or vacuum breaker

5.18.7

Potable water supply connection to any cistern or apparatus containing chemical(s) shall be done only with the special approval for such connection by the Authority and shall be marked by a tag.

5.18.8

All piping and fitting shall be designed, installed and maintained as to be and to remain completely air-tight and thereby avoiding waste of water, damage to property and to avoid the risk of contamination.

5.18.9

Non-potable water supply system shall have to be painted and marked by a tag.

5.18.10

Flushing valve operated water closets when installed in any building shall be supplied through a separate branch pipe with a back flow preventer at the starting point where the branch pipe is taken off from the supply pipe.

5.19 HEALTH CARE WATER SUPPLY

5.19.1 General Requirement

All hospitals shall have at least two service pipes from the individual water supply source or from the water main for supplying water without any interruption. For roof storage system, the hospital shall have at least two storage tanks such that each of them is capable of serving the water distribution system in absence of the other. All special fixtures shall be installed without interference to the transportation and to the safety of patient and staff.

5.19.2 Hot Water Supply

All hospitals shall be equipped to supply hot water as required by different fixtures and equipment.

5.19.3 Water Supply Protection

The water supply connection to all special equipment or fixtures shall be protected against backflow, flooding, fouling and contamination of water supply system in accordance with Section 5.9.

5.20 CLEANING AND DISINFECTING THE SYSTEM

5.20.1 General

The new and repaired potable water supply system including storage tank shall be disinfected before their use. The existing water supply system shall be cleaned and disinfected depending upon the quality of water. The storage tank shall be cleaned and disinfected at least once a year.

5.20.2 Disinfection Procedure

The following procedure may be adopted to disinfect the plumbing system :

a) The water supply system or storage tank shall be flushed with potable water until clean water appears at the outlets.

b) The system or part thereof which requires disinfection shall be filled up with chlorinated water containing 50 mg/l of chlorine for 24 hours or for 3 hours with a chlorinated water of chlorine concentration of 200 mg/l.

c) After the period of disinfection, the system shall be flushed with potable water until the chlorine is completely removed from the water in the system.

d) The above procedure shall be repeated until the bacteriological examination shows presence of no water contamination within the system.

5.21 INSPECTION, TESTING AND COMPLETION CERTIFICATE

5.21.1 Inspection

Piping and joints shall not be enclosed, concealed or covered until they have been inspected and approved by the Authority. All piping and fixtures shall be inspected for satisfactory supports and protection from damage and corrosion.

5.21.2 Testing

After installation of the entire water supply system or part thereof, it shall be tested and approved by the Authority before its use.

a) Testing of Water Mains : The section of the main to be tested shall be charged with water carefully by providing a 25 mm inlet with a stop cock to expel all air from the main. The main shall be allowed to stand full of water for a few days. After that the mains shall be tested to a pressure of 500 kPa or double the maximum working pressure, whichever is greater for at least 5 minutes. The system shall be able to maintain the above test pressure.

b) Testing of Distribution Pipes and Fixtures : The distribution system to be tested shall be slowly and carefully charged with water to expel all air from the system and to avoid all shocks and water hammer. The piping and fittings shall be absolutely water tight when all draw off taps are closed. The system shall be able to maintain the pressures and flow required under working conditions.

c) Testing of Hot Water System : The entire hot water system shall be tested for the maximum rated temperature and pressure of hot water storage system. The system shall be able to maintain the required test pressure. All safety devices shall be tested for their proper operation.

5.21.3 Completion Certificate

The licensed plumber shall issue completion certificate in a prescribed form (Appendix 8.5.B) to the Authority on completion of the water supply system or part thereof for inspection and testing. After testing, the Authority will allow the water connection from the water main (if any) and give the final approval (Appendix 8.5.B) to use the system.

5.22 GUIDE TO MAINTENANCE

The owner or his/her designated agent shall maintain the water supply system in a safe operating condition as specified by the Code.

5.22.1 Frequency of Cleaning

The storage tank shall be inspected regularly and shall be cleaned and disinfected periodically. Metal tanks showing the sign of corrosion shall be coated as specified in Section 5.9.2.2.

5.22.2 Over flow Pipe

The overflow pipes of storage tank shall be inspected regularly to keep the flow free from obstruction.

5.22.3 Water Quality

A periodical examination of water quality may be made.

5.23 INDIVIDUAL WATER SUPPLY SYSTEM

5.23.1 General

In the absence of a public water supply, the individual potable water source shall be used to supply water in a distribution system. The following water sources may be used for individual water supply purposes : drilled well, dug well, driven well, spring, infiltration gallery.

5.23.2 Water Requirements

The capacity of source shall be sufficient to supply water as specified in Section 5.5.

5.23.3 Quality of Water

Water from developed well or cistern shall meet the potable water quality standard requirements specified by the Department of Environment, Bangladesh.

5.23.4 Chlorination

The well or cistern shall be chlorinated after their construction or repair.

5.23.5 Location of Water Source

The minimum distance of water source and pump suction line from potential sources of contamination shall be in accordance with Table 8.5.16.

Table 8.5.16: Distance from Potential Sources of Contamination

Potential Source of Contamination	Distance (m)
Pump floor drain of cast iron, draining to ground surface	1
Sewer	3
Farm silo	8
Septic tank	8
Subsurface pit/Seepage pit	15
Subsurface disposal field	15
Barnyard	30
Pasture	30

5.23.6 Well Construction

5.23.6.1 Location of Water Table

The individual water supply shall not be developed from a water bearing stratum with water table at a depth less than 3 m below the ground surface.

5.23.6.2 Outside Casing

The outside watertight casing shall have to be installed for each well up to a depth of at least 3 m below the ground surface and shall project at least 150 mm above the ground surface. The lower end of the casing shall be sealed in an impermeable stratum or extend into the water bearing stratum. The size of the casing shall be large enough to permit the installation of an independent drop pipe. The casing may be of concrete, tile, or galvanized or corrugated metal pipe. The annular space between the casing and the earth shall be filled with grout to a minimum depth of 3 m. For flood prone regions, top of the casing or pipe sleeve shall be at least 300 mm above the flood level.

5.23.6.3 Well Cover

All potable wells shall be equipped with a watertight cover overlapping the top of the casing or pipe sleeve. For dug or bored well, the overlap and downward extension of the cover shall be at least 50 mm outside the well casing or well. The annular space between the casing or pipe sleeve and the drop pipe shall have a watertight sealing.

5.23.6.4 Drainage from Well Platform or Pump House

The construction of well platform or pump house shall be such that this will drain away from the well by gravity.

5.23.7 **Pumping Equipment**

The design, installation and construction of pumps shall be such that they will not permit the entrance of any contaminating material into the well or water supply system. The pump shall be accessible for inspection, maintenance and repair.

Relevant Appendices:-

Appendix – 8.5.A Application for Permit to Construct Water Supply and Distribution System
Appendix – 8.5.B Completion Certificate (Water Supply Works)
Appendix – 8.5.C Sizing of Cold Water Supply and Distribution Piping
Appendix – 8.5.D Recommended Water Quality for Domestic Purposes.