CHAPTER 20

DRINKING WATER SYSTEMS

Drinking water systems provide either chilled or ambient temperature water used only for drinking purposes. This chapter describes the drinking water systems, selection of components, design criteria and the piping distribution system used to supply and distribute chilled water to all units of the system.

CODES AND STANDARDS

1. Americans With Disabilities Act. (ADA) Accessibility of all drinking fountain types.
2. ANSI/NSF 61. Testing criteria recommendations for the Clean Drinking Water Act.
3. ASHRE Standard 18. Ratings and test methods.
4. American Refrigeration Institute (ARI) Standard 1010. Standard rating conditions.
5. American Refrigeration Institute (ARI) Standard 1020. Standard Rating Criteria
6. Clean Drinking Water Act. Contaminant levels for potable water.
7. Applicable plumbing code that regulates the number of drinking fountains.
8. Federal Specifications for government agency projects.

SYSTEM COMPONENTS

Drinking Water Fixtures

Bottled Water Unit. Bottled water units are not considered plumbing fixtures because they have no connection to any plumbing system. These units are completely self contained and do not require a piped water supply or a drain. Water is supplied from bottles, generally containing 5 gallons of water, that must be replaced when empty. Water is discharged from faucets and dispensed into cups because there is not enough pressure to use a spout. Spills are contained in a receptacle on the unit under the faucet and must be emptied when full. If not emptied, the water overflowing the spill receptacle will spill onto the floor. If electricity is available, the water could be cooled or heated.

Drinking Fountains. (DF) Drinking fountains are considered plumbing fixtures and are directly connected to plumbing potable water and drainage systems. Water to the unit is supplied either from a remote, central chilled water unit, adjacent chiller unit for a single fixture only or ambient temperature water from the potable cold water system in the facility. Water is dispensed under pressure through a bubbler or spout and does not require a cup to drink from. Excess water not consumed is piped direct to the sanitary drainage system. Pedestal units are used for isolated outdoor use; the non-freeze type is used where freezing is a possibility.

Electric Water Cooler. (EWC) An electric water cooler is a completely self contained plumbing fixture consisting of an integral, directly connected drinking fountain and water chilling unit serving only this unit. These units are supplied with pressurized ambient temperature water, which is chilled by the self contained refrigeration unit. Water is dispensed under pressure through a bubbler or spout and does not require a cup to drink from. Excess water not consumed is discharged directly into the sanitary drainage system generally through a coil that additionally cools the incoming water.

If a refrigeration unit is intended to serve more than one DF, a maximum of 10 ft distance from the unit is recommended.

Drinking Water Fixture Accessories

There are many different accessories and components that can be provided for many models of drinking fountains.

1. Bubblers of many different configurations are available
2. Glass fillers
3. Hot water supply
4. Different filters for removal of various contaminants
5. Foot pedal control

Central Water Chiller Assembly

The central chilled water assembly is a mechanical refrigeration unit specifically designed to chill incoming water and distribute the chilled water to multiple drinking fountains. It consists of a compressor and condenser only used with the refrigeration cycle of the cooling medium, and an evaporator, which is the device that actually removes the heat from the cold water supply.

The *central chilling unit assembly* consists of a *compressor and condenser,* converting the cooling medium, which is usually R-20, from liquid to vapor states. The condenser can be cooled either with building chilled water or air.

The evaporator is a heat exchanger that uses the vapor state of coolant and is actually the device that produces the chilled drinking water by drawing out the heat of the water inlet to convert the cooling medium from vapor back to liquid. The evaporator could either be remotely located or installed in the drinking water storage tank.

A storage tank is necessary to even out fluctuations in demand that might cause chiller overloading short cycling of the chiller and to keep the size of the chiller unit to a minimum while providing the capacity to adequately supply the facility with enough chilled drinking water.

A recirculation pump is necessary to keep the chilled water at the lowest possible temperature by continuously cooled the water in the piping as it gains temperature in the piping network.

Filters on the water supply to the chilled water unit may be necessary if there are objectionable particulates in the water supply.

System controls usually are freeze protection cutouts, high and low pressure controls, and a thermostatic control to stop the compressor when there is no flow through the chilling unit.

Chilled water distribution piping is insulated to prevent heat gain and condensation. Refer to Chap. 5 for appropriate selection of insulation.

DRINKING FOUNTAIN INSTALLATION

Individual drinking fountains are capable of being mounted in many ways depending on the requirements of the facility and the availability of a pipe space or recess. These are illustrated in Fig. 20.1. In many cases, provisions for handicapped persons

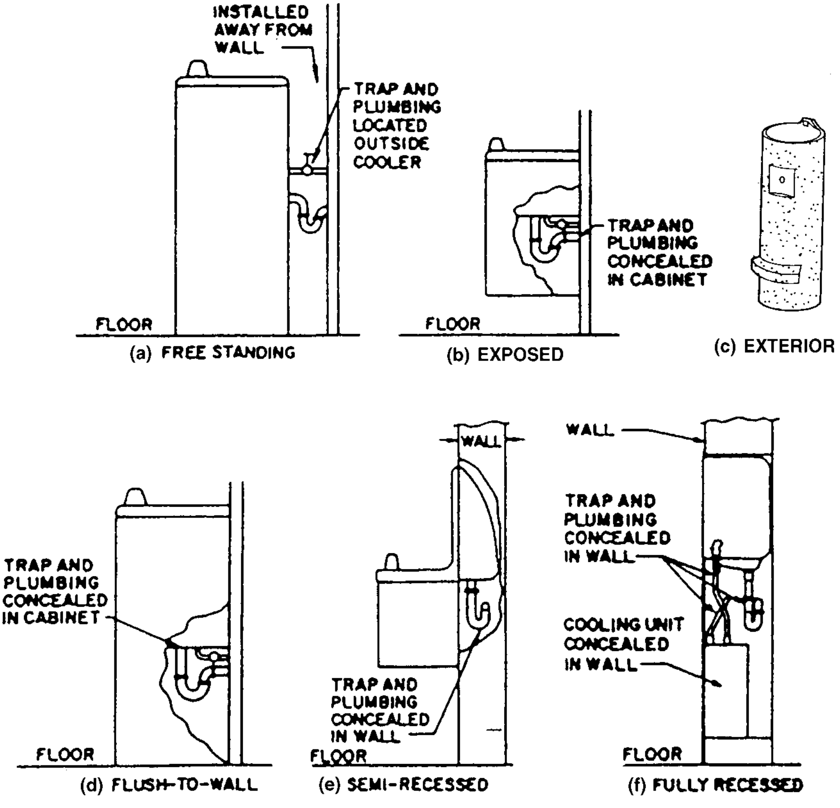

FIGURE 20.1 Types of installation for drinking water fountains.

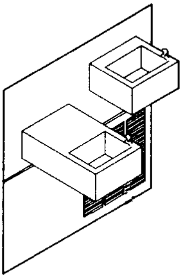

FIGURE 20.2 Dual drinking fountains

or children will require that drinking fountains be installed next to each other with one being mounted lower that the other. Such an installation is shown in Fig. 20.2.

SYSTEM DESIGN

Number of Drinking Fountains Required

The first step is to determine the minimum number of drinking fountains required for the specific facility. The applicable plumbing code generally has requirements for the minimum number of DFs required based on the amount of people served and the facility type. Very often, convenience for building occupants will dictate additional drinking fountains. The following information has been compiled from various code sources.

1. Places of assembly range from 1 DF for each 200 to 1000 people.
2. Educational and institutional facilities require 1 DF per 100 people.
3. Factories require 1 DF per 75 people.
4. Mercantile and residential facilities require 1 DF per 1000 people.

Types of Drinking Fountains Available

1. For normal temperature ranges, an air cooled EWC it the most economical choice.
2. If very high ambient temperatures are expected, and where excessive dust is present, a water cooled model EWC is recommended.
3. Where there is a possibility of explosive atmospheres and dust, select a hazardous duty model EWC.
4. For potentially corrosive atmospheres, a corrosion protected model will be necessary.
5. Determine from the client if any special features, such as glass fillers, refrigeration space or hot water capability is requested.
6. Determine requirements for children and ADA compliant fixtures. This is usually done by an architect, but advise if deficient.

Available Location and Space for DF Installation

1. Is there enough space to install any specific type based on available room in corridors, pipe spaces and recesses?
2. Where in the facility will the DFs be located? Will they be one above the other or widely separated?
3. Are domestic water, drainage and electricity available?

System Space Requirements

1. Is space available for installation of a central chiller unit in a conveniently located Mechanical Equipment Room?
2. Free standing units require about 18 in (460 mm) square, with a recess of 30 in (760 mm) wide by 24 in (600 mm) deep.
3. The chiller pack for an EWC requires a recess under the unit of about 24 in (600 mm) square and 9 in (230 mm) deep. The recess for the DF itself varies with the model selected.

Storage Tank Sizing

The storage tank is normally sized for one half of the calculated system hourly demand. For example, if a 100 gph (380 L/h) demand is calculated, a 50 gallon (190 L) tank would be selected. Use a standard size tank from the manufacturer.

PIPE AND INSULATION SIZING AND SELECTION

Central System Pipe Material

The most often used piping is copper water tube, conforming to ASTM B88 and soldered joints.

Central System Insulation

Fiberglass insulation with a vapor barrier and a recommended thickness of 1 in (25 mm) is used to keep the heat gain to a minimum and also to prevent condensation. The minimum thickness to prevent condensation is found in Table 5.1 but the 1 in (25 mm) thick insulation is used for economic reasons. Refer to Table 20.6 for the heat gain from copper pipe with 1 in (25 mm) insulation.

SYSTEM AND COMPONENT SIZING

General Criteria

The standard used by manufacturers for the capacity of chilled water produced from a single EWC is based on ARI standard 1010. This standard uses an inlet water temperature of 80°F (27°C) a discharge water temperature of 50°F (10°C) and the DF installed in an area with an ambient temperature of 90°F (35°C). Table 20.1 lists standard rating conditions for a variety of installations. If any conditions are different, use Table 20.2 to determine a factor that will calculate the flow at those nonstandard conditions.

Tests have shown that water at 50°F (10°C) is considered too cold by most people tested, and the flavor buds of the tongue are numbed by the cold. Based on this study, a higher temperature of discharged water will not be considered as detrimental.

When using unit capacity tables, it is up to the design engineer to determine which condition is applicable before deciding on the criteria to be used for unit capacity sizing.

The distribution pipe for a central project is a looped header originating at the chiller, serving all of the drinking fountains and returning to the chiller.

TABLE 20.1 Standard Rating Conditions

	Temperature, F (°C)				
Type of cooler	Ambient	Inlet water	Cooled water	Heated potable water*	Spill, %
Bottle types	90 (32.2)	90 (32.2)	50 (10)	165 (73.9)	None
Pressure types					
Utilizing precooler (bubbler service)	90 (32.2)	80 (26.7)	50 (10)	165 (73.9)	60
Not utilizing precooler	90 (32.2)	80 (26.7)	50 (10)	165 (73.9)	None
Compartment-type coolers	During the Standard Capacity Test, there shall be no melting of ice in the refrigerated compartment, nor shall the average temperature exceed 46 F (7.8°C).				

Note: For water-cooled condenser *water coolers* the established flow of water through the condenser shall not exceed 2.5 times the Base Rate Capacity and the outlet condenser water temperature shall not exceed 130 F (54.4°C) Base Rate Capacity of a pressure water cooler having a precooler is the quantity of water cooled in one hour, expressed in gallons per hour, at the Standard Rating Condition, with 100% diversion of spill from the precooler.

* This temperature shall be referred to as the Standard Rating Temperature (Heating).

Source: Reprinted by permission from ARI Standard 1010.

TABLE 20.2 Factor for Determining Drinking Fountain Capacity for Non Standard Conditions

	G.P.H. of 50° drinking water at various temperatures and water inlet temperatures.											
Factor	1.58	1.15	0.84	1.53	1.08	0.80	1.40	1.00	0.75	1.25	0.92	0.65
Room Temprature °F	70	70	70	80	80	80	90	90	90	100	100	100
Water Inlet Temperature °F	70	80	90	70	80	90	70	80	90	70	80	90

Example: Water Cooler size—8.9 G.P.H. (at Standard rating 90°–80°). Desired condition—Ambient 80°F, water inlet 70°F. Estimated capacity = factor × G.P.H. (rated).

= 1.53 × 8.9

= 13.6 GPH

The maximum recommended velocity for circulating water is approximately 3 ft per minute (FPM) or 1 meter per minute (1 m/min).

The friction loss through the piping should be limited to approximately 10 ft (3 m) of head for each 100 ft (33 m) of pipe.

Dead end piping should be limited to approximately 10 ft (3 m) in length.

The maximum recommended pressure for any system is 125 psig (870 kPa). If more than this, a second zone should be established.

Individual Unit Sizing Criteria

The primary criteria in the sizing process, whether individual EWCs or a central system, is the number of persons served either at a specific location or by the entire system. Table 20.3 is the recommended number of persons served per gallon (liter) of water from a single DF. This table is used by determining the number of people served by the unit and dividing the figure in the table by the number of people served. The answer will give the capacity for the unit.

Another often used table often found in manufacturers' literature is Table 20.4, which is the number of persons served per hour by a unit.

There is a wide discrepancy between information for offices, schools and hospitals found in Tables 20.3 and 20.4. The use of Table 20.3 will generally result in

TABLE 20.3 Drinking Water Requirements (Based on Standard Rating Conditions)

	Bubbler service	Cup service	
Location	Persons served per gallon (litre) of standard rating capacity	Persons served per gallon (litre) of base rate capacity	
Offices	12 (3)	30 (8)	
Hospitals	12 (3)	—	
Schools	12 (3)	—	
Light manufacturing	7 (2)	—	
Heavy manufacturing	5 (2)	—	
Hot heavy manufacturing	4 (2)	—	
Restaurants		10 (3)	
Cafeterias		12 (3)	
Hotel	0.08 (0.02) per room		
		Required rate capacity per bubbler gph (L/h)	
		One bubbler	Two or more bubblers
Retail stores, hotel lobbies, office building lobbies	12 (3)	5 (20)	5 (20)
Public assembly halls, amusement parks, fairs, etc.	100 (26)	20 to 25 (80 to 100)	15 (60)
Theaters	19 (5)	10 (40)	7.5 (30)

Source: Reprint by permission from ARI Standard 1010.

TABLE 20.4 Number of Persons Served per Hour

Installation	Standard rating bubbler service*	Installation	Standard rating bubbler service*
Offices	25	Light Mfg.	15
Hospitals	25	Heavy Mfg.	12
Schools	25	Hot Heavy Mfg.	10

* Based on Standard Rating Conditions of ARI Standard 1010.
IRA Standard 1020.

one half the size unit that results from the use of Table 20.4. Experience has shown that a value of between 5 and 8 gallons (19 and 30 L) per hour for average conditions is sufficient for DFs found in these areas.

Individual fluid requirements for various work loads given in Table 20.5 should be compared to information found in Tables 20.3 and 20.4 and used if necessary. Sufficient unit capacity should be allowed for the required amount of water replenishment provided at the unit based on the number of people the unit is serving.

Individual Unit Selection

1. Determine the number of units required from where shown on the plans, required from the code or from the architect.
2. Determine the ambient environment in which the units will be installed.
3. Find the specific area where the installation will be made to see if there is water, drain and space necessary for the style of unit to be installed.
4. Determine children or ADA requirements (for mounting height).
5. Size the refrigeration requirements for individual units based on Tables 20.3, 20.4 and 20.5 using judgment as to the various conditions encountered.

Central Water Chiller Sizing

1. Calculate or obtain the total number of DFs.
2. Determine a single fountain usage by using Tables 20.3, 20.4 and 20.5, as applicable, to find the number of gallons per hour required for one unit.

TABLE 20.5 Individual Fluid Replenishment for Heavy Work

Work load	Amount prior to task	Amount during task	Amount at the end of the task
Light	8 oz	As needed	8 oz
Moderate	8 oz	8 oz/60 min	8 oz
Heavy	8 oz	8 oz/30 min	8 oz

1 oz = L.

3. Calculate the total water usage (make up) for all units served by the central chiller by multiplying the figure found in step 1 by the figure calculated in step 2.
4. Calculate a portion of the chiller cooling load, in BTUs, necessary to cool the make up water for drinking purposes found in step 3. First, select the inlet water temperature. Next, use Table 20.6 by entering with the water temperature and read the make up heat gain in BTU/h per gallon (W/h/L) for each 100 ft (30 m) of pipe.
5. Select a preliminary size for the distribution loop header. The size will be selected to reduce the friction loss in order to keep the circulation pump horsepower as low as possible. A general starting point is generally a 1 in (DN 100) size line. This is an iterative procedure to find the final pipe size.
6. Calculate the capacity of the chilled water circulation pump. First, select the gpm of the pump. This is accomplished using Table 20.7. Entering the table with the pipe size found in step 5 and ambient room temperature, find the gpm required to limit the heat loss from the pipe to 5° F (2.8° C) at the intersection of the two figures. The actual pump selection must overcome the friction loss of the flow in the distribution loop using the GPH (LPH) and can be obtained from Fig. 9.28 or other standard engineering text. Selecting the size is an iterative procedure using manufacturers pump curves to select a cost efficient pump.
7. Calculate the heat gain from the piping distribution system by using Table 20.8. Entering with the pipe size and ambient room temperature, read the BTU (W)

TABLE 20.6 Make Up Water Chiller Cooling Requirements

	Btu/h per gallon (W/L) cooled to 45 F (7.2°C)					
Water inlet temp. F (°C)	65 (18.3)	70 (21.1)	75 (23.9)	80 (26.7)	85 (29.4)	90 (32.2)
Btu/gal	167 (13)	208 (17)	250 (20)	291 (23)	333 (27)	374 (30)

TABLE 20.7 Circulating Pump Capacity

Gph per 100 ft (L/h per 30 m) of pipe including all branch lines necessary too circulate to limit temperature rise to 5 deg F (2.8°C) [water at 45 F (7.2°C)]

Pipe size	Room temperature, F (°C)		
in. DN	70 (21.1)	80 (26.7)	90 (32.2)
½ (15)	8.0 (99)	11.1 (138)	14.3 (177)
¾ (20)	8.4 (104)	11.8 (146)	15.2 (188)
1 (25)	9.1 (113)	12.8 (159)	16.5 (205)
1¼ (32)	10.4 (129)	14.6 (181)	18.7 (232)
1½ (40)	11.2 (139)	15.7 (195)	20.2 (250)

Add 20% for safety factor. For pump head figure longest branch only. Install pump on the return line to discharge into the cooling unit. Makeup connection should be between the pump and the cooling unit.

TABLE 20.8 Heat Gain from Copper Pipe with 1 in Fiberglass Insulation

Pipe size		Btu/h per ft per deg F (W·°C/m)	Btu/h per 100 ft (watt per 100 m) [45 F (7.2°C) circulating water]		
			Room temperature, F (°C)		
in.	DN		70 (21.1)	80 (26.7)	90 (32.2)
½	15	0.110 (0.190)	280 (269)	390 (374)	500 (480)
¾	20	0.119 (0.206)	300 (288)	420 (403)	540 (518)
1	25	0.139 (0.240)	350 (336)	490 (470)	630 (605)
1¼	32	0.155 (0.268)	390 (374)	550 (528)	700 (672)
1½	40	0.174 (0.301)	440 (422)	610 (586)	790 (758)
2	50	0.200 (0.346)	500 (480)	700 (672)	900 (864)
2½	65	0.228 (0.394)	570 (547)	800 (768)	1030 (989)
3	80	0.269 (0.465)	680 (653)	940 (902)	1210 (1162)

TABLE 20.9 Circulating Pump Heat Input

Motor Hp (kW)	¼ (0.19)	⅓ (0.25)	½ (0.37)	¾ (0.56)	1 (0.75)
Btu/h (W)	636 (186)	850 (249)	1272 (373)	1908 (559)	2545 (746)

per hour heat gain. To calculate the total heat loss from the pipe distribution system, use the total measured feet (m) run of piping, in increments of 100 ft (30 m), by the heat loss value found in Table 20.8.

8. Calculate the heat generated by the circulating pump that must be made up. Use Table 20.9 entering with the circulating pump horsepower from the size selected in step 6.
9. Heat gain from the chilled water storage tank; 1½ in fiberglass insulation is usually selected. This thickness has a conductivity of 0.13 BTU/ft2 (0.4 W/M2). Since the tanks vary in size, obtain the area of the tank from the manufacturer.
10. The actual central chiller size in BTU (W) is calculated by adding the results of steps 4, 7, 8 and 9. Add an additional 10% as a safety factor.

REFERENCES

ASPE Data Book Chapter 27, Water Coolers, 1994.
American Refrigeration Institute Standards.

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Elkay Manufacturing Company
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