CHILLED-WATER DISTRIBUTION

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1. GENERAL

1.01 This section discusses and provides standards for chilled water. These standards are provided for use in the design of new buildings or building additions that are intended to house telephone equipment that meets the requirements of Section 800-610-164, "New Equipment-Building System (NEBS), General Equipment Requirements."

1.02 This section is reissued to remove polyvinyl chloride (PVC) from the list of acceptable pipe materials for use in telephone equipment buildings.

2. SCOPE

2.01 The distribution of chilled water to remote equipment cooling units (process coolers) has been shown to be a practical and thoroughly reliable means of providing conditioned air to the newer high-heat central office equipment. A typical chilled-water system consists of: (1) a temperature control system, with controls and other apparatus on the water side of the process coolers; (2) a distribution system of pumps, pipes, valves, fittings, and insulation; and (3) a moisture removal system of collectors and drains. This section presents information pertinent to the distribution system and the moisture removal system.

2.02 Electronic components in central offices are particularly vulnerable to water damage. Therefore chilled-water systems must be designed, built, and maintained to be totally leakproof. This is feasible and practical with present technology. A survey of 34 instances of water damage to telephone equipment revealed that only 4 were related to chilled-water systems and none occurred in the distribution pipes. The few features occurred at process coolers, which were suspended from ceiling mounts. For this reason, process coolers should never be positioned over telephone equipment.

2.03 The typical chilled-water cooling system is characterized by relatively low operating pressures, moderate temperatures, and mild pressure and temperature transients. Because of this, the mechanical and thermal stresses on such a system are usually low. Standards to follow in the design, construction, and maintenance of a chilled-water system are provided in Part 12 of this section.

2.04 Provisions must be made to remove air from the system either manually or automatically with vents at system high points as needed.

3. PIPING MATERIALS

3.01 Chilled-water piping should have excellent corrosion resisting properties. The fluid lines must be insulated to prevent the formation of condensate and to minimize heat loss. The generally accepted materials for chilled-water pipes include "black iron" steel and copper. Polyvinyl chloride (PVC) is also rated for use in chilled water systems but is not recommended for telephone switching equipment room applications. Local conditions govern the choice of which material to use in a new system—the water supply, relative costs, and the capabilities of available contractors and craftspersons. All of the system must meet local and federal building codes.

3.02 "Black iron" pipe, either American Society of Testing Materials (ASTM) A120 or A53, is a black or hot-dipped, galvanized, welded or seamless steel pipe, relatively economical and reasonably resistant to corrosion. It has been used successfully for many years and can be installed by most experienced contractors and craftspersons. Type ASTM A120 is the most common and the most economical. As an example, combined material and installation costs are 70 percent lower than those for copper pipe. Type ASTM A53 is 20 to 40 percent more expensive than A120. Table A shows comparative costs for chilled-water pipe of various materials, normalized with respect to ASTM A120. Of course, costs may vary with geographic location.

3.03 While more expensive than iron pipe, copper pipe is, by comparison, relatively more resistant to corrosion, lighter, easier to form and bend, and easier to fabricate into smooth joints.

3.04 Polyvinyl chloride pipe, the newest of piping materials, is relatively more resilient and, hence, has an inherent resistance to shock, vibration, and surges. It requires less insulation, resists corrosion, is very easy to handle and install because of its light weight, and costs less than iron or copper pipe. Compared with metal pipe, PVC pipe has a high rate of thermal expansion, but this is not significant in the mild environment of a chilled-water cooling system. At the present time service life experiences with PVC in chilled water systems are limited and reliability is not as well established as for the metals.

3.05 Composite double-walled piping such as RIC-WIL HI-GARD is available. This pipe consists of a pipe-within-a-pipe assembly with insulation between the outer and inner pipes. Installed costs of such piping are approximately 77 percent greater than ASTM A120 steel pipe. (See Table A.) However, the built-in insulation and the use of the outer pipe to contain leaks are unique advantages that may justify the cost in some installations.

3.06 All material covering insulation or facings, vapor barrier joints, sealing tapes, mastic and fittings shall comply with UL fire hazard classifications for pipe and equipment coverings in accordance with ASTM E-84 (FS-25, FC-50, SD-50).

4. HORIZONTAL SYSTEMS

4.01 A view of a typical horizontal chilled-water system is shown in Fig. 1. The chilling unit is located on the same floor as the telephone equipment; it may be a self-contained unit or it

TABLE A

NORMALIZED COSTS FOR PIPING AND CONDUITS*

TYPE OF MATERIAL	PIPE	INSULATION	INSTALLATION	TOTAL
Steel (ASTM A120)	1.00	1.00	1.00	1.00
Steel (galvanized)	1.43	1.00	1.00	1.10
Wrought iron	2.28	1.00	1.00	1.31
Copper (type L)	4.46	1.00	0.82	1.46
Prefabricated jacketed pipe; double wall including insulation (RIC-WIL HI-GARD)	4.00	—	1.67	1.77‡

* In dollars relative to ASTM A120.

‡ Includes drainage protection features.

may be refrigerated by a central unit located elsewhere. Horizontal pipes lead from the chiller to horizontally arranged process coolers.

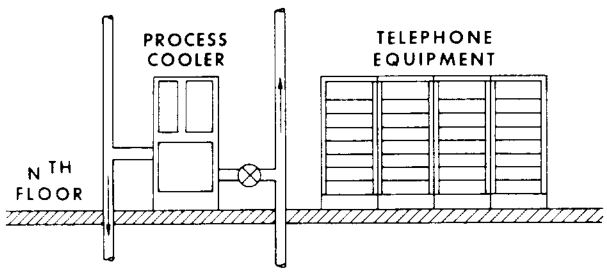

Fig. 1—Horizontal System—Process Cooler Fed by Chiller on Same Floor

4.02 Horizontal systems are characterized by relatively low pressures, since each chiller is on the same level as the cooling equipment. Although the probability of leakage is thus minimized, leaks can occur at points along the horizontal pipes. Precautions should be taken, therefore, to prevent moisture from reaching telephone equipment.

5. VERTICAL SYSTEMS

5.01 The layout of a chilled-water system depends primarily on the location of the water chillers and secondarily on the location of the process coolers in the equipment rooms. In large buildings, the chilled-water system may be arranged either vertically or horizontally. Figure 2 shows the arrangement of a vertical chilled-water distribution system in a multistoried central office. This system eliminates the need for horizontal pipes to the process coolers. Vertically arranged process coolers are fed by vertical water lines from a chilled unit that may be located in the basement, on the roof, or in a mechanical equipment room on some other level.

6. JOINT AND FITTING RELIABILITY

6.01 A system is only as reliable as its joints and fittings. The possibility of leakage increases directly with the number of joints in a system; it is good practice, therefore, to minimize the number of joints. To meet the requirement of central office performance, the reliability of joints should be so high that each joint will be virtually as leakproof as the pipe itself.

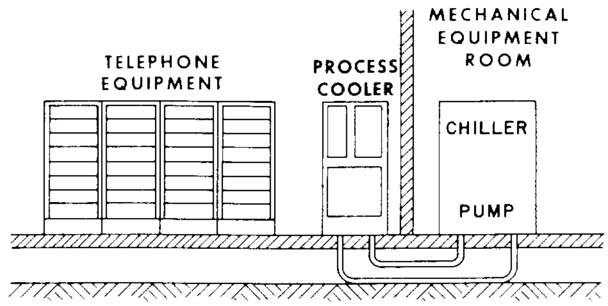

Fig. 2—Vertical System—Process Coolers on Each Floor, All Fed by a Single Chiller

6.02 Techniques for making reliable joints have been developed. Surfaces at the joints in copper tubes should be cleaned before flux is applied; "self-cleaning" acid fluxes should not be used because of their lack of uniform effectiveness and their extreme corrosive action. Specifications for soldered copper joints and standards for pipe fittings are summarized in Tables B and C, respectively.

6.03 "Quick" Disconnect (QD) fittings may be convenient and reliable in some applications. Such fittings typically use static seals of elastomer compounds. Elastomers are subject to aging and change in stiffness over relatively short periods of time, becoming potential causes of leaks. Therefore, where QDs are used, hand valves should also be provided to permit access to the QDs for periodic maintenance.

6.04 All welded joints and fittings shall meet the applicable AWS specifications.

7. DESIGN CONSIDERATIONS

7.01 Although the stresses on a chilled-water system usually are minimal, precautions should be taken to guarantee that they remain minimal. Mechanical stresses to which a system may be subjected include external shock and vibration developed by pumps, for example, and internal shocks generated by pressure transients in the system. Pumps and other vibration-generating apparatus, therefore, need to be mounted so as to minimize such stresses, and pipes and supports

TABLE B

RECOMMENDED INTERNAL WORKING PRESSURES FOR JOINTS IN COPPER TUBE SYSTEMS (TYPES K, L, AND M, 100°F OR LESS)

ALLOY USED FOR JOINTS	RATED WORKING PRESSURE OF JOINT (psi) FOR VARIOUS TUBE DIAMETERS				
	1/4 TO 1 INCH	1-1/4 TO 2 INCHES	2-1/2 TO 4 INCHES	5 TO 8 INCHES	10 TO 12 INCHES
95-5 Tin-antimony solder*	500	400	300	150	150
Silver alloy solders or brazing alloys (melting at or above 1000° F)		Same as rated internal pressure of tube			

* As per ASTM B32.

TABLE C

APPLICABLE STANDARDS FOR FITTINGS AND VALVES

PRESSURE CLASS (psig)	ANSI STANDARD AND REVISION DATE
Drainage	B16.12 (1965), B16.23 (1960), B16.29 (1966)
25	B16.1 (1967)
125	B16.1 (1967), B16.4 (1963), B16.5 (1964)
150	B16.3 (1963), B16.24 (1962)
250	B16.1 (1967), B16.4 (1963), B16.15 (1964)

should have sufficient elasticity to absorb common external shocks. Quick-acting shutoff valves, which can subject the system to internal stresses, should not be used. Pressure transients are relatively suppressed in nonmetallic pipes.

7.02 Thermal stresses in chilled-water pipes are not appreciable, and the effect they might have on the system can be minimized at the time of installation. The installation should be made with proper care, loop expansion joints should be used, and the pipes and supports selected should be reasonably flexible.

7.03 Despite quality-control efforts and the relatively mild conditions under which a chilled-water system operates, leaks are possible. Building engineers should acknowledge this and design the system to minimize the volume of leaking water that might occur. To do this, where possible, flow limiting devices should be used and pumps with the proper operating characteristics should be chosen. Pump performance should match the system requirements, with only a small margin for possible system degradation.

7.04 Leak-detection devices are available, but a survey has shown that none are readily applicable to the needs of a central office.

8. EARTHQUAKE AREA DESIGN CONSIDERATIONS

8.01 Flow limits should always be used in systems located in areas where earthquakes are likely to occur. These devices act like hydraulic fuses—they shut off or limit flow when a downstream leak occurs. As with any other system component, however, flow limiters increase system pressure drop, add two more joints, and add one more possibility of mechanical failure to the system.

9. ACCEPTANCE TESTS

9.01 Chilled-water distribution systems differ from other high-quality industrial piping systems in that the emphasis is on high reliability at moderate pressures rather than on the ability to withstand high pressures. Acceptance tests of chilled-water systems are designed accordingly.

9.02 All sizes of the metal pipes recommended, "black iron" steel and type L or M copper, are able to withstand the maximum pressures to be expected in a chilled-water system.

9.03 The fluid system should be hydrostatically tested at 1.5 times the maximum working pressure. One test method is to bleed all air from the system using the working fluid, impose the required pressure and remove the pressure source. Any delay in pressure not accounted for by temperature change constitutes failure.

9.04 In small buildings, many components of chilled-water systems, such as heat exchangers and chilled-water tanks, are designed for relatively lower pressures. These components are to be bypassed during the acceptance tests.

10. MOISTURE REMOVAL

10.01 If a leak occurs, the chilled-water system must have associated with it some means of carrying escaping moisture safely away from telephone equipment areas. An adequate moisture removal system consists of collection pans under process coolers and adjacent fittings, with channels and pipes to remove the collected water.

10.02 The requirements for the components of a moisture removal system are less severe than those for the chilled-water cooling system. Any pipe that is relatively stable, crush-resistant, and corrosion-resistant is acceptable for moisture removal. PVC pipes are especially useful, because they usually need not be insulated and can be constructed of transparent material, which permits easy inspection.

10.03 Drains should be large enough to carry the flow of any catastrophic leak safely away from exposed electronic equipment. They should be capable of being inspected easily. The appropriate sizes of vertical leakage drain tubes, horizontal leakage drain tubes, and horizontal leakage drain channels can be found in Fig. 3 for chilled-water systems of various capacities.

10.04 Horizontal drain channels used in other applications to remove condensate can be used in conjunction with chilled-water cooling systems to remove leakage as well. Chilled-water pipes may be located directly above the channels. Available sizes of channels placed below the waterline and pitched 1 inch in 10 feet can be found from the curve in Fig. 3. The assumed leakage flow rate is that of the design flow to a process cooler.

10.05 If condensation drains are not pitched as noted above, the drain system shall be sized to provide a 50 percent larger capacity.

11. REFERENCES

1. Section 760-510-151—Piping—Exposed and Concealed

2. Section 760-550-200—Engineering Guide for Ventilation and Air Conditioning—Purpose and Scope

3. Section 760-550-208—Engineering Guide for Ventilation and Air Conditioning—Design Parameters

4. Section 760-550-260—Engineering Guide for Ventilation and Air Conditioning—Standard Detail Drawings

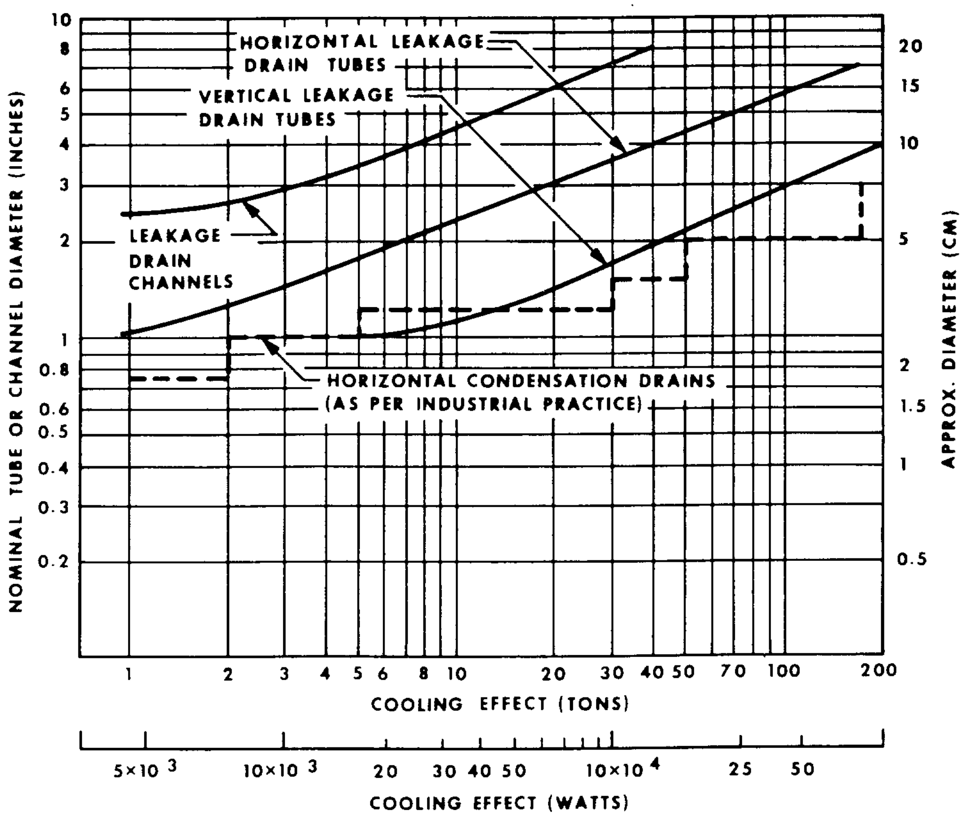

Fig. 3—Recommended Drain Tubes and Channels for Process Coolers and Chillers

5. Section 760-620-151—Standpipe and Hose Systems

6. Section 770-230-300—Fundamental Principles of Water Conditioning

7. Section 770-230-301—Water Treatment—Air Conditioning Systems

8. ASHRAE Guide and Data Book—Systems 1973—American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., New York, 1973; Chapter 35

9. ASHRAE Guide and Data Book—Equipment 1972—American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., New York, 1972; Chapter 33

10. Sabin Crocker and Reno King—Piping Handbook McGraw-Hill Book Company, Inc., New York; Chapter 7

11. Copper Tube Handbook for Plumbing, Heating, Air Conditioning and Refrigeration—Copper Development Association, Inc., New York

12. Lee Kendrick—Design Manual for Heating, Ventilation and Air Conditioning with Coordinated Standard Details—Technical Standards Publications, Inc., Arlington, Virginia; page 15B-6

13. Lee Kendrick—Specification Manual for Heating, Ventilation, Air Conditioning and Plumbing—Technical Standards Publications, Inc., Arlington, Virginia; page 225

14. The Encyclopedia of Plastic Piping Systems—Plastic Piping Systems, Inc., Newark, New Jersey, 1972

15. M. F. Obreck and J. R. Myers—Potable Water Systems in Buildings: Deposit and Corrosion Problems—Heating/Piping/Air Conditioning, Volume 45, No. 5, pages 77-83, May 1973

12. CHILLED-WATER DISTRIBUTION STANDARDS

12.01 Locate chilled-water pipes or process coolers adjacent to or below, but not directly above, telephone equipment.

12.02 Place moisture-collection pans (or equivalent isolation) with drains under all process coolers and adjacent fittings.

12.03 For elevated or inaccessible process cooling units, provide two entrances from the drain pan to the condensation drain line.

12.04 Size moisture-removal passages in accordance with Fig. 3.

12.05 Use "black iron" steel (ASTM A120 or A53) or copper (ASTM B88-71, type L or M) for chilled-water piping.

12.06 Specify special preparation and treatment for PVC drain piping.

12.07 Size metal pipes to conform to the safe working pressure and temperature limits of the ASA codes. Check all applicable codes and regulations to determine the acceptable piping practices.

12.08 Reject pipe with surface defects more than one-third of the nominal wall thickness.

12.09 Test piping systems hydrostatically for 24 hours at 1.5 times maximum working pressure.

12.10 Do not use quick-acting shutoff valves in the fluid system.

12.11 Do not use QD fittings without adjoining valves.

12.12 Provide loops, expansion joints, and hangers to minimize line and interconnecting equipment stresses. In earthquake zones, particular attention to loops and expansion joints is required to ensure that provisions are made for relative movement between subsystems as appropriate to the particular region.