Table 2 .... Thermal Linear Expansion of Copper Tubing and Steel Pipe

(Inches per 100 ft)

Temp Range, F deg	Copper Tubing	Steel Pipe
0	0	0
50	0.56	0.37
100	1.12	0.76
150	1.69	1.15
200	2.27	1.55
250	2.85	1.96
300	3.45	2.38
350	4.05	2.81
400	4.65	3.25
450	5.27	3.70
500	5.89	4.15

NOTE: Above data are based on expansion from 0 F but are sufficiently accurate for all other temperature ranges.

head plug cock. If a globe valve is used as a balancing valve, the handle should be removed after adjustment to prevent accidental re-adjustment.

If low first cost is of prime importance, a single balancing valve may be used as both a balancing valve and a shutoff valve. However, the system must be re-balanced after each use of the valve.

Control Valves

Automatic control valves are used whenever automatic control of flow rate is desired. Both 2-way (throttling) and 3-way (bypass) valves are available. For most applications, a reduction in system water flow will not be objectionable, since the pump will operate at 5 percent flow with no damage, and the other control valves in the system will automatically compensate for the increased pressure in the system. However, a reduced flow rate, may result in chiller tube velocities below the minimum required to prevent freezing. In this application, three-way valves, or a single automatic bypass or relief valve across the supply and return mains should be used.

Automatic control valves are generally globe valves designed for throttling action.

Check Valves

Check valves are used to prevent reverse flow through part or all of a system. If a pump operates between two water levels in an open system, the water will drain through the pump on shutdown, and perhaps lose its prime if the pump is above the lowest water level. For example, a condenser may be located above the water level in a cooling tower basin and a check valve will prevent drainage of the condenser during shutdown. Or, if several pumps are installed in parallel, a check valve should be used on each pump to prevent water from bypassing through an idle pump when the others are in operation.

Swing check valves are the generally recommended type.

Strainers

Strainers should be used where necessary to protect the elements of a system. Centrifugal pumps will pass rather large objects and it is not always necessary to protect the pump. Automatic control valves or spray nozzles, however, will quite frequently operate with small clearances and high seat velocities, and will be damaged or clogged by pipe scale, gravel, welding slag, etc. Generally one strainer at the pump suction (providing the pressure loss at this point will not cause pump cavitation) is recommended for jobs with automatic valves, although an isolated small valve remote from the pump may be provided with a separate strainer. An extreme example of this is the secondary water system of an induction unit or fan-coil unit system where each unit control valve is provided with a fine mesh strainer and the pump is also provided with a strainer to minimize the amount of trash which will collect in the small strainers and thus reduce their maintenance.

Y-type strainers with 20 mesh baskets are recommended for general service.

Condenser water systems without water regulating valves do not necessarily require a strainer. If a cooling tower is used, the strainer provided in the tower basin will generally be adequate.

Air Vents

Air vents must be provided to properly vent the system of air, both during initial filling and normal operation. Manual vents should be used where venting will be required only at initial filling or infrequent intervals. Automatic vents (float-type) should be used at all points where air will continually accumulate in the system. Air dissolved in water can be expected to accumulate as bubbles of air where the water stream reduces velocity, changes direction, or is heated. Automatic vents must be piped to plumbing drains if damage to the building or contents would result from sticking and subsequent leaking of the vent. An expansion tank is an excellent air vent, and it should be located at a natural vent point in the system.

Provision for Dismantling

Unions or flanged connections should be used at all equipment which may need to be removed from the piping system. Ground joint unions are used with screwed steel pipe. Flanged unions are used with welded steel and large copper pipe.

Flexible Connectors

Flexible connectors are sometimes installed at pumps and machinery to reduce pipe vibration. It should be noted that vibrations are transmitted through the water column across a flexible connection, and thus reduce the effectiveness at the connector. Flexible connectors are, however, effective in preventing damage due to misalignment of equipment piping flanges.

Thermometers

Thermometers or thermometer wells should be installed to assist the system operator on routine operation and trouble-shooting. Permanent thermometers of correct scale range and with separable sockets should be used at all points where temperature readings are regularly needed. Thermometer wells should be installed where readings will be needed only during start-up and infrequent trouble-shooting.

Gages

Gage cocks should be installed at points where pressure readings will be required. It should be remembered that gages installed permanently in the system will deteriorate due to vibration and pulsation and will not be reliable for use when needed. For this reason, gages should be removed from the system except when readings are being taken. Good practice is to install gage cocks and provide the operator with several good quality gages for trouble-shooting.

Expansion of Piping

Consideration should be given to expansion and contraction of piping due to temperature changes. Table 2 gives thermal expansion data.[3] Small amounts (up to 1 in.) of expansion can frequently be absorbed by the offsets normally

Table 3 .... Recommended Support Spacing for Schedule 40 Pipe

Nominal Pipe Size (in.)	Distance Between Supports (ft)
¾–1¼	8
1½–2½	10
3 –3½	12
4 – 6	14
8 –12	16
14–24	20

required for installation. If long runs (200 ft) with no offsets or large temperature variations (100 F deg) will occur, additional provision should be made to prevent damage to piping or building. Bellows-type expansion joints should be located to permit inspection and possible replacement. Slip-type joints require inspection and periodic adjustment. Loop-type joints require considerably more space, but are free from maintenance.

Pipe Hangers

Hangers or supports are required at frequent intervals depending upon pipe size. Tables 3 and 4 give recommended hanger spacing.[2]

Split-ring type hangers are recommended for pipe 2½ in. and smaller. Clevis-type hangers are recommended for piping 3 in. and larger. Roll-type hangers are used if substantial pipe movement will occur from expansion and contraction.

Vibration isolation may be provided by means of spring or rubber-in-shear isolator units in the hanger, although the degree of isolation required is beyond the scope of this text. If pumps are mounted on isolators, the first two hangers on the suction and discharge of the pump should be provided with isolators of at least equal deflection.

For further information on vibration isolation, see Chapter 14 of the 1961 Guide And Data Book.

Insulation

Provision must be made in the piping if insulation is to be applied. For chilled water service, insulation and vapor seal are run full-size through hangers and hangers are sized large enough to carry pipe and insulation. For hot water service where expansion of piping is not sufficient to require roller-type hangers, the hanger and pipe are the same size and are insulated together.

If piping weight is to be supported by the insulation, a sheet metal saddle must be provided to enlarge the bearing area of the hanger so that the insulation is not crushed between the pipe and hanger.

The thermometer wells and gage cocks must be provided with extensions to project beyond the surface of the insulation.

Drains

Condensate drains from dehumidifying coils should be trapped and piped to an open-sight plumbing drain. Trap should be sufficiently deep to overcome air pressure differential between drain inlet and room, which will ordinarily not exceed 2 in. of water. Pipe should be copper or galvanized steel, or should be insulated to prevent moisture condensation. Depending on quantity and temperature of condensate, plumbing drain lines may require insulation to prevent sweating.

Table 4 .... Recommended Support Spacing for Copper Tubing

Tube OD (in.)	Distance Between Supports (ft)
⅝	6
⅞–1⅛	8
1⅜–2⅛	10
2⅝–5⅛	12
6⅛–8⅛	14

Drains should be provided at pumps to handle gland leakage and at coils and heat exchangers if desired to facilitate servicing of equipment. Drains are required at low points of outdoor piping to permit draining during freezing weather.

Coil Freeze Protection

The return bend arrangement of ordinary serpentine chilled water coils usually prevents complete drainage of the coil when the drain and vent connections are opened. In the event of preheat coil failure or stratified air flow through the preheater, the water that remains in such coils can freeze and rupture the tubes. The possibility of such freeze-up can be reduced by installing caps which can be removed to blow air through the coils and thus force the water out of the coil, or by installing valved connections which can be used to circulate antifreeze through the coil after it has been valved off from the chilled water system and drained.

Sleeves

Sleeves are usually provided at points where piping passes through walls and floors. In finished areas, sleeves are fabricated by cutting a length of pipe of sufficiently large diameter for pipe and insulation to pass through. In unfinished areas, sleeves may be fabricated from sheet metal. Wall sleeves are generally flush with both sides of the wall. Floor sleeves in equipment rooms usually project several inches above the floor to prevent water leakage around the pipe in case of flooding.

Escutcheons may be installed where piping passes through walls in finished areas. They are generally made of chromium-plated brass.

Pump Suction Connections

The piping at the suction connection of a pump should be arranged to avoid air pockets as shown in Fig. 3.[3] If the suction pipe is above the pump, a vertical elbow the same size as the suction connection should be installed, and any pipe between this elbow and the pump suction should be maintained level. If the pump suction is from an open tank, the horizontal suction pipe may be larger than the pump connection, and an eccentric reducer (flat on top) should be installed at the pump connection.

Horizontal elbows should never be installed on the suction of a double-suction pump because the resulting nonuniform inlet water flow condition results in unequal loading of the two sides of the impeller and creates an unbalanced thrust condition.

Make-up and Fill Connections

Provision must be made for initially filling each system with water, and adding make-up water to replace evaporation, pump gland leakage, cooling tower evaporation, bleed, and drift losses. Codes generally govern the exact manner in which a city water system can be connected to a recirculating water system, and extreme care must be exercised to prevent