ATT-TP-76405
Technical Requirements For Supplemental Cooling Systems In Network Equipment Environments

This practice provides guidelines and requirements for engineering a supplemental cooling system for very high heat equipment environments in AT&T buildings.

Audience: All network, video, internet services, mobility, data center employees

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Related Documents:

ATT-TELCO-812-000-155, Next Generation Network Space: Design & Construction Guidelines

ATT-TP-76300/TP76301, AT&T Installation Guidelines

CRE-50-09-01-IOP-001, CRE Alarm Management Strategy

NFPA 70, National Electrical Code

Emerson Liebert Xtreme Density System, Design Manual
Download document from Emerson Liebert website
http://www.liebert.com/product_pages/ProductDocumentation.aspx?id=200&hz=60

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1. INTRODUCTION

This technical practice defines and establishes requirements for the design and installation of a very high heat density cooling system in AT&T equipment environments. A high density cooling system provides supplemental cooling capacity where required to accommodate high heat loads of equipment that cannot be handled with normal space cooling systems.

2. GENERAL

2.1 Description

2.1.1 To accommodate the greater heat density demands of current and future equipment technologies, a supplemental cooling design may be required beyond the traditional overhead ducted room cooling systems or perimeter Computer Room Air Conditioner (CRAC/CRAH) units. Heat densities approaching 15 KW per cabinet are being deployed with latest generation of products in AT&T equipment space. The higher heat densities become a challenge for traditional space cooling designs. The supplemental cooling designs discussed in this practice shall be deployed when equipment heat loads exceed traditional room cooling system capabilities.

2.1.2 The cooling system designs in this practice provide pumped refrigerant-based remote cooling units immediately adjacent to source of heat. The cooling units may be in-row units integrated into equipment lineups or be located overhead of equipment lineups.

2.1.3 In systems recommended by this standard, remote cooling units use a refrigerant loop to move heat from the equipment space to a pump unit with heat removal by chilled water or a remote condenser unit. A pump unit shall be placed away from equipment lineups and designed to pump liquid refrigerant to the remote cooling units. The refrigerant turns into gas as it absorbs heat within the heat exchangers of the remote units. The gaseous refrigerant is pumped back to the pumping unit where the heat is transferred to either the building chilled water system or air cooled condenser(s).
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2.1.4 The refrigerant used in these units becomes a harmless and non-ozone depleting gas if a leak should occur in the plumbing. Exposure to the gas will not harm electronic equipment or occupants in the room unless skin comes in direct contact with escaping gas resulting in frostbite.

2.1.5 Remote cooling units integrated in network equipment lineups or placed immediately above equipment lineups shall not use or contain water, liquid coolant, condensate drainage or require the removal of any of these fluids.

2.1.6 Some supplemental cooling systems (e.g., Liebert XD system) only provide sensible cooling. In cases where said units are deployed, the building central plant or CRAC/CRAH’s located in the equipment area shall be used to remove latent heat (e.g., humidity).

2.1.4 Cooling design must be used in conjunction with hot aisle/cold aisle equipment configuration as shown in **Figure 1**. Equipment framework shall be configured in continuous lineups with front-to-front and back-to-back layout. All efforts to reduce mixing between hot and cold aisles shall be made by use of blanking plates and equipment cooling airflow in front-to-back direction.

2.1.2 The deployment of remote cooling units will require close coordination between CRE and Network Engineers because cooling units are integrated into equipment lineups or placed overhead of equipment lineups.

3. DEPLOYMENT STRATEGY

3.1 Design Approach Network Equipment Space

3.1.1 In existing equipment buildings, space cooling is provided by overhead ducts and air handling equipment with actual building cooling capacity designed for 40 to 50 Watts per square foot. Using designed building cooling capacity, equipment heat density limits are extended to 100 Watts per square foot with cooling capacity from non-equipment space used to increase heat density in occupied space. Following AT&T planning guidelines for aisle space dimensions, frame footprint standards and heat density limits typically permits 850 Watts of heat load per frame. Heat load greater than 850 Watts in one frame requires added floor space for distributing heat across a larger floor footprint.

3.1.2 More recent equipment space, such as Next Generation Network (NGN) space, may have perimeter CRAC/CRAH units and cooling air distributed by a raised access floor and perforated floor panels. Heat density limits for these spaces may be extended above 100 Watts per square foot.

3.1.3 Preparing existing equipment space for even greater heat densities may be difficult or not possible due to inability to move cooling air to locations of high heat equipment. Overhead duct size and runs can be restricted by cable racks and cables over equipment frames. Air handling units may not have the capacity for added heat load.

3.1.4 Supplemental cooling systems may provide the only way towards higher heat density limits in existing equipment space. Extra cooling capacity applied to a specific space in the equipment room can be provided with remote cooling units. The cooling units are connected by refrigerant tubing that will occupy very little space and flexible enough to be routed around cable racks.

3.1.5 In general, heat loads above 4 KW per frame are difficult to cool using conventional space cooling techniques. Supplemental cooling methods may provide the additional capacity to handle these high heat loads. Precise cool air supply directed to equipment becomes key to cooling such concentrated heat loads.

3.1.6 Using supplemental cooling designs, heat density in equipment space should be viewed as total Watts per frame rather than Watts per square feet. Supplemental cooling designs provide cooling in localized area of high heat equipment. Two adjacent equipment frames housing equipment with total heat load of 20 KW can be served by a single remote cooling unit of 20 KW capacity. Locating remote cooling units should be planned for current and future heat loads of a lineup. Great care should be taken to lay out the electronic equipment with the air inlets and outlets designed to take full advantage of the alternating cold and hot aisle A/C design to maximize efficiency of heat removal.

3.1.7 CRE shall obtain permits for the installation of the pump unit, chiller and associated remote units for the ultimate installation planned for the space based on COLD Engineers ultimate forecast and equipment and cable racking layout. The CRE project manager/consultant in cooperation with the COLD Engineer shall select the specific type of remote unit required. CRE contractor shall install pump unit, chiller and remote units to meet either the minimum operational efficiency threshold (i.e., 20% for XDP or 40% for XDC) or the three year forecast whichever is greater. For subsequent remote cooling unit installations, CRE shall coordinate the installation of remote cooling units by their mechanical contractor and connect refrigerant lines to quick-connect ports in the header distribution assembly.

3.2 Primary Cooling

3.2.1 The building central air handler units (AHU) shall be used to provide 50 watts/sq.ft. of cooling of the planned space being considered for supplemental cooling. This is a practice that is being increasingly adopted by owners and operators of Data Centers and Telecommunications facilities due to its inherent energy saving and redundancy advantages. The use of building central air handlers allows for substantial energy savings through the use of outside air in the majority of AT&T’s territories. Furthermore, the availability of outside air provides an added level of redundancy in case of catastrophic failure of the refrigerant plant. The building central plant performs the function of removing latent heat and humidity control when used with supplemental cooling systems not possessing this capability.

3.2.2 In those cases where the building central air handlers are not available for primary cooling or use of outside air is limited by local conditions (e.g., high humidity), consideration should be given to the use of the supplemental cooling system as the primary sensible cooling for all equipment. The main advantage of this option is the gradual deployment of remote cooling unit capacity as equipment is installed and the matching of cooling capacity to the individual loads. The smaller fans in the remote cooling units use much less electric power to run than a number of constant volume CRAC/CRAH’s or AHU’s. Note that some nominal space cooling will have to be deployed to address latent heat loads if this option is deployed using the systems without ability to control room humidity. A very small cooling system air handler and overhead ducts or one updraft CRAC/CRAH unit can provide latent cooling for humidity control and other heat load in room.

3.2.3 Sites designed with raised access floors and perimeter CRAC/CRAH units for primary space cooling could consider the use of the pumped refrigerant based cooling system for the majority of sensible cooling load of network equipment, however there is always the need for a CRAC/CRAH unit(s) to control room humidity and general room heat. The CRAC/CRAH units will be sized for lower cooling capacity when used in that scenario.

3.2.4 Supplemental cooling design does not require raised access floors and can allow sharing of overhead space with cable management systems and cooling air ducts in the same space. Size of overhead ducts would not be required to be as large if some of the latent cooling load for equipment heat is handled by supplemental cooling systems. The scenario could be most beneficial when supplemental cooling systems are applied in legacy central office space.

3.3 Spot Cooling

3.3.1 Supplemental cooling designs are intended for applications where localized cooling is required for a lineup of very high heat products or an individual cabinet of very high heat. Heat loads per cabinet above 4KW should be considered very high heat and where supplemental cooling solutions would be utilized.

3.3.2 Remote cooling units of a supplemental cooling design permits placing additional cooling capacity directly where high heat load cabinets are located. The remote cooling units draw in air from the hot aisle, cools the air and discharges the cooled air into the cold aisle where it is drawn into the equipment cabinets.

3.3.3 Supplemental cooling is intended to be applied in addition to existing space cooling system of a room. For sites with overhead duct diffusers or under access floor air distribution, those diffusers or perforated floor panels should remain in place aided by the supplemental cooling units.

3.3.4 The remote cooling units should be placed within lineup or overhead of cabinets generating the greatest amount of heat. If heat loads are dispersed evenly throughout the lineup, the remote cooling units may need to be distributed across the lineup.

3.3.5 The remote cooling units in the Liebert XD system connect to a central refrigerant pump that removes heat from equipment space by way of the refrigerant loop.

3.3.6 Reduction of floor space use is another benefit with supplemental cooling because thermal management spacing of network equipment would not apply. Thermal management spacing rules are established to spread high heat equipment across a larger floor footprint to stay within heat density limits, usually 100 Watts/square feet. Supplemental cooling systems allow for higher heat density within each equipment cabinet than previously permitted.

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4. REFRIGERANT PUMPING UNIT

4.1 Chilled Water Refrigerant Pumping Unit

4.1.1 In buildings with available chilled water capacity for additional equipment heat load, the chilled water pumping unit is the most convenient and economical solution. The pumping unit interfaces between the building chilled water system and the remote cooling units. It circulates and controls refrigerant to the remote cooling units placed in network equipment lineups. The pumping unit contains a heat exchanger, redundant circulating pumps, control valve, receiver, controls, valves and piping. Each pumping unit is rated at 160KW (~45 Tons sensible cooling). **Note: Chilled water supplemental cooling systems such as Liebert XDP pumping units shall not be specified for spaces where the initial heat load is expected to be less than 32 KW (i.e., 20% of system nominal capacity) as the units will not run efficiently under these conditions.**

4.1.2 Once the COLD Engineer has completed the space allocation and forecasted equipment, the CRE D&C Project Manager and consultant shall designate the number and location of supplemental cooling system in said space. The pumping units shall be located against walls near building chilled water sources. Ideally, each unit shall be installed perpendicular to the cold aisle it is intended to support in order to minimize refrigerant pipe runs and bends. Additionally, 36 inches of maintenance access clearance shall be provided in front of each unit. CRE shall design and install supply and return pipes to each pumping unit tapped off of the closest chilled water lines, line sizes 2-5/8 inch diameter. Chilled water supply and chilled water return pipe connections enter at bottom left-rear of cabinet. The pumping unit may require a platform if supply and return pipes cannot be brought up through the building floor. Pressure drop across pumping unit will be 20 psig @ 140 gpm, control valve fully open.

4.1.3 Pumping units come equipped with a two-way chilled water control valve as standard. As such, a pressure activated bypass valve shall always be specified and installed by CRE when the units are added to constant volume (i.e., primary pumping only) chilled water systems in order to prevent dead-heading of the chilled water pump Also, chilled water temperature reset control method shall not be exercised in buildings using supplemental cooling units. Isolation valves shall be provided in supply and return pipes between the pumping unit and building chilled water headers.

4.1.4 Pumping unit cabinets shall be secured to the building floor slab with concrete expansion anchors in accordance to building code requirements. In high seismic risk locations, more robust anchoring requirements shall be required for resisting high ground motions. In high seismic risk locations, supply and return pipe connections shall be provided with flexible couplings to account building movement.

4.1.5 CRE engineering shall design and install power feeds for each pumping unit rated at either 460V/3ph/60Hz 2.1 Full Load Amps or 208V/3ph/60Hz, 4 Full Load Amps (depending on available building distribution panel (MCC) voltage rating).

4.1.6 Refrigerant supply and return lines routed to the remote units are located at the top center of the pumping unit, 1-1/8 inch diameter for supply and 2-1/8 inch diameter for return for runs up to 60 feet or 1-3/8 inch and 2-5/8 inch over 60 feet but less than 175 feet (equivalent pipe length).

4.2 Air Cooled Refrigerant Pumping Unit

4.2.1 In buildings where chilled water capacity or supply is not available, air or water-cooled refrigerant chiller units shall be installed. The refrigerant chiller units have two distinct circuits each utilizing different refrigerants and mechanical parts. The R-134a circuit is the pumped circuit between the network equipment remote cooling units and the chiller. The R-407c circuit is a dual direct expansion (DX) circuit connected to outdoor condenser. Either an air-cooled condenser or water/glycol condenser for colder climates is available to match each of these units . Each pumping unit is rated at 160KW, ~45 Tons sensible cooling. **Note: Air cooled supplemental cooling systems such as Liebert XDC units shall not be specified for spaces where the initial heat load is expected to be less than 64 KW (i.e., 40% of system nominal capacity) as the units will not run efficiently under these conditions.**

4.2.2 Once the COLD Engineer has completed the space allocation and forecasted equipment layout, the CRE D&C Project Manager and consultant shall designate the number and location of pumping units in said space. The pumping units shall be located against walls near building chilled water sources. Ideally, each unit shall be installed perpendicular to the cold aisle it is intended to support in order to minimize refrigerant pipe runs and bends. Additionally, 36 inches of maintenance access clearance shall be provided in front of each unit. For air-cooled condensers, CRE shall design and install a 1-3/8 inch diameter hot gas refrigerant line and 1-1/8 inch diameter liquid line. Pipe runs cannot exceed 200 feet equivalent piping length. The CRE Contractor must install 400 psig pressure relief valves in the R-407c refrigerant circuit. Shutoff valves shall not be installed between the compressor and the pressure relief valve. The pumping unit may require a platform if supply and return pipes cannot be brought up through the building floor. In the case of water/glycol condensers, CRE shall design and install two sets of building water supply and return lines routed through the left side of the platform. Pipe size shall be 2-1/2 inches diameter to match the internal thread connections of the condenser.

4.2.3 Condenser units cannot be placed in locations lower than 15 feet below the pumping unit. Condenser units shall be secured in accordance to building code requirements. In high seismic risk locations, more robust anchoring requirements shall be required for ground motions.

5 REMOTE COOLING UNITS

5.1 Network Equipment Lineups

5.1.1 In extreme heat density environments, network equipment shall be housed in consistent height, width and depth frameworks such as data cabinets configured in continuous lineups as shown in **Figure 1**. The lineups shall be arranged in “Cold” and “Hot” aisle configurations with every effort made to contain as much of the cold air in the front aisle and preventing hot exhaust air in the rear from mixing. Blank panels, side panels and equipment airflow directed from front to back shall be maintained to reduce mixing of air.

5.1.2 Extreme heat density equipment housed in individual cabinets and not intended to be in continuous lineups shall also be configured for “Hot” and “Cold” aisles leaving space between cabinets. Cooling air intake shall be from one aisle and warm air exhaust to other aisle for all cabinets.

5.1.3 Remote cooling units of the supplemental cooling system are designed for “Hot/Cold” aisle environments with cool air introduced to the front “Cold” aisles and exhausted warm air returning from rear “Hot” aisles.

5.1.4 Equipment lineups may require leaving space between equipment cabinets for the insertion of remote cooling units within the lineup. Planning of equipment lineups where supplemental cooling designs are deployed requires coordination with CRE engineers on placement of remote cooling units.

5.1.5 Remote cooling units are integrated into network lineups either with in-row horizontal cabinets or suspended overhead above network equipment . In-row cooling units shall be secured to adjacent equipment frames with brackets at each top corner, using self tapping screws. Cooling unit shall be anchored to floor at front and back. Floor securing of in-row cooling may require external bracket.

6. REFRIGERANT LINE INSTALLATION

6.1 Locating Refrigerant Pipes

6.1.1 From the pumping unit, CRE shall design and install refrigerant header distribution assembly along or as close to the cold aisle as possible. The header distribution assembly shall be equipped with quick-connects and valves to allow for the connection of current and future remote cooling units. Future unit location based on the ultimate equipment layout provided by the COLD Engineer.

6.1.2 Refrigerant lines may be run up to a maximum 175 feet equivalent pipe length between the pumping unit and remote cooling units. Supply pipe shall be 1-3/8 inch diameter and return pipe 2-5/8 inch diameter. For runs of less than 60 feet equivalent pipe length, 1-1/8 inch diameter supply and 2-1/8 inch diameter return pipes may be used. (Equivalent pipe length includes pressure loss across bends, valves, joints, tees in each pipe run). The main supply and return lines must be installed sloping downward toward the pumping unit at a rate of 1”-2” per 20 feet of pipe run. Horizontal connector lines should also be sloped downward from the remote cooling units toward the main supply and return lines. The pipes shall be ASTM Type “L” copper pipe intended for refrigerant service at maximum operating pressure of 90 psi.

6.1.3 All refrigerant pipes shall be assembled with high temperature brazed joints. The lines being brazed must be filled with flowing dry nitrogen during brazing to prevent oxidation and scale formation inside of pipe. Brazing operations shall be very limited in equipment space with in-service equipment and shall comply with all **AT&T TP**

76300/76301 installation requirements (e.g., bagging or shut-off of smoke detectors and associated fire watch, detailed MOP's, etc).

6.1.4 All refrigerant pipes shall be insulated to prevent condensation.

6.1.5 Bypass flow controllers and shut off refrigerant grade ball valves shall be provided in pipe runs for servicing and emergency shutdown.

6.1.6 A header distribution assembly with quick-connect fittings and valves shall be provided in the piping run where remote cooling units are to be installed. The header distribution assembly provides a connection port to remote cooling units for all current or future units by quick connect couplings without disrupting refrigerant flow. Header distribution assembly is available in 10 feet segment with 5 or 10 ports, or 8 feet segment with 2 or 4 ports.

6.1.7 Runs between the remote cooling units and the connection port of the distribution assembly shall be with flexible pipe with quick-connect fittings. Flexible pipes are available in 4, 6, 8 or 10 feet lengths. In central office environments, refrigerant pipe runs will be located above cable racks and require flexible pipe to reach header distribution assembly at that height.

6.1.8 All horizontal runs of refrigerant pipes in network equipment areas shall be supported from ceiling inserts. Pipe supports shall be strut channel with vibration cushioned strut clamps sized for insulated pipes. Vibration cushions are necessary to reduce potential for noise. Supply and return runs shall be supported by the common strut channel. Threaded rod hanger diameter shall be ½ inch minimum. Provide diagonal bracing as required for high seismic risk locations per local building code requirements.

6.1.9 Refrigerant pipe runs shall be located between 11'-7" and building ceiling clear of all cable rack runs. Pipes shall not be located where it will interfere with cable piles extending 12 inches above cable rack. Refrigerant pipe runs are allowed between 9'-4" and 11'-7" level only if cable racks are not placed in that vertical space.

6.1.10 Flexible refrigerant pipes between remote cooling units and connection port shall be run vertically up to distribution assembly with support provided at approximately every 3 feet. Longest unsupported run of flexible pipe shall not exceed 4 feet. Support may be provided by securing pipe clamp to side of auxiliary framing channels or cable rack stringers for sites where auxiliary framing channels do not exist. See **Figures 8 and 9** for pipe support details.

6.1.11 Flexible pipe supply line is ½" diameter and return line is 1" diameter, overall outside diameter of flex pipe will be greater for both lines. Flexible pipe is available with straight connector or 90 degree connector if needed on pipe end connected to remote cooling unit.

6.1.12 Tag shall be affixed to each end of the flexible connecting pipe advising of refrigerant content and warning of gas discharge and low temperature risks when disconnecting. Eye protection requirement when servicing should be stated in label.

7 REMOTE COOLING UNITS

7.1 In-Row Horizontal Units

7.1.1 The freestanding in-row remote cooling units are best utilized when placed among the equipment cabinets within lineups in a hot aisle-cold aisle arrangement. The cooling units draw in air from the hot aisle, cools it and discharges cool air into the cold aisle. Distribute cooling units between equipment cabinets as shown in **Figure 3**.

7.1.2 In row cooling units are 12 inches wide, 42 inches deep and 78 inches high (80 inches including pipe connections). Empty weight of cooling unit is 246 pounds. In-row horizontal cooling unit is equipped with casters for transport.

7.1.3 In-row cooling units are available as 32 KW or 20 KW cooling capacity in cabinet of common dimensions.

7.1.4 In-row cooling units must be junctioned to adjacent equipment cabinets when installed in equipment lineup. In-row cooling units are equipped with casters and leveling feet. The leveling feet must be lowered to take weight of cabinet off casters. Cooling unit cabinet is to be attached to equipment cabinets using bracket provided with cooling unit at each corner on top of units. Secure cooling unit to floor with anchors using external bracket.

7.1.5 Front face of in-row cooling unit shall be aligned with front face of equipment cabinets. Rear of cooling units may not align and extend beyond depth of equipment cabinets if equipment frames are not 42 inch depth. Cooling shall be configured so cold air is introduced into front/cold aisle and return air into remote cooling unit drawn in from rear aisle.

7.1.6 In-row cooling units are to be placed at every two or at maximum every third equipment cabinet in lineups and in opposing lineups the cooling units should staggered with cooling unit of the opposing lineup as shown in **Figure 3**.

7.1.7 In-row cooling units may be applied to cool standalone equipment cabinets by locating cooling unit beside the equipment so warm discharged air of equipment can be recovered to rear and cold air directed to front of equipment. The in-row cooling unit should not be more than 3 feet from equipment cabinet.

7.2 Overhead Cooling Units

7.2.1 Remote overhead located cooling units are available to be placed in equipment aisles when overhead space is available. The cooling units draw air in from hot aisles, cools it and discharges cool air downward into the cold aisle.

7.2.2 Overhead cooling units are available in version that hangs over center of "Cold" aisle or units that attach directly to the top of an individual equipment cabinet. Suspended cooling units are designed with cooling capacity for multiple equipment cabinets while cabinet top units cool serve one cabinet.

7.2.3 Overhead cooling units are applied only where cooling unit will not create interference with cable rack runs or cable entrance into top of cabinets. Network equipment overhead space is reserved for one to three levels of cable racks from 7'-5" up to 11'-8" height. Cable racks may be planned for parallel runs directly over equipment frames, in front or rear aisles. Cross aisle cable runs may be installed perpendicular to lineup runs at 6 feet intervals.

7.2.4 Suspended cooling units should be placed in rows directly above the cold aisle with sides facing perpendicular to hot aisle. Each cooling unit can serve an area equal in width to the cold aisle spacing, typically 12 to 16 feet. Return air is drawn from the sides of unit and cold air discharged down into the cold aisle.

7.2.5 Suspended cooling unit shall not be installed above the equipment cabinets a height greater than 30 inches measured from bottom of cooling unit to top of cabinet.

7.2.6 Suspended cooling units shall be supported by threaded rod hangers from building ceiling anchors. Hanger rod lengths longer than 2 feet requires diagonal bracing cooling unit against sway. Diagonal bracing may be provided by rigid structural steel braces or wire rope cables in two direction. Cooling units shall be braced for side-to-side movement and front-to-back displacement. In high seismic risk locations, building code requirements shall be followed for bracing designs.

7.2.7 Suspended cooling unit has four 7/8" diameter mounting on top of unit. Minimum 5/8" diameter threaded rod hanger shall be used to support cooling unit to ceiling anchors or surface mounted Unistrut channel. Empty weight of suspended cooling is 150 pounds.

7.2.9 Suspended cooling units are available in 17.2 KW and 20 KW cooling capacity. Cabinet mounted cooling units are available in 8.8 KW and 10 KW cooling capacity. Cooling capacity shall chosen in accordance to heat load of equipment in cabinets. Multiple cooling units are required for greater heat loads than an individual unit can provide.

7.3 Cabinet Top Remote Cooling Units

7.3.1 Cabinet top cooling unit may interfere with cable management systems and access of cables in and out of equipment cabinet. Cabinet top cooling units shall only be applied where cable access are not an issue.

7.3.2 Cabinet top mounted cooling unit shall be secured to cabinet by through-bolts. Mounting clips supplied by cooling unit manufacturer permits attachment to cabinets to field drilled holes in cabinet top. Cooling unit shall be secured to cabinet with minimum four through-bolts of at least ¼” diameter. Cabinet must be verified to have capability to carry 80 pound cooling unit in addition to mounted equipment weight prior to installing cooling unit.

8. SYSTEM REDUNDANCY

8.1 Building Space Cooling

8.1.1 Building central air handlers or perimeter CRAC/CRAH units that provide base cooling for the space provides around 50 watts per square foot of base cooling. Air handlers may also be designed with economizer feature. These systems provide a level of redundancy in case of failure of the supplemental cooling system. Ideally, the central air handlers supplying the space shall be equipped with multiple fans or have a cross-connected air handler configuration to provide redundancy for the base 50 w/sq.ft. load. In case of failure of supplemental cooling system, the building space cooling system provides some relief until supplemental systems recover.

8.1.2 In cases where CRAC/CRAH units are used to provide the base capacity for the space, such as when use of building central air handlers are not feasible due to cost of upgrades, the capacity of these units can pick up all or part of the redundancy for the space.

8.2 Supplemental Cooling System

8.2.1 Extreme density cooling systems are designed with two pumps as part of the pumping units. If one pump were to fail, a backup pump comes on to continue refrigerant flow to remote cooling units.

8.2.2 When one pumping unit is installed in an equipment room, the remote cooling units shall be connected to refrigerant pipes in a non-interlaced configuration as shown in **Figure 4**. The pipe connections will be to common supply and return pipe.

8.2.3 Interconnection of pumping unit to remote cooling units by refrigerant lines can be connected with two pairs of pipes as coils in remote units are separated into two circuits. In horizontal in-row cooling units, there is top coil and bottom coil with each coil having supply and return lines.

8.3.4 In equipment rooms where two pumping units and two sets of refrigerant pipes, the remote cooling units can be configured for interlaced piping as shown in **Figure 5**. Remote cooling units will be connected with one half of the remote cooling units to one pump and the other half to another pump. Interlacing the connection piping will keep one of the circuits operating should one of the pump units fail.

8.3.5 Supplemental cooling systems rely on other space cooling systems for humidity control and cooling of lower heat equipment lineups in room. In case of failure of supplemental cooling system, the space cooling system can temporarily handle cooling until the problem is corrected. However time available before room temperatures rise and become service affecting will depend on capacity of space cooling system and amount of heat from network equipment.

9. ELECTRICAL REQUIREMENTS

9.1 General

9.1.1 Power to all supplemental cooling equipment (i.e. refrigerant pumping units, air cooled refrigerant chiller units, and the different remote cooling units) and any auxiliary equipment shall be in accordance with the requirements identified in this section.

9.1.2 Power to equipment will generally be from an electrical panel protected by a stand-by engine power source in case of commercial power failure. Supplemental Cooling Equipment is not required to be powered off essential or UPS power source based on cooling system's redundant design stated in other paragraphs of this document. The connections to the units themselves are typically hardwired to a terminal block within a power equipment enclosure but they can be plug- in type receptacles in the remote units.

9.1.3 All protective devices such as breakers and fuses, conduits, raceways and junction boxes, enclosures and cabinets, and conductors and cables shall be installed in accordance with the latest adopted version of **NFPA 70: National Electrical Code (NEC)** and all applicable state and local codes and ordinances, and in accordance with recognized industry practices.

9.1.4 Protective devices shall be suitably sized for the device being powered in accordance with the manufacturer's voltage and current load data.

9.1.5 All conductors, wires, cables and connectors shall be constructed of copper and be no less than 98% conductivity unless otherwise specified.

9.1.6 Location of power wire/cable and raceways must be coordinated with other disciplines to avoid interference with piping and telecommunications cabling for electronic equipment.

9.1.7 All conductors used for this purpose must be #12AWG or larger in accordance with the device being powered and must be stranded.

9.1.8 All connections and terminals shall be tightened in accordance with the manufacturer's recommended torque values.

9.1.9 All electrical raceway or conduit supporting equipment such as hangers, angle iron, straps, brackets, clamps etc., must be directly attached to the overhead concrete ceiling structure or building walls and not be supported or attached to network overhead cable racks, cable rack supporting structure or other ironwork intended for network equipment use only. Conduit runs to all remote cooling equipment shall be run under the raised floor or the overhead space depending on the site conditions and the type of unit. Self supported and cabinet mounted units such as the Liebert XDO's and XDV's respectively may be more suitable for overhead power distribution. Aisle mounted units such as the Liebert XDH may be suitable for overhead or under floor power distribution. Designer shall choose most appropriate method based on site conditions. Installation shall provide the maximum length of flexible conduit feeds for the end runs as allowed by the NEC and AHJ based on site conditions.

9.1.10 Alarm and control cabling associated with the spot cooling devices shall be in accordance with the manufacturer's recommendations or as defined in the drawings and specifications for the specific project.

9.1.11 Electrical grounding of all cooling equipment and enclosures shall be in accordance with the latest adopted version of **NFPA 70: National Electrical Code**.

9.2 Air Cooled Refrigerant Chiller Units

9.2.1 In general, all air cooled refrigerant units have a higher current load than most of the other spot cooling equipment, this is due to the larger motor required to compress the refrigerant into liquid form. As such, the Alternating Current (AC) voltage required for these units will usually be 460V-3phase-60 Hz. In general, this voltage is not available within the raised floor environment, so a separate circuit may be required from an MCC in order to provide this type of voltage. In this case, the power to the units shall still be from a circuit protected by a stand-by power engine source.

9.2.2 The typical load associated with these units will be around 80 Amps, and a 100 Amp circuit should be appropriate for the intended use. However, the designer should verify loads with the manufacturer, and size protective devices in accordance with the latest adopted version of the NEC.

9.2.3 Control wiring for associated control and alarming points must be installed as required to achieve the desired sequence of operations. In general, terminal strip connections are available for temperature and humidity sensor inputs, remote cooling unit alarm and condensation detection inputs, and remote general alarm and shutdown outputs. It is recommended that the remote general alarm output be tied in with the general environmental alarms as defined in the NGN Space: Design and Construction Standard, **ATT-TELCO-812-000-155**

9.3 Chilled Water Refrigerant Pumping Units

9.3.1 The refrigerant pumping units do not have the compressors associated with the Air Cooled Chiller units, as such, their load characteristics are significantly lower. The units can be purchased in either 460V-3phase-60Hz configuration, or 208V-3phase-60Hz configuration. The designer should specify the units based on the voltage and capacity available within the facility.

9.3.2 In general, the full load amperage at 460V-3 phase will be in the 2-3 Amp range, and in the 4-5 Amp range when supplied by 208V-3phase. The designer should verify the loads with the manufacturer selected and size the protective devices and wiring for the circuit according to the latest version of the NEC.

9.3.3 Control wiring for the pumping units is similar to the Air Cooled Chiller units described in Section 8.3.2.3. Control wiring for associated control and alarming points must be installed as required to achieve the desired sequence of operations. In general, terminal strip connections are available for temperature and humidity sensor inputs, remote cooling unit alarm and condensation detection inputs, and remote general alarm and shutdown outputs. It is recommended that the remote general alarm output be tied in with the general environmental alarms as defined in the NGN Design and Construction Standard, **ATT-TELCO-812-000-155**.

9.4 Remote Cooling Units

9.4.1 The remote cooling units have very small loads resulting mostly from the small motors powering the fan units to circulate air flow from the cold isles through the equipment, and back through the hot aisles to the cooling coils within the units. Power to all units is through a single phase circuit, but the voltage requirement can be specified as 120V, 208V, or 220V/230V/240V depending on the model specified.

9.4.2 Power to the overhead mounted units (XDO) shall be supplied from a hard wired single phase 120V, 60Hz source. Each unit draws an approximate total full load current of 2.7 Amps. A 20 Amp standard circuit should be sufficient to run the fan units.

9.4.3 Power to the cabinet mounted units (XDV) shall be supplied from a 120V, 60Hz, 20 Amp standard power outlet and an IEC Power cord. These units come equipped with two IEC power inlets, and are intended for two redundant power sources, however, we recommend only one inlet port be energized from a stand-by engine protected power source. These units shall not be powered from the UPS A & B power sources. The full load current for these units is approximately 2.0 Amps.

9.4.4 Power to the in-row horizontal cooling units (XDH) shall be supplied from a 120V, 15 Amp NEMA 5-15 standard power outlet. These units come equipped with two IEC power cords, and are intended for two redundant power sources, however, we recommend only one inlet port be energized from a stand-by engine protected power source. These units shall not be powered from the UPS A & B power sources. The full load current for these units is approximately 5.0 Amps for the XDH-20 Model and 10 Amps for the XDH-32 Model.

9.4.5 Control wiring for all the remote cooling units (XDO, XDV and XDH) consists of only wiring through a dry contact to be used for condensate alarm sensing and signaling to either an air cooled chiller unit or the central pumping unit. The alarm can be further remoted from the latter to a central station through the NGN alarming terminals. The dry contact is rated for 1 Amp capacity at a standard 24VAC control voltage.

9.5 DC Powered Remote Cooling Units

9.4.1 Job sites requiring remote cooling units to be powered by DC power source shall obtain power from network BDFB or secondary power distribution unit supplying power to the lineups. Fuse assignments shall be obtained by COLD planner for remote cooling units.

9.4.2 Power cables shall be routed to remote cooling units following similar practices as power for network equipment. Cable racks established for secondary power cables of network equipment can be used for routing power cables of remote cooling units.

9.4.3 Power load expected for remote cooling unit will be approximately 1240 Watts or around 30 amps at worst case voltage of 42.6 Volts. Fuse size would be 40 Amps at the secondary power distribution for these loads.

9.4.4 Power installation to DC version remote cooling units shall be responsibility of network installation contractors to include running and securing power cables between secondary power distribution unit and remote cooling unit, connecting power cables to remote cooling unit, connecting power cables to secondary power distribution unit, install fuses to secondary power unit and providing ground connection to remote cooling unit.

10. COORDINATION BETWEEN CRE/NETWORK

10.1 Engineering System

10.1.1 Following a request from COLD engineers for deployment of high heat equipment, CRE building engineer shall determine space cooling requirements to accommodate the high heat products. CRE site engineer shall notify COLD Engineer of intent to use supplemental cooling system if it is determined that is best solution for the site.

10.1.2 COLD Engineer shall design equipment layout with space for remote cooling unit and if using in-row cooling unit, provide 12 inch space within lineup for each cooling unit. One 12 inch wide cooling unit will be required between every 3 equipment cabinets.

10.1.3 CRE will design and procure all cooling components including remote cooling unit for the application with the remote cooling unit intended to be placed in the equipment lineup.

10.1.4 Installation of the remote cooling unit will be accomplished by a mechanical contractor hired by CRE. All electrical and plumbing requirements will be handled by the mechanical contractor. Exception would be for remote cooling units that will be DC powered. For DC powered units, the piping will be performed by CRE hired contractor while the power cabling and fuse assignment from BDFB will be accomplished by network equipment installation contractors.

10.1.5 Physical installation of the remote cooling units will be performed by the mechanical contractor in coordination with network installation contractors. Space shall be left for the cooling unit when network equipment lineups are installed or the cooling unit may be installed initially and equipment cabinets installed around the cooling unit. Securing of the remote cooling unit to adjacent equipment cabinets would be accomplished by mechanical contractors.

10.1.6 Coordination will be necessary between mechanical contractors and network contractors when running pipe from cooling units overhead to refrigerant distribution header. Flexible pipe runs and electrical connections should not interfere with cable racks and cables. Pipe runs and electrical connections should be accomplished following completion of cable runs unless pipe runs and electrical runs have been planned in areas away from cable racks.

10.1.7 CRE's consultant shall show future remote units in plans for permit submission (designated as future) to avoid future permits for each new remote unit installation. On the initial project, CRE's mechanical subcontractor shall only install pump, chiller and number of remote units to meet either the minimum operational efficiency threshold (i.e., 20% for XDP or 40% for XDC) or the three year forecast whichever is greater.

10.1.8 For equipment cabinets added subsequently, the responsible Network engineer shall contact the COLD Engineer at least four months in advance of the required equipment in-service date and provide specific information regarding the space, power and heat load requirements of the equipment to be added to the space. The COLD Engineer shall use this information to determine if the request can be accommodated. If COLD Engineer concurs with the request he or she shall then update the floor plan showing the new equipment cabinets, associated power drain and heat load (next to each cabinet) in bold red. This information shall then be sent to the CRE D&C Project Manager at least three months prior to the equipment required in-service date.

10.1.9 All work performed overhead of equipment space shall be conducted to TP76300/TP76301 requirements with all precautions taken to avoid service outage when working over live equipment.

11. SYSTEM MAINTENANCE

11.1 CRE Property Management shall be responsible for performing all preventative maintenance (PM) and repairs on the pumping units(XDP), chiller (XDC) and remote cooling units (e.g., XDO, XDH) as well as related plumbing, piping and electrical systems related to the supplemental cooling system.

12. ALARMS AND MONITORING

12.1 Any alarms required for monitoring performance of supplemental cooling system shall comply with procedures described in document IOP (Internal Operating Procedure) CRE Alarm Management Strategy - **CRE-50-09-01-IOP-001.**

13. CODE COMPLIANCE

13.1 All designs for supplemental cooling system and work to install system described in this document shall be performed in compliance with applicable codes.

14. FIGURES

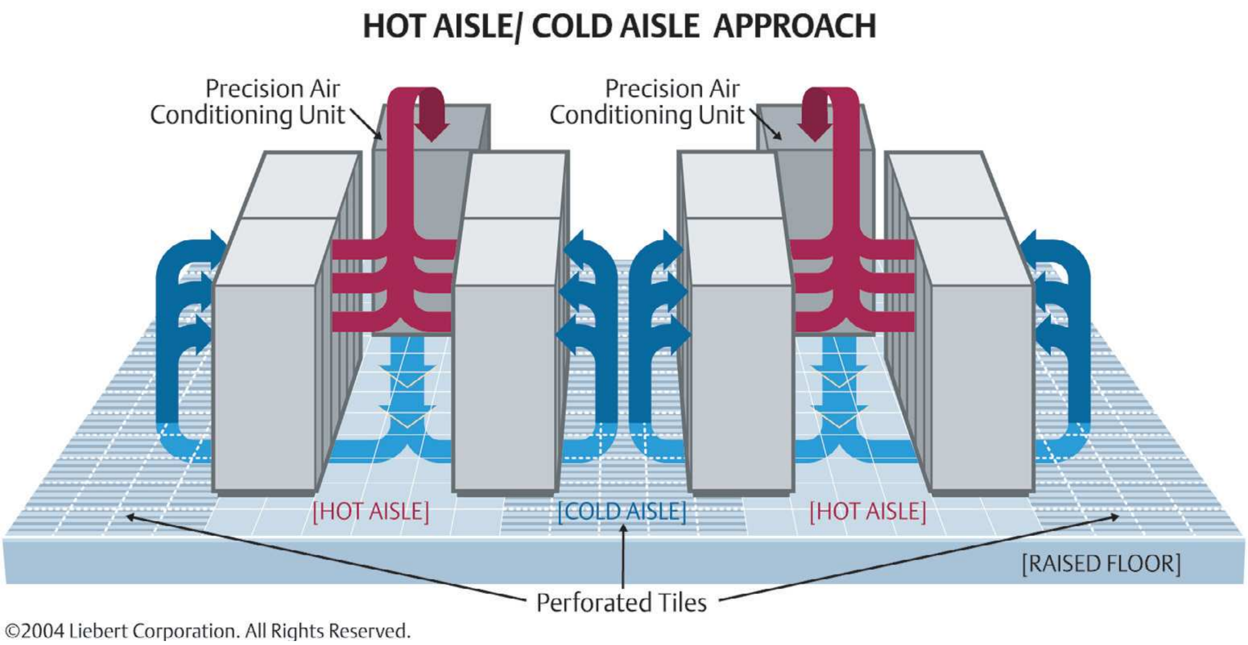


Figure 1
Hot Aisle/Cold Aisle Configuration

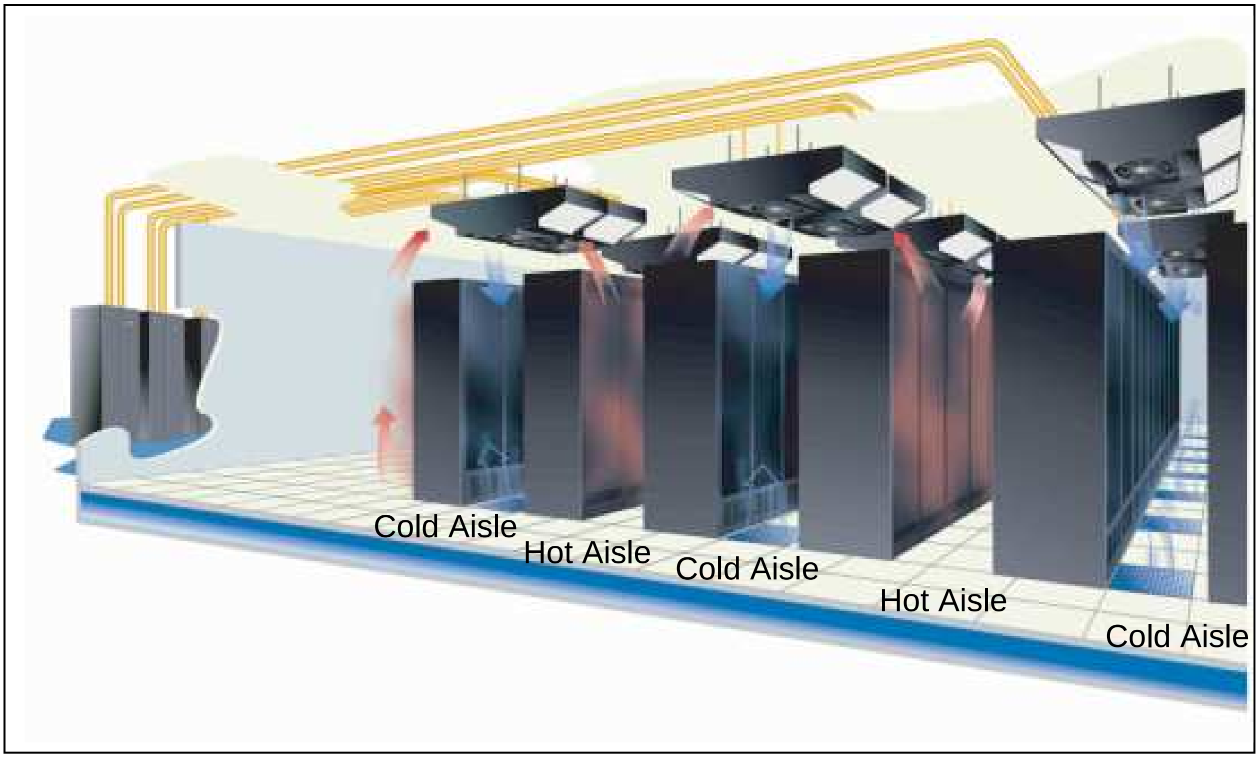


Figure 2
Equipment Lineups Configured For Hot/Cold Aisles
With Overhead Remote Cooling Units

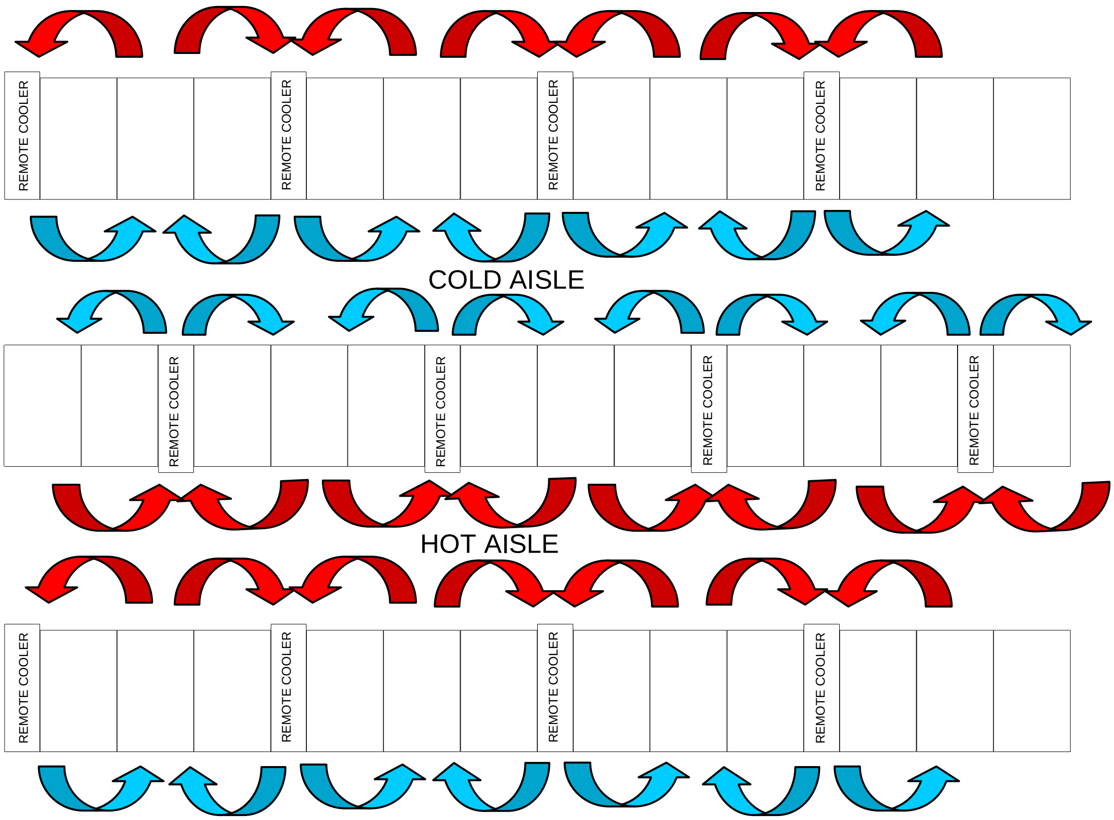


Figure 3

**Equipment Lineups Configured in Hot/Cold Aisle
With In-Row Horizontal Remote Cooling Units**

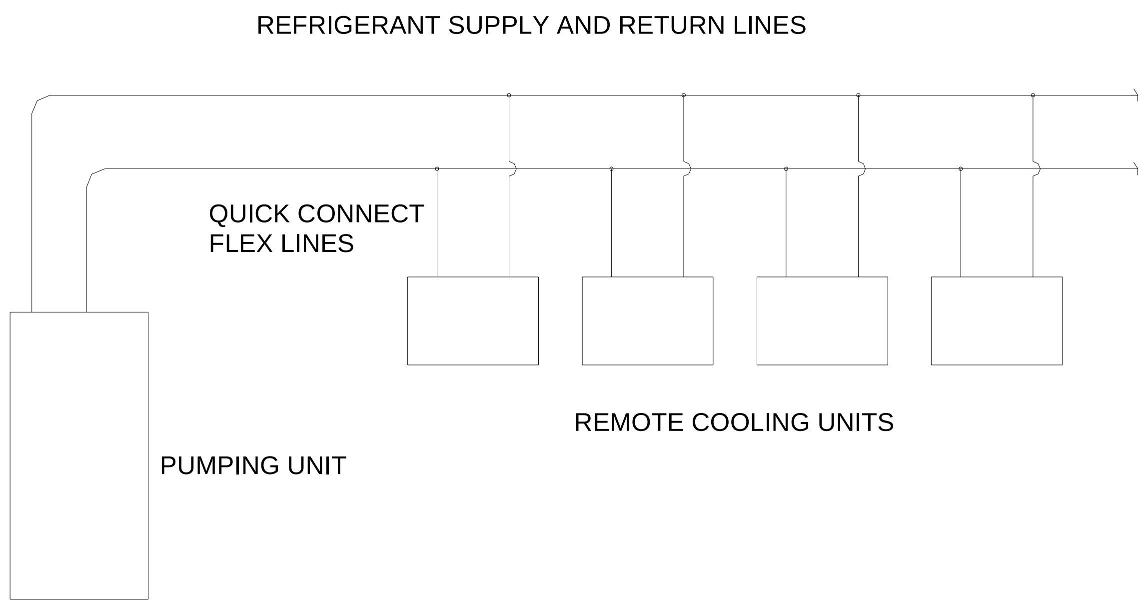


Figure 4
Refrigerant Piping Scheme
Pumping Unit to Remote Cooling Units

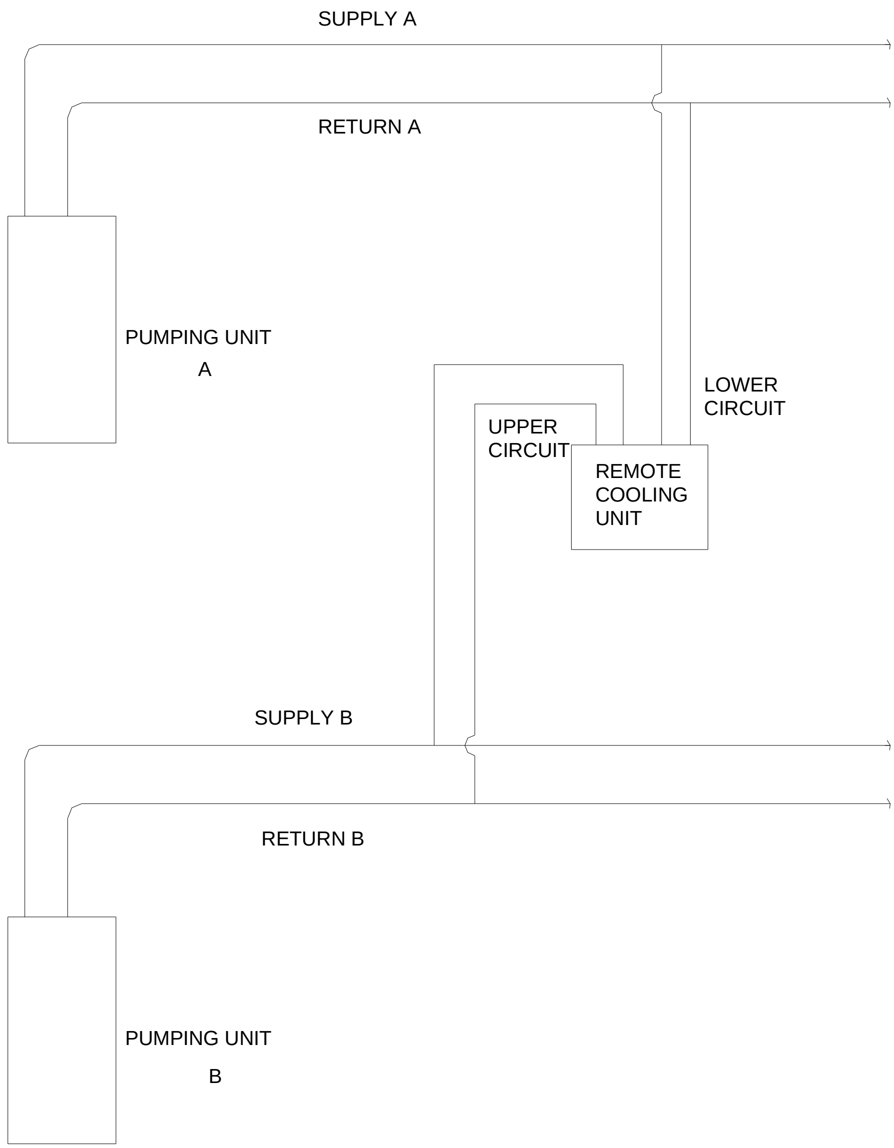


Figure 5
Interlaced Refrigerant Piping Scheme

Figure 6
Header Distribution Assembly
Quick Connect Ports

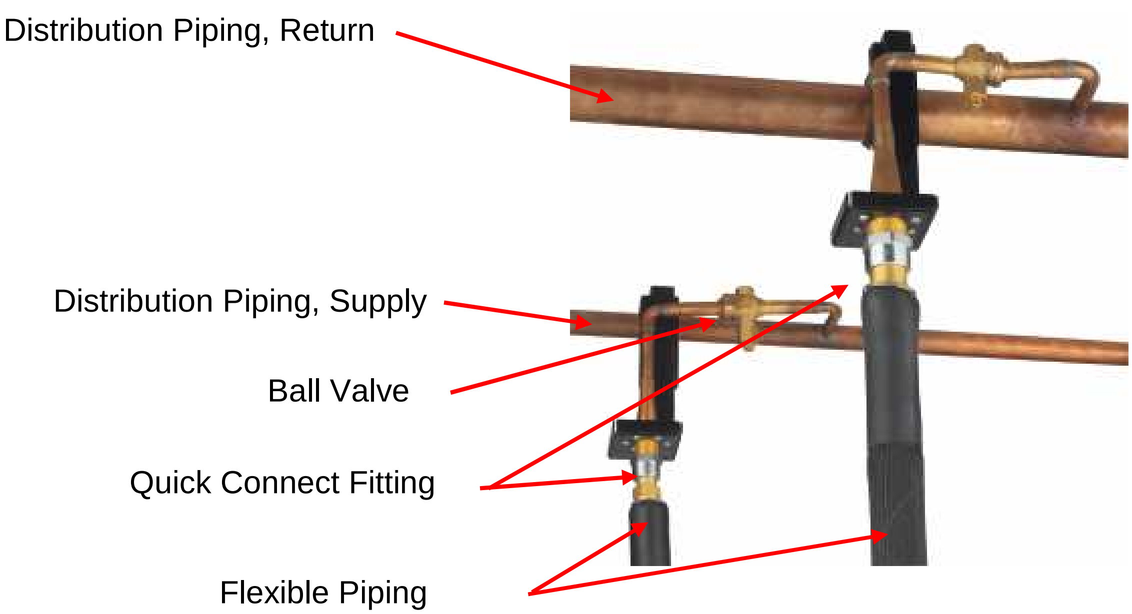
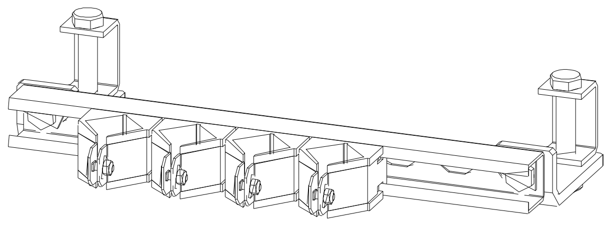
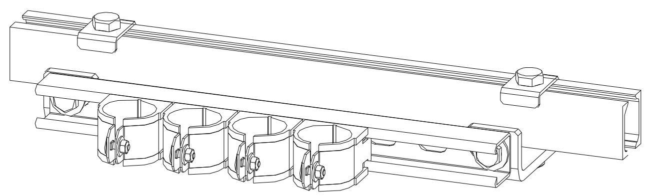


Figure 7
Flexible Piping Connected To Header Distribution Ports



Manufacturer: Part Number CCUDPX4CR2, Cooling Hose Support
Custom Cabinets & Rack
Topeka, Kansas
785 862-2271

Figure 8
Support Bracket For Flexible Pipes
Attached To Cable Rack Stringer



Manufacturer: Part Number CCUDCPX4, Cooling Hose Support
Custom Cabinets & Rack
Topeka, Kansas
785 862-2271

Figure 9
Support Bracket For Flexible Pipes
Attached To Auxiliary Framing Channel

Figure 10
Pumping Unit
Building Chilled Water

Figure 11
Pumping Unit
Remote Condenser Cooled

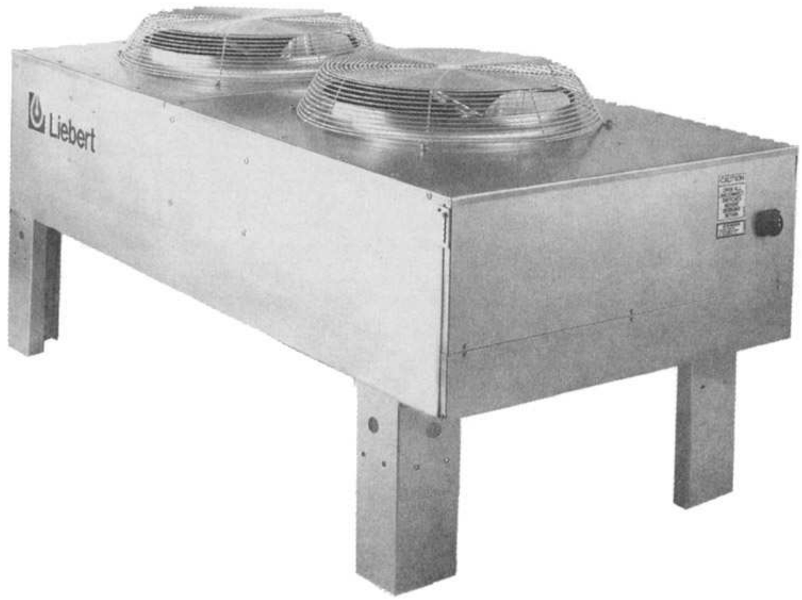


Figure 12
Outdoor Air Cooled Condenser

Figure 13
Horizontal In-Row Remote Cooling Unit

Figure 14
Overhead Suspended Remote Cooling Unit

Figure 15
Top of Cabinet Remote Cooling Unit