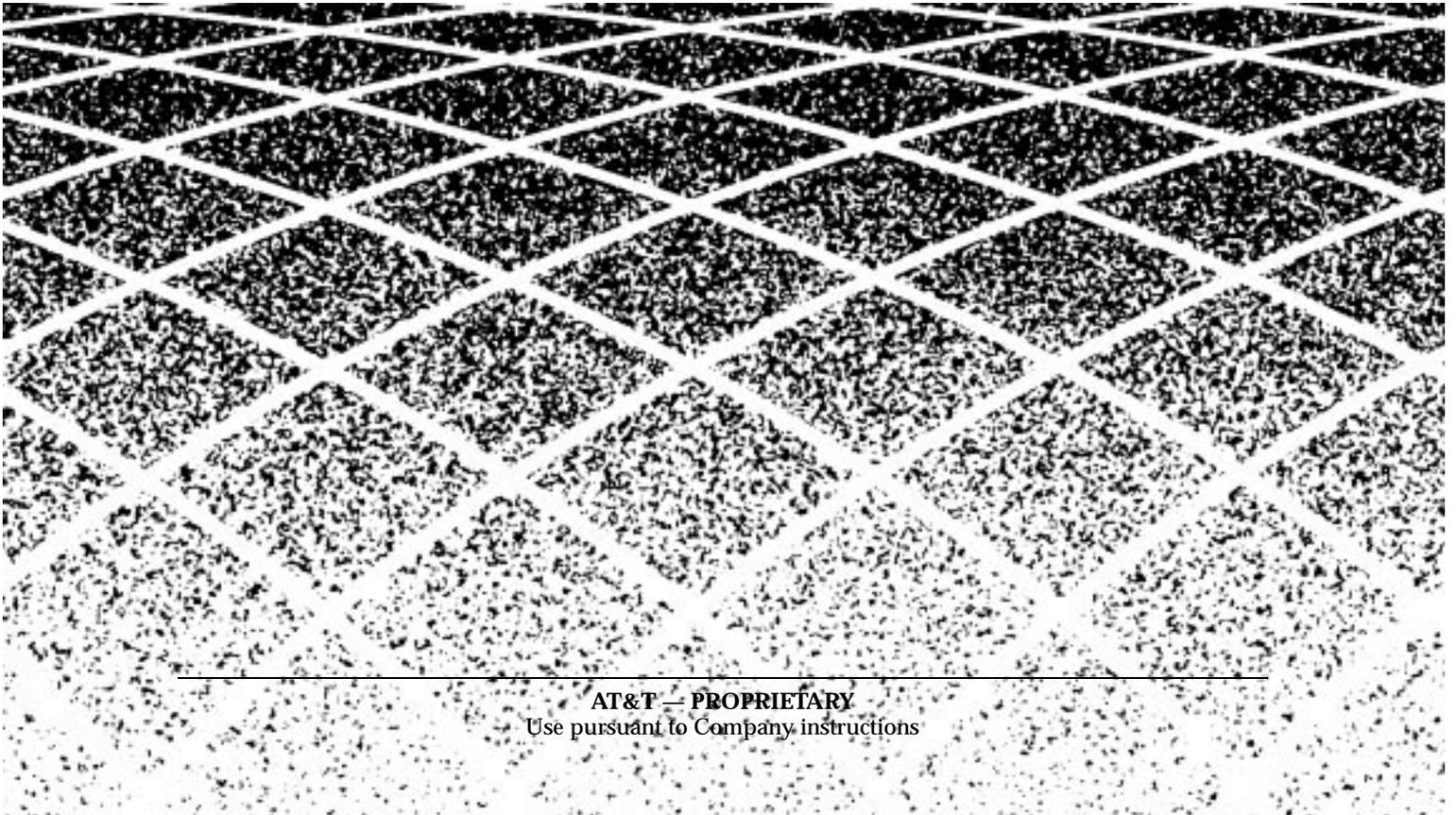




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Network Mechanical Standards



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General

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General

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1.1 Overview

The reliability of critical network telecommunications equipment depends upon the continuous operation of supporting environmental systems to maintain temperature, rate of temperature change, humidity and air quality within design limits. Due to the sensitivity of critical network equipment it is imperative that environmental systems be provided which ensure a highly reliable and stable environment.

This document provides general and specific design criteria for the environmental systems serving critical network telecommunication equipment for new and existing AT&T locations. The basis of this document is to achieve a maximum practical level of reliability and standardization at all critical locations. It shall also be used as the basis for evaluating existing locations.

Each application of an environmental system shall be analyzed to determine the most practical and reliable method for implementing the requirements set forth herein.

Where conditions do not allow for these criteria to be implemented, alternate designs shall be reviewed with the Infrastructure Process District. Acceptance of these designs must consider availability and reliability requirements for the location, cost feasibility and reliability of the environmental systems proposed. Acceptance of an alternate design for a particular project does not constitute a change in the Standard or acceptance for any other project.

To ensure the long-term network reliability, a Basis of Design must be prepared prior to the detail design of a project and must be kept current as the project progresses. This document provides basic requirements for developing the Basis of Design.

1.2 Applicability

This document is directed at all new environmental system installation projects in all network equipment buildings, AT&T 760-200-026, *Seismic Zone Classification for*

NCS Equipment Locations (Lower 48 States), lists the buildings that are classified as critical.

1.3 Design Methods

The long-term reliability of any environmental system is predicated upon accurate design methods and accurate record keeping. To ensure that every installation has acceptable levels of accuracy, the following methods of design will be followed.

1.3.1 Basis of Design

All environmental systems shall be based upon a clear, written Basis of Design. The Basis of Design shall include all pertinent information in the development of a project's design. Assumptions, load calculations, selection criteria, layout considerations, options and any other information necessary to support a set of decisions shall be incorporated into the document. The detail, in most cases, should be proportional to the size and complexity of the project. Although this standard includes specific instructions for development of a Basis of Design, good engineering practice should guide the creation of the document.

The Basis of Design shall be kept with project documents and shall become a permanent record of the project.

1.3.2 Computer Aided Drafting

All designs shall be produced using commercially available and acceptable computer aided drafting (CAD) systems. They must be compatible with AutoCAD® 14 by Autodesk, Inc. The system selected shall be able to produce a drawing file format acceptable to the COP Engineering CAD system employed and according to *AT&T CAD Specification Standard Document*.

Background drawings and equipment layout drawings may be available in electronic format suitable to most commercially available CAD systems. Efforts should be made to utilize existing drawing information.

1.3.3 Computer Aided Engineering

The detail design and calculation and modeling of systems and equipment may be performed with commercially available Computer Aided Engineering (CAE) systems.

1.3.4 Record Keeping

Equipment and component data shall be maintained on a computer data base system compatible with AutoCAD® 14 software. Data shall include design requirements, vendor information, construction attributes such as as-built shop drawings and installation, operations and maintenance instructions.

1.3.5 As-Built Documentation.

As-built documentation, including drawings, submittals and Operations & Maintenance (O&M) manuals, shall be made available in electronic form to the greatest extent possible. Drawings shall be maintained on CAD systems per the above requirements. Documentation shall be maintained in a format acceptable to the building engineer and the network operations supervisor.

Piping and Instrumentation diagrams (P&ID) in AutoCAD® format are required for HVAC systems serving network equipment spaces and administrative spaces in the same buildings. For buildings with central chilled or hot water systems, the P&IDs shall show the entire chilled water and hot water systems to include equipment serving non-network equipment spaces. Air-side AutoCAD® format schematic diagrams for systems serving network equipment spaces and administrative spaces are also required. Additionally, operating descriptions for the above systems in electronic format are required.

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Design Requirements

2

2.1 Design Parameters

2.1.1 Local Conditions

This document defines the parameters used to in selecting mechanical systems and their associated components. The design professional must satisfy the performance criteria defined in this document and resolve any conflict caused by local conditions.

2.1.2 Outdoor Design Parameters

The design of air conditioning systems shall be based on the American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) recommended regional summer 2½% design values for dry-bulb and coincidental wet-bulb temperatures.

The design of space heating systems shall be based on the ASHRAE recommended regional winter 97½% dry-bulb design temperature.

Seismic design data for the site shall be obtained using the most recent methods of the Uniform Building Code (UBC), with seismic spectral data from building-mounted accelerometers (if available) and appropriate analysis by modeling of soil, building and proposed equipment. A Seismic Importance Factor of 1.50 per UBC charts shall be used.

Design wind velocity for the site shall be obtained by the best available local source (e.g. local airport), documented and used in the design calculations. As a minimum, values for wind velocity shall reflect the highest recorded wind velocity within the past 50 years.

Design of evaporative condensers and cooling towers shall be based on the 5% regional wet bulb design temperature as published by the Cooling Tower Institute (CTI).

The environmental systems shall perform their intended functions when installed per the site elevations. Suitable correction factors shall be applied in design to compensate for the altitude of the location.

2.1.3 Indoor Design Parameters

The environmental systems design shall be capable of maintaining the environmental conditions as stated in Table 2-1. The recommended set point describes the space conditions during normal operation within the range of design outdoor conditions. The environmental system shall produce a constant temperature within the given space. Non-uniform temperatures across a room are allowed provided the spot temperatures are constant and within the operating limits described in Table 2-1.

Maximum and minimum short term conditions (as shown in Table 2-1) may occur due to abnormal events such as heating, ventilation and air conditioning (HVAC) equipment failures, temporary loss of commercial AC power or outdoor conditions beyond design values.

2.1.4 Humidity Parameters

The relative humidity and specific humidity of the air surrounding network equipment can have significant effects on the operation of that equipment. Low humidity can increase the potential for electrostatic discharge. High relative humidity and any specific humidity over 0.024 lb. H₂O per lb. of dry air increases the carrying capacity of air for soluble salts which lead to corrosion and damage to network equipment.

Designs shall conform to the humidity range detailed in Table 2-1 for all indoor installations. The use of vapor barriers, humidifiers and tightly controlled cooling coils for dehumidification shall be incorporated into the design of the environmental systems to maintain the humidity within the acceptable range.

2.1.5 Air Quality

Particulate matter suspended in air affects the short and long term operability of the network equipment. It is a function of the environmental system to restrict the total quantity of certain sized particles to acceptable levels. The acceptable levels are defined in Table 2-1. Refer to the latest issue of AT&T 801-900-160 AT&T Network Equipment Development Standards, (NEDS) Generic Requirements.

2.1.6 Heat Rejection Rates

This standard sets the minimum level of heat rejected in a potential equipment space as shown in Table 2-1. COP Engineering is responsible for categorizing the use of building space including equipment spaces. Any environmental system must be sized to maintain a constant environment within equipment spaces. Environmental system design must incorporate requirements from Table 2-1 and provide an efficient means to maintain environmental conditions with actual heat rejection rates from existing or anticipated equipment.

Current AT&T Network Equipment Development standards (NEDS) Generic Requirements specifies the overall heat dissipation of an entire area is limited to 50

W/ft² rather than only the 20' X 20' area. Accordingly, the Central Office Planner would not design any footprint in which the overall space to be conditioned would exceed 50 W/ft².

2.1.7 Cold Weather Operation

Typical network telecommunications offices have heating, cooling and ventilating requirements unlike most conventional building facilities. Outside freezing temperatures occur at least occasionally for most sites. Accordingly, equipment freeze protection is required during times of operation and idleness for these sites.

Table 2-1 Summary of Design Parameters

Condition	Limit	Recommended Set Point
Temperature		
Operating	+40°F to +100°F	75°±5° dead band
Short Term	+35°F to +120°F	
Maximum Rate of Change	+/- 15°F/hr (linear)	
Humidity		
Operating	20% to 55% RH	40% RH±10% dead band
Short Term	15% TO 80%, but no more than 0.024 lb H ₂ O/lb dry air	
Airborne Particulate	25 microgram/m ³ , maximum	N/A
Equipment Heat Releasee	See notes 2, 3 & 4 below	N/A
Hydrogen Concentration	0.8% by volume, maximum	N/A

References:

- AT&T 801-900-160, AT&T Network Equipment Development Standards (NEDS) Generic Requirements
- GR-63-CORE, Network Equipment-Building System (NEBS) Requirements: Physical Protection, Issue 1, October 1995, pp 4-1 to 4-5.
- ANSI T1.304-1989, Telephone Central Office Equipment-Ambient Temperature and Humidity Requirements.

NOTES:

1. Short term refers to a period of not more than 72 consecutive hours and a total of not more than 15 days in one year. Another description is a total of 260 hours in any given year, but no more than 15 occurrences in that same period.
2. The cooling load for existing equipment shall be sized according to the actual output load of their respective rectifiers. Planned network equipment shall be rated according to the COP engineers' planned values. In situations where the COP engineers' planned values are not available, 40 watts per square foot shall be used. These requirements for determining heat loads are strictly for the equipment footprint including access and service space in the immediate area of the equipment. In areas where no existing or future equipment is indicated, space shall be allowed for future refrigeration and air handling equipment. Provide an easy means of connecting the future equipment to the existing system. Size risers, building openings and shafts for the ultimate load.
3. All ductwork shall be sized for 40 watts per square foot or COP value whichever is higher not to exceed 50 watts per square foot. This pertains only to areas being conditioned for new or future network equipment.
4. Power room loads should be sized for 15% of the equipment room load. It is estimated the rectifiers release 10-15% heat load of the actual output load feeding the network equipment. Confirmation must be made with the manufacturers of the specific rectifiers or AT&T Power Engineering, prior to determining design loads.
5. "Calculated loads" are defined as the measured loads from all existing equipment + COP loads for all forecasted equipment (COP plans) + 40 watts SQ/FT for all adjacent equipment space that has no forecast + all other variables including personnel, lighting, and skin loads.

2.2 Design Assumptions

Environmental systems generally consist of heating, air conditioning, ventilating, water-cooling and refrigeration systems necessary to fulfill one or more of the following functions:

- Operate continuously 24 hours a day, 7 days a week on a year round basis.
- Control the spread of toxic, noxious, corrosive and flammable gases and vapors.
- Control and limit the spread of smoke and other toxic and corrosive products resulting from a fire to support the life safety of building occupants and to protect critical network equipment.

2.3 Reliability and Redundancy

2.3.1 Reliability

The design of any project shall insure the continuous operation of critical systems. (Refer to the Segmentation Strategy as outlined in ACP 760-400-101 page 2-2.)

2.3.2 Redundancy

Mechanical and electrical elements in which Critical Systems are dependent on shall provide redundancy so as to ensure continuous operation of the Critical Systems in the event of unscheduled equipment failures and maintenance downtime. The Basis of Design shall include evaluation of redundant elements and provide an economically feasible resolution of the same.

2.3.3 Redundancy Guidelines

The principal redundancy requirement for any system serving Critical Systems is $N + 1$, where N is the number of units required for 100% full load. Non-Critical Systems are not subject to the aforementioned redundancy guidelines.

2.3.4 Common Mode Failure

The design team shall identify all possible common mode failure points in the system that could have a detrimental effect on the Critical Systems in the event of a failure. All identified common mode failure points shall be included in the Basis of Design along with their resolutions.

System Design Criteria

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System Design Criteria

3

3.1 Overview

This section describes the criteria that apply specifically to the design of environmental systems. It provides requirements for the system configuration, system sizing criteria, design considerations and redundancy.

The environmental systems shall be designed to the conditions shown in Table 2-1. Exceptions to this requirement are noted in the following sections. Based on these criteria, no additional safety factor shall be included in these calculations.

3.2 Site Walkdown

To obtain existing cooling and heating loads a physical inspection of the equipment room shall be made to obtain the following actual values:

- Operating amperage and voltage of the power equipment serving telecommunication equipment in the project area.
- Lighting
- Personnel working in Equipment room and Administrative Areas

3.2.1 Operating Amperage and Voltage of Power Plants

The operating amperage and voltage from all power plants providing power to an equipment room (i.e. rectifiers) shall be determined. All measurements shall be taken from the load side of the device. This data shall be used to determine the wattage of the existing equipment and added to the COP loads for planned equipment. The planned loads shall be designed according to the specified COP planned load. Where this value is unknown, 40 watts per square foot shall be used.

3.2.3 Lighting

The following heat release from lighting shall be used if actual walkdown data cannot be obtained:

- ❖ Equipment Areas – 2.0 watts/ft
- ❖ Administrative Areas – 1.5 watts/ft.

3.2.4 Personnel Working In Equipment Room and Administrative Areas

Obtain a headcount and work schedule.

3.3 Load Estimating and Component Sizing

The sizing of the fan and the refrigeration capacity should be based on the sum of the network equipment heat release total (refer to Note #3 in [section 2.1.7](#)), power equipment heat dissipation, lighting load, people, infiltration, outside air and the envelope load of the building.

Administrative areas typically have thermal loads that vary throughout a 24-hour period and may be small in comparison to other building thermal loads. Hence, these areas shall be served by variable air volume (VAV) systems using low-pressure ductwork and VAV boxes

3.3.1 Loads

The four principal sources of heat in a network building are equipment, lighting, building skin loads and personnel. Accurate HVAC design hinges on accurate determination of the actual loads.

3.3.2 Equipment

Telecommunications equipment produces substantial cooling loads, which are constant throughout the year. Environmental systems serving these equipment areas shall be designed as constant volume systems. The design capacity of air handling equipment and their relative accessories shall be based on the parameters listed in Table 2-1

3.3.3 Determination of Actual Equipment Load

The room air-distribution requirements are determined by evaluating the total and average heat loads and identifying any local hot spots in the area. The following information shall be obtained:

- Equipment layout information
- Total heat release for telecommunications equipment

- Heat release for frames that condition or distribute power.

3.3.3.1 Equipment Layout Information

An accurate layout of installed equipment, as well as the anticipated future growth, must be obtained from Central Office Planning (COP). The heat dissipation will vary for different equipment frames in a system and will not be uniform in an equipment area. COP may supply the information in the following formats.

- COP Layout Drawing (AutoCAD®)
- Manufacturers' Specifications

3.3.3.2 Total Heat Release for Telecommunications Equipment

The capacity of the HVAC air handlers shall be based on actual existing and the COP planned value. The ductwork shall be based on the COP loads or 40 watts per square foot, whichever is greater.

3.3.3.3 Heat Release for Frames which Condition or Distribute Power

Frame equipment such as rectifiers, converters and inverters condition power, which is then delivered to other frames. Frames such as Area Bus Centers and Battery Distribution Fuse Boards do not condition power, but are parts off the power distribution system. These dissipate very little heat. The air handlers and ductwork serving these areas shall satisfy these requirements.

3.4 Refrigeration Systems

3.4.1 Comparison of System Types

Central office cooling systems shall be either direct expansion (DX) systems or hydronic (chilled water) systems.

Direct expansion systems are those in which the refrigerant evaporator is in direct contact with the cooling load. DX units typically utilize refrigerant R-22, which is acceptable for use until the year 2020. Other refrigerant choices are limited. Personnel, whom have previously demonstrated competent installation of refrigerant piping, will be employed for the project.

Hydronic or chilled water cooling systems incorporates central water chilling units with a condenser loop and chilled water loop. Chilled water systems utilize one of a number of refrigerants depending on the type of compressor implemented.

3.5 Condensing Systems

Condensing systems can be characterized as either air-cooled or water-cooled. Cost analysis, as part of the Basis of Design, shall be performed to evaluate different

condensing equipment options. The following factors should be considered during system design selection.

- Level of maintenance required should be considered according to staff availability and/or maintenance response time.
- Systems with a calculated load over 200 tons should have centrifugal chillers with cooling towers unless local water conditions or availability preclude this option.

3.5.1 Water Cooled Condensing Systems

3.5.1.1 Cooling Tower System Design

The condenser water system shall consist of multiple cells in cooling towers and one condenser water pump and cooling tower cell for each chiller. All condenser water pumps shall draw from a common header. Each condenser water pump shall supply cooling water to a dedicated chiller. The cooling water leaving each chiller condenser shall enter a common discharge header feeding the cooling towers. These shall be arranged in a parallel circuit. Water levels should be maintained so neither overflowing nor air entrainment occur. This water quantity also includes all condenser system piping volume and water-in-suspension quantities. Water collected in the tower basin shall flow by gravity to the common condenser pump suction.

Provisions shall be made to allow each cell to be isolated and drained for service without interrupting the operation of the remaining cells.

The tower sump level shall be above the pump casing level in order to ensure positive prime. Further, Net Positive Suction Head Available (NPSHA) shall exceed Net Positive Suction Head Required (NPSHR) for condenser water pumps to eliminate cavitation. The basin design shall minimize vortexing at the basin outlet to reduce air entrainment. Provisions shall include low outlet velocities, vortex breakers or vortex baffles. Automatic float valves shall be installed to maintain a constant water level.

A makeup and fill water system is required, to replace the water lost by evaporation, drift and from blowdown to maintain acceptable water quality and quantity.

When reliable, redundant makeup water feeds are not available, the basin size should be increased to allow for at least 4 hours of continuous operation or furnish a storage tank to provide the 4 hours after Condensing Water Low Level Alarm indication. Provision for connection of a temporary makeup water supply shall be made unless there is an on-site backup water supply.

Special design considerations are necessary if the cooling tower is exposed to subfreezing weather. Exposed piping shall be protected if a cooling tower operates during cold weather. Sump heating shall be incorporated into the design. Freeze protection equipment shall be categorized as ESSENTIAL equipment in electrical plans.

Although open-type cooling towers can provide "free cooling" under conditions of reduced ambient dry bulb and wet bulb temperatures, system designers shall avoid contaminating the Chilled Water system with piping arrangements that supply cooling tower water directly to air handler cooling coils. The condenser Water

System and Chilled Water System must be kept separate. Heat may be transferred between them by means of a heat exchanger.

3.5.1.2 Space Requirements

Hydronic and refrigeration equipment space requirements, including access for servicing and removal of components, must be obtained from the equipment suppliers. It may be useful to have a rule-of-thumb to use as a temporary approximate guideline during a project's early stages, before specific equipment has been selected. AT&T Practice 760-550-208 estimates floor space required for chillers and their associate pumps as listed in Table 3-1.

Table 3-1 Refrigeration Equipment Floor Space Requirements

Equipment	Size (tons)	Space Requirement (ft.)
Reciprocating chiller – 1 unit	<100	20 X 15
Reciprocating chiller – 1 unit	100 – 240	25 x 15
Centrifugal chiller – 1 unit	150 – 500	35 x 20
Centrifugal chiller – 1 unit	500 – 1500	45 x 30

3.6 Hydronic Systems

Hydronic systems transfer heat to or from a space by means of a transfer fluid. Included in this category are chilled water systems, condenser water, hot water heating and other closed loop water systems. Hydronic system piping can be designed in a number of configurations.

3.6.1 Chiller Piping Configuration

The configuration of the central chilled water plant must be piped in parallel arrangement for systems incorporating multiple chillers.

3.6.2 Chilled Water Distribution System Piping

The central chilled water plant configurations include the following:

- Primary-Secondary Systems
- Single Loop Systems

3.6.2.1 Primary-Secondary Systems

Primary-Secondary Systems consist of a primary, constant flow chiller piping loop with a secondary, variable flow distribution loop. The primary loop is constant flow

through all chillers. The secondary loop pressure is controlled by variable frequency drives supplying power to the pump(s). The terminal units (air handlers) are piped with two-port modulating valves, which control chilled water flow through the units cooling coils. If there are four or more air handling systems, a primary/secondary chilled water distribution system shall be used. An air handling system shall be defined as one or more air handling units supplying a common duct system.

3.6.2.2 Single Loop Systems

Single loop systems are comprised of constant flow piping from chillers to terminal units and back again. Two-port modulating valves shall control flow at the terminal units. Constant flow at chillers shall be provided by a pressure controlled by-pass valve assembly.

3.6.3 Chilled Water Return Systems

3.6.3.1 Direct Return

The water returns to the chillers by the shortest possible route. The water supplied to air handlers that are near the chillers travel a shorter distance than the water supplied to more remote air handlers. While this arrangement minimizes the total amount of piping required, it may be difficult to balance due to the pressure differentials at the air handlers.

3.6.4 Piping Installation

Redundant piping is not required unless structural damage from external forces presents a significant risk. All non-redundant systems and elements shall be conservatively designed to reduce the likelihood of failure. Chilled water and condenser water piping shall have shut-off valves and access ports to allow for emergency bypass of critical piping paths. Isolation valves shall be provided in the piping system serving each of the coils.

3.6.4.1 Piping Layout Considerations

Water coils or piping should not be located over network telecommunications or electrical equipment. Avoid areas where a pipe break or a water leak in the heating/cooling coils could cause the failure of the network telecommunications equipment. Where water piping and/or other mechanical equipment is located in network telecommunications equipment spaces, provisions must be made in accordance with the rules given in the Piping Containment section below.

3.6.4.2 Piping Containment

These rules shall be applied to existing facilities or installations where pipes carrying liquids must be located in close proximity to network equipment, rectifiers, battery strings, switchboards, panel-boards and distribution boards for light and power.

Pipes passing directly over electrical equipment shall be supplied with sheet metal drip pans and moisture detectors connected to a local alarm to notify the OSWF of condensation. This rule shall not be interpreted to mean that the entire pipe run shall be equipped with a drip pan if only a short length of pipe passes directly over the electrical equipment. A reasonable length of drip pan should be installed to

prevent drips from falling onto the equipment. Further, the drip pan should be installed as close to the pipe as possible and shall be designed to maximize the working clearance above the electrical equipment. Drip pans are the preferred method of protection. Pipe encapsulation is not required.

Only network equipment, rectifiers, motor control centers, transformers, switchboards, panel-boards and distribution boards for light and power are covered by the above rules. Miscellaneous electrical devices and all other equipment are not subject to the rules stated above.

3.6.5 Expansion Tank Installation

A diaphragm expansion tank is preferred with a 1" connection to a vertical pipe. The tank shall be sized to accept the expansion of the system water from the normal operating temperature to 110 degrees. The tank shall be pre-charged with air to maintain 5 psi minimum pressure at the highest point in the system.

3.6.6 Water Fill

Manually filled systems are essential in situations where antifreeze may need to be added. Low pressure or low-level alarms shall be installed. Manual fill by direct connection to the city water supply can be made using a positive shut-off valve. Filling may be done with a hand-operated or electrically driven pump where adequate city water pressure is not available or for complete isolation of a system from the main water supply system.

On a properly designed system with effective air control, the pressure reducing valve operates when the system pressure falls below the valve setting, to keep the system full of water despite small leaks which may develop.

Automatic fill equipment requires a backflow preventer to guard against system water flowing back into the fresh water supply in the event of supply pressure loss. Most building and plumbing codes have specific requirements for backflow prevention. This must be coordinated with local code.

3.6.6.1 Water Treatment

Provisions for water treatment in condenser water systems to prevent scaling, corrosion, or biological fouling of the condenser water shall be incorporated into the design. A fixed continuous feeding chemical or ozone system shall be installed.

The primary consideration is control of corrosion, which can be achieved through the addition of a corrosion inhibitor. The actual selection of the type of corrosion inhibitor shall be based on site specific hydronic system design and water quality. Installation of monitoring coupons in system piping for periodic monitoring of the system shall be done upon initial installation of the system

3.7 Humidification Systems

Network telecommunications equipment is sensitive to the relative humidity (RH) of the air. Insufficient RH allows static electricity buildup creating a possible service

degrading discharge. Additionally, moisture content of hygroscopic materials must be maintained within the original equipment design limitations to allow proper operation of critical equipment.

3.7.1 Evaluation

The Basis of Design shall include psychrometric chart evaluation of the RH to determine if humidification and or dehumidification equipment is required at each site.

3.7.2 Location

Humidifiers should be located upstream of the coils so that they add moisture to the air before it passes through the cooling or heating coils. The moisture should be fully absorbed into the air stream before contact with the temperature control coils.

3.7.3 Water Source

The evaporated water source and heat source for the humidifier shall be determined from evaluating the available heat sources and the mineral content of the water. Some types of humidifiers can use water from the building's potable water system. Consider all possible sources of evaporation water, including the building's potable water and the availability of de-ionized or reverse osmosis purified water. If appropriate for the type of humidifier selected, automatic rinsing and complete replacement of the evaporation water in the reservoir shall be included to minimize scaling and mineral deposit development.

3.7.4 Controls

Humidifiers shall have automatic controls, including safeguards against moisture carryover, overflow or overheating due to the interruption in water supply or excessive scaling on the heating element. Humidification systems shall be monitored to provide local alarms upon malfunctions of the system components. Humidification systems shall have humidistats placed in sensitive locations to control the overall operation and maintain the proper relative humidity.

3.7.5 Cost Analysis

Specific sites may require humidification of a relatively small area of the network telecommunications equipment room. Among the cost factors that must be considered are:

- Operating cost of water supply and treatment required for the particular humidifier.
- Operating cost of power required to operate the humidifier and the capital cost of providing the power.

- Operating and capital costs of additional refrigeration required in the building HVAC system to remove the energy added by the humidification equipment. In the cases of ultrasonic and evaporative humidifiers, these costs may be negative because the humidification process helps cool the air.
- Maintenance cost.

3.8 Dehumidification

Specific dehumidification equipment shall only be considered when the atmospheric conditions indicate that dehumidification is required in order to meet design parameter and the mechanical cooling system is not required for cooling. The need for dehumidification is rare, and re-heat capacity for dehumidification should not be redundant. The condensate drain pan and associated piping shall be designed to collect and dispose of the moisture generated by the cooling coil.

3.9 Air-Distribution Systems

The air-handling unit and air-distribution system delivers conditioned air to equipment areas, administration areas and building utility areas to maintain the design environmental conditions. Electric power required by the equipment shall be fed from the ESSENTIAL bus.

3.9.1 Temperature Control

Of the various methods for controlling supply air temperature, the use of chilled water cooling coils is the most common. The flow of chilled water through the coils, which cools the supply air, is modulated by a valve under the control the environmental systems control system. The flow control valve is either of the 2 port type, directly controlling total flow in the cooling coil circuit, or the 3 port which regulates flow through the coils by bypassing some of the total flow. 2 port valves are required where a primary/secondary piping system exists and are preferred in primary only systems.

Hot water heating coils are controlled by either 2 or 3 port valves where heating is required. In many installations it is preferable to use electric heating coils, either in the air handler or in the supply ductwork. Reheat coils for temperature control are undesirable. A small support area supplied by network equipment area air should include a parallel type powered induction unit with heat preferably located to draw heat from the Communication Equipment Room as a first stage of heating.

3.9.2 Air Volume Control

On/off fan operation shall not be used for temperature control in network equipment spaces due to the adverse impact on equipment performance. Variable speed drives shall not be used for fan drives serving network equipment areas. The nature of typical telecommunications equipment cooling load calls for a supply airflow that is essentially constant over time. Furthermore, Horizontal Air Throw System (HATS) supply registers used in network equipment space operate only in a narrow air flow

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volume range. Minor adjustments to airflow may be efficiently made by means of variable inlet guide vanes on the air handler fans.

Variable speed fan drives may be appropriate for some applications such as administrative areas with VAV.

3.9.3 Redundancy

3.9.3.1 Air Handlers

In providing a high degree of reliability for areas housing critical network equipment, multiple air handling units are required for each floor. Air handling arrangements shall be sized according to the redundancy principles discussed in the Design Requirements in Chapter 2. Where the measured load is 75% or greater of the total equipment heat release, N + 1 redundancy measures for major equipment are required. However, if the measured load is less than 75% of the total equipment heat release, then redundancy requirements for air handling units **only**, may satisfy N where $N - 1 = 80\%$, where N is the total fans required to carry the full load. In the event of a single air handler failure, 80% of the air requirements and cooling/heating loads must be met. This requirement allows heat gains, in the event of a single air handler failure, to stay within design parameters as listed in Table 2-1. Where the mechanical cooling system is dedicated to the Air Handling Units on a one-to-one basis, N + 1 systems are required.

3.9.4 Ductwork

If practical, it may be desirable to provide cross-connects between separate supply duct systems so that partial cooling of critical spaces may be supplied in the event of total failure of the space's primary cooling system.

3.9.5 Economizer Cycle

The use of an air economizer cycle, wherein cool outside air is the source of supply to an air handler instead of return air from conditioned space, is discussed in AT&T Practice 760-550-210, Air and Water Economy cycles. Even if not justifiable by any other means, it can be an additional backup system to enhance the redundancy of the environmental systems.



NOTES:

For space where the average equipment heat dissipation exceeds 10 watts/ft², ventilation systems capable of handling 100% outside air should be considered.

The following factors must be considered:

- Outdoor temperature and humidity are characteristics of the local area climate. There must be provision made for the protection against freeze-up of indoor heating or cooling coils.
- Building occupancy requirements.

- Compatibility with other building mechanical systems.
- Systems control. Usually a DDC system can control an economizer with little additional hardware.
- Installation costs. Usually this simply involves sizing inlet and exhaust ducts and fans to handle 100% outside air.
- Operation and maintenance costs. Increased loads on the air filtration and humidity control systems must be considered.
- Possible code requirements for smoke venting and economizer operation.

3.9.6 Horizontal Air Throw System (HATS)

The standard air distribution system for AT&T network telecommunications equipment areas shall be the Horizontal Air Throw System (HATS).

3.9.6.1 Application

HATS ductwork design is appropriate at locations containing one or more of the following:

- Heat producing equipment. 20-50 watts/ft² is typical, with local concentrations as high as 80 watts/ft².
- Equipment which must operate uninterrupted for short periods after a failure of the cooling system.
- Areas where rapid room temperature change is a problem for the equipment served.
- Areas where equipment requires clearance from ductwork or adjacent equipment.
- Installations where a self-balancing system is required to allow flexible equipment layouts.

3.9.6.2 System Design Criteria

- Operating duct pressures at registers should not exceed 0.10" wg.
- Direct discharge from registers into adjacent structures or equipment shall be avoided.
- Supply air discharge into the space shall be as high as possible. This is to cool as much of the ceiling space as possible.
- The direction of the air discharge should be parallel to the maintenance aisle, but does not have to be directly over an aisle. One discharge register can supply air for three or four line-ups.

- The maximum air throw shall be 15 feet to 50 feet per minimum threshold. The throw shall be approximately 10 feet when ducts are low due to reduced ceiling heights.
- Face velocities from the registers shall be no more than 250 fpm at 15 foot throw or 200 fpm at 10 foot throw.
- Five foot clearance is desirable between the top of the equipment and the lowest overhead beam, but installations can be engineered with as little as 3½ foot clearance.
- Air return ducts shall not be used to control air distribution. Large enough return paths shall be provided to prevent air velocities over 50 fpm through the equipment area.
- Return air shall be removed from the space at room temperature. This is normally accomplished by low returns (below the top of the equipment frames), so that cold primary air is not removed.

3.9.6.3 Certain Common Design Standards in Conflict with HATS

Conventional design uses airflow patterns for complete distribution. The air velocities used in normal design to provide distribution are designed to disrupt natural convection. HATS uses low air velocities to maintain natural convection.

Conventional design requires use of diffusers that maximize dissipation of the stream into the surrounding air. This can cause airflows that do not settle to the floor. HATS allows the cooling air to sink to the floor by natural convection, making maximum cooling available at equipment level.

Convection is enhanced by maintaining cooling air temperatures as low as possible. The recommended supply air discharge temperature is 55° F. Cooler temperatures may be used if minimum humidity requirements can be satisfied. If variable temperature control design requires air above 60° F, then variable volume control should be used instead.

Selection of supply registers will fall at or below the low end of the manufacturer design scales. The low discharge air velocities minimize the effectiveness of diffuser patterns. Most manufacturers do not recognize these areas of operation, as effective and published data may not be available for the lower velocities.

3.9.6.3.1 Other Design Considerations

HATS is not prone to ceiling influences and cable racking problems. These problems, if encountered, are the result of high air velocities. Large volumes of slow moving air will overcome the normal skip and diffusion problems associated with close equipment layouts.

HATS duct losses are approximately 0.08" w.g. per 100 feet. Duct size must be larger than conventional systems in order to provide the required low static pressure air inherent in the HATS design. Duct sizes for main ducts without directly connected registers may be designed for pressure losses not to exceed 0.2" w.g. per 100 feet.

3.9.6.4 Conventional Air Distribution System

Where HATS is deemed inappropriate due to existing obstructions, available building space constraints or other functional limitations, a conventional air distribution system may be used for cooling in the network equipment area.

The assembly of air ducts over cable racks, lights, and equipment for a typical arrangement in electronic switching offices is a Conventional Air Distribution System still in use throughout the network that most resembles HATS. In this arrangement, the air is injected into the room at the 10 ft. (3m) level from duct-mounted diffusers and registers. The spacing of the diffusers is determined by the amount of cooling air required and where it must be delivered.

Refer to AT&T Practice 760-550-218, Issue 1 (1983), KS-21344 *Air Diffuser Performance – Data and Application Guidelines, for information about conventional systems using KS diffusers.*

3.9.6.5 General Construction Requirements for HATS and Conventional Systems

All penetrations in mechanical equipment room floors shall be sleeved and sealed water-tight. Retaining curbs or gutters shall be provided at the mechanical equipment room doors to prevent flooding of the central office equipment room.

All duct connections to the air handling units shall be made with a flexible connection. A braided grounding strap shall be installed across all flexible duct connectors. Air handling equipment and ductwork shall be designed for vibration levels.

Volume dampers shall be provided on all branch duct connections to the supply main for balancing of the distribution system. Volume dampers shall be provided at all registers and diffusers. Where outlets are connected by means of a spin-in connector and flexible duct, provide a damper in the spin-in connector and not in the outlet.

The installation of all environmental systems equipment shall satisfy, at minimum, applicable local seismic and wind design load codes. Refer to AT&T Practices on Seismic Design Systems and Wind Load Design.

3.9.6.6 Location of HVAC Equipment

Refer to AT&T Practice 760-550-208, Engineering Guide for Ventilating and Air Conditioning – Design Parameters and General Planning Information.

3.9.6.7 Clearances in Telecommunication Equipment Rooms

Allot a minimum of 10 feet of vertical clear space from the floor to any mechanical work.

3.9.7 Ventilation

3.9.7.1 Outside Air and Exhaust Requirements

The outside air/exhaust system shall provide the amount of outside air required by the ASHRAE Standard 62-1989 or local code, whichever is the most stringent.

Excessive amounts of outside air shall be avoided to minimize the loads on the air filtration, cooling and humidity control systems. Outside air intakes shall be located to minimize contaminants entering the building.

Network telecommunications equipment space shall be slightly positively pressurized to help exclude dust. Engine rooms shall be either neutral or slightly negatively pressurized to prevent dust and odors from migrating to other parts of the buildings.

For additional ventilation guidelines and requirements, refer to AT&T Practice 010-160-170, *Indoor Air Quality Guidelines*.

3.9.7.2 Non-Conditioned Spaces

Building areas using only outside air for cooling shall be insulated and air-sealed from conditioned areas. Where air flow is restricted, both supply and exhaust fans shall be used, so that large static pressure differences between conditioned and non-conditioned spaces are avoided. A control system with outdoor and indoor sensors shall control the fans in order to maintain design parameters.

3.9.7.3 Mechanical and Engine Rooms

Mechanical/Chiller rooms and standby generator rooms normally are not conditioned. In certain climatic zones air conditioning is required to provide for the proper performance of the equipment. If not conditioned, ventilation of these spaces shall be in accordance to AT&T Practice 760-550-151, Ventilation of Transformer Vaults, Heating Plants, Power Room, Internal Combustion Rooms, and Gas Meter Compartments.

Mechanical Equipment Rooms containing refrigeration equipment shall be vented to the outdoors using a powered mechanical ventilation system that is independent from all other building ventilation systems. The mechanical ventilation system shall operate when people occupy the Mechanical Room, at a rate of 0.5 cfm/ft² room area. The exhaust fan shall be capable of continuously maintaining the room at a static pressure of 0.05" wg below adjacent spaces and removing refrigerant from the room at the rate of

$$Q = 100 G^{0.5}$$

Where Q is the airflow in cfm and G is the amount of refrigerant in pounds in the largest system, any part of which is in the room. The exhaust inlet shall be between 18 in. and 5 ft. above the floor. A refrigerant sensor or oxygen depletion sensor shall be mounted within 18" of the floor and will activate the exhaust system at the required rate whenever the oxygen concentration drops below 19.5% by volume or when refrigerant vapor concentration approaches the Threshold Limit Value. For additional requirements and information refer to AT&T Practice 760-550-208, *Engineering Guide for Ventilation and Air-Conditioning – Design Parameters and General Planning Information*.

3.9.7.4 Filtration

Network telecommunications switching equipment is very sensitive to airborne dust particles. The relatively low costs of filtration systems far outweigh the losses that can occur through equipment malfunction resulting from airborne contamination. Protection from the detrimental effects of airborne particles is required for all areas containing network telecommunications equipment. All air shall be filtered before entering the ventilated space. Minimum filtration shall be 25%. Finer filtration may be required, depending on the use of the space and outside condition.

Bellcore GR-63-CORE (NEBS) specifies that network telecommunications equipment space have a Total Particulate Content of less than $25\mu\text{g}/\text{m}^3$. The measurement is made by a dichotomous sampler with a 15 micron inlet, yielding a measure of the amount of all particulate small enough to stay in suspension.

In non-telecommunications equipment spaces, such as mechanical equipment rooms, switchgear rooms, or electrical rooms, use single filters of the 25-30% dust spot efficiency range, located across intake louvers to reduce lint or dirt from settling in these areas.

All filters shall be Class I or II, UL listed and rated for the efficiency based on the ASHRAE Standard 52.1-1992.

3.10 Heating Systems

3.10.1 Heating Plant

Steel boilers of the fire-tube design are recommended with capacities up to 50 MBTUH and where the heating requirements will not vary greatly from the initial load over the life of the boiler.

The heating plant and room requirements shall conform to the applicable local and national codes, American Society of Mechanical Engineers (ASME), and all applicable standards.

3.10.2 Design Criteria

- The selection of the heating plant is determined by an evaluation of the building loads. Low temperature water systems, such as water temperatures up to 200° F is preferred.
- Closed hydronic systems should be used whenever possible
- Mechanical seals are required for all closed system circulating pumps.
- Automatic air vents should be used in conjunction with manual air vents where initial venting of high points is necessary to fill the system with water.
- Air Separators should be used where the operating water temperature is more than 50 degrees different from the "off" or room temperature.
- Heat recovery should be reviewed in buildings where there is a potential for re-use of the energy from high heat producing equipment.

- Boiler water temperatures must never be lower than the flue gas dew point temperature.
- The boiler water temperature should not be below 170° F as boiler temperature is reset when the outdoor temperature increases. The minimum return water temperature is typically 150° F. Maintaining minimum temperatures will prevent condensing of flue gases.
- Hot water boilers should be installed so that there is continuous water circulation through the boiler under all operating conditions. The minimum circulation rate shall be 1 gpm per 33,000 BTUH boiler input. Providing a 3-way mixing valve may be needed to insure this condition.
- Thermal shock should be avoided.
- The boiler burner shall be held in the low-fire position a minimum of 30 minutes if the boiler has not operated within the last 4 hours.
- Combustion air shall be provided and in colder climates shall be preheated to at least 40° F to prevent freeze-up of adjacent water piping, and to at least 60° F when combustion air comes into contact with personnel.
- All pipes, valves and fittings shall comply with ANSI/ASME Standard B-31.9, Building Services Piping
- Hot water coils or piping are not permitted over network telecommunications or electrical equipment.
- Any water pipes present in network telecommunications rooms must follow the design criteria described in Section 3.6.5.2 *Piping Containment*.

3.10.3 Pumps

Pumps shall operate in parallel, with each pump providing its share of flow at the required head. Should one pump fail, the remaining pumps shall provide a minimum of 60% of design flow.

Selected pumps should operate slightly to the left of the peak efficiency point of the curve and should have a flat head characteristic. This prevents undesirable pump operation, overloading, or reduction in available head across maximum pressure drop circuits. Base-mounted pumps are preferred for primary pumps; inline pumps may be used for the secondary pumps.

The final piping system configuration shall be designed such that lower pump operating heads and initial costs will be considered. Net positive suction head for the system must be calculated and checked against the required net positive suction head of the pump.

3.10.4 Heating in Spaces

Direct electric heating systems are preferred over hot water heating systems. Heating can be accomplished utilizing duct heaters, electric unit heaters or strip heaters.

Administrative spaces within a network telecommunications equipment floor, having a small area compared to the network telecommunications equipment floor, and

requiring heat shall be provided with electric baseboard, electric unit heaters or electric duct heaters. This is preferable to a hydronic system.

Mechanical equipment rooms or others areas requiring heating shall be provided with thermostatically controlled electric unit heaters.

Fan-powered induction units to serve bathrooms or lobbies often provide the best utilization of room air from the network telecommunications equipment space that would otherwise be lost through exhaust.

It is not necessary to provide power to any electric heating device from the ESSENTIAL bus unless that device is required for maintaining environmental conditions in critical equipment space as specified in Table 2-1.

3.10.5 Hot Water Heating

Administration spaces occupying whole floors and requiring heating shall be provided with a forced-air, hot water hydronic systems. If the administrative floor is located over a network telecommunications equipment floor, the floor must be watertight. Piping systems constructed above or within network telecommunications equipment areas shall conform to the additional containment requirements described in Section 3.6.5.2 *Piping Containment*.

Hot water coils shall be provided and confined to the air handling unit and if hot water from a heating plant is available. An electric coil shall be installed in the air handling unit if hot water is not available. Hot water coils and/or water piping shall be limited to the mechanical room.

3.10.6 Safety Devices

Water coils shall be protected from freezing.

The system shall be provided with automatic controls to allow for system surveillance. Fail safe devices shall be incorporated, including low-water cut-off, and relief devices as required by the ASME Boiler and Pressure Vessel Code.

Electric duct heaters shall be equipped with approved automatic reset air outlet temperature limit control set at no more than 200° F. The electric elements of the heater shall be equipped with fusible links or a manual reset temperature limit control that will prevent outlet temperatures greater than 250° F. An airflow proving switch shall be incorporated in the design to prevent the heater from energizing when there is no airflow.

Combustion-type heating plant enclosures shall be separated from the rest of the building by 1 hour fire-rated wall, ceiling and floor, or as local code mandates, whichever is more stringent. Combustion air shall be brought from the outdoors, per applicable codes. In areas of freezing weather, a motorized damper may be installed to avoid freezing pipes in heating plant areas. The damper must be interlocked with the burner controls so that the boiler cannot operate unless the combustion air damper is open. In locations where heating plant enclosures are not adjacent to an outside wall, electric fans and metal intake ducts can be used to bring in air for combustion and ventilation. The ducts must have fire dampers wherever they penetrate fire-rated partitions. The boiler control and electric fans shall be interlocked with the fire dampers so that the burner cannot operate if the fire dampers are closed

Refer to AT&T Practice 760-530-108, *Heating Plant controls – Description and Installation*, 760-530-110, *Flame Safeguard Controls – Fuel Burning Heating Plants – Description*, and 760-550-151, *Ventilation of Transformer Vaults, Heating Plants, Power Rooms, Internal combustion Rooms, and Gas Meter Compartments*.

3.11 Fire Protection Systems

3.11.1 Fire Dampers and Fire Seals

Air distribution system design shall consider fire area requirements as specified in AT&T Practice 760-630-400, *Fire Safety Compartmentalization*, used in conjunction with NFPA 90A, *Installation of Air Conditioning Systems and Ventilating Systems*. Ductwork penetrations through the fire rated walls shall be provided with fire dampers of the same fire rating. Fire dampers in the systems serving multiple fire areas, shall be capable of closing under full flow conditions, and shall not affect airflow to other areas. An access panel or door shall be provided adjacent to the fire damper.

Fire rated seals complying with UL 1479, *Fire Tests of Through Penetration Fire Stops*, matching the fire rating of the wall being penetrated shall be provided for pipe and conduit penetrations through fire rated walls. 3M Fire Protection Products and Fire Stopping Materials shall be used exclusively within AT&T Facilities. Substitutions are strictly prohibited.

3.11.2 Ventilation for Control of Flammable and Combustible Vapors

The following areas have the possibility of flammable or combustible vapors being present: Network communications power rooms, engine-driven standby generator rooms, boiler rooms, flammable liquid storage areas. These areas require adequate ventilation and shall be designed and installed to prevent vapor concentration from reaching the flammable limits listed in NFPA 325M, *Fire Hazard Properties of Flammable Liquids, Gasses, Volatile Solids*. The installation of sensing devices to initiate forced ventilation of the space shall be provided for hydrogen gas or hydrocarbon vapors where applicable and other specific emissions when required by NFPA, UFC, UBC, or local codes. The exhaust ventilation shall be a separate system, discharging directly to the outdoors. For engine-driven standby generators and boiler rooms, interface between dilution ventilation and combustion air supply shall be considered. In addition, for air-cooled engines and indoor mounted engine radiators, consideration shall be given to interface dilution ventilation with the cooling air.

The two most prevalent combustible vapors encountered in AT&T structures are hydrogen and hydrocarbons.

3.11.2.1 Ventilation of DC Power Areas:

Hydrogen buildup in DC Power areas can be controlled by exhausting relatively small quantities of air from the space, as discussed in AT&T Standard BLDV-ENV-001. Hydrocarbons can originate from sources such methane from a cable vault,

diesel or other fuel evaporated from the fuel tank for standby generator or boiler. The following design criteria for exhausting these gases shall be followed:

- The minimum ventilation rates for power plants shall be based on the requirements of AT&T Power and Infrastructure Standard BLDG-ENVL-001, *Calculating Sufficient Battery Area Ventilation to Maintain a Hydrogen Level at or below 0.8% by Volume*, or local code requirements, whichever is greater. When power plants are not separated from other areas such as network equipment, the ventilation rate for the power plant shall be based on the area occupied by the power plant only. The power plant shall include the area occupied by the batteries and the rectifiers (footprint of equipment only).
- Hydrogen sensors for power plants are not required, but any new control system installed shall have the capability to provide and/or accept a hydrogen sensor input to accommodate possible future retrofit.
- Hydrocarbon sensors shall be in addition to leak detection sensors required by the building alarm specifications. The sensors will operate the fan(s) when a concentration equal to 25% of the Lower Explosive Limit of the fuel stored in the tanks (reference NFPA 49, *Hazardous Chemicals Data*). This sensor will also be coordinated with the central DDC and the building alarm to notify the OSWF of the concentration level of the fuel vapor in the storage tank area.
- Return air from DC Power areas can be recirculated, as long as the minimum amount of air determined in Item 1 above is exhausted to outside.
- DC Power areas can share air handling units with other use spaces as long as the minimum amount of air determined in Item 1 above is exhausted to outside.
- DC Power areas can share air handling units with other use spaces as long as the minimum amount of air determined in Item 1 above is exhausted to the outside, and AT&T and local code requirements for ventilation of the other use spaces are satisfied.
- DC Power areas can share space with network equipment areas without being isolated from these areas by permanent partitions.
- DC Power areas can be non-conditioned spaces, as long as the space environmental conditions described in Table 2-1 are maintained.
- "N + 1" exhaust fan redundancy during "normal" (trickle charge) power plant operation, and total exhaust fan capacity for ventilation during full charge power plant operation is mandatory
- The exhaust fan status shall be monitored by the building alarm system.

3.11.2.2 Smoke Control

Air distribution systems shall incorporate provisions for smoke control and purging if required by local code. When smoke control and purge capabilities are required, they shall be designed in accordance with AT&T Practice 760-640-110, *Fire Safety Considerations for Smoke Control*, NFPA 90A, *Installation of Air Conditioning Systems and Ventilating Systems*, NFPA 92A, *Smoke Control Systems*, and any requirements of local codes.

Smoke control shall include coordination of the HVAC supporting adjacent areas, immediately overriding normal operation, for maintaining a pressure differential as required in NFPA 90A and NFPA 92A. Smoke purge activation shall take

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precedence over all other programs within the DDC and will be set for a predetermined period upon activation. The smoke purge shall have manual reset capabilities after system operation.

3.12 Noise and Vibration Design

3.12.1 Acoustic Isolation

Design criteria to achieve satisfactory noise control is as follows:

- Seal all duct, pipe and conduit penetrations in the Mechanical Room wall, floor and ceiling with filler such as mineral wool or fiberglass and flexible caulking compound, except where fire-stopping materials are required.
- Mount rotating equipment on isolators except where equipment is mounted on slab on grade.
- Use flexible connections between noisy equipment and ducts, pipes and conduits, so that sound will not be transmitted along them.

Duct sound traps may be used to provide additional quieting in administrative areas and conference rooms. Fibrous internal duct lining must never be used in network equipment buildings because of the possibility of fibers flaking off and being carried by the supply air stream into the telecommunications equipment. "Hospital-type" linings are acceptable.

3.12.2 Vibration Isolation

Vibrations from rotating or reciprocating equipment mounted in basements or on grade seldom cause problems in the rest of the building. For equipment mounted elsewhere, the following vibration isolation methods are recommended:

- Mount rotating equipment on spring isolators.
- Connect piping to vibrating equipment with flexible vibration isolators.
- Support the piping in mechanical areas with vibration isolation mountings.

3.13 Wind Design

Environmental systems and any other equipment vital to the operation of network telecommunications equipment shall be designed and installed to function during and after severe wind conditions or other natural phenomena and safeguard against equipment overturning and dislocation of piping, ductwork or equipment.

In order to ensure pressure boundary integrity of fluid system components (e.g., piping tanks, etc.) during a high wind condition, they shall be designed in accordance with the high wind design requirements of the applicable design code (e.g., ANSI B31.1, ANSI B31.9, ASME B&PV Code Section VIII).

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Mechanical Equipment Design Criteria

4

4.1 Overview

To ensure reliability of the network environmental systems serving critical areas, all mechanical equipment shall be of a heavy-duty fabrication, with components, such as electric motors, bearings and other mechanical devices, selected for long and reliable life. Standardization of the mechanical equipment shall be utilized to the maximum extent possible to reduce spare parts inventory, without sacrificing system performance and efficiency.

For all mechanical equipment sized only for installed load, provisions shall be made for future system expansion up to levels specified in Table 2-1 "Summary of Design Parameters." Incorporation of design features shall be considered, such as fan speed change capability, or provision for fan inlet vane position control, providing space for future banks of cooling or heating coils in the air handling equipment, or selection of pump sizes which allow for larger impellers. Efforts shall be made, within this context, to optimize component performance and efficiency.

Physical arrangement of system components shall incorporate requirements for routine systems maintenance and adequate space for removal of components requiring periodic replacement, with as little effect on the operating system as possible. Provisions shall be made to operate high-mounted manual valves from floor level.

Major mechanical equipment such as chillers, pumps, boilers, cooling towers and large fans shall be factory operated and tested or certified to meet or exceed performance requirements of applicable codes and standards listed below.

4.2 Refrigeration Equipment

4.2.1 Chillers

4.2.1.1 Performance Ratings

Chillers shall be factory certified by manufacturer to verify the overall performance, including proper operation of the control and safety devices. The chiller Coefficient of Performance (COP) shall be not less than 0.75 unless the unit is of the absorption type. The chiller Energy Efficiency Ratio (EER) shall not be less than 12 BTU/watt-hour, as tested per Air Conditioning and Refrigeration Institute (ARI) Standard 590, *Reciprocating Water Chilling Packages*, for reciprocating and ARI Standard 550, *Centrifugal or Rotary Screw Water Chilling Packages*, for screw type units at ARI standard rating conditions. The Integrated Part Load Value (IPLV) and Application Part Load Value (APLV) shall be determined, based on tests conforming to the ARI, Standard 550. The IPLV efficiency shall be not less than 0.6 kW per ton.

4.2.1.2 Controls and Alarms

The following safety controls and alarms shall be included on all compressor type chillers installed in network telecommunications equipment buildings and shall be installed per ASHRAE Standard 15-1994, *Safety Code for Mechanical Refrigeration*:

- High condenser pressure
- Low refrigerant pressure or temperature
- High oil temperature or bearing high temperature
- High motor temperature (hermetic machines only)
- Motor overload
- Low oil sump temperature
- Low oil pressure
- Chilled liquid flow interlock
- Condenser water flow interlock
- Low chilled liquid temperature (freeze protection)
- Relief valves
- Time delay relay – prevents compressor from restarting for a specified time after shut down.

4.2.1.3 Manufacturers

The following vendors shall be used for chiller units:

- Carrier Corp.
- Trane Co.
- York Co.

4.2.1.4 Refrigerants

R-22, R-123 and R-134a are acceptable refrigerants.

4.2.1.5 Capacity Control

Centrifugal chillers have a capacity reduction system to match compressor output with the cooling load for energy efficiency. The preferred load control methods in order from most favored to least are:

- Variable Speed Drive: Motor speed and compressor pre-rotation vane positions are adjusted independently for maximum part-load efficiency.
- Microprocessor Control: Chiller capacity can be varied according to the Chilled Water Return temperature. This ties the chiller output to the actual building cooling load.
- Demand Limiter: The motor current draw is limited by stops that limit the positions of the pre-rotation vanes.
- Chilled Water Control: A motor operator positions compressor pre-rotation vanes to regulate CHW temperature.

4.2.1.6 Absorption Equipment

Absorption equipment is available in capacities from 100 to 1700 tons. In the event absorption equipment is chosen the design basis document must clearly demonstrate one of the following reasons.

1. The installation is a replacement of an existing absorption chiller and an electric chiller cannot be used as a replacement without extensive modification of the existing building infrastructure. Such as the requirement of a new electric service and switchgear.
2. Utility Company rebates or incentives result in a substantial saving over the installation of a conventional chiller system and the incentives or rebates can be contracted long term (minimum of 5 years).

4.2.1.7 Safety and Operating controls

The following are required:

- Chilled Water Low Limit
- Pump Interlock
- Water Flow Switch – shut down the unit on loss of CHW or CW flow.
- Condenser Water Temperature Control
- Chilled Water Temperature Control
- Steam Pressure Control
- Hot Water Control

4.2.1.8 System Selection

Below are the ASHRAE recommended chiller types for the sizes shown. Central offices that have greater than a 200 ton building cooling load shall use centrifugal or

AT&T — PROPRIETARY

Use pursuant to Company instructions

4-3

Network Mechanical Standards

screw chillers with water-cooled condenser systems unless local water quality or availability prevent reliable operation.

Chiller Selection Guidelines (per ASHRAE Equipment Handbook, 1988, page 17.4)

Load	Type of Equipment
Up to 25 tons (88 kW)	Reciprocating
25 to 80 tons (88 to 280 kW)	Screw or reciprocating
80 to 200 tons (280 to 700 kW)	Screw, reciprocating, or centrifugal
200 to 800 tons (700 to 2800 kW)	Screw or centrifugal
Above 800 tons (2800 kW)	Centrifugal

4.2.1.9 Other Design Considerations

- **Diversity:** The system should be designed to provide diversity over varying building loads. This can be accomplished by installing multiple chillers in parallel to allow installed cooling capacity to exceed normal building load, which will permit cooling to be produced by any number of chillers.
- **Constructibility:** Avoid major building retrofit to accommodate equipment, if possible. Installation should accommodate future replacement and upgrade of equipment and the access required to accomplish these items.
- **Redundancy:** Main chiller systems shall be provided with multiple chillers. Sizing of the chillers shall be such that 100% of the critical equipment building load capacity can be provided should any one chiller fail.
- **Power Supply:** Central chiller plant equipment including, but not limited to, chillers, chilled water pumps, condensing water pumps and all associated controls shall be connected to essential building power.

4.2.1.10 DX Cooling Systems

DX systems shall be installed by qualified personnel with demonstrated experience in the installation of refrigerant piping. In split systems the EER shall not be less than 12 BTU/watt-hour at ARI standard rating conditions, as tested per ARI Standard 360, *Commercial and Industrial Unitary Air Conditioning Equipment*, and ARI Standard 365, *Commercial and Industrial Unitary Air Conditioning Condensing*.

The following vendors shall be used for the packaged and split DX equipment:

- Carrier Corp.
- Trane Co.
- York International

4.2.1.11 Containment of Existing Refrigerants

For chillers less than 15 years old and in good condition, containment may be an alternative even more economical than retrofit.

⇒ NOTE:

Prior to a containment strategy being implemented the expected life cycle costs of containment versus the replacement costs for the chiller must be calculated and included in the Design Basis documents.

Since current legislation phases out only the production of CFC refrigerants, the use of CFC refrigerants may continue as long as supplies exist. However, prices of these refrigerants will continue to rise, as will excise taxes on them. The industry's focus on responsible refrigerant management could ensure ample CFC supplies. A significant amount is expected to be reclaimed and recycled from old chillers as they are retired.

A variety of products are available to minimize CFC emissions and losses:

- Refrigeration storage and recycling equipment
- High efficiency purge unit- preserves up to 99% of the refrigerant during purging.
- Pressurization device, for air and moisture inward leak prevention.
- Relief valve and rupture disk- prevents refrigerant charge from being vented in an overpressure emergency

4.2.1.12 Retrofit Evaluation Process

Assemble the following information.

- Make, model, nominal size (tons)
- Operating history (commissioning date, total operating hours, service history, present condition, estimated efficiency at average load)
- System arrangement
- Original system design load, entering and leaving CHW and CW temperatures and flow rates
- Current system design load, entering and leaving CHW and CW temperatures and flow rates
- Access and space available for replacement chiller

Evaluation criteria:

- Age: Chillers more than 20 years old are good candidates for replacement because they are reaching the end of their useful life. Furthermore, new chillers are far more efficient. Chillers 10 to 20 years old may or may not be candidates for replacement, depending on the respective efficiencies of the proposed new, retrofitted and existing units for the anticipated loads. Retrofits typically cost 20-40% of installed new chillers. Chillers 2 to 10 years are good candidates for conversion to an alternative refrigerant. These new machines usually are more efficient and have much of their useful lives remaining. The best time for a

retrofit is during a scheduled overhaul, usually at 7-10 years, as recommended by the manufacturer. This will result in substantial cost savings.

- Type: Reciprocating and screw chiller retrofits are nearly as expensive as replacements and may have much less capacity, so replacement is usually a better option. Low-pressure, single-stage, open drive centrifugal chillers can easily be converted from R-11 to R-123. New gear sets can provide the required capacity. High pressure, single-stage, open drive centrifugal chillers can easily be converted from R-12 or R-500 to R-134a. The compressor mineral oil must be replaced with an ester-based synthetic oil. Multistage centrifugal chillers can also be converted, but these conversions may be more elaborate and may require custom-made components. Hermetic machines may also be converted, with the replacement of impellers, motors or complete compressors, and other parts whose materials are incompatible with the new refrigerant.

4.2.2 Cooling Towers

Induced draft cross-flow or counter-flow cooling towers with axial fans. Fans shall be gear reducer or power band driven. Cold and hot water basins shall be 304 stainless steel. Other steel components may be stainless steel or galvanized. Hot water distribution pans, if used, shall be covered. Fill and drift eliminators shall be non-corrosive and non-combustible. Provide access ladder and handrails when access to the top of the tower is required for service. The cooling tower performance shall be CTI certified.

The following vendors shall be used for cooling towers:

- Baltimore Aircoil
- Marley Cooling Towers
- Evapco, Inc.

4.2.3 Piping

Piping shall be in accordance with Chapter 42, Table 5, 1992 ASHRAE, *Equipment Handbook*, for both refrigerant and recirculating (hydronic) water systems. Piping shall be installed per local codes and per ANSI/ASME B31.5, *Refrigerant Piping*, and ASHRAE 15 for refrigerant piping and per ANSI/ASME B31.9 *Building Services Piping*, for hydronic system piping.

Pressure and temperatures for HVAC systems shall be established during the system design phase. This information shall be maintained in the Basis of Design.

For each piping system, a pipe class shall be selected which equals or exceeds the maximum allowable system design temperature and pressure. Piping for all systems shall be rated for a minimum working pressure of 150 psi.

All buried piping shall be heavy walled, minimum Schedule 80, bituminous coated and wrapped with protective tape to minimize damage by corrosion. Provide thrust blocks and or swing joints where required for piping flexibility. Installation shall be per UPC or applicable local code.

NOTE: Use of PVC pipe in AT&T facilities are prohibited. Use of flexible connections in the piping system shall be limited to mechanical equipment rooms.

Similarly, threaded joints shall also be limited to the mechanical equipment rooms and shall not be used in the network telecommunications equipment rooms, within pipe chases, or other inconspicuous areas within the building.

Provisions shall be made in the design of the piping system to minimize the stresses due to vibration isolators, loop expansion joints and hangers.

The piping system design shall incorporate strategically located flow alarms, to minimize the damage due to potential pipe breaks in the network telecommunications equipment rooms. Provisions shall be made for orderly drainage of the water in mechanical equipment rooms and electronic equipment rooms during any catastrophic leak.

Balancing stations shall be provided for ease of periodic balancing of the hydronic systems.

Dielectric connections shall be used where dissimilar piping materials join.

4.2.4 Pumps

Pumps for chilled, condenser, and hot water systems shall be centrifugal, base mounted, end suction or horizontal split casing design. Pumps shall be provided with mechanical seals. Bearings shall be selected for a minimum calculated life of 100,000 hours, per Subsection 5.2 of AFBMA/ANSI-9, *Load Ratings and Fatigue Life for Ball Bearings*, and AFBMA/ANSI 11, *Load Ratings and Fatigue Life for Roller Bearings*. Single or variable speed pump drive motors shall be selected for non-overloading characteristic at any point on the pump curve. Motor speed shall not exceed 1750 rpm. Minimum efficiency of motors shall be 85%

Pumps shall be designed, manufactured, tested and certified in accordance with applicable Hydraulic Institute standards for the type of pump and UL® 778, *Motor Operated Water Pumps*.

Where required, vibration isolators, between the pump base and supporting structure, shall be provided.

The following pump manufacturers shall be used:

- Aurora
- Goulds Pumps, Inc.
- ITT-Bell & Gossett, Division
- Ingersol-Rand Co.
- Paco
- Taco

4.2.5 Humidification Equipment

All humidifiers shall be UL® listed. The humidifier shall be supplied by a manufacturer as a packaged unit, including necessary appurtenant equipment, and be installed in compliance with manufacturer's guidelines.

The units shall be designed to include all safeguards and alarm points described under the Systems Design Criteria tab and include all associated piping systems required. The units shall have adequate anchoring pints to ensure compliance with Seismic Bracing required for the facility's Seismic Zone.

If appropriate for the type of humidifier used, back flushing will be done periodically to preclude the build up of algae, bacteria and scaling. For this purpose an automatic back flushing device shall be incorporated into the unit at the factory. At installation the back flush interval shall be incorporated into the unit at the factory. At installation the back flush interval shall be set per manufacturer's recommendations or based upon the previous experience of the site Building Operations Technician.

4.3 Air Distribution Equipment

4.3.1 Air Handling Equipment

Air handling units shall be designed for 30-year life for both factory assembled or field erected units. Fan systems designed for operating total pressure of 4" or less shall be a minimum of Class II rated fan all others shall be Class III. When design requirements result in a question between a Class II or Class III air handling unit the Class III is preferred. The air handling units shall comply with *Air Movement and Control Association (AMCA) Standard 210, Laboratory Methods of Testing fans for Rating*, and *AMCA 500, Test Methods for Louvers, Dampers, and Shutters*, and *ARI Standard 4430, Central Station Air Handling Units*.

4.3.1.1 Sizing

The air handling units shall be sized for a maximum face velocity of 500 fpm through the cooling coil. Chilled water coils shall be selected for water temperature rise of approximately 10°F. The mechanical equipment schedule shall indicate fan performance (cfm and bfp) for each air handler at the intended operating point. Fan motors shall be sized to prevent motor overload during fan pressure deviations caused by occasional opening of access doors or damper malfunctions while sizing for maximum possible load operation at the intended fan operating point. Space shall be provided for retrofit to larger motors when needed for future system upgrade. See Table 2-1. "Summary of Design Parameters."

The system design pressures shall be based on the maximum pressure differential developed during normal, emergency (closure of the smoke or fire dampers) or upset (inadvertent closure of dampers) modes of system operation. For the most economical design, portions of the ductwork in high pressure systems, not subjected to pressure transients, shall be designed for the section specific, normal operating pressures.

4.3.1.2 Insulation

The air handling units shall be insulated as necessary for heat transfer and noise control. The insulation, installed so that insulation particles cannot enter the conditioned air stream, shall comply with NFPA 90A, *Installation of Air Conditioning Systems and Ventilating Systems*.

4.3.1.3 Motors

Electric motors shall conform to all applicable National Electrical Manufacturers Association (NEMA) Standards for that type of motor. They shall be of the "high-efficiency" type. Air handling unit electrical appurtenances shall be UL® listed.

4.3.1.4 Fans

Application: This Section applies to all fans used for moving building ventilation, exhaust, transfer and conditioned supply air.

Fan Selection: Only fans satisfying AMCA standards shall be used. Fans shall be selected based on the maximum efficiency and lowest sound level criteria available when serving administration spaces or quiet areas that do not have normal transient noise in excess of the fan noise produced through the system. All others shall be selected to a sound level that does not exceed the transient noise in the environment being served for the specified duty. Specified rating shall include the system effect factor, based on the fan inlet and outlet duct configuration. Selection of the fans in parallel operation shall preclude operation in unstable region. Vaneaxial fans shall be of adjustable blade construction only where the available air handler space does not allow for future installation of additional fan units thereby requiring the blade adjustment to allow for current sizing as well as future expansion. Typically, tube axial fans shall not be specified. Propeller fans shall not be used in ducted systems.

Bearings: Fan bearings shall be selected for a minimum calculated life of 200,000 hours, per subsection 5.2 of ANSI/AFBMA-0 and 11. Where required, vibration isolators, between the fan base and the supporting structure, shall be provided.

Installation: Sound attenuators shall be provided, if required, to comply with the design noise criteria. Centrifugal fans with power requirements exceeding 3 horsepower, shall be belt driven, with provisions for not less than 10% speed adjustment. Fan brake horsepower shall not exceed motor nameplate horsepower at specified duty.

Testing: All fans shall be tested in accordance with AMCA Standard 210 and rated in accordance with AMCA Publication 211, *Certified Ratings Program – Air Performance*.

4.3.1.5 Mixing Plenum

The mixing plenum design shall incorporate provisions for prevention of thermal air stratification. The use of an air blender may be appropriate.

4.3.1.6 Cooling Coils

Cooling coil materials shall be compatible with the local air quality. Where high concentrations of industrial gases such as sulfur dioxide, hydrogen sulfide, carbon dioxide or salt are present, copper tubes with copper fin coil construction shall be considered. Since the inlet and outlet headers are not insulated and subject to surface condensation, copper headers shall be specified to reduce surface corrosion. Maximum coil face velocity shall not exceed 500 fpm.

NOTE:

Standard coil materials are adequate for the majority of AT&T installations. Upgraded materials shall be considered appropriate in areas of known or

suspected corrosive atmosphere. Life cycle analysis should be performed in all questionable cases.

4.3.1.7 Heating Coils

Hot water or electric coils shall be provided if heating is required. Protection of water coils from freezing shall be incorporated by maintaining continuous water flow by provision of bypass dampers or other means. Maximum coil face velocity shall not exceed 800 fpm. See also Heating Equipment under this tab.

4.3.1.8 Duct Construction Standards

All environmental systems ductwork shall be designed in accordance with the latest edition of Sheet Metal and Air Conditioning Contractors National Association (SMACNA), HVAC Duct System Design and HVAC Duct Construction Standards, amended as follows:

- Transverse joints (cross joints) shall be of angle reinforced standing seam, welded companion angle type or Ductmate connectors (or equal). Duct and fire damper sleeves and air handling equipment connections shall be compatible. Sections of the ductwork shall be bolted and sealed with the neoprene gaskets. Caulking compound shall not be allowed. Maximum spacing between transverse joints shall be 5 feet.
- Longitudinal seams shall be Pittsburgh lock type. Proprietary joints may be used if installed in accordance with the manufacturer's instructions. Performance of the proprietary joints shall be verified by tests. Test data, detailed drawings, and manufacturer's installation instructions shall be submitted for approval, prior to start of construction.
- Maximum air velocity in the ductwork shall be limited to 4000 fpm in duct risers in multistory buildings and 2600 fpm in all other parts of the systems.
- Branch ducts shall not be located less than five duct diameters or larger duct side dimensions from elbows unless space limitations make it impossible.
- To reduce noise and pressure drop, primary supply duct direction changes shall be by means of long-radius forms or by elbows with turning vanes in them. This does not apply to branch ducts
- To ensure air tightness to ductwork, duct seal class shall be as follows (based on the system pressure construction class):

Pressure Class	Maximum Duct Leakage
2" wg and below	5%
above 2" wg	1%

4.3.1.9 Duct Design Criteria

Standard ductwork shall be designed for low-pressure application. Design pressure drop shall be between 0.05 and 0.1" w.g. per 100 feet of duct, unless other design considerations override. Operating pressures at the registers shall not exceed 0.05" w.g. on HATS ducts. Design air velocity shall generally be below 1500 fpm, except at fan discharges, where higher velocities may occur.

The ductwork and ductwork fittings shall be fabricated from galvanized steel. Aluminum or stainless steel materials shall be used in environments requiring protection from excessive air moisture content and/or salt content. Stainless steel duct construction shall be used for handling air containing corrosive fumes. Zinc coating shall conform to ASTM Standard A525. Specification for General Requirements for Steel Sheet, Zinc Coated (Galvanized) by the Hot-Dip Process, Coating designation G90. All duct materials shall conform to the ASTM specifications selected from the latest edition of SMACNA HVAC Duct System Design.

Flexible connections shall be provided between ductwork and air handling equipment. The flexible connection material shall be UL®listed and comply with NFPA 90A for fire and smoke spread.

4.3.1.10 Routing and Cross Section

Rigid ductwork in shall run as close to the ceiling as the building structure allows.

NOTE:

The maximum permissible extended length of flexible duct is 12 feet. Use rigid duct for longer branches.

The duct cross section shall be sized for area thermal loads listed in Table 2-1 "Summary of Design Parameters" unless space limitations make this impossible. Frequent cross section changes shall be avoided.

4.3.1.11 Diffusers, Registers and Grilles

Diffusers, registers or grilles shall not be installed less than two duct diameters or larger duct side dimensions from elbows, unless space limitations make this impossible. All supply registers shall be parallel blade type with integral opposed blade damper. Perforated face diffusers shall not be used. Dampers associated with diffusers, registers or grilles shall be used for final adjustment of flow but not as the sole devices to reduce duct pressures exceeding 0.2" wg.

NOTE:

Selection of HATS supply registers will fall at or below the low end of the manufacturer's design scales. Most manufacturers do not recognize these areas of operation, as effective and published data may not be available for the lower velocities. However, some manufacturers will supply this data if requested.

Noise Criteria (nc) ratings shall not exceed 35 for administrative areas and 50 for all other areas.

4.3.1.12 Louvers

Exterior louvers shall be aluminum, rainproof, rated for design wind conditions and sized for a maximum of 400 fpm gross face velocity.

4.3.1.13 Control Dampers

Control dampers shall be selected for the maximum pressure differential, including system start-up and power loss failure mode. Opposed-blade dampers shall be used in return and exhaust ducts. Parallel-blade dampers shall be used for on/off applications. Blade edge seals shall be vinyl or PVC and jamb seals shall be flexible metal compression type. The maximum face size of any damper shall be 25 ft². Arrays of dampers shall be used for areas larger than 25 ft², each damper shall have its own actuator. Motorized dampers shall have leakage of 5% to 7% or less at 4"wg and 1000 fpm gross face velocity. Pneumatic actuators, if used, shall have positive positioners.

The failure mode of dampers controlling ventilation in DC power rooms and engine rooms shall be such that ventilation is provided to those spaces (Fail Open).

Control damper actuators shall be externally mounted and compatible with the type of control system. If required, in retrofit systems, appropriate transducers shall be specified.

Dampers exposed to outdoor conditions or very moist air shall be aluminum or stainless steel for salt air environments.

4.3.1.14 Balancing Dampers

Manual balancing dampers, necessary for initial system balance, shall be incorporated into all supply and return branch ductwork. Wherever automatic dampers are not installed. Damper design shall be of the opposed blade type for supply ductwork with smaller duct side dimension exceeding 12 inches. Damper position indicator and positive locking device shall be externally located. Unless prohibited by space limitations, damper location shall be minimum of two diameters or two larger duct side dimensions from the duct fitting and as far as possible from an outlet.

4.3.1.15 Insulation

Ductwork routed within conditioned spaces shall not be insulated. Environmental systems ductwork located in non-conditioned spaces shall be insulated in accordance with ASHRAE/ANSI/IES Standard 90A, Energy Conservation in New Building System Design. However, insulation inside ductwork is not allowed.

4.3.1.16 Sound and Vibration Attenuation

Ductwork systems shall be designed to minimize flow generated noise, within the context of all other design considerations. Air moving equipment selection shall include consideration for noise attenuation. Duct connections at the inlet and outlet of fans and air handling units shall be designed for 100% effective duct length. Noise control should be considered whenever the air handling and ductwork systems total noise production will exceed the ambient room noise that is expected for the equipment being installed. This consideration should be outlined in the design basis documents to allow consideration by the A.T. & T. personnel involved in the project. Dissipative type sound attenuators shall be provided when noise control is required. Interior duct lining shall not be used in any ductwork that is part of a system serving areas that will never be used for network telecommunications equipment. The duct lining shall be of the "hospital type," e.g., have protective coating to prevent flaking in the air stream. It shall comply with NFPA 90A.

Vibration isolators shall be provided between rotating equipment and housings or building structure.

4.3.1.17 Access Panels

Access panels shall be provided for duct mounted equipment such as cooling or heating coils, filters and all fire/smoke control dampers.

Panels located in externally insulated or internally lined ductwork shall have insulation or liner of the same type as duct. The minimum access door size shall be 18" x 18" unless the size or configuration of the duct dictates a smaller size.

4.3.1.18 HVAC Actuators and Sensors

For new systems, actuators and sensors shall be of DDC compatible, electric/electronic type.

4.3.2 Air Filters

4.3.2.1 Filter Equipment Description

Roll filters not recommended.

Differential pressure sensors across the filters shall be provided to send a "DIRTY FILTER" alarm to the HVAC control panel when the reading reaches 0.5" w.g. for the lower resistance media and 2.0" wg for the highest resistance filters. Older systems may still incorporate manometers or draft gauges installed across the filters to indicate when the filter needs servicing.

4.3.2.2 Filter Construction

Overall required efficiencies of filter systems shall be as calculated using the methods described in the System Design Criteria chapter. Filter media shall be preferably of unbreakable organic fibers that do not degrade under periods of high humidity. Filters shall be capable of operating to a final pressure differential of 3" w.g. and 625 fpm face velocity without damage. The media shall be sealed to the casing to prevent any bypassing. The filters shall not support combustion and be classified UL®900 Class II.

The filter supplier shall provide certified performance data for all filters to be used on a project, to include:

- Air flow rate
- Pressure drop, clean
- Pressure drop, dirty
- Initial atmospheric dust spot efficiency
- Average atmospheric dust spot efficiency
- Average dust holding capacity
- Curve showing pressure drop vs. flow rate.

Filter systems shall be designed for an installed maximum face velocity of 500 fpm. To extend the useful life of high efficiency filters, upstream, pre-filters of 25-40% dust spot efficiency, based on ASHRAE Standard 52-1-1992, shall be provided. The pre-filters shall be of the pleated panel type.

Final filters shall be of the pocket-type design. Pockets shall be self-supporting leak free and an integral part of the header. Pockets shall be thermally welded for a leak free bond. The header shall be of polyurethane to prevent bypassing of contaminants, with the pockets integral to the header.

4.3.2.3 Filter Framing Systems

Frame shall be made of galvanized steel, aluminum or plastic.

Filter to frame integrity shall be maintained by utilizing knife edge contact points all around the frame. The use of field caulking at the joints of modules is not acceptable. The filter headers shall be of hard polyurethane foam material or similar to prevent dust particles from bypassing mating components (filter and frame) and entering the air stream.

4.3.2.4 Manufacturers

Filters for use in air handling equipment shall be supplied from:

- Airguard Industries, Inc.
- Cambridge Inc.
- Donaldson Company, Inc.
- Eco-air Products, Inc.
- Farr Company
- Luwa Filter Corp.
- Purolator Products
- Viedon Air Filtration Division, Freudenberg Nonwovens L.P.

4.4 Heating Equipment

4.4.1 Hot Water Heating Boilers

Cast-iron boilers shall be modular with metal push nipples rated for low pressure. 250° F hot water, designed for burning #2 fuel oil or electricity. Boiler shall be of a commercial grade, cast iron, package type, equipped with all code-required safety devices. Boilers shall be built in accordance with the requirements of the ASME Boiler and Pressure Vessel Code, factory tested, and provided with Hydronics Institute (formerly IBR) certified net ratings.

Fire-tube boilers shall be four-pass updraft boiler, 30 psig design pressure complete with integral forced draft burner controls suitable for light oil firing. The boiler shall have a high burner turndown ratio. The unit shall be UL® listed as a complete package boiler and able to meet special insurance requirements. Front and rear doors shall be hinged to provide access and maintenance. Hot water inlet and outlet connections shall be from the top, furnished with dip tube and air vent to remove entrained air.

The boiler burner shall be air atomizing type with automatic electric ignition. The burner shall return to low fire for ignition. Oil burner piping shall include integral mounted oil pressure gauges, oil metering controls, solenoid shutoff valves, pressure gauges and fuel strainer.

Low water cutoff controls, relief valves, pressure and temperature controls to regulate burner operation shall be standard.

Fuel to water efficiency shall not be less than 80%.

Boiler stack piping shall be stainless steel with provision for thermal expansion, and in accordance with all applicable codes.

Life cycle cost analysis for utilization of the hot water boilers, for domestic water heating, shall be used for hot water heating boilers.

The following vendors shall be used for hot water heating boilers:

- Well-McLain, Division
- The A.O. Smith Co.
- The Peerless Heater Co.
- Burnham Corp.
- Cleaver-Brooks

4.4.2 Hot Water Heating Coils

Coils shall be tested and certified in accordance with ARI Standard 410, *Forced Circulation Air-Cooling and Air-Heating Coils*.

Standard water coil tubes shall be copper with aluminum fins. A flexible metal hose assembly, consisting of one continuous length of seamless tubes shall be used to control vibration. Water coils shall be suitable for a minimum working pressure of 250 psi.

4.4.3 Electric Heating Coils

Electric heating coils shall be heavy duty, commercial grade, with built-in protective devices, as required by all applicable codes. The built in modulating controls shall be of silicon controlled rectifier (SCR) type with terminals provided for external system temperature controls.

The coils and coil appurtenances shall be UL® listed for the intended application. Where the coil capacity is outside of the UL® rating, multiple UL® listed coils shall be provided.

4.4.4 Electric Space and Unit Heaters

Electric space and unit heaters shall be heavy duty, commercial grade, with built in protective devices, as required by applicable codes. Unit heaters shall be provided with built-in controls and terminals for the remote temperature sensing devices. Space and unit heaters shall be UL® listed for the intended application. Unit heaters shall be of the propeller type operating to overcome heater coil friction only.

4.4.5 Hot Water Space Heaters

Space heaters shall be heavy duty, commercial grade finned tube radiators or convectors. Copper tube/aluminum fin type shall be specified.

All space heaters shall be provided with Hydronic Institute, IBR certified ratings.

4.5 Controls and Alarms

4.5.1 General Hardware Requirements

4.5.1.1 Compatibility

The AT&T HVAC control system supplier list contains the contact information and system design rules for the approved DDC control systems to be used when installing a first system or expanding/upgrading an existing control system. Please refer to AT&T Practice 760-200-070, *Network Mechanical Control System Standards (NCSS)* for the current approved system/supplier list. All new HVAC control system installations will be implemented by using a HVAC control system supplied by one of the approved suppliers. For building projects that involve remodel of sites which have existing (legacy) HVAC control systems that will be retained, the new control equipment selected must be compatible with the existing system.

HVAC control system manufacturers typically have proprietary communication formats. When adding new controls to a building already containing a DDC system, the designer must ensure that the new equipment can communicate with the old. An element of the DDC system/supplier selection criteria was the ability of the HVAC control system to interface with legacy DDC systems. Because of this it is felt that in most cases a system supplied by one of the approved vendors will provide a seamless integration with the existing DDC control system. Where integration with

the existing DDC control system is not practical consult the AT&T Alarm and Building Control Standards group for an alternative solution. In all cases the DDC control system supplied must comply with AT&T Practice 760-200-070, *Network Mechanical Control System Standards (NCSS)* and the *AT&T Screen Standards*.

In many areas a single OSWF office is responsible for the operation of several buildings. Adherence to AT&T Practice 760-200-070, *Network Mechanical Control System Standards (NCSS)* and the *AT&T Screen Standards* will ensure that a standard man-machine interface for local and remote system access is provided regardless of which DDC system supplier is selected. This will minimize the number of different system formats that the OSWF must deal with.

It is recommended that all parts of the HVAC control system come from one supplier, who will assume overall responsibility for the system's original commissioning and performance.

4.5.1.2 Features

Refer to AT&T Practice 760-200-070, *Network Mechanical Control System Standards (NCSS)*, for detailed description of required features and requirements.

4.6 Fire Protection Equipment

4.6.1. Smoke Dampers

Smoke dampers shall be UL®555S, Smoke Dampers, listed and classified to Leakage Class 1. The dampers shall assume closed position upon interruption of power supply.

The smoke dampers shall be controlled by the building fire detection system and shall be incorporated into the DDC program. A Smoke Purge system design shall determine the sequencing of each smoke damper and shall be activated by switches located within the Firefighter's control panel(s) on each floor of the building.

4.6.2 Fire Dampers

The fire damper ratings shall be consistent with the ratings of the floor, wall or ceiling penetrated by the duct.

Fire dampers shall be capable of closing, sealing and maintaining the seal under maximum anticipated pressure differential.

The dampers shall be of curtain type, suitable for horizontal or vertical mounting with positive locking in closed position. The fire dampers shall be tested and listed in accordance with UL®555, Fire Dampers.

Fire damper access ports or doors shall be installed within one foot of the fire damper and suitably marked on the exterior of the duct for ready identification. The access opening shall be sized large enough for complete inspection of the damper.

Fire dampers shall be installed with sleeve fire rated equivalent to the damper extending a minimum of 6" either side of the fire barrier or as required by applicable code.

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Use pursuant to Company instructions

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4.6.3 Identification and Labeling

Color-coded duct and pipe identification markers or bands with arrows indicating direction of flow shall be provided. Engraved, laminated plastic, aluminum, or brass equipment identification tags shall be attached on the valves and dampers.

Nameplates, including model number and rating identification, shall be securely attached to all electrical and mechanical equipment. Painting of piping systems is prohibited except where required by code. Identifying color bands 7 inches or more in width are placed or painted near valves and at other conspicuous or important locations. A lettered legend is abbreviated or otherwise stenciled in contrasting color on each band to further identify piping contents. In order to avoid obscuring the legends by accumulation of dust, the lettering is stenciled on the lower quarters of the pipe (or cover) whenever possible. The size of lettering is graduated from ½ inch on ¾ inch pipe to 3½ inches on 12-inch pipe (or cover). For pipes smaller than ¾ inch, the use of tape bands or metal tags with lettering etched and filled with color enamel is suggested.

All access panels and dampers in ductwork shall be provided with markers indicating the purpose and service.

Generally, piping ID bands shall be properly color coded to avoid confusion that may cause injury. Table 4-1 provides the classifications that should be utilized.

Table 4-1. Piping Identification

Piping Systems	Contents	Color
Water Supply	Chilled Water	Green
	Domestic Cold Water	Green
	Hot Water	Yellow
	Condenser Water	Green
	Drinking Water	Green
	Fire Protection	Red
	Sprinkler	Red
Drainage	Sewerage	Green
	Waste	Green
	Roof Drainage	Green
	Vent	Green

Heating	Steam (Supply)	Yellow
	Steam (Return)	Yellow
	Hot Water (Risers)	Yellow
	Hot Water (Return)	Yellow
Miscellaneous	Gas	Yellow
	Fuel Oil	Yellow
	Diesel Oil (Power)	Yellow
	Oil Vent	Yellow
	Compressed Air	Black

Legends shall depict the product flowing in the pipe utilizing the full product name such as drinking water, hot water, chilled water, etc. Abbreviations shall only be used based on Chapter 34 of the latest issue (currently 1997) of ASHRAE, Fundamentals Handbook.