City & County of Denver
Denver International Airport

Mechanical Design Manual

2012 REVISIONS
Volume 1 of 2

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## DESIGN STANDARDS
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Vol 2: Appendix A  Specifications
Vol 2: Appendix B  Details, schedules and symbols
The Denver International Airport (DIA) Design Standards have been developed to insure a unified and consistent approach to the thematic and technical design for the Denver International Airport. These standards are for use and strict implementation by all Consultants under contract to DIA, to tenants, and all other Consultants under contract to any other entity for the design of projects at the Denver International Airport.

The Standards Manuals are intended to be working documents, which will be revised and updated, as required, to address the general, conceptual, design, and technical standards for all areas of design for the DIA.

This Design Standards Manual for the Denver International Airport have been prepared for use by competent, professionally licensed architectural and engineering Consultants under the direction of DIA Maintenance and Engineering or Tenants of DIA.

The Design Standards shall not be quoted, copied or referenced in any bidding or construction contract documents. All information contained in these standards must be fully explained and shown in all bidding and contract documents.

The Design Standards Manuals are intended to be used as a whole, as each manual is complimentary to the others. In order to understand the overall thematic and design standards for the Denver International Airport, the manuals must be utilized together and not separated from the Design Standards Manuals as a whole.

### REVISIONS

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CHAPTER 1
GENERAL

SECTION 101 - GENERAL

101.1 INTENT
The Mechanical systems consist of HVAC, Plumbing, Fire Protection, Automatic Controls and Process Systems located in the Terminal Building, the Airport Office Building (AOB), Concourses and Outlying Support Buildings. The goals and objectives are to develop a Mechanical design to achieve an efficient, economical, maintainable and reliable installation consistent with the goals and objectives of the Airport/City and County of Denver.

The space environment shall be designed to be controllable within acceptable year around comfort and health levels. The Design Engineer shall utilize the latest state-of-the-art, energy conservative, readily available equipment and components based on proven design techniques.

101.2 GENERAL
The designer shall prepare the design, construction documents, drawing and specifications for HVAC equipment, ductwork and piping, exhaust equipment, controls, insulation, structural, plumbing, fire protection, automatic control systems and operational services such as aircraft and vehicle fuel and glycol systems. The designer shall coordinate the Mechanical design with the applicable sections of the Architectural, Electrical, Structural, Civil and DIA standards and criteria.

All Construction Documents shall be developed by the designer and reflect a complete engineered design. The installing contractor may perform certain engineering tasks, such as the Fire Protection, but the designer is responsibility for the total overall design.

101.3 DIA MECHANICAL ENGINEER
All references in this document to the “DIA MECHANICAL ENGINEER” refer to the individual listed below. For questions, updates or requests for deviations to this document contact:

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Phone: (303) 342-4444
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101.4 REGULATORY REQUIREMENTS
Specify that work shall be per Underwriters, Public Utility, Local, State and Federal Codes, Ordinances and applicable regulations. Work shall also comply with latest editions of all applicable codes, ordinances and regulations in effect as of the date of the Contract Documents. If discrepancies occur between the Contract Documents and any applicable codes, ordinances, acts, or standards, the most stringent requirements shall apply. Where hourly fire ratings are indicated or required, provide components and assemblies meeting requirements of the American Insurance Association, Industrial Risk Insurers, Factory Mutual Insurance Association and listed by Underwriters Laboratories, Inc.
101.5 WORK SEQUENCE, COORDINATION & INSTALLATION

Develop Project Documents so that work is furnished and installed in logical sequence and performed in an expeditious manner for efficient flow of work. Particular attention is to be given to the positioning of large equipment items and tie-ins to existing systems that will require system shutdowns. Progress of mechanical work shall be coordinated with other trades.

Verify all site conditions and dimensions by field measurements. Chases, slots, and openings shall be verified and designed to allow for mechanical installation. When mounting heights are not specifically detailed or dimensioned, systems, materials, and equipment are to be installed so as to provide the maximum headroom possible with minimum headroom of 7'-6". If there are spaces with finished ceilings, the systems shall be of adequate height above the ceiling.

All systems that require periodic servicing or equipment replacement shall be readily accessible from the space. Coordinate connection of mechanical systems with exterior underground and utility services.

Contract Drawings shall indicate general arrangement of mechanical systems. Information shown may be schematic. Field verification by the designer of all existing Architectural, Mechanical, Electrical, Civil and Structural system locations is required.

Drawings and specifications are to complement each other. The designer shall state that any work, materials or equipment indicated on the drawings but not described by the specifications, or described by the specifications but not shown on the drawings. In case of a conflict the contractor shall obtain clarification from the designer through the DIA Project Manager in writing prior to bidding the job. After the job is bid the conflict shall be resolved at the sole discretion of the DIA Project Manager.

Although the General Criteria may not be specifically indicated, design and specify all supplementary or miscellaneous items, appurtenances and devices incidental to or necessary for a complete mechanical system.

101.6 DEFINITIONS

A. "ASHRAE": The American Society of Heating, Refrigerating and Air Conditioning Engineers.
B. "BTU": British Thermal Unit
C. "City": All City and County of Denver Agencies and Departments that have applicable Airport Tenant Project jurisdictional codes and/or regulations.
D. "CFM": Cubic feet per minute.
E. "Concealed": Embedded in masonry or other construction, installed in furred spaces, within double partitions or hung ceilings, in trenches, in crawl spaces, in soffits, or in enclosures.
F. "Contractor": Tenant's Contractor and Sub-contractors
G. "Control or Actuating Devices": Automatic sensing and switching devices such as thermostats, pressure, float, electro-pneumatic switches and electrodes controlling operation of equipment.
H. “Designer”: Designer of record documents.
I. “DIA”: Denver International Airport
J. "Exposed": Not installed underground or "concealed" as defined above.
K. "Furnish": To supply and deliver to the project site, ready for unloading, unpackaging, assembly and installation as applicable to the project unless noted otherwise.
L. “GPM”: Gallons per minute.
M. “HVAC”: Heating, ventilating and air conditioning systems.
N. “HV”: Heating and ventilating systems
O. "Install": Operations at the project site including unloading, unpackaging, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protection and cleaning as applicable to the project unless noted otherwise.
P. "Material": All mechanical system components required for project construction including equipment.
Q. "Mechanical Systems": HVAC, Plumbing, Fire Protection and related Control Systems as contained herein.
R. "Motor Controllers": Manual or magnetic starters (with or without disconnects), individual push buttons or hand-off-automatic (HOA) switches controlling the operations of motors.
S. "Piping": Pipe, tube, fittings, flanges, valves, controls, strainers, hangers, supports, unions, traps, drains, insulation, and related items.
T. "Project Manager": Project Engineering representative of the City and County of Denver (CCD)/Department designated by the Aviation Airport's Deputy Director of the Aviation/Planning & Engineering Division.
U. "Provide": To "Furnish" and "Install" as defined herein.
V. "Related Work" includes, but is not necessarily limited to, mentioned work associated with, or affected by, the Work specified. All "related work" is included as Work of this Division unless otherwise specifically excluded.
W. “SF”: Square feet.
X. "Similar" or "Equal": Equal in materials, weight, size, design, capacity, performance, and efficiency of specified product.
Y. "Supply": To purchase, procure, acquire and deliver complete with related accessories.
Z. "Tenant": Lessee to the CCD/Airport. Includes the Tenant's Architectural/Engineering Consultant(s).
AA. “TDG’s”: DIA Tenant Development Guidelines
BB. "Wiring": Raceway, fittings, conduit, wire, boxes and related items.
CC. "Work": Labor, materials, equipment, fixtures, trim, apparatus, controls, accessories, and other items required for proper and complete installation.
101.7 SITE CONDITIONS

The designer shall field verify the site location and availability of existing mechanical and electrical systems and the building structure. The designer shall examine site premise and utilities to become familiar with existing local conditions affecting work, such as obstructions, levels necessary cutting, before submitting the design. No allowance will subsequently be made by reason of any misunderstanding with respect to existing site conditions. All possible interferences inhibiting routing of services shall be verified.

SECTION 102 - DESIGN CRITERIA

102.1 SYSTEM CRITERIA

The mechanical systems for all facilities at the Denver International Airport are to be based on straight-forward, proven design techniques utilizing the latest state-of-the-art development in readily available equipment and hardware. The overriding criteria for the use of systems and equipment shall be the safety, convenience, and comfort of the traveling public.

It is most important that the systems installed serve the public well, are readily serviceable and maintainable, are stable and direct in their operation, and provide flexibility for future change and development. All equipment, appurtenances, and hardware shall be accessible for adjustment and maintenance. Suitable access is required to permit removal and replacement of equipment items. Provisions are to be made for centralization of operating and maintenance diagnostics.

It is anticipated that there will be changes and development in many areas of the airport facilities and the mechanical systems will have to be revised or expanded to accommodate these changes. In addition, development in state-of-the-art technology may suggest updating systems and system components in the future. All designs of mechanical systems must include built-in flexibility in keeping with the nature of change that is ever present for air transportation facilities.

In addition, energy conservation and cost savings will also be guiding criteria in the design of mechanical systems. All facilities must meet the energy conservation requirements included in these standards. Both initial system and equipment costs and life cycle owning and operating costs are to be important considerations in concept design efforts and these considerations must be carried through final design and construction.

102.2 MECHANICAL DESIGN CRITERIA - FLEXIBILITY

Special provisions are to be made in determining terminal and concourse building heating and air conditioning load requirements to properly allow for the dynamic nature of the application of these loads. During normal operation these loads can vary dramatically from zone to zone and the peak load can fluctuate significantly within each zone. This is due to the rapid mass movement of people within the building, as well as, the shifting solar load on glass walls, infiltration loads associated with people and baggage movement in and out of the building, and outside air ventilation requirements.

Heating and air conditioning system controls must provide system flexibility so as to be able to deal with the shifting internal cooling loads. The HVAC system must be able to handle varying perimeter loads during heating and cooling seasons while the internal and other loads fluctuate between no load and peak conditions. In addition, appropriate air quality conditions must be
maintained in the spaces while the natural ambient (outside) conditions are very often of less than ideal quality.

102.3 DESIGN PARAMETERS

A. Indoor Design Temperatures: It is intended that the mechanical systems (in general) maintain indoor design conditions in all occupied spaces normally accessible to the public as follows (unless specified otherwise):

1. Summer: 78 degrees F, 50 percent maximum relative humidity
2. Winter: 72 degrees F

B. Outdoor Design Temperatures: Outdoor design conditions to be used for system designs are as follows:

1. Summer: 92 degrees F dry bulb/59 degrees F wet bulb (coincident conditions). 96 degrees F air cooled condensing temperature. 63 degrees F wet bulb design condition.
2. Winter: -5 degree F

These design criteria conditions are based on the recommended conditions listed for areas near Denver in the 1987 ASHRAE Fundamentals Handbook at the 2-1/2 percent summer condition and the 99 percent winter condition. That is, based on historical data, the outdoor temperatures can be expected to exceed the summer design conditions 2-1/2 percent of the time and exceed the winter design conditions 1 percent of the time.

The more stringent design condition is required for winter criteria due to the inherent outdoor air infiltration condition present in most airport situations. The design wet bulb condition is based on the 2-1/2 percent mean coincident wet-bulb condition.

102.4 VENTILATION STANDARDS

Ventilation Standards for occupied spaces are to be based upon ASHRAE Standard 62-2001, "Ventilation for Acceptable Indoor Air Quality." The minimum required ventilation rate of outdoor air per person is to be 15 CFM per person, with several special use areas in the buildings having significantly higher requirements. The distinction between smoking permitted and smoking prohibited has been abandoned in the revised standard, however, areas where there is a potential for heavy smoking shall be considered for increased ventilation and filtration.

102.5 ENERGY EFFICIENCY REQUIREMENTS

Energy efficiency is an important consideration in the design of the mechanical systems for all Denver International Airport facilities. Heating, ventilating and air conditioning systems are to be designed to exceed the requirements of 2001 ASHRAE Standard 90.1 - "Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings," and the City and County of Denver building code.

Equipment selections must be specified to meet or exceed these standards. The equipment and systems described herein must be selected to obtain the optimum in conserving owning and operating costs considering energy efficiency, initial costs, maintainability, and comfort. Energy use budgets and criteria are described in detail in this section of the Mechanical Design Standards.
102.6 REQUIRED "U" FACTORS

The Denver Airport buildings shall be designed so as to have a thermally efficient building shell. Based on 2001 ASHRAE 90.1 requirements, and an analysis of thermal factors affecting the building shell, the following "U" factors are recommended.

A. Roof "U" factor = 0.05 Btuh/sq ft degree F
B. Wall "U" factor = 0.10 Btuh/sq ft degree F

Past experience in the design of airport terminals indicates that the wall and roof loads are a small percentage of the total heating and cooling load of an airport facility. Therefore, it is not an advantage or economically practical to further increase the thermal resistance of the walls and roof beyond these values.

Glass walls and skylights can make up a significant portion of the building heating and cooling skin load. Double glazing in combination with tinted glass surfaces should be incorporated into the facility design to enhance the thermal efficiency of the building shell. The impact of the glass surfaces is discussed later under "Energy Analysis: Building Envelope Evaluation" in Chapter 10 of the Mechanical Design Standards. Highly reflective glass is not to be used.

A. Glass: 0.35 BTUH/sq ft o F, SC = 0.35

In performing the actual mechanical systems design, the building shell construction will be determined by coordination with the architectural design, and the "U" values utilized in HVAC load calculations must be based on the actual material and wall/roof sections specified. It is suggested that the architect be advised of the above "target" U-factors requirements prior to starting design concepts, and an agreement reached as to actual materials and sections to be used.

102.7 NOISE CRITERIA

The mechanical (HVAC) system shall be designed to minimize noise in the occupied space. The system and components shall be designed so as not to transmit or generate sound above a specified noise level in the space. Sound attenuators, duct liner, lower duct velocities and appropriate ductwork fittings and components shall be utilized as required to attain acceptable sound levels. Vibration isolation shall also be evaluated and utilized. Sound attenuators shall be isolated from the building structure.

Sound tests shall be conducted in accordance with accepted procedural standards in and around all major sound producing equipment to either confirm adequate attenuation or to identify problem areas requiring additional modifications as required by the Project Manager.

Maximum noise levels in the occupied space produced by HVAC equipment shall be in accordance with the following NC (noise criteria) curves.

A. Offices NC-35
B. Terminal & Concourse NC-40
C. Maintenance Facilities NC-45
D. Mechanical Equipment Rooms NC-50 – NC-60
E. Refer to DSM 2 for additional requirements for spaces not listed.
Where mechanical noise is to be utilized for sound masking, RC (room criteria) curves shall be utilized as described in the ASHRAE Handbook, "Fundamentals," 1989.

Equipment and ductwork noise levels to permit attaining sound pressure levels in all 8 octave bands in Tenant occupied spaces shall conform to noise criteria NC-35 curves. Motor drives for pumps or any equipment shall operate with noise levels not exceeding OSHA 8 hour 90dBA Time Weighted Average (TWA). Noise levels shall be determined in accordance with IEEE Standard #85 Test "procedure for Air-Borne Noise Measurements on Rotating Electric Equipment.

102.8 ALTITUDE CORRECTION

The design of all air systems, gas-fired equipment and other affected mechanical equipment shall incorporate an adjustment for the altitude at DIA of 5,400 feet above sea level. The following parameters for altitude conditions are:

A. Relative density correction factor = 0.819
B. Air density = 0.0614 lbs/cu.ft
C. CFM Transfer Factor = 0.884

102.9 SUPPORTS AND PENETRATIONS

All supports for mechanical and plumbing equipment shall be designed, detailed and specified by a Colorado licensed Structural Engineer.

Penetrations and reinforcement of penetrations through structural floors and/or walls shall be designed, detailed and specified by a Colorado licensed Structural Engineer.

SECTION 103 - SUBMITTALS

103.1 DESIGN SUBMITTALS

Regardless of requirements outlined by the Design Analysis Report, or lack of, the Designer shall submit the following at the 100% phase of the project to the DIA Mechanical Engineer:

A. (1) CD-ROM containing
   1. Space load calculations.
   3. Equipment sizing and selection (AHU, MAU, FCU, Pump, Expansion tank, water heater, etc.)
   4. Duct sizing and static pressure analysis
   5. Hydronic piping sizing and static pressure analysis
   6. Plumbing sizing and code analysis
   7. Building pressurization analysis
   8. Smoke Control Analysis
   9. Energy Analysis
   10. Additional calculations as requested by the DIA Engineering Group
Each item shall be included as a single, book-marked PDF file (Adobe Acrobat 5.0 or later). No paper copies are required or will be accepted. All equipment shall be labeled as identified on the contract drawings. Each filename should include the contract number.

103.2  AS-BUILT SUBMITTALS

The Engineer shall submit a single CD-ROM of the information outlined in Section 103.1, with corrections made due to field changes in Construction.

END OF CHAPTER 1
CHAPTER 2
CENTRAL PLANT

SECTION 201 - OVERVIEW

201.1 EXISTING CAMPUS HEATING/COOLING SYSTEMS OPERATION

Chilled water and heating water for the HVAC systems in the Terminal buildings, AOB and Concourses is supplied from the Central Plant. Heating water is provided by hot water generators consisting of one (1) startup 17,000 MBH Boiler, and three (3) 60,000 MBH main boilers. Chilled water is produced by three (3) 4,150 ton centrifugal chillers and one (1) 3,250 ton electric driven centrifugal chiller.

The Hot Water and Chilled Water systems consists of boiler and chiller circuit or distribution piping loops located in the Central Plant and the utility tunnels below the AGTS tunnel. This circuit piping supplies the variable speed "transport" or primary loop pumps located at the terminal, Airport Office Building and the Concourses. The variable speed primary pumps delivers water to the constant volume "User" or Secondary loops that supply water to the coils in the air handling units, VAV, Fan Powered boxes, and other terminal air devices. The primary loop consists of pumps in parallel supplying a variable flow, as required by the demand sensed by differential pressure to the secondary pump loops.

The interface between the primary-transport distribution loop and the user-secondary loops utilizes a "BRDG-TNDR" (pronounced "Bridge Tender") control system that contain valves, flowmeters, temperature transmitters, differential pressure transmitters and electronic control panels. The function of the control system is to control the water temperature within the user-secondary loop and controls the flow and pressure relationships between the transport-primary loop and the user-secondary loops. The user-secondary hot water discharge temperature from the boiler is a constant 230ºF and is reset by outside air temperature (OAT) to deliver approximately 200ºF water at 0ºF OAT, and approximately 70ºF at 70ºF OAT. During the cooling seasons when the Chiller compressors are energized the user-secondary chilled water supply temperature is 42ºF± (although this varies) and the return is controlled by the BRDG-TNDR to a constant 58ºF±.

When the refrigeration load decreases because of lower outside temperatures during the fall, winter and spring seasons, the cooling mode utilized is the "free-cooling" system using plate and frame heat exchangers. In the "free-cooling" mode, the chillers are by-passed and the condenser water is pumped from the 456,000 gallon sump through the plate and frame heat exchanger that cools the chilled water. A minimum of two cooling towers run during this time. The system change over to "free-cooling" mode is manual, due to the amount of the time it takes for the sump temperature to stabilize. The manual change-over to the "free-cooling" occurs when outdoor air temperatures do not rise above 60ºF to 65ºF and chilled water supply temperature can be maintained below 52ºF±. On a further increase in demand when the chilled water rises to 52ºF±, the heat exchangers will be bypassed and additional cooling towers and chillers come on sequentially.

201.2 SEASONAL OPERATION

The heating and chilled water systems do not run continuously throughout the year. In general the heating plant is offline from May 15th to September 15th. The chilled water system runs without chillers in a free-cooling mode from Nov 15th to Mar 15th. Weather plays an important scheduling factor in the operations of these systems. Typically when average daily temperatures...
drop below 50°F the boiler plant is operational. When average daily temperatures are above 60°F, the chiller plant is operational and not running in a free-cooling mode.

SECTION 202 - EQUIPMENT

202.1 CHILLERS

The final chiller selection and sizing shall be determined as a result of refined load calculations and profiles. The chillers shall be open drive, centrifugal type, using a refrigerant not currently listed by the United Nations Environmental Program "Montreal Protocol" for production and consumption limitations. The existing chillers use R-22. The chiller prime mover shall be electric driven. Chillers shall have a maximum energy consumption of 0.60 kw/ton at design conditions. Chillers should be selected based on a life cycle cost analysis.

Cooling plant design shall provide sufficient space and equipment support for adding future capacity of at least two additional chillers of the larger percent capacity range.

Chiller design parameters:

A. Chiller Entering Chilled Water Temp.: 56°F
B. Chiller Leaving Chilled Water Temp.: 40°F
C. Chiller Entering Condenser Water Temp.: 71°F
D. Chiller Leaving Condenser Water Temp.: 81°F

Chillers shall be provided and rated in accordance with ARI-550-88 (or latest addition) and ASHRAE 30-78 on Energy Consumption. One large chiller shall be provided with a "free-cooling" option which consists of piping and valves which permit the use of reduced condenser water temperature for cooling via thermally migrating refrigerant.

Chillers shall be furnished and piped in such a manner as to provide easy access to the tube bundles for cleaning. Chiller machine motor, gear drive and compressor shall be mounted on a common base to ensure shaft alignment.

The chillers shall be provided with controls to modulate the chiller operating capacity to match load or as required by the Energy Management Control System (EMCS). The chillers shall be provided with all safety controls, limits, interlocks and accessory devices to maintain efficient safe operation per the manufacturer’s recommendations.

In addition to the migrating refrigerant "free-cooling" option mentioned earlier, a water side economizer (plate frame heat exchanger utilizing tower water) piping, valves and controls for mild weather "free cooling" shall be provided. The heat exchanger shall cool water in the chilled water system from sub-cooled condenser water. Installation shall allow for all maintenance and servicing clearances. Construction documents shall indicate all servicing and maintenance clearances required.

Absorption chillers may be used in the central utility plant for waste heat recovery applications only.

202.2 REFRIGERANT RECOVERY
The existing chillers are directly connected to a common refrigerant recovery system for containment of refrigerant in an emergency or maintenance activities. The system consists of a manual valve arrangement for each chiller, two recovery tanks with associated compressors capable of storing R-22 refrigerant. As of 2006, each RTU is mounted on load cells and connected to a common digital display to allow for weighing and logging off-loaded refrigerant.

RTU – Capacity = 1 chiller

202.3 COOLING TOWERS

The cooling tower capacity shall be based on chiller selection, free cooling requirements, preconditioned air and other miscellaneous loads on the condenser water system. The cooling towers shall be architectural concrete tower exterior, counter-flow evaporative type cooling towers with induced air fans. The selection shall be made to minimize energy consumption and initial cost, and to provide for ease of maintenance. Alternate tower selections requiring less energy consumption shall be solicited from the construction contract bidders for review by the City as to suitability and cost savings. Final selection is to be made by the City on the basis of an evaluation by the Design Consultant.

Design Parameters:

A. Chiller Entering Condenser Water Temp.: 71ºF
B. Chiller Leaving Condenser Water Temp.: 81ºF
C. Wet Bulb Temp: 64ºF
D. Cell Flow Rate: 6,500 GPM

The towers shall be provided with means of controlling tower capacity for mild and low ambient operation, and with adequate means for winter operation without excessive ice build-up or damage to the tower. The towers and chillers shall be designed to take advantage of the large number of operating hours at low ambient conditions for "indirect free cooling." Tower water flow across each section or cell should be held constant during low ambient conditions.

The tower location shall also minimize effects of staining, scale deposits and water treatment chemicals from tower drift.

The tower fill media shall have a 25-year life with a maximum temperature rise of 1ºF in leaving water conditions over that life span. Fill shall be suitable for winter operation.

The cooling towers shall be installed on concrete basins with sumps. The basins shall be designed with provisions for freeze protection, sump pump for complete drainage (allow for sediment), and access for maintenance. The cooling tower pumps shall be located in the central plant if possible. The cold basin shall be capable of being separated per cell. Evaluate the feasibility of providing drain down tank sized to handle one tower cell.

The cooling tower system shall be provided with a water treatment system and filtration system for maintaining good water quality for efficient tower operation. Tower shall be provided with bird screens. The initial installation of tower cells shall be sized for the initial central plant chiller capacity, with provisions for tower expansion to match the future expansion of chiller plant capacity. The tower basin shall also be arranged for the future expansion of tower capacity.
All towers shall be certified in accordance with Cooling Tower Institute Standard 201 "Certification Standard for Water Cooling Towers" or field tested in accordance with ASME Standard PTC23 or Cooling Tower Institute "Bulletin ATC-105" to verify tower performance.

202.4 BOILERS
The existing boiler plant contains one (1) startup 17,000 MBH Boiler, and three (3) 60,000 MBH main boilers. The three units have a capacity equal to 33% of the peak design load and the other unit has the capacity of 17% of peak design load.

New boilers shall be provided with dual burners and controls and shall be fired on natural gas, with jet fuel (or light oil) as a standby fuel source. The boilers shall have a minimum efficiency of 80% fired on natural gas, and shall be provided with combustion controls to maintain maximum combustion efficiency over the full burner modulating range.

The boiler burners shall be arranged for a high turndown ratio for improved operation at low firing rates. Low-NOX burners shall be used. Flue gas economizers shall not be used unless subsequent economical studies indicate that a suitable cost savings could be realized. Flue gas recirculation shall be provided to minimize air pollution effects.

The boilers shall supply hot water to the hot water heating distribution piping system. The boiler plant shall be provided with treatment equipment to minimize corrosion and other detrimental effects on the boilers and piping system. The central plant shall allow for expansion to meet the estimated future heating requirements of the new airport. Boiler safety devices shall be provided as required by the Denver Building Code and as recommended by ASME.

202.5 PUMPS
Pumps shall be selected for maximum operating efficiency, (i.e., slightly to the right of maximum efficiency point on the pump curve). Single pumps to be used in throttling applications without variable speed drives shall have relatively flat performance curves and be selected for operation on the pump performance curve to the right of the point of highest efficiency. Multiple pumps for parallel operation shall have relatively steep performance curves. Multiple pumps for series operation shall have relatively flat performance curves. Pumps for variable speed drive applications shall have relatively steep performance curves. All pumps shall be specified with suction and discharge flange taps for pressure gauge connections.

The final selection of pump types and the application arrangement shall be made to maximize pump efficiency without excessive initial pump costs. All pumps that are selected for both current and future needs will be sized for the future requirements, where practical, and equipped with the necessary accessories. The lower initial performance requirement will be met by balancing valves or by the use of a trimmed impeller to provide energy efficient operation in start-up performance.

Standby pumps and accessories shall be provided for both heating and cooling systems. Pumps shall be arranged in a parallel configuration and headered so as to maximize pumping flexibility.

Generally: Vertical turbine pumps shall be used for pumping cooling tower water. Hydronic water applications shall use end suction pumps for flow rates below 500 GPM. Horizontal split case, double suction pumps shall be used for flow rates above 500 GPM.
202.6 AIR COMPRESSORS
The main control air compressors shall be the oil-free, screw type, provided with regenerative air dryers. The final compressor capacity and storage volume shall be determined from the compressed air demands of the temperature controls, pneumatic operating door systems, and any other functions that require oil-free air.

The control compressed air system shall be designed for a compressed air main pressure of 100 psig. Air dryers shall dry the compressed air to a pressure dew point of -40°F. Regenerative or refrigeration type systems shall be used. The regenerative air dryer shall be provided an external heat source for drying element regeneration.

The control air compressor system shall be complete with air cooled after-cooler, storage tank, regenerative air dryer and coalescing and particulate filters. The central compressed air system shall have full stand-by redundancy in the compressors, dryers and after-coolers.

All main equipment rooms shall have quick disconnect fittings and valves to facilitate using portable air compressors should the main control air compressor system fail.

Any shop air compressors may be lubricated reciprocating type for 100 psig and equipped with after cooler, storage tank and inlet air filters. No regenerative or refrigerated air dryers are required.

202.7 MOTORS
Electric motors shall conform to NEMA Standards. All 3-phase motors shall be high efficiency type. Motors shall not be selected for operation in the service factor range.

The minimum system installed power factor shall be 90% with a goal to attain a 95% system power factor. Motors larger than 15 h.p. shall have power factor correction.

Motors shall be specified to be provided with adequate thermal protection, integral or external control and branch circuit protection, and starters suitable for use with the motors. Motor and starter types shall be selected to minimize voltage fluctuations and current surges. Motors and starters shall be provided with auxiliary contacts for control and operation interface with the central Energy Management Control (EMC) system and any other control functions included.

202.8 WATER TREATMENT
Chemical treatment systems shall be provided at the central plant for the protection of the chilled water, condenser water and hot water systems from scale, corrosion, biological growths and suspended solids.

Chemical treatment for the chilled and hot water systems shall include the use of a corrosion inhibitor. The water treatment for the condenser water system shall include blowdown, pH, and microbiocide control.

The services of a qualified water treatment specialist shall be used and specified for running tests on the water supply and the establishment and implementation of the water treatment programs for the central plant systems.
Water cleaning shall be accomplished by providing a strainer at the suction of each pump. In addition, a final strainer shall be installed downstream of the last system pump.

The chilled water, hot water and condenser water systems shall each also have a by-pass sand filter installed.

202.9 HVAC

The central plant shall be provided with equipment to heat and ventilate the central plant equipment areas. Heating shall be provided with hot water unit heaters. Ventilation for summer heat relief shall be provided by the application of outside air louvers and exhaust fans. A minimum air change rate of 10 ac/hr shall be provided for summer. The existing central plant main air handling systems are:

A. AHU 1-4: Boiler Room Combustion Air:
   1. 100% OSA
   2. Hydronic heat
   3. Constant Volume

B. AHU 7: Pump Room:
   1. Recirculation with Economizer
   2. Hydronic heat/cool
   3. Constant Volume

C. AHU 8: Pump Room:
   1. Recirculation with Economizer
   2. Hydronic heat/cool
   3. Constant Volume

D. AHU 9-11: Chiller Room:
   1. Recirculation with Economizer
   2. Hydronic heat/cool
   3. Constant Volume

The existing chiller room emergency exhaust fan is sized for 12 ACH.

202.10 PIPING AND VALVES

Piping for both the central plant and the distribution systems shall be designed to minimize pressure losses and maximize energy use efficiency. Valves to be specified for equipment servicing shall be selected to minimize losses while open, and have suitable pressure drop characteristics for intended use. The piping shall be designed to allow for central plant equipment expansions.

Control valves shall be sized for the correct and appropriate Cv value at the design flow rate. All valves shall be suitable for extended service operation without extensive requirements for lubrication or servicing.
Tees, valves and blind flanges shall be provided to allow for additions of equipment and piping to the central plant without interruption of services. Piping systems shall be sized for ultimate loads. Tees, valves and blind flanges shall be provided on distribution piping systems for expansion of distribution systems; sectional valves shall be provided in the distribution piping for piping system repairs and at key locations to provide isolation and servicing of equipment. On compressed air lines, quick disconnect connections shall be installed down stream of sectional valves to enable use of portable compressors in emergencies. The piping design and materials selection shall be in accordance with ANSI/ASME Standard B31.9 Building Services and ANSI/ASME Standard B31. Power Piping.

The hydronic systems design shall be based upon the criteria following:

A. Piping shall be designed in accordance with the technical criteria in Section IV of this manual. Water pipe sizing shall be based on the stricter of the two following parameters:

B. | Pipe Size   | Max. Velocity (fps) | Max. Press. Drop* (ft per 100 ft pipe) |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>up to 2&quot;</td>
<td>4</td>
<td>8.5</td>
</tr>
<tr>
<td>2-1/2&quot; thru 6&quot;</td>
<td>6</td>
<td>4.5</td>
</tr>
<tr>
<td>8&quot; thru 12&quot;</td>
<td>8.5</td>
<td>2.5</td>
</tr>
<tr>
<td>14&quot; thru 20&quot;</td>
<td>10.5 (14)**</td>
<td>2.5</td>
</tr>
<tr>
<td>24&quot; thru 42&quot;</td>
<td>11.0 (14)**</td>
<td>1.5</td>
</tr>
</tbody>
</table>

*Based on new, clean steel pipe.
** Number in parenthesis is velocity limit applicable to long straight runs where noise is not critical (such as pipe tunnels, etc.). Maximum pressure drop still applies.

C. Pressure drops in piping systems shall be calculated to allow for aging and corrosion of the interior surface. Therefore, all water piping systems shall be designed with the following friction factors ("C" values) based on the Hazen Williams Friction Factor formula.

D. | "C" Value |
<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Closed Water Systems</td>
</tr>
<tr>
<td>Closed, Treated Water Systems</td>
</tr>
<tr>
<td>Open Water Systems</td>
</tr>
<tr>
<td>(New clean steel pipe)</td>
</tr>
</tbody>
</table>

E. Hot and chilled water distribution systems should be designed for variable volume flow.

F. Hydronic systems should be designed for widest practical delta T and the closest possible approach of the return water temperature to the terminal equipment supply air temperature.
G. The terminal equipment must be selected not only for its full load capacity, but also for its performance over the full range of partial loads. Laminar fluid flow in the coils shall be avoided.

H. Integral face and bypass coils should be utilized with preheat coils.

I. Coils subject to 100% outside air at winter design conditions shall be protected by one of the following methods:
   1. Provide propylene glycol in the water loop serving the air handling unit coils for those units arranged for smoke removal - automatic 100% outside air capacity. These units must not be equipped with protective override controls to shut off fan if freezing condition is determined when operating for smoke removal. The glycol-water loop for this system is to be linked to the main heating hot water system through a plate and frame type heat exchanger.
   2. For those units not arranged for smoke removal use, provide freeze protection thermostats on the coil face to shut down unit fan if a freezing condition is detected.

J. The impact of the change in volume due to thermal expansion of the distribution system fluids during all operations must be addressed in the design process.

K. Control valves in hydronic systems must not be oversized. The flow characteristics and pressure drops are to be selected for the appropriate Cv value corresponding to the design flow to be controlled.

L. Provide automatic air vents at all coils and at the high points of all piping. Provide drains at the low points of all piping.

M. Hydronic systems controls shall be automatic and adjustable to optimize pumping and thermal efficiency.
   1. When close control is essential, do not use three-way valves either for output control in constant-volume-flow systems or for blending control in any variable-volume-flow systems, since their characteristics are of the linear type. Provide equal-percentage valves.
   2. When using three-way valves for throttling, avoid pressure under one port being significantly higher than under the other.
   3. Use mixing three-way valves with caution for flow diversion or diverting valves for mixing since the valves have tendencies to slam shut at reduced flows.
   4. Use two-way valves at terminal coils in variable flow systems.
   5. Hot water coil valves shall fail to the open position.

202.11 CENTRAL PLANT FACILITIES
The central plant facilities shall include toilets, equipment operator areas, maintenance personnel offices, control room, EMCS control station, and spare parts tool and inventory areas. The central plant shall house: the chillers; chiller pumps; chilled water primary distribution pumps; boilers; hot water pumps; cooling tower and pumps; emergency power generators; water softeners; water treatment equipment; water treatment chemicals; air compressors; compressed air after coolers; compressed air dryers; compressed air storage tank and the associated piping and valves for the chilled water, condenser water, hot water and compressed
air systems and miscellaneous equipment. Provide sufficient space to allow equipment additions to the central plant systems to meet the ultimate system loads.

Each water distribution system shall be designed to maximize system and equipment performance and minimize energy usage under all load conditions throughout the systems seasonal operation. The system must also provide the required water flow to and from all load points under all system load conditions. The following proposed system configurations describe a means to accomplish the system objectives. However, the final system configuration and layout should be determined based on the actual equipment capacities and sizes and system requirements. The chilled water, hot water and condenser water system configurations should be refined and finally established when final system parameters are determined.

Refer to the hydronic system design criteria presented in Section 201.9.

202.12 CHILLED WATER SYSTEM

The chilled water system shall be configured with multiple water circulation loops. The first loop is the "chiller loop", which shall use chiller pumps in parallel and headered to circulate water through the chillers which are piped in parallel.

The pumps shall be connected in parallel on suction and discharge headers with a 1 to 1 ratio of chiller pumps to chillers. Pumps shall provide a constant flow to each chiller. The chiller loop must be arranged to easily adapt additional chillers and chiller pumps for future capacity requirements.

The second circulation loop is entitled the "primary loop" system which is a variable flow system. The primary loop distributes the chilled water from the chiller loop to the terminal building, concourses and other buildings and areas to be served with cooling. Pumps in parallel supply the distribution piping with chilled water. The pumps shall be staged on and off based on chilled water demand.

Variable chilled water flow is provided in response to a signal/signals from differential pressure controllers in the primary loop circuit. The controllers shall cycle the primary loop pumps to maintain sufficient pressure differences between the primary supply and return mains to provide chilled water to the most remote secondary subcircuit.

The systems described herein may be served similarly by a two-loop distribution system in lieu of the three-loop system.

Flow measuring devices will be required in each loop and subcircuit.

202.13 CONDENSER WATER SYSTEM

The condenser water system shall be arranged with cooling tower pumps, piped in parallel to supply condenser water to the chillers which are also piped in parallel. The condenser water leaves the chillers and then is routed to the cooling towers for heat rejection.

The condenser water system shall be provided with the necessary accessory piping, valves, controls, and equipment for the utilization of "free cooling" directly as part of the chiller equipment or provided through a separate heat exchanger.

202.14 HEATING SYSTEM
Heating in all building spaces shall be provided by hot water from hot water generators (boilers) located in the central plant. The hot water system will consist of a boiler circuit or loop; a primary hot water distribution system loop and a secondary distribution system loop serving the terminal units. Hot water boiler pumps shall be equal in number to the boilers and shall circulate and maintain a constant temperature in the boiler loop (reset with outside temperature). The primary loop will consist of pumps in parallel supplying a variable flow, as required by demand and differential pressures, to the secondary loops. Each concourse and major facility adjacent to the central plant shall have its own primary loop. The secondary loop pumps shall provide a variable flow sufficient to maintain a differential pressure between supply and return legs of the most remote unit on the secondary loop.

The water service to the end use equipment is provided from the "secondary loop" variable chilled water flow pumps which are provided at each secondary equipment area. These pumps are to be controlled by return water temperature in the secondary loop, with these systems to be equipped with differential pressure controllers to insure adequate flow to the most remote subcircuit.

Provide one stand-by pump for each loop system.

SECTION 203 - ENERGY MANAGEMENT

203.1 GENERAL

In 2009, an energy management system (Honeywell Energy Manager) was installed to monitor the energy usage of the chillers. This system connects to the new HVAC control system (Honeywell EBI). The intent is to expand this system to encompass all components of the Central Plant and eventually all critical mechanical equipment airport wide.

END OF CHAPTER 2
SECTION 301 - HVAC SYSTEMS DESCRIPTION

301.1 AIR HANDLING SYSTEMS

The most appropriate designs for an airport terminal necessitate that the space conditioning system be flexible and responsive to wide swings in thermal loads. Factors include constantly changing people loads, high people door usage, air infiltration, shifting passenger densities, shifting solar loads, and baggage handling transfers in and out of the building. These items change in timing and intensity depending on changes in aircraft schedules and special peak passenger periods.

The air handling systems, including fans, motors and duct static pressure losses, shall be adjusted for the high altitude at the airport site.

The air handling unit selection must also consider the primary system design. For the Denver International Airport, the air handling units will utilize hot and chilled water from a four-pipe distribution system. Separate cooling and heating coils shall be required. The heating coils shall be selected for a minimum 40 degrees F temperature differential (190 degrees F to 150 degrees F, plus or minus). The cooling coils shall be selected for an approximate 16 degrees F temperature differential (42 degrees F to 58 degrees F, plus or minus 2 degrees F) or as required by the psychrometrics of the specific system design. This criterion shall be coordinated with the central plant design.

Packaged air handling units should be used for applications below 50,000 CFM. Customized, built-up air handling units may be used in applications above 50,000 CFM.

Cooling and heating coils are to be sized and arranged for water velocities in the 6 fps range. Air cooling coils shall be designed to have a maximum air face velocity of 600 fpm. Air heating coils shall have a maximum air face velocity not to exceed 800 fpm. Fin spacing shall be as wide as possible to provide the specified leaving coil conditions.

DX cooling coils shall be row split (in lieu of face split) where multiple coil sections are required.

All supply air handling units shall be draw-through, built-up systems except in instances where sound control would favor the application of blow-through units. Each unit shall consist of a non-overloading supply air fan with selected for maximum efficiency. Fan selection shall be based on noise criteria requirements. Centrifugal fans shall be used, however, vane-axial fans may be considered if economy, efficiency and noise criteria parameters can be assured.

In addition, each air handling unit system shall contain separate cooling and heating coils (includes cooling only units), a final filter section, a throwaway filter section, an air blender section to eliminate air stratification, a mixed air plenum for outside air and return air duct damper connections, and a sound attenuation section if required. Integral face and bypass dampers shall be considered for preheat coils in appropriate areas. Each air handling unit section shall be provided with an access door and non-breakable plenum light (coordinate with corresponding electrical designs). Heating coils shall be located upstream of the cooling coils.
with space in between the two coil sections to facilitate access for maintenance and inspection. Tight shutoff type dampers shall be provided for the outside air damper.

The following air handling systems may be used for various applications at the Denver International Airport terminal, concourse areas, and other support facilities. These include single-zone systems, Multi-zone systems, variable volume systems, heat pump systems, and roof-top HVAC systems.

### 301.2 SINGLE-ZONE SYSTEMS

Single-zone type air handling systems will effectively handle any particular local area (zone) of a facility. However, a multitude of different temperature zones may necessitate a high number of single-zone air handling units. The disadvantages of such a design would be the requirement for more mechanical room space, higher maintenance costs, and increased capital cost due to the number of individual units that would be required. The use of single-zone air handling units on a large scale is not economical. A multitude of single zone units serving large, main spaces would also reduce the flexibility required to accommodate future space modifications.

Single-zone air handling units do have suitable application, however, to serve certain perimeter zones of the terminal building and concourses. They also have application in many areas in the various support facilities, where their use would prove to be the most suitable solution.

### 301.3 MULTI-ZONE SYSTEMS

Multi-zone air handling systems offer the advantage of centralizing air handling equipment to an extent; however, the use of this equipment is not an energy efficient alternative. This is due to the constant mixing of heated and cooled air that could create a situation where the cost of distribution ductwork could exceed that of other alternatives. Also, multi-zone units operate most of the time in a partial reheat mode (the air is cooled and dehumidified, and then warmed - thus the term "reheat"). This is an energy waste that cannot be reconciled with current energy standards of the Model Energy Code. Multi-zone units do not offer the flexibility desirable in airports for future space modifications.

Multi-zone units shall not be utilized in the design of the Denver International Airport, its terminal or concourses. Multi-zone units should be used only in unusual situations in remote facilities where only a few zones are required and the economics justify their use.

Dual duct systems are similar to Multi-zone in that both systems have a hot and cold deck. Constant volume dual duct systems will not be permitted. However, variable air volume dual duct systems, where there is no mixing of the hot and cold decks, is an acceptable system for application at the new Denver airport.

### 301.4 HEAT-PUMP SYSTEMS

Heat-pumps are not recommended for application in the support facilities due to the predominately cooler climate of Denver Colorado. Nearly 40 percent of the heating hours in Denver are below 30 degrees F. At approximately 30 degrees F and below, air-source heat pumps no longer function efficiently and some other form of auxiliary heating is required.

Heat pump systems shall not be used in the design of the Denver International Airport, its terminal, concourses, or support facilities except potentially for very small remote facilities.
where economic evaluations justify such systems. In these cases supplemental heating is required.

301.5 ROOF-MOUNTED HVAC SYSTEMS

Another alternative, viable in many building applications, is the decentralized, roof mounted, packaged HVAC system. The greatest advantage of this type of system is its lower initial cost (both mechanical system cost and building space allocation costs).

The disadvantages of the packaged roof top equipment include the concerns of aesthetic appearance, maintenance, energy efficiency, and noise:

Roof top HVAC equipment shall not be incorporated into the designs for the Denver International Airport terminal or concourses or other air side buildings. This equipment does have application however, for some of the support facilities. Whenever a roof-top unit is utilized in the mechanical design of a building, the following concerns should be addressed in detail:

A. Maintenance - is the equipment readily accessible?
B. Energy Efficiency - this equipment is normally air-cooled and is often not designed to be energy efficient.
C. Noise and Vibration - proper vibration isolation is usually not provided unless special requirements are specified.
D. Aesthetics - this equipment can have a negative impact on the appearance of a building, depending on the elevation of other buildings or facilities in the vicinity. An architectural enclosure shall be provided around roof-mounted mechanical equipment.

301.6 VARIABLE AIR VOLUME SYSTEMS

In a variable air volume (VAV) system, the air volume supplied to the conditioned space is modulated to maintain the space temperature utilizing a constant supply air temperature. This system can offer the best approach to meet two major goals; energy efficiency and moderate initial capital costs.

The VAV system shall contain the air-handling system components described above for air handling systems, plus fan inlet vane controls or variable frequency fan motor drives. The air distribution system shall be of a single or dual duct design, based upon further analysis of such items as maintenance, capital, and operating costs. The appropriate variable volume terminal boxes shall then be provided to control the airflow to the space.

It is important with VAV systems that proper outside air ventilation rates be maintained, as well as building pressurization. Additional HVAC equipment or controls may be required with VAV systems to control pressurization. This issue will be addressed in the temperature control system requirements. The advantages of VAV systems both in flexibility and energy efficiency outweigh the additional control requirements.

Variable air volume systems are recommended for a number of areas in the Denver International Airport terminal buildings and in office areas, concourses and many other interior zone applications.
Systems shall be designed to deliver a minimum 0.5” WC at the most remote VAV box.

301.7 PERIMETER SYSTEMS

Any expanse of exterior glass wall area, in the Terminal, Concourses, or other areas will require a perimeter thermal conditioning system. These systems are to be designed to handle at least the conduction and infiltration loads of the perimeter walls plus potentially some radiant solar and internal loads near the perimeter, depending on the application.

There are two suitable methods to handle the perimeter loads.

A. A perimeter finned-tube hot water radiation system. This is effective but only serves during the winter heating system.

B. A forced air system at the perimeter. Air circulation at the perimeter reduces pockets of stagnant hot or cold air. Air movement near the glass can also minimize the chance of condensation forming on the glass.

A perimeter forced air system is to be provided for the terminal and concourse buildings. This should be a constant volume system in order to provide the necessary "throw" at the sill diffusers during mild weather. The perimeter system is preferably located at the sill rather than overhead to counteract down-draft at the windows during the winter. Some perimeter areas with low ceilings (9 ft. or less above finished floor) may use ceiling supply for the perimeter system; in addition these areas could be VAV with reheat if the system supplies only the perimeter and can handle both heating and cooling peak load conditions.

Perimeter finned-tube hot water radiation systems are recommended in vestibules and other areas where there are small expanses of glass limited in height. In these cases the winter heating condition is the only condition of need.

Caution should be used in providing sill system components so that they do not easily collect trash.

301.8 HVAC FOR UNFINISHED (TENANT) AREAS

HVAC systems for unfinished future tenant areas shall be designed to provide for heating and cooling in accordance with the same criteria as for the systems described previously. The interior space(s), (defined as that space 12 +/− feet from the exterior wall) shall be designed for VAV with only cooling primary air ductwork routed to the terminal units. The VAV units shall be sized to deliver approximately 1.25 CFM of supply air per square foot. Prior to setting air flows the anticipated use of tenant areas shall be reviewed for functions that may require airflow rates above this amount (i.e. kitchens, bars, etc.). Additional CFM shall then be built into the air handling system design to easily handle these special areas. Controls will be connected to the VAV terminal unit only if some cooling or ventilation is required in the space.

The exterior glass walls shall utilize a perimeter forced air system as described previously. The perimeter system shall be complete in the unfinished area. The interior system shall be complete only to the VAV terminal system components.

SECTION 302 - SPECIAL SYSTEMS
302.1 COMPUTER ROOMS

Computer rooms that do not require cooling year round, shall have their HVAC systems connected to the central plant chilled water system for cooling. Electric resistance coils shall be used for reheating when dehumidification is required. Computer room units shall also have electric, steam generating humidifiers, equipped with suitable controls which limit supply humidity. Computer rooms which require year around cooling, shall have separate dedicated air conditioning systems for the winter operation.

In remote areas where chilled water and hot water are not available, computer room units shall have a dedicated, dual circuit refrigeration system, with remote condensing units located on the building roof, and with electric reheat coils. If economically feasible a condenser water system water cooling tower may be installed to replace the condensing units.

302.2 EVAPORATIVE COOLING

Evaporative cooling is economically practical and should be considered where acceptable air quality is available. The use of evaporative cooling is limited at the Denver International Airport to specific areas such as support facilities. Evaporative cooling shall not be considered for the public areas in the terminal or concourses.

Total evaporative cooling may be utilized, with an indirect/direct method of operation to limit the humidity level. The use of evaporative cooling is economically attractive, especially in the low humidity climate of the Denver area. However, if a back-up chilled water or DX system is incorporated with the evaporative cooling to handle humid days, the economics are unfavorable and this should be avoided.

The disadvantages of the indirect/direct evaporative cooling units that must be addressed in the design process include:

A. Additional air handling unit cost and space requirements.
B. Increased maintenance requirements.
C. Increased potential for water leakage and resulting damage.
D. Decreased reliability due to the historical rapid deterioration of equipment utilized in evaporative cooling.

302.3 HUMIDIFICATION

Areas having special humidification requirements such as computer rooms, radar equipment rooms, radio equipment rooms, etc., shall utilize individual electric humidifier units located in either the zone ductwork or in the individual room air conditioning units. Humidification through the main air handling system(s) is not to be provided. Humidifiers shall be the steam generator type. Provide high limit humidity sensors down stream of the humidifiers. Down stream ductwork shall not be internally lined.

302.4 AIR CURTAINS

Air curtains, plastic curtains and rapid operation doors are to be considered for use at doors and openings at all maintenance type facilities and also at baggage doors and openings.
Overhead fan-coil units or fan powered terminal boxes may be used as a modified type of air curtain at each concourse Jetway entrance. The fan-coil units shall be activated, if not already in operation, whenever the Jetway door is opened utilizing a 30-second time delay, and the supply air temperature is to be controlled from a space thermostat.

Air curtain type units shall be used at all terminal entrance vestibules. These air curtain units are controlled by vestibule thermostats.

SECTION 303 - VENTILATION SYSTEMS

303.1 OUTDOOR AIR REQUIREMENTS

Outside air shall be brought in through the air handling systems to satisfy minimum ventilation requirements plus provide building pressurization and minimize air infiltration at building entrance door areas.

Existing outdoor air requirements on air handling equipment in the Terminal Facilities were designed around ASHRAE Standard 62-1989. Outside air ventilation amounts shall be provided in accordance with the latest revision to ASHRAE Standard 62. With the adoption of the International Mechanical Code, there may be a conflict in the required amount of outdoor air. The Engineer shall coordinate those requirements with the Denver Building Department and provide electronic copies of correspondence and documentation of final design direction to the DIA Project Manager. It is the responsibility of the Engineer to provide documentation that the existing equipment can comply with any modifications in outdoor air.

Outside air intakes shall be located high and away from landside vehicle traffic and airside jet exhaust to the greatest extent possible, a minimum of seven feet above grade. Most ventilation air will be brought in through air intakes in the mechanical penthouses. If additional ventilation air is required, consideration should be given to using indirect fired gas make up air units.

303.2 AIR ECONOMIZER CONTROL

All air-handling units over 4,000 CFM capacity shall be equipped with air side, dry-bulb economizer cycle operation. The control system for this operation must be arranged to modulate outside and return air dampers to maintain a mixed air set point temperature. Outside air dampers will close to the minimum position and return air dampers open when the O.A. is 75°F or higher (adjustable).

It may not be appropriate to provide air handling units to be located on the apron level and similar areas with 100 percent outdoor air capability due to the air quality in these areas. Therefore, some air handlers shall be provided with continuous minimum outside air levels. These units shall utilize water-side economizer cycles (if applicable).

303.3 RETURN AIR\TRANSFER AIR

Return air from the conditioned space back to the air handling unit should be via ductwork and ceiling plenums. The pressure drop in the return air system shall be minimized in the design. Return air fans should not be required in most cases. Maximum velocity shall be 500 fpm over net free area for general return and transfer air and 200 fpm over net free area for smoke control areas.
Eggcrate grilles shall be used in return air plenums that are used for smoke control. Perforated face grilles shall not be used.

**303.4 VENTILATION RATES**

As described earlier in this document, the outside air ventilation rate shall be as recommended in the latest edition of ASHRAE Standard 62. Careful consideration shall be given to these new recommended rates, particularly considering recent attention in the HVAC industry to indoor air quality. A summary of the applicable rates published in ASHRAE Standard 62-2001, as applicable to airport building spaces, is presented below:

<table>
<thead>
<tr>
<th>Area</th>
<th>(CFM/person)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waiting Rooms, Ticketing</td>
<td>15</td>
</tr>
<tr>
<td>Baggage &amp; Gate Areas</td>
<td>15</td>
</tr>
<tr>
<td>Retail Shops</td>
<td>15</td>
</tr>
<tr>
<td>Dining Areas</td>
<td>20</td>
</tr>
<tr>
<td>Bars/Cocktail Louges (nonsmoking)</td>
<td>30</td>
</tr>
<tr>
<td>Office Space</td>
<td>20</td>
</tr>
</tbody>
</table>

Outside air requirements, unless otherwise specified, shall be as follows for "normal" occupancy levels.

The occupancy load in many public areas of the airport (i.e., concourses, hold rooms, ticketing areas, baggage claim, etc.) is highly variable. As an alternate to the ventilation air flows indicated as based on "normal" occupancy levels, it is acceptable to calculate the minimum ventilation rate on 10 CFM per person, based on peak load occupancy; unless exhaust requirements override this amount.

Ventilation shall be provided in all ground level spaces that may have occasional or full-time occupancy. This ventilation shall be such as to minimize any possibility of an accumulation of radon gas; however, shall not be less than one (1) air change per hour.

Unoccupied crawl spaces in contact with the ground, shall be ventilated likewise to eliminate radon gas hazards at a rate of one (1) air change per hour - on a time clock to run not less than four one-hour periods in each 24-hour day.

**303.5 FILTRATION**

Air filtration is an important consideration in the design of HVAC systems to serve airport facilities. Air should be brought in at the roof or penthouse level wherever possible in an attempt to use the highest quality air available. As a minimum, outside air is to be filtered by the use of 2” dry type pre-filter section having a minimum rating of MERV 7, 12” dry type filter section having a minimum rating of MERV 13 and a 12” filter section for future removable mixed media (IE: carbon/potassium permanganate) filter section.

Filters for small air-handling units serving maintenance or non-public areas should be provided with 4” dry type pre-filter section having a minimum rating of MERV 10.

**SECTION 304 - HEATING, VENTILATION, EXHAUST SYSTEMS**
304.1 GENERAL

This section covers areas of the building that are primarily mechanically heated and/or ventilated only; no air conditioning to be included. Basically, ventilation rates, filtration etc., mentioned previously for HVAC systems will apply unless otherwise indicated. Special exhaust requirements are also discussed.

304.2 BAG MAKEUP AND TUG DRIVE AREA

A. Ventilation: These spaces shall be maintained under a negative pressure in relation to the main terminal (public space) area. This will be accomplished with the use of exhaust fans. The exhaust shall exceed the 100% O.A. make-up air quantities by approximately 10 percent in the bag make-up area. Ventilation rates shall be a minimum of 6 air changes per hour in the bag make-up area and 10 air changes per hour in the tug drive area, if internal combustion engines are utilized. If all electric vehicles are utilized, the air change rate may drop to 2.0 air changes per hour of makeup air.

B. Heating: The bag make-up area shall have a 100% outside air make-up unit filters and with heating coils or indirect gas-fired equipment. In addition hot water unit heaters or low intensity infrared heaters shall be strategically located throughout the area and near overhead doors to maintain space temperature. Consideration will be given to providing low intensity infrared heat in lieu of some unit heaters, depending on overhead door activity. This will be based on input from the individual airlines which will utilize this space. Consideration shall also be given to recover heat from the exhaust air stream.

The tug drive shall be tempered with low intensity infrared heaters placed at bag drop-off areas.

304.3 TRUCK DOCK VENTILATION

An exhaust system shall be provided to ventilate truck docks on the apron level. This exhaust system shall provide 10 air changes per hour in the truck dock area. This ventilation system will provide the added benefit of creating air movement and reducing carbon monoxide build up.

304.4 TOILET EXHAUST

The ventilation (exhaust) rate for all toilet room facilities shall be a minimum of 2.0 CFM/sq ft of floor space or 15 air changes per hour, whichever is the larger requirement. Toilets with extremely high traffic, such as those located in concourse areas, should have a minimum daytime exhaust rate of 2.5 CFM/sq.ft. (based on 8'-0" ceiling).

Under no circumstance shall a positively pressurized toilet exhaust duct run through a return air plenum or occupied space.

304.5 KITCHEN EXHAUST

All kitchens shall be air conditioned. The exhaust requirements shall be based on the number and size of the exhaust hoods installed within the facility. All ovens, fryers and grilles shall have dedicated exhaust hoods serving the equipment. Kitchen exhaust systems shall be designed in accordance with NFPA 96, "Standard for the Installation of Equipment for the Removal of Smoke and Grease-Laden Vapors from Commercial Cooking Equipment." Heat recovery from kitchen hood exhaust should be considered in the final design if grease build up or collection
can be avoided. In addition, make-up air systems for large kitchens must be evaluated. Make-up air should be heated to 70°F, or cooled via evaporative cooling equipment, and supplied at the kitchen hoods. Packaged, factory designed and NFPA approved kitchen exhaust hoods with make-up air systems are acceptable.

Under no circumstance shall a positively pressurized kitchen or hood exhaust duct run through a return air plenum or occupied space.

304.6 SERVICE LEVEL

A. Ventilation: Provide dampered air intakes and exhaust fans in all electrical and mechanical equipment rooms for adequate ventilation. Air intakes should be from the ramp or apron area. Compliance with applicable fire codes is essential.

B. Heating: Provide hot water or gas-fired unit heaters to heat the storage and equipment room areas where a heat loss is involved.

304.7 ATRIUM/GREAT HALL

The Atrium or Great Hall of the terminal building shall contain a relief air system in the high bay area which will relieve air due to pressure or temperature build up. A make up air unit shall also serve the high bay area to provide ventilation air and pressurization when required. These systems shall also be incorporated into a smoke removal system as required by NFPA and the Denver Building Code for high rise structures.

SECTION 305 - EQUIPMENT IDENTIFICATION

305.1 GENERAL

All major air handling equipment shall have a unique equipment designation. Engineer shall obtain designation from the DIA Mechanical Engineer or the DIA HVAC Maintenance group. In general equipment shall be identified by: AHU-C-E44

AHU Equipment type/service
C Building specific identifier
E44 Nearest logical building column number

SECTION 306 - PC AIR SYSTEMS

306.1 GENERAL

All new or remodeled domestic gates shall be furnished with a stand alone, 60 ton DX PC Air unit. Commuter or Regional Jet gates shall be furnished with a stand alone, 20 ton DX PC Air unit when loading bridges are installed. All PC Air units shall connect to the existing Concourse PC Air Control system. Stand alone controls are not allowed.

Hydronic PC Air units shall be used where available. When replacement units are installed that are of larger capacity than the original, a hydronic and load analysis shall be performed by the Engineer to verify piping, pumping and chiller capacity. Design calculations and report shall be submitted to the DIA Mechanical Engineer.
SECTION 307 - EQUIPMENT SUPPORTS

307.1 DESIGN

All equipment supports shall be manufactured systems or designed and detailed by a Professional Engineer. Supports shall be coordinated with Architectural and Structural disciplines.

Under no circumstances shall the Construction Documents direct a Contractor to provide supports without detailed performance specifications outlining criteria and requirements of supports and their design and installation.

END OF CHAPTER 3
CHAPTER 4
AIR DISTRIBUTION SYSTEMS

SECTION 401 - AIR DISTRIBUTION SYSTEMS

401.1 DUCTWORK DESIGN

Ductwork layout and sizing shall be done using the best practices to ensure minimum energy loss by thermal transfer and friction. Ductwork shall generally be designed for low pressure, i.e., 2.0” w.g. or less. In no instance shall the pressure exceed 4.0” w.g. All medium pressure ductwork shall be sized based on the static regain method. All low pressure ductwork shall be sized using either the static regain method or the equal friction method. Existing main ductwork upstream of VAV boxes is considered medium pressure. All ductwork systems shall be designed to minimize noise transmission through the ductwork and avoid noise generation from components or fittings.

Ductwork air velocities shall not exceed the following limits:

A. Mains (equipment rooms and non-occupied spaces) - 3400 fpm
B. Mains (occupied spaces) - 2200 fpm
C. Branch (or mains w/diffuser connection) - 1600 fpm
D. Branch with diffusers - 1200 fpm

Aspect ratios shall not exceed 4:1 for mains.

401.2 DUCTWORK REQUIREMENTS

Ductwork shall be either rectangular or round (spiral) as appropriate for the specific application. All designs shall be in accordance with SMACNA “HVAC Duct Construction Standards” and the technical criteria in this manual. All supply air distribution ductwork shall be galvanized sheet metal with flanges, seams, supports, etc., to match the appropriate duct classification as defined by SMACNA unless moisture in the system dictates the use of aluminum or stainless steel materials. Kitchen exhaust ductwork shall be welded stainless steel.

Although SMACNA allows spin-in fitting for medium pressure ductwork, the fact they are difficult to differentiate in field inspections from low pressure fitting, spin-in fittings are not allowed at DIA. Spin-in fittings shall not be represented on plans or sketch for medium pressure systems. Spin-in fittings are allowed on low pressure systems.

Exposed ductwork used as an architectural feature shall be round and constructed of sufficient gage metal to prevent dings or dents. Ductwork material shall be either aluminum finish or suitable for painting. No external insulation shall be provided on architecturally exposed ductwork. Lined ductwork shall be used in exposed areas when radiated sound level exceeds that required in Chapter 1.

All 90 degree elbows in both medium and low pressure ductwork shall contain double-walled, air foil type turning vanes, unless long radius elbows are used.

Ductwork near air-handling units and outside air ductwork will be lined, as required for thermal performance, noise control and condensation control.

The Design Consultant shall designate the calculated duct static pressure on the drawings to establish duct construction classification.
Flexible round duct shall be a maximum of 5 feet in length and be of a material acceptable by the Denver Building Code.

401.3 DAMPERS
All control dampers shall be the parallel-blade type. Outside air intake dampers shall have air-tight seals at both the edges and ends of the blades. The seals shall be of a material that will not disintegrate with exposure to jet exhaust fumes.

Control dampers shall be provided on all main branch take-offs and on the main ductwork down stream of a branch take-off.

All fire dampers shall be U.L. listed and conform to the standards and requirements of the City and County of Denver Building Code. Fire dampers shall be located at all fire zone penetrations and will have access doors provided for service and maintenance.

401.4 DIFFUSERS
Various types of diffusers are to be considered based on architectural input. Consideration shall be given to quality, durability, capacity, aesthetics, throw and noise level. Coordinate with the architect all diffuser types and locations. Linear slot diffusers shall be individual, 4-foot maximum sections with individual supply boots. Perforated face diffusers are not to be used.

Sidewall and perimeter diffusers shall be selected based on quality, durability, aesthetics, capacity, throw and noise level. Coordinate with architect all diffusers types and locations. Continuous linear slot diffusers shall be individual 4 (four) foot maximum sections with an individual supply boot.

401.5 GRILLES
Standard core 1/2” x 1/2” x 1/2” eggcrate grilles shall be used in return air plenums/systems. Eggcrate grilles shall have a minimum free area of 90%. Perforated face, louvered-face or other face types shall not be used in return air systems in smoke control areas.

401.6 TRANSFER AIR
Transfer air openings are required in all walls to structure in return air plenums and smoke control zones. Transfer air openings shall be sized for a maximum velocity of 200 fpm in smoke zones and 500 fpm in return air plenums that are not used for smoke control. Sizing shall accommodate the entire return air\smoke control system to the point of installation. Refer to Smoke Control Chapter for additional requirements.

401.7 VAV TERMINAL AIR UNITS
Designer shall ensure all components of VAV terminals are completely accessible for maintenance and no additional HVAV or Tenant equipment is required to be removed from operation in order to complete maintenance activities. Control modules shall have a minimum twenty-four (24) inches of clear space to allow for maintenance activities.

401.8 SECURITY GRATES
Security grates shall be installed on all ductwork and transfer air openings larger than 144 square inches between public spaces and private spaces. All roof penetrations larger than 144 square inches with a direct path of access to indoors shall be required to have a security grate.

### 401.9 PRESENTATION OF DUCTWORK SYSTEMS

All ductwork shall be shown on construction documents as double line, regardless of the drawing scale and pressure classification. Round ductwork shall be indicated with a centerline. Limits of all lined ductwork shall be identified clearly by double line symbology. The Design Consultant shall detail all ductwork fittings and connection types.

Single line ductwork is allowed to be shown on Schematic Design, Design Development, 30% and 60% submittals only.

All ductwork shall be identified by system type (exhaust, supply, return, etc). All callouts for ductwork continuations off of the plan shall identify its termination/origin. All callouts shall be in the direction of airflow. General notes of direction are not allowed.

#### Table 1 - Allowable direction callouts

<table>
<thead>
<tr>
<th>Not allowed</th>
<th>Allowed</th>
</tr>
</thead>
<tbody>
<tr>
<td>24x24 up</td>
<td>24x24 SA up to mezz tenant service</td>
</tr>
<tr>
<td>24x84 SA from below</td>
<td>24x84 SA from AHU-D</td>
</tr>
<tr>
<td>22x36</td>
<td>22x36 EX</td>
</tr>
<tr>
<td>84x36 up</td>
<td>84x36 RA to REF-4</td>
</tr>
</tbody>
</table>

END OF CHAPTER 4
SECTION 501 - GENERAL

501.1 GENERAL

A complete system of automatic controls shall be provided to maintain space conditions within allowable limits. When heating and cooling is incorporated in one system for personnel comfort, the automatic temperature controls shall not be capable of simultaneous heating and cooling and shall provide a "dead band." Automatic temperature control devices for personnel comfort shall have a heating control range between 65 degrees F and 74 degrees F and a cooling control range between 72 degrees F and 85 degrees F.

The system shall consist of all necessary control devices, control valves, control dampers, damper motors, pneumatic and electric switches, relays, gages, panel boards, tubing, and fittings, including all necessary accessories required for a complete and operative control system. All control wiring and control system electric power is to be furnished to provide a complete of environmental control and central panel functions.

Control systems shall be electronic, digital systems controlling all HVAC equipment utilizing local microprocessor field panels located in the applicable adjacent equipment rooms. The field panels shall be capable of interfacing with a central (EMCS) equipment provided by a different vendor. Pneumatic operators shall be used for valve and damper actuators. Controls shall be provided as described in the Technical Section of these standards and the Appendix, Section V.

The local field panels shall be tied to the Energy Management Control system (EMCS) located at the central plant, but capable of stand-alone operation.

501.2 EXISTING BASE BUILDING HVAC CONTROL SYSTEMS

The HVAC host control system consists of a network of fully independent direct digital control (DDC) controllers that are interconnected via a multiplexed digital data trunk. Data available to any one direct digital controller is available to all DDC controllers. Each macro controller may supervise a sub-network of micro level DDC controllers. Sensor input devices and output devices shall be connected to either the macro or micro level DDC controllers. Each room with macro controller(s) have a local operator interface using an English language format. The control system interfaces over a phone modem with a subsystem operator interface computer in the Command Center. Each macro in the system is connected together by a Local Area Network (LAN) for peer-to-peer communication, multiple user programming and data gathering.

Existing building control system manufacturers:

A. AOB: Honeywell
B. Terminal: Honeywell
C. Concourse A: Honeywell
D. Concourse B: Kreuter Controls
E. Concourse C: Honeywell
F. Central Plant: Johnson Controls
As of 2011, all buildings are being converted to a common Honeywell EBI Control System. All renovations, building expansions and new buildings that are maintained by DIA maintenance personnel shall be connected to this control system.

Fire and security automation system is an independent and separate system from the HVAC automation system.

SECTION 502 - CONTROL SYSTEM INSTRUMENT AIR

502.1 GENERAL

Independent instrument air systems occur on in the Central Plant, Terminal and each Concourse. These systems are largely undocumented and should not be used for building expansions or renovations. All new control devices shall be electrically operated/actuated. The information below is for historical design reference only.

Compressed air is generated from a centralized compressed air facility with oil-free reciprocating or screw type compressors. Because of the critical nature of this system, there is one operational system with at least one stand-by system under all circumstances. This means that if one system is down for maintenance, there will be one system in operation and one additional system as a stand-by for a minimum of three systems.

The main distribution system air pressure is 80 to 100 psig with pressure reducing stations to reduce the pressure to the respective usable levels for temperature control systems. The main control air is dried with externally heated, regenerative air dryers to a -40ºF dew point to prevent air lines from freezing ambient air temperatures. The dryers have adequate filters located both before and after the dryer. The dryers are interlocked to operate with their respective air compressor.

SECTION 503 - SAMPLE CONTROL COMPONENTS AND REQUIREMENTS

503.1 AIR HANDLING UNIT CONTROLS

A. Provide economizer controls to utilize free cooling when possible during mild weather.

B. Variable volume control should be monitored from reliable static pressure control sensors located approximately 2/3's of the total duct length downstream of the air unit supply fan.

C. Provide control logic to permit reduction in ventilation (outside air) requirements at night and during any extended off-peak periods that can be determined. (The specified ventilation rate is the minimum condition required at peak occupancy; this condition will occur infrequently.). This will not be achievable in the Terminal and Concourses.

D. Provide control elements required by code and for efficient air handling unit operation (i.e. smoke detectors, freeze stats, etc.) in addition to items just described. Specific requirements for these items are included in other subparagraphs in this section.

E. Provide an adjustable non-averaging element freezestat to be mounted on the downstream side of every heating coil section arranged to stop the supply fan (and return air fan as applicable), close the outside and exhaust air dampers, and open
return air dampers when any one foot section of the element of the freeze stat senses a temperature below the set point (36ºF). Note: Freezestat controls shall be prevented from shutting down any air unit when it is operating in a smoke removal mode. No equipment is to be provided that could shut down unit fan when it is operating in a smoke removal mode. Coil freeze protection is to be provided by use of a glycol solution in the circulating coil piping and separation of the coil piping system from the central hot water heating system by a plate and frame heat exchanger. A coil circulation pump is required for this piping system.

F. Provide air flow measuring stations and install them on the discharge of each supply fan, on the intake duct for any return air fan installed, and on the outside air duct for each unit. This is to provide ventilation air flow rate monitoring and fan tracking control between the supply and return air fans (where used).

G. Provide override control to reset the outside air dampers during extreme weather or in emergency situations.

503.2 UNIT HEATER CONTROLS
Small unit heaters shall be controlled by cycling the fan on and off and controlling a two-way valve on the hot water coil. Large unit heaters shall run continuously while heating is required, and water flow to the coil shall be modulated to maintain the set space temperature.

503.3 SPLIT SYSTEMS (FAN COIL UNITS [FCU])
Where split systems are installed in critical spaces such as telecommunications and electrical rooms, the BAS shall monitor the status of the fan-coil unit fan and air-cooled compressor with the use of a current transformer, and shall alarm the system in the event of a fan failure. The BAS shall also monitor the room temperature. The fire alarm system shall stop fans.

The split system shall run through factory controls based on room thermostat.

503.4 EXHAUST FAN
Exhaust fans should be interlocked with the building AHU and run continuously.

503.5 MONITORING
Fire system monitoring or security provisions is not incorporated into the energy management system initially, however, provisions should be made to allow for these features to be added should this requirement change.

503.6 CONTROL FUNCTIONS
The air handling units and the spaces they condition shall be controlled by stand-alone, remote, automation control systems. These systems shall be located directly in the areas under control. The micro processor based control system shall communicate with the central host computer through an EIA RS 232 port interface and all other necessary equipment for proper signal level reception and transmission.

The following control functions shall be programmed into the control system:

A. Provide air-side economizer controls to utilize free cooling when possible on all air handling units with air flows greater than 4,000 CFM.
B. Variable air volume boxes are to be controlled by the temperature control system. The controller shall adjust the box's damper position based on the space temperature.

C. The total supply air volume shall be controlled by static pressure sensors located in the supply air duct. The supply fan's inlet damper or motor speed controller shall be modulated to maintain the duct static pressure set point.

503.7 THERMOSTATS

Provide a non-averaging freeze thermostat to be mounted on the downstream side of every heating coil section, arranged to stop the supply fan when any one foot section of the element of the freeze thermostat senses a temperature below the set point. (Set point shall be 36°F, adjustable.)

503.8 CARBON MONOXIDE SENSORS

Carbon monoxide sensors shall be provided in the service drive or wherever internal combustion engine traffic is utilized in an enclosed space. Sensors shall increase air flow and/or alarm out-of-tolerance conditions.

SECTION 504 - CENTRAL CONTROL SYSTEMS (FOR MAIN AIRPORT BUILDINGS)

This section is for historical reference only. It will be modified once the new control system is in place.

The Energy Management Control System (EMCS) consists of a central host computer including an IBM-PC/AT computer (or compatible) with a VGA/color monitor. This host computer is located in the Central Utility Plant, and stand-alone remote system controllers shall be located in the areas under control. The EMCS shall be a user programmable, all electronic, digital control system. The central host computer shall have, as a minimum, an EGA/color monitor, printer, alarm printer, mouse (or ball), storage and shall consist of all necessary components to provide communications to the field panels. This shall be a comprehensive system and shall be coordinated with all other ongoing projects at the airport that will be tied to the EMCS.

Note: All field panels must be able to interface with the EMCS (potentially provided by a different vendor) and be able to stand alone.

504.1 SOFTWARE

The Central Computer shall have all software necessary for real time monitoring, program loading/editing, report generation, and data acquisition. The software shall be programmed to display color graphic screens of the areas and systems controlled, provide operating reports, trend logs, energy consumption, analysis capability, and alarm reports. The software shall display actual operating conditions on the graphics display screens. Software should be non-proprietary and reprogrammable by user. Source codes should be provided to the owner. The Design Consultant shall review the current stage in the development of universal protocol and make every practical effort to incorporate this into the temperature control automation system.

The software shall have the following capabilities:

A. Run Time

B. Optimum Start/Stop
C. Economizer Controls
D. Load Shedding
E. Time of Day Scheduling
F. Chilled Water Outdoor Air Reset
G. Hot Water Outdoor Air Reset
H. Variable Condenser, Hot, and Chilled Water Pumping (to optimize HP vs load)
I. Night Set Back
J. Status
K. Change of Status
L. Smoke Venting and Control
M. Ambient High/Low Alarms
N. Energy Totalizing
O. Electrical System Monitoring (as outlined in Electrical Design Standards)
P. Maintenance and Alarm Reports
Q. Heating/Cooling Mode

504.2 GRAPHICS CAPABILITIES
The central computer terminal shall have dynamic color graphic display programmed for each air handling system and also for the areas being monitored and controlled.

504.3 TREND LOGGING AND GRAPHING
Trend logs and graphing capability shall be provided.

504.4 ALARM PRINTOUTS
All alarms shall be printed both on the display monitor and printer, providing information on the type of alarm, time and date of occurrence. Change of state alarms are to be programmed to be disabled or enabled at the option of the operator.

504.5 SYSTEM ACCESS CONTROL
Provide access control (passwords) for system operation.

504.6 REPORT CAPABILITY
The software shall be capable of being user programmed to generate custom user designed reports.

Basic Report Printouts required are as follows:
   A. Alarm Summary
   B. Run Time Summary
   C. Maintenance Reports

SECTION 505 - SEQUENCE OF OPERATION
The start up, operation and shutdown of systems shall be sequenced in accordance with the general control sequences outlined in Technical Specifications, in Volume 2 of the Mechanical Design Standards. Prior to installation of a specific system, a specific and more detailed "sequence of operation" shall be developed for each type of HVAC, HV or ventilation system. In these sequences of operation, specific points of measurement of temperature, humidity, pressure, etc. shall be designated.

### 505.1 EMERGENCY SHUTDOWN

Operating facilities with potentially explosive, toxic or otherwise hazardous processes shall be equipped with emergency process shutdown "panic buttons" located at the main control panel and at all exits to the affected areas. Each HVAC system shall have a manual shutdown button per NFPA 90A located at a fireman's emergency shutdown station.

### 505.2 AUTOMATIC SHUTDOWN

Each HVAC system with 2000 cfm or more capacity shall be equipped and arranged to automatically shut down fans (and close dampers on units larger than 15,000 cfm) in accordance with NFPA 90A and initiate the fire alarm. Smoke detectors installed in HVAC ductwork shall be tested prior to acceptance for proper air flow and voltage sensitivity in the presence of the Project Engineer. The shutdown circuit shall prevent the air handling unit from restarting until the smoke detectors have been reset by the City's fire protection personnel. This test for proper operation shall be made with the air handling unit in all modes of operation.

Those units which are to be used for smoke removal shall be arranged such that no control function can shut down the unit fan and override the smoke removal function when activated.

**END OF CHAPTER 5**
SECTION 601 - OVERVIEW

601.1 EXISTING CAMPUS HEATING/COOLING SYSTEMS OPERATION

Chilled water and heating water for the HVAC systems in the Terminal buildings, AOB and Concourses is supplied from the Central Plant. Heating water is provided by hot water generators consisting of one (1) startup 17,000 MBH Boiler, and three (3) 60,000 MBH main boilers. Chilled water is produced by three (3) 4,150 ton centrifugal chillers and one (1) 3,250 ton electric driven centrifugal chiller.

The Hot Water and Chilled Water systems consists of constant volume boiler and chiller circuit or distribution piping loops located in the Central Plant and the utility tunnels below the AGTS tunnel. This circuit piping supplies the variable speed "transport" or primary loop pumps located at the terminal, Airport Office Building and the Concourses. The variable speed primary pumps delivers water to the constant volume "Tenant" or Secondary loops that supply water to the coils in the air handling units, VAV, Fan Powered boxes, and other terminal air devices. The primary loop consists of pumps in parallel supplying a variable flow, as required by the demand sensed by differential pressure to the secondary pump loops. This secondary pumps will be removed starting in summer 2012 and completing in fall of 2013.

The existing interface between the primary-transport distribution loop and the user-secondary loops utilizes a "BRDG-TNDR" (pronounced "Bridge Tender") control system that contain valves, flowmeters, temperature transmitters, differential pressure transmitters and electronic control panels. The function of the control system is to control the water temperature within the user-secondary loop and controls the flow and pressure relationships between the transport-primary loop and the user-secondary loops. The user-secondary hot water discharge temperature from the boiler is a constant 230°F and is reset by outside air temperature (OAT) to deliver approximately 200°F water at 0°F OAT, and approximately 70°F at 70°F OAT. During the cooling seasons when the Chiller compressors are energized the user-secondary chilled water supply temperature is 42°F± (although this varies) and the return is controlled by the BRDG-TNDR to a constant 58°F±. This system will be removed starting in summer 2012 and completing in fall of 2013.

All new hydronic loops, primary, secondary or tenant shall use the latest BRDG-TNDR technology.

When the refrigeration load decreases because of lower outside temperatures during the fall, winter and spring seasons, the cooling mode utilized is the "free-cooling" system using plate and frame heat exchangers. In the "free-cooling" mode, the chillers are by-passed and the condenser water is pumped from the 350,000 gallon sump through the plate and frame heat exchanger that cools the chilled water. A minimum of two cooling towers run during this time. The system change over to "free-cooling" mode is manual, due to the amount of the time it takes for the sump temperature to stabilize. The manual change-over to the "free-cooling" occurs when outdoor air temperatures do not rise above 60°F to 65°F and chilled water supply temperature can be maintained below 52°F±. On a further increase in demand when the chilled water rises to 52°F±, the heat exchangers will be bypassed and additional cooling towers and chillers turn on sequentially.
SECTION 602 - EQUIPMENT

602.1 CHILLED WATER SYSTEM
The chilled water system shall be configured with multiple water circulation loops. The first loop is the "chiller loop", which shall use chiller pumps in parallel and headered to circulate water through the chillers which are piped in parallel.

The pumps shall be connected in parallel on suction and discharge headers with a 1 to 1 ratio of chiller pumps to chillers. Pumps shall provide a constant flow to each chiller. The chiller loop must be arranged to easily adapt additional chillers and chiller pumps for future capacity requirements.

The second circulation loop is entitled the "primary loop" system which is a variable flow system. The primary loop distributes the chilled water from the chiller loop to the terminal building, concourses and other buildings and areas to be served with cooling. Pumps in parallel supply the distribution piping with chilled water. The pumps shall be staged on and off based on chilled water demand. The method of variable flow control shall be determined during final design.

Variable chilled water flow is provided in response to a signal/signals from differential pressure controllers in the primary loop circuit. The controllers shall cycle the primary loop pumps to maintain sufficient pressure differences between the primary supply and return mains to provide chilled water to the most remote secondary subcircuit.

The water service to the end use equipment is provided from the "secondary loop" variable chilled water flow pumps which are provided at each secondary equipment area. These pumps are to be controlled by return water temperature in the secondary loop, with these systems to be equipped with differential pressure controllers to insure adequate flow to the most remote subcircuit.

The systems described herein may be served similarly by a two-loop distribution system in lieu of the three-loop system.

Flow measuring devices will be required in each loop and subcircuit.

No glycol is used in this system

602.2 HEATING SYSTEM
Heating in all building spaces shall be provided by hot water from hot water generators (boilers) located in the central plant. The hot water system will consist of a boiler circuit or loop; a primary hot water distribution system loop and a secondary distribution system loop serving the terminal units. Hot water boiler pumps shall be equal in number to the boilers and shall circulate and maintain a constant temperature in the boiler loop (reset with outside temperature). The primary loop will consist of pumps in parallel supplying a variable flow, as required by demand and differential pressures, to the secondary loops. Based on final facility and system considerations, more than one primary loop may be justified. The secondary loop pumps shall provide a variable flow sufficient to maintain a differential pressure between supply and return legs of the most remote unit on the secondary loop.

Provide one stand-by pump for each loop system.
No glycol is used in this system

602.3 HYDRONIC REQUIREMENTS

Chilled or Heating Water shall be sized for a maximum of 10 feet pressure drop per 100 feet of equivalent pipe for any run, but no more than an average of 4 feet pressure drop per 100 feet of equivalent pipe for the entire connected system. Circuit setters or balancing valves shall not be used for equipment isolation.

A. Hydronic design temperatures for Airport Distribution and Primary Loops:
   1. Chilled Water Supply Temperature: 42ºF (note: temperature not constant)
   2. Chilled Water Return Temperature: 58ºF
   3. Heating Water Supply Temperature: 230ºF
   4. Heating Water Return Temperature: 200ºF

B. Hydronic design temperatures for Building Secondary Loops (including Tenant Loops):
   1. Chilled Water Supply Temperature: 46ºF (note: temperature not constant)
   2. Chilled Water Return Temperature: 58ºF (note: in heating season this temperature is fixed to 70ºF maximum.)
   3. Heating Water Supply Temperature: 190ºF
   4. Heating Water Return Temperature: 150ºF

602.4 TENANT LOOPS

No more than 20 GPM of chilled or heating water shall be used for any Tenant. Connections shall only be made to the Base building Tenant hydronic loops, no exceptions will be made. Tenant loop connections are located at each central core and concourse subcore on the apron level. The Tenant Engineer is responsible for verifying the existing Tenant loop pumps have adequate capacity to serve the Tenant space. Existing pump data is available from the DIA Project Manager upon request.

602.5 PIPING AND VALVES

Piping for both the central plant and the distribution systems shall be designed to minimize pressure losses and maximize energy use efficiency. Valves to be specified for equipment servicing shall be selected to minimize losses while open, and have suitable pressure drop characteristics for intended use. The piping shall be designed to allow for central plant equipment expansions.

Control valves shall be sized for the correct and appropriate Cv value at the design flow rate. All valves shall be suitable for extended service operation without extensive requirements for lubrication or servicing. Control valves shall be Flow Control Industries Delta P valves.

Tees, valves and blind flanges shall be provided to allow for additions of equipment and piping to the central plant without interruption of services. Piping systems shall be sized for ultimate loads. Tees, valves and blind flanges shall be provided on distribution piping systems for expansion of distribution systems; sectional valves shall be provided in the distribution piping for piping system repairs and at key locations to provide isolation and servicing of equipment. On compressed air lines, quick disconnect connections shall be installed down stream of sectional...
valves to enable use of portable compressors in emergencies. The piping design and materials
selection shall be in accordance with ANSI/ASME Standard B31.9 Building Services and

602.6 PUMPS

Pumps shall be selected for maximum operating efficiency, (i.e., slightly to the right of maximum
efficiency point on the pump curve). Single pumps to be used in throttling applications without
variable speed drives shall have relatively flat performance curves and be selected for operation
on the pump performance curve to the right of the point of highest efficiency. Multiple pumps for
parallel operation shall have relatively steep performance curves. Multiple pumps for series
operation shall have relatively flat performance curves. Pumps for variable speed drive
applications shall have relatively steep performance curves. All pumps shall be specified with
suction and discharge flange taps for pressure gauge connections.

The final selection of pump types and the application arrangement shall be made to maximize
pump efficiency without excessive initial pump costs. All pumps that are selected for both
current and future needs will be sized for the future requirements, where practical, and equipped
with the necessary accessories. The lower initial performance requirement will be met by
balancing valves or by the use of a trimmed impeller to provide energy efficient operation in
start-up performance.

Standby pumps and accessories shall be provided for both heating and cooling systems.
Pumps shall be arranged in a parallel configuration and headered so as to maximize pumping
flexibility.

Generally: Vertical turbine pumps shall be used for pumping cooling tower water. Hydronic
water applications shall use end suction pumps for flow rates below 500 GPM. Horizontal split
case, double suction pumps shall be used for flow rates above 500 GPM.

Vertical split case, double suction pumps will be allowed for use with flow rates above 500 GPM,
only in existing rooms when adequate space for horizontal arrangements does not exist.

602.7 MOTORS

Electric motors shall conform to NEMA Standards. All 3-phase motors shall be high efficiency
type. Motors shall not be selected for operation in the service factor range.

The minimum system installed power factor shall be 90% with a goal to attain a 95% system
power factor. Motors larger than 15 h.p. shall have power factor correction.

Motors shall be specified to be provided with adequate thermal protection, integral or external
control and branch circuit protection, and starters suitable for use with the motors. Motor and
starter types shall be selected to minimize voltage fluctuations and current surges. Motors and
starters shall be provided with auxiliary contacts for control and operation interface with the
central Energy Management Control (EMC) system and any other control functions included.

602.8 WATER TREATMENT

Chemical treatment systems shall be provided at the Central Plant for the protection of the
chilled water, condenser water and hot water systems from scale, corrosion, biological growths
and suspended solids. Any system connecting shall not have glycol or separate chemical
treatment system.

Any chilled water, condenser water and/or hot water systems not connected to the Central Plant
hydronic distribution system shall have a chemical treatment system.

SECTION 603 - DESIGN CRITERIA

603.1 GENERAL REQUIREMENTS

The hydronic systems design shall be based upon the criteria following:

A. Piping shall be designed in accordance with the technical criteria in Section IV of
this manual. Water pipe sizing shall be based on the stricter of the two following
parameters:

<table>
<thead>
<tr>
<th>Pipe Size</th>
<th>Max. Velocity (fps)</th>
<th>Max. Press. Drop* (ft per 100 ft pipe)</th>
</tr>
</thead>
<tbody>
<tr>
<td>up to 2&quot;</td>
<td>4</td>
<td>8.5</td>
</tr>
<tr>
<td>2-1/2&quot; thru 6&quot;</td>
<td>6</td>
<td>4.5</td>
</tr>
<tr>
<td>8&quot; thru 12&quot;</td>
<td>8.5</td>
<td>2.5</td>
</tr>
<tr>
<td>14&quot; thru 20&quot;</td>
<td>10.5 (14)**</td>
<td>2.5</td>
</tr>
<tr>
<td>24&quot; thru 42&quot;</td>
<td>11.0 (14)**</td>
<td>1.5</td>
</tr>
</tbody>
</table>

*Based on new, clean steel pipe.

** Number in parenthesis is velocity limit applicable to
long straight runs where noise is not critical (such as
pipe tunnels, etc.). Maximum pressure drop still
applies.

B. Due to availability issues and relative cost, 5-inch piping and valves shall not be
used.

C. Pressure drops in piping systems shall be calculated to allow for aging and
corrosion of the interior surface. Therefore, all water piping systems shall be
designed with the following friction factors ("C" values) based on the Hazen
Williams Friction Factor formula.

<table>
<thead>
<tr>
<th></th>
<th>&quot;C&quot; Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Closed Water Systems</td>
<td>120</td>
</tr>
<tr>
<td>Closed, Treated Water Systems</td>
<td>130</td>
</tr>
<tr>
<td>Open Water Systems</td>
<td>100</td>
</tr>
<tr>
<td>(New clean steel pipe)</td>
<td>(140)</td>
</tr>
</tbody>
</table>

D. Hot and chilled water distribution systems should be designed for variable volume
flow.

E. Hydronic systems should be designed for widest practical delta T and the closest
possible approach of the return water temperature to the terminal equipment
supply air temperature, but not exceed temperatures listed in Section 602..
F. The terminal equipment must be selected not only for its full load capacity, but also for its performance over the full range of partial loads. Laminar fluid flow in the coils shall be avoided.

G. Integral face and bypass coils should be utilized with preheat coils.

H. Coils subject to 100% outside air at winter design conditions shall be protected by one of the following methods:
   1. Provide propylene glycol in the water loop serving the air handling unit coils for those units arranged for smoke removal - automatic 100% outside air capacity. These units must not be equipped with protective override controls to shut off fan if freezing condition is determined when operating for smoke removal. The glycol-water loop for this system is to be linked to the main heating hot water system through a plate and frame type heat exchanger.
   2. For those units not arranged for smoke removal use, provide freeze protection thermostats on the coil face to shut down unit fan if a freezing condition is detected.
   3. Pumped coils shall not be used as a means of freeze protection.

I. The impact of the change in volume due to thermal expansion of the distribution system fluids during all operations must be addressed in the design process.

J. Control valves in hydronic systems must not be oversized. The flow characteristics and pressure drops are to be selected for the appropriate Cv value corresponding to the design flow to be controlled.

K. Provide automatic air vents at all coils and at the high points of all piping. Provide drains at the low points of all piping.

L. Hydronic systems controls shall be automatic and adjustable to optimize pumping and thermal efficiency.
   1. When close control is essential, do not use three-way valves either for output control in constant-volume-flow systems or for blending control in any variable-volume-flow systems, since their characteristics are of the linear type. Provide equal-percentage valves.
   2. When using three-way valves for throttling, avoid pressure under one port being significantly higher than under the other.
   3. Use mixing three-way valves with caution for flow diversion or diverting valves for mixing since the valves have tendencies to slam shut at reduced flows.
   4. Use two-way valves at terminal coils in variable flow systems.
   5. Hot water coil valves shall fail to the open position.

603.2 EXPANSION REQUIREMENTS

In modular buildings that are designed for to be expanded as the Airport capacity increases (such as Concourses and the Terminal) all hydronic systems shall be sized for the maximum build out of the facility. Piping flow diagrams shall indicate all calculated flowrates of all general spaces anticipated for future construction.
Concourse A West: since the west side of the facility cannot be expanded substantially past subcore 6W, the hydronic system shall not be designed for future capacity of any space to the west of 6W.

END OF CHAPTER 6
CHAPTER 7
SPACE REQUIREMENTS AND MAINTAINABILITY

SECTION 701 - GENERAL

701.1 GENERAL

Mechanical equipment and layout shall be selected to maximize equipment performance; and minimize equipment servicing, repair and maintenance. Equipment selection shall also consider durability, reliability, maintainability and serviceability. Equipment arrangement and layout shall allow for safe and efficient accessibility for equipment removal, replacement, repair and maintenance.

During the design phase, coordination with other design disciplines is essential to provide for the necessary access to equipment. All otherwise in accessible equipment and equipment components shall be provided with OSHA approved catwalks, platform, or etc. to allow maintenance. The catwalks, platforms, and adequate lighting, etc. shall provide for maximum safety to both personnel and equipment while allowing access for equipment maintenance. Standardization of equipment and materials shall be used to the maximum extent possible. Standardization and interchangeability will minimize the space and expense of the maintenance spare parts inventories. Items for consideration for standardization shall include, but not be limited to: Air handling units and components, terminal units, control components, heat exchangers, pumps, valves, and fans.

SECTION 702 - DESIGN REQUIREMENTS

702.1 DESIGN

The design shall, in general, include equipment layouts with maintenance and repair clearances indicated. Special maintenance items or equipment, or necessary auxiliary equipment shall be specified to be provided and installed with the equipment it is to serve. Avoid locating equipment requiring frequent service or repair above ceilings or in occupied spaces.

702.2 EQUIPMENT SELECTION

Equipment shall be selected for stable operation at both full and part-load conditions. Equipment selections shall be below maximum limits for capacity, speed, temperature and pressure. The equipment installation design and specification shall include sufficient instrumentation for measuring, indicating, monitoring, operating and servicing at full and part loads.

702.3 BEARINGS

Use permanently lubricated bearings on fans, if available. Equipment which cannot be furnished with permanently lubricated bearings shall have lubrication lines extended to the exterior of the unit.

702.4 CONSTRUCTION REQUIREMENTS

Require the contractor to include in the shop drawing submittals manufacturers recommended spare parts lists, maintenance and service clearances, special maintenance equipment or requirements and recommended maintenance schedules. Conflicts between equipment and maintenance requirements or clearances shall be submitted, along with contractors solutions to
the conflicts, for approval. Approval of conflict resolution shall be required before equipment installation. Require the contractor to revise all flow diagrams, control diagrams and additional information to reflect any revisions to designed systems and/or required performance capabilities to suit the actual equipment installed.

Require the contractor to provide instruction for operating personnel on the operation, attendance and maintenance of equipment. Include all data necessary to establish an efficient and effective preventive maintenance program.

702.5 FAN HOUSING
All supply fan housings shall have ladder rungs mounted on the side of each unit next to the coil pipe connections to provide access to the top of each unit without stepping on insulated pipes.

702.6 ACCESS DOORS
All air handling units shall be equipped with access doors for each compartment (coils, filter, fan, etc.), with piano hinges, door handles, and a viewing window in each compartment access door. The doors should be sturdy enough to permit opening the door using one handle.

Provide in accessible locations access doors of adequate size at all fire damper locations for the purpose of inspection as well as for replacing fusible links.

SECTION 703 - SPACE REQUIREMENTS

703.1 MECHANICAL ROOMS
Mechanical room space requirements and dimensions shall be coordinated with the architect so that appropriate space is provided for the equipment and its service and maintenance.

703.2 MECHANICAL CHASES
Mechanical chase space requirements shall also be determined and coordinated, including space for supply and return air ductwork, outside ventilation air, exhaust air, hot and chilled water piping, domestic water piping, sanitary drainage, and roof drains, etc. All chases with plumbing equipment shall have a minimum one floor drain.

703.3 EQUIPMENT CLEARANCE
Provide a minimum of four feet (clear space) around all sides of boilers and chillers, plus tube pull space. Provide three feet (clearance space) around all sides of pumps, and air handling equipment. These are minimum design requirements, if manufacturers recommendations exceed these values, Design Consultant shall comply with the more stringent requirement.

All rooftop equipment shall be serviceable through existing roof access.

Drawings shall show minimum clearances for service and access to equipment.

703.4 CONVEYOR RIGHT OF WAY
In certain areas baggage conveyors will be routed through ceiling plenums. The space requirement for these conveyors will be approximately 4 feet deep by 4 feet wide per conveyor,
plus the additional space needed for personnel cat walks (preferable 4 feet wide). Therefore, all ductwork must be routed to avoid conveyors and structural members. Physical space may prohibit ductwork crossing baggage conveyors. Careful coordination is required.

Design Consultant shall coordinate with all systems and disciplines throughout the design process to insure adequate space is available and to avoid interferences.

END OF CHAPTER 7
CHAPTER 8
PLUMBING REQUIREMENTS

SECTION 801 - PLUMBING SYSTEMS

801.1 GENERAL
This section applies to the systems used to receive, transport or discharge liquid waste or sewerage; the systems used to receive and distribute potable water; the systems used to receive and distribute fuel gas; the systems used for the collection and transport of rain water and cooling coil condensate drains, etc.

801.2 SYSTEM REQUIREMENTS
A. Facilities for the physically handicapped shall be provided in all public building restrooms.
B. Provision shall be made within the terminal building and each of the concourses for future expansion of the plumbing systems at such time that the complex is expanded to meet increased usage.
C. All domestic hot and cold water piping and designated storm drainage piping within conditioned areas shall be insulated. All piping subjected to freezing temperature shall be insulated and heat traced accordingly.
D. Buildings, in the Terminal Complex and Concourse areas, shall be provided with roof drains and a drainage collection system. The roof drainage system shall be connected to the exterior storm sewer system. Overflow roof drain system shall be piped separately and terminated at grade level.
E. Structural roadways shall be provided with deck and curb drains, and a suitable collection system.
F. An industrial waste sewer shall be provided for all liquid wastes that would be detrimental to the public sewer system or detrimental to the operation of a sewage treatment plant. Industrial waste shall be collected, treated and disposed of as required by the authority having jurisdiction.

SECTION 802 - PLUMBING DESIGN PARAMETERS

802.1 GENERAL
All plumbing systems shall conform to the requirements of the codes and standards listed in Volume 1 of the Design Standards.

802.2 FIXTURE COUNT
To determine the minimum number of fixtures required for the terminal and concourse areas a plumbing fixture count method shall be used. The plumbing fixture method is a method of adjusting the numbers of people on which the number of fixtures are determined in setting the design for the plumbing facilities. After the numbers of people are appropriately adjusted, the fixture per persons for the type of building or occupancy from the uniform plumbing code shall be used for determining the minimum plumbing facilities.

The plumbing fixture method typically allows for additional fixtures for peak loads not adequately accounted for by the codes. The basis for the plumbing fixture count method is based on historical airport experience and the following criteria: (Design Consultant shall utilize this
criteria or City and County of Denver building code, whichever requires the higher number of fixtures.)

A. Projected Peak Occupancy (per area).
B. Thirty-three percent of passengers and 15 percent of visitors will use concourse facilities. (Departures and arrivals levels.)
C. Fifteen percent of visitors and fifteen percent of passengers will use terminal building facilities.
D. The percentage of men and women of total occupancy is estimated at 55 percent male/45 percent female.
E. Each level and area shall be subdivided into terminal public space, restaurant, office and retail to determine fixture count for each particular occupancy.
F. Urinals shall be utilized in lieu of water closets in men's toilets to the maximum ratio allowed by code.

Fixture counts and/or flow rates shall be shown on all isometric drawings.

802.3 CALCULATIONS
Design calculations shall be based on ASPE Data Book (Chapter 8) and the Denver Amendments to the International Code Series, latest edition. Recognized acceptable engineering practices shall be applied for areas where design criteria have not been established specifically by these codes and standards.

Several areas of the Terminal and Concourses experience dramatic pressure fluctuations. The engineer shall make every effort to ensure that new designs do not amplify current conditions. In these areas, static and dynamic pressure calculations shall be performed and submitted.

No assumptions shall be made on plumbing system capacities. All connections to existing plumbing systems shall have capacity calculations proving capacity. The design consultant shall submit all calculations directly to the DIA Mechanical Engineer in PDF format.

802.4 TERMINAL
The terminal building plumbing facilities shall be designed for optimum passenger use and the total future terminal size to prevent undersizing of initial terminal building plumbing facilities.

802.5 CONCOURSES
The plumbing facilities in the concourses shall be designed for the current initial passenger use. Expansion in concourse passenger service will be in conjunction with concourse construction expansions. Those expansions will include the necessary additional plumbing facilities. Plumbing utility systems (pipe sizes and arrangement) shall be designed to allow for future facilities expansion.

802.6 SAND TRAPS
Sand traps and oil separators shall be installed for vehicle wash areas, deck and curb drains and any other areas where sand and oil may enter the drainage system.

802.7 INDUSTRIAL WASTE
Industrial waste sewer shall be provided for areas where fueling of aircraft and vehicles take place.
802.8 FLOOR DRAINS
Buildings shall be provided with floor drains that have traps and cleanouts. The location and types of all cleanouts shall be noted on the drawing. All drains exiting the building shall have a double cleanout so that the drain line may be cleaned into and out of the building.

Mechanical rooms shall contain general area floor drains and equipment drains for condensate and other miscellaneous drainage. Equipment drains shall not serve dual duty.

All floor drains in chases, basement areas, restrooms, mechanical rooms and entry vestibules shall have trap primers.

802.9 BACKFLOW PREVENTION
The potable water supply system shall be designed, installed and maintained in such a manner as to prevent the contamination from non-potable liquids, solids or gases being introduced into the potable water system through cross-connections or any other connections to the system. Protective measures and the requirement for backflow prevention devices shall meet or exceed the requirements of the International Plumbing Code, Denver Building Code Amendments and the requirements of water utility, Denver Water. If there is any conflict between these requirements the most stringent requirement shall apply in the design and/or modification to the existing potable water system. Should existing systems be found that do not comply with the latest backflow prevention requirements, the design will include upgrading the backflow prevention of that system being renovated, added to and/or constructed. All domestic water connections to mechanical, plumbing and fire protection systems, including lawn sprinkling systems, shall be protected from backflow by use of backflow preventers installed in the piping. Plumbing designs shall meet best management practices for cross connection control.

802.10 COORDINATION
It is the responsibility of the plumbing engineer/designer to provide design, specification and detail of all plumbing connections to systems outside of the building (IE: water, storm drainage, sanitary sewer, natural gas, etc). The interface point shall note elevations (building reference and civil reference), sizes and acceptable means of connection of differing materials and allowable tolerances of connection. “RE:Civil” notes shall not be used to solely identify this connection.

SECTION 803 - PLUMBING SYSTEM COMPONENTS

803.1 GENERAL
A. It has not been determined how many water services or meters will be provided, however, it is preferred that the terminal building complex should be provided with one central water meter, with the main water entrance located at the terminal building with branch services to each of the concourses. Remote buildings may have separate meters.

B. Electric (instantaneous type or small storage tank) domestic water heaters shall be provided at each toilet room. Larger requirements for domestic hot water such as restaurants, etc., shall have gas-fired or steam hot-water heaters. No central hot water system shall be provided in the terminal building complex or in the concourses.

C. Exterior grease traps shall be provided for fixtures in kitchen and food service concessions areas as these facilities may require.
D. All water supply to fixtures shall be protected by an approved vacuum breaker.

E. A detailed area chart/plan shall be prominently displayed in the main equipment rooms showing the locations of all main piping and valves. The Design Consultant is to include this as a contractor requirement.

F. All domestic hot and cold water and storm drainage piping within conditioned areas shall be insulated. All piping subjected to freezing temperatures shall be insulated and protected from freezing as appropriate.

803.2 PLUMBING FIXTURE AND EQUIPMENT

A. All lavatory faucets in public and private toilet rooms shall be provided with flow restricting devices on all outlets. Provide single tempered water faucet at lavatories with 102°F supply temperature.

B. All lavatories (including physically handicapped) can be wall hung or counter mounted. Wheelchair access must be provided for handicapped fixtures. A minimum 29" clear knee space is required with maximum 34” rim height or as defined by the latest version of the ADA.

C. Water closets and urinals shall be a wall hung "blow out" type. Tank-type water closets shall not be used in the Terminal Complex. The flush valves and fixtures shall be provided as follows:

<table>
<thead>
<tr>
<th>Fixture</th>
<th>Maximum Water Flow*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water Closets</td>
<td>1.6 gpm</td>
</tr>
<tr>
<td>Urinals</td>
<td>1.0 gpm</td>
</tr>
</tbody>
</table>

*Design Consultant may provide lower flow fixtures as new technology may permit reliable operation.

D. Urinals shall connect directly downstream of water closet sanitary sewer main for allowance of future low flow fixtures. Urinals shall not be headered together and then connected to the sanitary mains.

E. Automatic valves shall be provided for urinals and lavatories in public areas. Valves shall be provided with infra-red sensors for valve actuation (coordinate with electrical Design Consultant).

F. Stop valves shall be provided on all fixtures including water coolers.

G. All fixture types shall be located in the design documents and called out on the contract drawings.

H. All water coolers in public area shall be barrier free bi-level type.

I. Roof vents (DMV) shall be of 3-inch diameter minimum.

J. Drains from service and slop sinks shall be minimum of 3-inch diameter.

K. Minimum potable water line size shall be 3/4-inch except for branch to fixture which may be 1/2-inch.

L. Provide a floor drain below all non-carpeted interior vestibule areas. (Drain shall be located below steel mat.)

M. Air admittance valves shall not be used unless approved in writing by the DIA.
Mechanical Engineer. Only foot valves as described by code shall be used (See DIA Detail for connection).

N. A minimum of one hose bibb shall be located in each mechanical and pump room for general wash down.

O. All sump pumps must have a remote alarm, strobe/light, and sign in a nearby occupied area.

803.3 PIPING
Refer to the specifications for pipe material types. PVC shall not be used inside the building without written permission of the DIA Mechanical Engineer. PVC may be used below grade as long as it is encased in flowable backfill. Cast-iron shall not be used for underground piping.

All sanitary sewer piping shall slope at no less than ¼” per linear foot for allowance of future low flow fixtures.

SECTION 804 - ENERGY CONSERVATION IN PLUMBING SYSTEMS DESIGN

804.1 HOT WATER
Hot water for domestic water use shall be designed in accordance with ASHRAE 90.1-2004 Section 7 and OSHA requirements. ASHRAE 90.1 establishes minimum requirements for hot water generator recovery efficiency, storage tank insulation, pipe insulation, temperature controls, pump operation, equipment automatic shutdown and conservation of hot water.

804.2 TEMPERATURE
The domestic hot water system shall be designed for a supply temperature of 122ºF for circulated systems and 140ºF for storage systems per OSHA requirements. For the public spaces provide lavatories with 102ºF water at each point of use.

804.3 SAFETY DEVICES
Safety devices shall be provided on the hot water generators and storage devices. Safety devices shall be as required by code and as a minimum shall include energy cut-off devices, relief valve and/or temperature or combination temperature and pressure relief valves.

All water heaters, regardless of size, shall have an expansion tank on the domestic cold water inlet.

SECTION 805 - NATURAL GAS

805.1 SIZING
Gas piping shall be sized per the requirements of the International Fuel Gas Code, City and County of Denver Amendments to the code and local Gas Utility.

Additional criteria:
   A. Gas specific gravity: 0.65
   B. Gas thermal capacity: 834 BTU per 1,000 cubic feet

805.2 METERING
Metering and pressure regulation for all buildings shall be in compliance with the requirements of Xcel Energy. Contact:
   Dan Turner
Natural gas service for Concourse Tenants will be connected from metered area designated by DIA. The designer shall coordinate gas and meter requirements with the local Gas Utility.

All gas requirements (demand and pressure) shall be shown on the drawings.

**805.3 GAS SYSTEMS PROTECTION**
Architect and Engineer of Record for design of facilities shall design protective measures for all gas piping systems at DIA. Protective measures shall be coordinated with the utility company so that all gas systems above ground level are provided for the entire gas system, including upstream and downstream piping from the meter.

All gas piping, meters, pressure regulators, appurtenances and systems shall be fully protected from possible collisions with vehicles, baggage cart tugs, support equipment, etc. To the greatest extent possible, gas systems shall be located away from areas where it is possible for vehicles and/or equipment to strike it directly and/or indirectly through adjacent walls that offer inadequate protection from such vehicle strikes. Standard CMU walls and concrete curbs do not provide adequate protection as can be seen from attached photo. In addition, gas systems shall be protected from grade level to ceiling as strikes can occur at nearly all elevations that are not either protected and/or concealed in ceilings.

Gas piping, meters, pressure regulators, appurtenances and systems exposed to aircraft apron areas shall be fully protected all the way from grade level to the bottom of the soffit level. Refer to Photos #805.1 through #805.3b for depiction of existing problems with vehicle crashes and collisions that can occur on a daily basis at DIA.
END OF CHAPTER 8
CHAPTER 9
FIRE PROTECTION

SECTION 901 - GENERAL

901.1 GENERAL

Fire sprinkler and fire alarm systems are required for single facilities, larger than 1,500 square feet, per the Denver Fire Prevention Bureau, F.M. Global and NFPA. Fire protection systems shall be provided in accordance with the latest editions of the standards and codes listed in Volume 1, of the Design Standards and the International Fire Code as adopted and modified by the building code of the City and County of Denver (Note that IBC, Appendix N has additional requirements). It shall represent all of the requirements of the agency Insurance Underwriters, F. M. Global at this time. The following description of fire protection requirements is based on National Fire Protection Association codes (NFPA).

As the final design develops, Design Engineer shall meet with local code officials to verify code compliance. Design Engineer shall coordinate fire protection and sprinkler systems with the Architect.

901.2 RELATED WORK

Fire Protection System Design includes coordination with Division 16 electrical for proper placement of devices for initiation or alarm by the Fire Alarm System and initiation of the Smoke Control System if applicable. The devices include, but are not limited to: fire protection sprinkler flow switches, rate of rise detectors, smoke detectors, beam detectors, pressure alarm switches, manual pull stations and other alarm initiating devices. Refer to chapter 10 of this manual and Design Standards Manual 5 for additional requirements.

901.3 DESIGN DOCUMENTS

All design documents shall contain at a minimum the following:

A. Plan(s) showing as-built fire-sprinkler layout of existing/new space.
B. Plan(s) location of existing and new Zone Control Valves.
C. Building Fire Protection Riser Diagram identifying zones of project impact.
D. DIA Specifications, 15300 series. No substitutions are allowed without written approval of DIA Mechanical Engineer AND DIA Life Safety Team.

901.4 SUBMITTALS

Fire Sprinkler and Fire alarm as-built documents are a required for ALL projects that modify or add these systems. These documents shall be included in the Designer’s “Conforming to Construction Records” submittal.

SECTION 902 - FIRE PROTECTION SYSTEMS (TERMINAL & CONCOURSE AREAS)

902.1 LOWER LEVELS AND PARKING

A. The following areas shall be sprinklered.
   1. Foyer, Car Rental and Public Area.
   2. Service Drive.
3. Storage Areas.

4. All areas of these buildings, (except large computer rooms) will have special type systems, usually clean agent or possibly supervised dry type pre-action systems.

5. Top floor of control tower(cabs) will have only detection systems

B. The electrical equipment rooms shall be provided with automatic detection systems. These areas include:
   1. Electrical Substations.
   2. Public Address and Telephone Equipment Rooms.
   3. Electrical Generator Rooms.

C. Service drives shall have a dry-type sprinkler system (exception existing concourse drive-thrus shall have wet pipe systems with dry style pendent heads).

D. Provide Class III stand pipe system, with portable fire extinguishers at F.D.V. stations in enclosed areas, as required at all required exits/stairs at each level. Provide Class I standpipe, system (dry type with no water connection), with parking areas.

E. Provide manual pull type fire alarm system throughout below ground parking areas foyer areas and all entry/exit points.

F. All escalator and stair openings shall be protected with a closely spaced sprinkler system around the perimeter forming a water curtain, as well as an 18” deep baffle for smoke zone containment.

G. On level 1, 2, and the part of level 3 where there is no alternate baggage conveyors the dry pipe systems extends 75’ from entrance doors. On level 4 the dry pipe systems extends through out the driving lanes in front of the doors. On level 5 the dry systems cover the entire covered area. All covered drive lanes on all structures have either dry systems or heated blind spaces with dry pendent heads. (Exception is the passage)

902.2 BAGGAGE HANDLING AREAS

A. Entire alternate baggage area, on level three of the terminal shall be protected with automatic dry pipe sprinkler systems.

B. All escalator and stair openings shall be protected with a closely spaced sprinkler system around the perimeter forming a water curtain.

C. All conveyor opening perimeters shall be protected with closed head sprinklers on 6-foot centers providing water curtains.

D. Class I standpipe system shall be provided with extinguishers at each station.

E. Provide manual pull fire alarm system throughout entire level.

F. Protect baggage conveyor and the area beneath the conveyors.

902.3 BAG CLAIM & TICKETING LEVELS

A. All areas shall be sprinklered with a wet-pipe system, except as noted herein.

B. Provide a Class III standpipe system with extinguishers at each F.D.V. station.
C. Provide a manual pull fire alarm station at each stairwell and exit area.

D. All escalator and stair openings shall be protected with a closely spaced sprinkler system around the perimeter to provide a water curtain.

E. Exterior glass partitions surrounding foyer areas shall be protected with closed head sprinklers on 6-foot centers to provide a water curtain.

F. Detection systems shall be provided in offices, mechanical rooms and restrooms (no sprinklers).

G. Conveyor openings passing through floors or fire wall separations shall be protected with closed head sprinklers at the perimeter to provide a water curtain.

902.4 ATRIUM

A. Atrium area shall be protected with a wet-pipe sprinkler system. This includes "Hot-Snack" and restaurant areas, security area train loading and unloading platforms and general area. The main terminal tent area has beam detection and automatic sprinklers on all exterior tenant walk ways and under all bridges and canopies.

B. Provide detection system only, for offices, restrooms, mechanical rooms electrical rooms, communications rooms, rental spaces and concession areas.

C. Provide a Class III standpipe system with extinguishers at each F.D.V. station.

D. A detection and smoke evacuation system shall be provided in the atrium area.

902.5 CONCOURSE - APRON LEVEL

A. The following areas will be sprinklered:
   1. Baggage Areas
   2. Service Areas
   3. Storage Areas
   4. All areas of the building unless otherwise noted.

B. The electrical equipment rooms will be provided with automatic detection systems. These areas include:
   1. Electrical Substation.
   2. Public Address and Telephone Equipment Room. Limits in size and construction materials exist.

C. Service Drives and tunnels to concourse areas shall have 2-hour rated self-closing access doors.

D. Provide Class III standpipe system with extinguishers at each station.

E. Detection system shall be provided in offices and mechanical rooms.

902.6 CONCOURSE - CONCOURSE LEVEL

A. Sprinkler concession areas and potential "Hot-Snack" areas with wet-pipe system.

B. Sprinkler: Janitor closet and hold rooms with wet-pipe sprinkler system.

C. Detection: A detection system shall be provided in the following areas:
1. Airline Offices
2. Men's and Women's Restrooms
3. Mechanical Rooms

D. Provide manual pull fire alarm stations at all exits.
E. Provide Class III standpipe system throughout area - including concourse areas with extinguishers at each station. Fire extinguisher placement shall be reviewed and approved in writing by the DIA Mechanical Engineer or the DIA Life Safety Group.
F. Hydrants: A system of fire hydrants will be provided on both sides of the concourses at apron level. In the terminal in addition to the perimeter protection at ground level there also exists dry style knox key operated fire hydrants located along the drive lanes of both levels 5 and 6 which are supplied by deluge valves on the first level.

902.7 COMMUNICATIONS ROOMS
Communications rooms, in the Terminal and Concourses only, smaller than 600 SF are not required to have a fire protection system as long as the room has full smoke ionization detection connected to the building fire alarm system in accordance with NFPA 92 and the room is constructed to meet a two hour fire rating.

902.8 ELECTRICAL ROOMS
Electrical rooms, in the Terminal and Concourses only, are not required to have a fire protection system as long as the room has full smoke ionization detection connected to the building fire alarm system in accordance with NFPA 92 and the room is constructed to meet a two hour fire rating.

902.9 OTHER FACILITIES
In general, single facilities larger than 1,500 Square feet require fire sprinkler and fire alarm systems per the requirements of Denver Fire Prevention Bureau, F.M. Global and NFPA.

See Chapter 12, Facility Design, of this Manual, for individual building descriptions of fire protection requirements.

SECTION 903 - MISCELLANEOUS REQUIREMENTS

903.1 STANDPIPE SYSTEM
The terminal and concourse structures was protected by a hydraulically calculated wet standpipe system (exception 6" minimum diameter risers) and fire extinguishers, as required by 1986 NFPA Standard 14 and NFPA 416, 1987 Standard. The current Fire Code as amended by the Denver Fire Prevention Bureau requires NFPA 415 as well as current issue of applicable NFPA codes and standards. The Design Consultant shall specify the installing contractor to perform hydraulic calculations based on his final layout.

903.2 EXTINGUISHERS
Portable fire extinguishers shall be provided throughout the building. Extinguisher type and distribution shall conform to 1988 NFPA Standard 10 requirements.
A. An automatic carbon dioxide protection system shall be provided for kitchen hood and surface cooking equipment in food preparation areas, kitchens, etc. (Exception alternate extinguishing system types which are acceptable to the Denver Fire Prevention Bureau are allowed in lieu of CO2 but must complete all necessary steps as outlined) Provide alarm contact for interfacing with fire alarm. Sprinklers may be required in extended exhaust duct runs from the kitchen hoods.

903.3 HYDRANTS

A. Fire hydrants shall be provided in the short term parking areas and at each end of the enplaning and deplaning drives, installed in accordance with 1987 NFPA Standard 24 requirements.

B. A system of exterior fire hydrants or wall hydrants shall be provided on both sides of each concourse building and the airside of the International Concourse.

C. The use of sidewalk or wall hydrants shall be in accordance with NFPA 13 and 14 and shall be based on fire equipment access to the hydrants and as acceptable by the Denver Fire Prevention Bureau.

903.4 WATER SUPPLY

Water supply data and preliminary hydraulic calculations require immediate analysis to verify adequacy of the system pressure and flow available, or the need for fire pumps. If fire pumps are required:

A. A fire pump system, if necessary, located in separate fire pump room in the main terminal building service level will be provided. Installation shall conform to the 1987 NFPA Standard 20.

B. Water supply to the fire pumps for fire protection systems will be taken from the service main ahead of the meter. Detailed design of these systems and design criteria for hydraulically calculated sprinkler and standpipe systems will commence after consultation with local authorities and insurers.

C. The fire pump room shall be sprinklered.

D. Use only current years actual site fire pump tests data and City of Denver Water Department flow tests which are no older than 6 months for the Hydraulic Calculations basis.

903.5 FOAM SYSTEMS

Provide foam water systems where applicable. Generally foam systems will be AFFF and be furnished in some aircraft hangars and at fuel tanks and fuel loading areas.

903.6 COORDINATION WITH SMOKE CONTROL ZONES

Where fire sprinklers are installed in an existing or new smoke control zone, the zoning of the fire sprinkler system shall match the smoke control zones. There may be multiple sprinkler zones in a single smoke control zone. In no case shall a fire sprinkler zone cross more than one smoke control zone.

END OF CHAPTER 9
CHAPTER 10
SMOKE CONTROL

SECTION 1001 - GENERAL

1001.1 GENERAL
This Chapter is intended to outline specific requirement to be included in the overall mechanical system designs and specifications for issuance of construction documents suitable for bidding and permitting. These designs and specifications shall include engineered smoke control systems where applicable for specific locations. This Chapter describes the smoke control system design requirements and criteria for specific locations and the scope of participation that is required by design professionals of record.

Denver International Airport (DIA) has an electrically supervised addressable fire management system. The system includes: Fire Department Operations Center Color Graphic Panel (CGP); Fire Alarm Graphic Annunciation Panels (GAP, or PCFC monitor); Fire Alarm Master Panel (FAMP); and Fire Alarm Remote Control Panels (FARP). Independent fire alarm systems and related life safety smoke control systems are installed for the Main and North Terminals, Concourses, Airport Office Building, AGTS/Baggage Tunnels, Passenger Bridge from the North Terminal to Concourse A.

1001.2 RELATED WORK
Smoke Control System Design includes coordination with Division 16 electrical for proper placement of devices for initiation of the smoke control sequence by the Fire Alarm System. The devices include, but are not limited to: fire protection sprinkler flow switches, rate of rise detectors, smoke detectors, beam detectors, pressure alarm switches, manual pull stations and other alarm initiating devices.

Smoke Control System Design includes coordination with Division 15 mechanical for design of the fire suppression systems and how they relate to specific smoke control zoning as defined herein.

Coordinate fire alarm system address availability for monitor and control with Design Manual 5 – Electrical and Chapter 9 of Design Manual 4. Engineer is responsible for assuring that fire alarm addresses are available for use in smoke control systems designs prior to issue of construction documents.

1001.3 QUALITY ASSURANCE
Engineered construction documents shall be executed by design professionals that are Professional Engineer(s) licensed in the State of Colorado, (Engineer). The Engineer shall have working knowledge and experience in the designs of smoke control systems and be familiar with the current codes and requirements of the City and County of Denver authorities having jurisdiction.

SECTION 1002 - DESIGN CRITERIA

1002.1 STANDARDS
Smoke control design shall be performed in accordance with the latest versions of:

A. International Building Code
B. International Mechanical Code
C. International Fire Code  
D. Denver Amendments to the International Codes (specifically IBC Appendix N and the IFC)  
E. NFPA 92A - Recommended Practice for Smoke-Control Systems  
F. NFPA 92B - Guide for Smoke Management Systems in Malls, Atria, and Large Areas  
H. NFPA 415 - Airport Terminal Buildings, Fueling Ramp Drainage, and Loading Walkway  
I. Principles of Smoke Management (Published by ASHRAE & SFPE)  
J. Any requirements set forth by FM Global  

Where the requirements of this chapter deviate from the above standards and codes, the more stringent of the two shall apply.

**1002.2 GENERAL**  
Design shall comply with the requirements of the latest City and County of Denver Amendments as revised and accepted by all jurisdictions having authority including requirements set forth in approved administrative changes in place at the time of the original permit and approved contract documents associated with the designs and installations of the life safety smoke control systems.

**1002.3 EQUIPMENT**  
Other than for renovation work in existing areas, all new smoke control system design(s) shall provide dedicated smoke control equipment for providing pressurization or exhaust. Base building air handling systems on all new facilities shall not be used for smoke control. Duct materials should be selected and ductwork should be designed to convey smoke and withstand additional pressure (both positive and negative) provided by the smoke control pressurization or exhaust fan(s) when operating in a smoke control mode. Pressurization and exhaust ductwork shall maintain their structural integrity during the period of time required for the system to operate.

Equipment including but not limited to: fans, ductwork, balancing dampers, damper actuators, motors, etc. utilized for smoke control should be suitable for the intended operating temperatures. Materials used for systems providing smoke control should conform to NFPA Standard 90A, and other applicable NFPA documents. Smoke control system components (e.g. fans and dampers) shall be U.L. listed for use in smoke control systems.

Where existing base building air handling systems are being used as smoke control, the Engineer shall investigate alternatives to provide dedicated smoke control equipment to the DIA Mechanical Engineer and Life Safety Team.

Other than for initiating smoke control system pressurization for stairways and hoistways in certain locations, manual pull stations shall not be programmed to initiate smoke control systems in either smoke control system exhaust or pressurization.

**1002.4 EQUIPMENT/ZONE IDENTIFICATION**  
The Engineer shall obtain equipment and zone identification from the DIA Mechanical Engineer.
In general, smoke control equipment is identified by: A-BBCC

A. A: F for fan or D for Damper
B. BB: SP for Smoke Pressurization or SE for Smoke Exhaust
C. CC: Numerical sequence for building (obtain from DIA ME).

Smoke pressurization and exhaust fans serving the same area shall have the same numerical sequence. In no case shall smoke control equipment be identified by any other method. Coordinate with other disciplines for naming conventions associated with fans and peripheral equipment such as starters and disconnects to ensure that a single system of identification is being applied to HVAC, Electrical and Fire Alarm drawings.

1002.5 AIRFLOW RATES
The public circulation areas smoke removal systems shall provide at least four (4) air changes per hour.

The public circulation areas smoke removal systems shall be located to preclude accumulation of smoke in any part of the public circulation areas zoned not to exceed 52,000 square feet on a single floor and must coincide with required fire sprinkler zones. The smoke control zones shall match sprinkler zones. There may be multiple sprinkler zones in a single smoke control zone. In no case shall a fire sprinkler zone cross more than one smoke control zone.

The control system, both pressurization and exhaust system(s) shall be capable of manual override operation from the Fire Department Operations Center.

The tenant spaces located in the basement, concourse and mezzanine Levels of Concourses A, B, C and tenant spaces in the Terminal shall be part of a smoke control zone, not to exceed 52,000 square feet on a single floor. Tenant spaces that are within 2 adjacent smoke control zones may be connected to either of the adjacent smoke control systems.

For tenant spaces adjoining the concourse or terminal exceeding 5,000 square feet, a separate smoke control zone shall be provided.

Airflow analysis shall be performed on every zone to verify that smoke will move through all portions and no dead spaces occur. 90% of what is exhausted in a single zone shall be supplied by adjacent zones.

1002.6 TRANSFER AIR
Smoke exhaust transfer air openings in walls to structure and ceilings shall be sized for a maximum velocity of 200 fpm based on the net free area where transfer air grilles or other security devices may be installed over the air openings. Sizing of smoke exhaust transfer air openings for the smoke zones or tenant areas with adjacent smoke zones or tenant areas shall allow for sizing of openings to include smoke exhaust air quantities for the tenant areas and all adjacent zones or tenants to the final point of smoke exhaust. Coordinate requirements for security grilles or barriers with DIA Mechanical Engineer.

1002.7 SMOKE ZONE AND AIRFLOW DIAGRAMS
Established Smoke Control Zone diagrams and Smoke Control Matrices are available from the DIA Mechanical Engineer or the DIA Life Safety Team for the Terminal, AOB and Concourses. These diagrams and matrices shall be used whenever a smoke test is required, no exceptions.
These files shall only be modified when smoke control zones or equipment are added or modified. The Mechanical Systems Design Engineer shall update the DIA Smoke Control Diagrams and the Smoke control matrix for the building of design and submit the updated electronic file to the DIA Mechanical Engineer, separate from the Contract Documents. Additionally, it is the responsibility of the Mechanical Systems Design Engineer to obtain the most current copy of these files at the start of design.

Building airflow diagrams are available for limited areas only and are in the process of being created for all areas. When the airflow diagram is available the Mechanical Systems Design Engineer shall update the DIA Airflow Diagram for the building of design and submit the updated file to the DIA Mechanical Engineer, separate from the Contract Documents.

1002.8 SMOKE DETECTION
Two (2) devices located in a smoke control zone shall initiate automatic smoke control sequences for that zone. Those sequences include automatic smoke control exhaust for the zone in alarm and automatic smoke control pressurization for adjacent smoke control zones. Initiation of both smoke control pressurization and exhaust system fans for the Baggage and Train tunnel zones is performed manually through the CGP. Smoke control exhaust for the Main Terminal is automatically initiated with the activation of (2) devices. Smoke control pressurization of adjacent zones, within the Main Terminal, is performed manually. Smoke control system pressurization and exhaust for the Main Terminal Great Hall zones is performed manually through the CGP. All other smoke control zones shall remain in normal operation unless commanded otherwise either automatically or manually through the fire alarm system.

The mechanically operated supply and return exhaust systems servicing smoke control zones shall be arranged to exhaust at the indicated rates when activated by the smoke detection and/or sprinkler systems; all adjoining areas or smoke control zones shall be arranged to supply 100% outside air to prevent smoke migration to the unaffected areas. In addition to other smoke zone area requirements, passenger holding areas shall be treated as tenant spaces if separate systems are used; otherwise, they shall be treated as part of the concourse/passenger terminal public circulation space and horizontal smoke control zones shall be limited to 52,000 square feet maximum.

The building HVAC air handling units shall have a product of combustion detector located in the supply air system after the air filters, which will stop the supply fan upon detection. In addition, a product of combustion detector shall be provided in the return or the exhaust air stream ductwork and are utilized as a first device to initiate smoke control for the smoke control zone for which they are located or serve. Return air detection is not required or desired in new spaces that have full smoke detection.

SECTION 1003 - TERMINAL SMOKE CONTROL OPERATION OVERVIEW

1003.1 GENERAL
The following is a general description of the smoke control systems in place for specific areas in the Terminal. This information shall not be used as criteria for final smoke control design. Refer to the Smoke Control Diagrams and Smoke Control Matrices for specific Information.

1003.2 ZONES
Main and North Terminal: The smoke control zones for Main and North Terminal are as follows:
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<thead>
<tr>
<th>Level</th>
<th>Zone Identifier</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 1</td>
<td>SZ-1-1E</td>
<td>Area 11 Level 1 East</td>
</tr>
<tr>
<td>Level 3</td>
<td>SZ-3-8E</td>
<td>Area 8 Level 3 East</td>
</tr>
<tr>
<td>Level 3</td>
<td>SZ-3-11E</td>
<td>Area 11 Level 3 East</td>
</tr>
<tr>
<td>Level 3</td>
<td>SZ-3-14E</td>
<td>Area 14 Level 3 East</td>
</tr>
<tr>
<td>Level 3</td>
<td>SZ-3-9E</td>
<td>Alternate Baggage Area 9</td>
</tr>
<tr>
<td>Level 3</td>
<td>SZ-3-12E</td>
<td>Alternate Baggage Area 12</td>
</tr>
<tr>
<td>Level 4</td>
<td>SZ-4-INE</td>
<td>Inbound AGTS</td>
</tr>
<tr>
<td>Level 5</td>
<td>SZ-5-8E</td>
<td>Area 8 Level 5 East</td>
</tr>
<tr>
<td>Level 5</td>
<td>SZ-5-11E</td>
<td>Area 11 Level 5 East</td>
</tr>
<tr>
<td>Level 5</td>
<td>SZ-5-14E</td>
<td>Area 14 Level 5 East</td>
</tr>
<tr>
<td>Level 6</td>
<td>SZ-6-8E</td>
<td>Area 8 Level 6 East</td>
</tr>
<tr>
<td>Level 6</td>
<td>SZ-6-11E</td>
<td>Area 11 Level 6 East</td>
</tr>
<tr>
<td>Level 6</td>
<td>SZ-6-14E</td>
<td>Area 14 Level 6 East</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Level</th>
<th>Zone Identifier</th>
<th>Location</th>
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<tbody>
<tr>
<td>Level 1</td>
<td>SZ-1-1W</td>
<td>Area 11 Level 1 West</td>
</tr>
<tr>
<td>Level 3</td>
<td>SZ-3-8W</td>
<td>Area 8 Level 3 West</td>
</tr>
<tr>
<td>Level 3</td>
<td>SZ-3-11W</td>
<td>Area 11 Level 3 West</td>
</tr>
<tr>
<td>Level 3</td>
<td>SZ-3-14W</td>
<td>Area 14 Level 3 West</td>
</tr>
<tr>
<td>Level 3</td>
<td>SZ-3-7W</td>
<td>Alternate Baggage Area 7</td>
</tr>
<tr>
<td>Level 3</td>
<td>SZ-3-10W</td>
<td>Alternate Baggage Area 10</td>
</tr>
<tr>
<td>Level 3</td>
<td>SZ-3-13W</td>
<td>Alternate Baggage Area 13</td>
</tr>
<tr>
<td>Level 4</td>
<td>SZ-4-INW</td>
<td>Inbound AGTS</td>
</tr>
<tr>
<td>Level 5</td>
<td>SZ-5-8W</td>
<td>Area 8 Level 5 West</td>
</tr>
<tr>
<td>Level 5</td>
<td>SZ-5-11W</td>
<td>Area 11 Level 5 West</td>
</tr>
<tr>
<td>Level 5</td>
<td>SZ-5-14W</td>
<td>Area 14 Level 5 West</td>
</tr>
<tr>
<td>Level 6</td>
<td>SZ-6-8W</td>
<td>Area 8 Level 6 West</td>
</tr>
<tr>
<td>Level 6</td>
<td>SZ-6-11W</td>
<td>Area 11 Level 6 West</td>
</tr>
<tr>
<td>Level 6</td>
<td>SZ-6-14W</td>
<td>Area 14 Level 6 West</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Level</th>
<th>Zone Identifier</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 4</td>
<td>SZ-4-OUT</td>
<td>Outbound AGTS</td>
</tr>
<tr>
<td>Level 5</td>
<td>SZ-5-8C</td>
<td>Area 8 Level 5 Great Hall</td>
</tr>
<tr>
<td>Level 5</td>
<td>SZ-5-11C</td>
<td>Area 11 Level 5 Great Hall</td>
</tr>
<tr>
<td>Level 5</td>
<td>SZ-5-14C</td>
<td>Area 14 Level 5 Great Hall</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Level</th>
<th>Zone Identifier</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 3</td>
<td>SZ-3-N</td>
<td>Level 3 Area 5A/B</td>
</tr>
</tbody>
</table>
Level 3 | SZ-3-S | Level 3 Area 5C/D
Level 4 | SZ-4-N | Level 4 Area 5A/B
Level 4 | SZ-4-S | Level 4 Area 5A/B
Level 5 | SZ-NT5 | Level 5 INS
Level 6 | SZ-6-N | Level 6 Bridge
Level 7 | SZ-7-2A | Level 7 Barrel Vault

1003.3 EXHAUST
Exhaust for the Main Terminal Levels 5 and 6 east and west, Level 4 inbound and outbound Train Platform and North Terminal Levels 4, 5, 6 and 7, is ducted from the tenant area ceiling plenum. Within the tenant area, the return air plenum acts as the route for smoke evacuation. Therefore openings in full - height partitions above the ceiling area are required connecting all the tenant spaces. Openings shall be designed to assure adequate smoke removal of the tenant space and adjacent tenant spaces is in place at completion of the facility. If no ceiling is planned in a tenant space or adjacent spaces, ducted return must be designed connecting the adjacent tenant plenums. Provide return air registers within the ductwork sized to accommodate the smoke exhaust air quantity. Provide balancing dampers as required to balance the system. Coordinate with Chapter 3 HVAC Systems portion of this standard for required return air grille specifications.

Smoke control for baggage areas located in the Main and North Terminals on Level 3 and 4 utilize the baggage ventilation systems to serve as the exhaust systems for these zones. There are dedicated smoke exhaust fans for these areas and work in parallel with the baggage handling area exhaust fans to provide smoke exhaust. The baggage area heat-recovery/exhaust fans are enabled to provide smoke control exhaust. Dampers are installed in the heat recovery unit exhaust ductwork and operate as required to isolate the defined smoke control zones. Smoke control for baggage areas located at the north end of North Terminal Level 3 have dedicate smoke exhaust fans to serve as the smoke control exhaust for this area. These fans are physically installed under the Airport Office Building but are considered part of the North Terminal smoke control exhaust systems.

Alternate baggage handling in areas 7, 9, 10, 12, and 13 utilize the existing ventilation exhaust fans for providing smoke control exhaust for these zones.

1003.4 PRESSURIZATION
Smoke control system pressurization is provided through the HVAC System. Pressurization is performed manually and is not automated. VAV terminal unit controllers communicate through the respective temperature control panels located in the level 4 mechanical rooms. VAV terminal units open through temperature control programming via an input from the fire alarm system. The main air handling systems are enabled in pressurization mode. Coordinate with Chapter 3 HVAC Systems portion of this standard for required VAV terminal unit controllers.

Dedicated pressure fans are installed for portions of the North Terminal Level 5 INS areas. The N.E. area has a constant volume rooftop unit utilized for pressurization and a dedicated smoke exhaust fan. These fans operate in conjunction with the other smoke control fans serving all of level 5 INS.

Smoke control for baggage areas located in the Main and North Terminals on Level 3 and 4 utilize the baggage ventilation systems to serve as the pressurization systems for these zones.
The baggage area supply fans are enabled to provide smoke control pressurization. Dampers are installed in the supply air ductwork and operate as required to isolate the defined smoke control zones. Smoke control for baggage areas located at the north end of North Terminal Level 3 utilize the baggage ventilation systems to serve as the smoke control pressurization for this area. These fans are physically installed under the Airport Office Building but are considered part of the North Terminal smoke control pressurization systems.

Alternate baggage handling in areas 7, 9, 10, 12, and 13 utilize the existing ventilation air handling units for providing smoke control pressurization for these zones.

Stairway pressurization fans are installed for service to all public stairways that exit on Level 4. Hoistway pressurization fans are installed serving both passenger and service hoistways within the Main Terminal. Hoistways that serve three floors or less are not provided with smoke control pressurization.

SECTION 1004 - PASSENGER BRIDGE SMOKE CONTROL OPERATION OVERVIEW

1004.1 GENERAL
The following is a general description of the smoke control systems in place for Passenger Bridge connecting the North Terminal to Concourse A. This information shall not be used as criteria for final smoke control design. Refer to the Smoke Control Diagrams and Smoke Control Matrices for specific Information.

1004.2 ZONES
Passenger Bridge: The smoke control zones for the Passenger Bridge are as follows: Established Smoke Control Zone Diagrams and updated Sequence of Operation Matrices are available from the DIA Mechanical Engineer or the DIA Life Safety Team.

<table>
<thead>
<tr>
<th>Level</th>
<th>Zone Identifier</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 6 and 7</td>
<td>SZ-BRIDGE</td>
<td>Passenger Bridge</td>
</tr>
</tbody>
</table>

1004.3 EXHAUST
The return air fans located in the roof level mechanical room are utilized to provide smoke control exhaust for the Passenger Bridge. Smoke control exhaust is ducted from both levels and both sides of the bridge through return air grilles and the ceiling plenum.

1004.4 PRESSURIZATION
The air handling units located in the roof level mechanical room, are utilized to provide smoke control pressurization for the Passenger Bridge. Smoke control Pressurization is provided though the HVAC system distribution and is ducted to both levels and both sides of the bridge.

SECTION 1005 - AIRPORT OFFICE BUILDING (A.O.B.) SMOKE CONTROL OPERATION OVERVIEW

1005.1 GENERAL
The following is a general description of the smoke control systems in place for specific areas in the A.O.B. This information shall not be used as criteria for final smoke control design. Refer to the Smoke Control Diagrams and Smoke Control Matrices for specific Information.

1005.2 ZONES
Airport Office Building (A.O.B.): The smoke control zones for the A.O.B. are as follows: Established Smoke Control Zone Diagrams and updated Sequence of Operation Matrices are available from the DIA Mechanical Engineer or the DIA Life Safety Team.

<table>
<thead>
<tr>
<th>Level</th>
<th>Zone Identifier</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 4</td>
<td>Level 4</td>
<td>Loading Dock Refuge Area</td>
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<tr>
<td>Level 5</td>
<td>Level 5A</td>
<td>Level 5A Refuge Area</td>
</tr>
<tr>
<td>Level 5</td>
<td>Level 5B</td>
<td>Level 5B Refuge Area</td>
</tr>
<tr>
<td>Level 6</td>
<td>Level 6</td>
<td>Level 6</td>
</tr>
<tr>
<td>Level 6</td>
<td>Level 6R</td>
<td>Level 6 Refuge Area</td>
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<tr>
<td>Level 7</td>
<td>Level 7</td>
<td>Level 7</td>
</tr>
<tr>
<td>Level 7</td>
<td>Level 7R</td>
<td>Level 7 Refuge Area</td>
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<tr>
<td>Level 8</td>
<td>Level 8</td>
<td>Level 8</td>
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<tr>
<td>Level 8</td>
<td>Level 8R</td>
<td>Level 8 Refuge Area</td>
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<tr>
<td>Level 9</td>
<td>Level 9</td>
<td>Level 9</td>
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<tr>
<td>Level 9</td>
<td>Level 9R</td>
<td>Level 9 Refuge Area</td>
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<td>Level 10</td>
<td>Level 10</td>
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</tr>
<tr>
<td>Level 10</td>
<td>Level 10R</td>
<td>Level 10 Refuge Area</td>
</tr>
</tbody>
</table>

1005.3 EXHAUST
The main building relief air fans located in the Level 11 mechanical room are utilized to provide smoke exhaust for the A.O.B. Exhaust is ducted from the tenant area ceiling plenum. Within the tenant area, the return air plenum acts as the route for smoke evacuation. The smoke exhaust for the floor of incident are isolated via return/ exhaust dampers located at the return air shafts on each floor.

A dedicated exhaust fan and multiple risers and dampers are installed for providing smoke exhaust for the typical floor refuge area smoke control zones.

1005.4 PRESSURIZATION
Pressurization is provided through the dedicated building pressurization fans connecting to the main HVAC system duct risers at Level 5. VAV terminal unit controllers communicate through the respective temperature control panel. VAV terminal units open through temperature control programming via an input from the fire alarm system. Coordinate with Chapter 3 HVAC Systems portion of this standard for required VAV terminal unit controllers.

Smoke control system pressurization for a typical floor refuge area is provided via the hoistway pressurization fans through transfer air smoke control dampers located above the ceiling over the hoistways.

Stairway pressurization fans are installed for service to all public stairways that exit on Level 5 parking garage refuge areas.

SECTION 1006 - CONCOURSE A SMOKE CONTROL OPERATION OVERVIEW

1006.1 GENERAL
The following is a general description of the smoke control systems installed for specific areas in Concourse A. This information shall not be used as criteria for final smoke control design. Refer to the Smoke Control Diagrams and Smoke Control Matrices for specific Information.
1006.2 SMOKE CONTROL ZONES
Concourse A: The smoke control zones for Concourse-A are as follows: Established Smoke Control Zone Diagrams and updated Sequence of Operation Matrices are available from the DIA Mechanical Engineer or the DIA Life Safety Team.

<table>
<thead>
<tr>
<th>Level</th>
<th>Zone Identifier</th>
<th>Location</th>
</tr>
</thead>
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<tr>
<td>Level 9 and 10</td>
<td>9&amp;10LO</td>
<td>Tower</td>
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<tr>
<td>Level 8</td>
<td>8LO</td>
<td>Tower</td>
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<td>Level 7</td>
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<td>Level 6</td>
<td>6LO</td>
<td>Tower</td>
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<td>Level 5</td>
<td>5FR</td>
<td>Center Ramp</td>
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<td>Level 5</td>
<td>5BL</td>
<td>Upper Level Bridge</td>
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<tr>
<td>Level 4</td>
<td>4FCW</td>
<td>West Ramp</td>
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<tr>
<td>Level 4</td>
<td>4FCE</td>
<td>East Ramp</td>
</tr>
<tr>
<td>Level 4</td>
<td>4FR</td>
<td>Ramp to Mezz.</td>
</tr>
<tr>
<td>Level 4</td>
<td>4FT</td>
<td>Clubs and Offices</td>
</tr>
<tr>
<td>Level 4</td>
<td>4BL</td>
<td>Lower Level Bridge</td>
</tr>
<tr>
<td>Level 4</td>
<td>WSC4</td>
<td>West Sub-core</td>
</tr>
<tr>
<td>Level 4</td>
<td>ESC4</td>
<td>East Sub-core</td>
</tr>
<tr>
<td>Mezzanine</td>
<td>HCW</td>
<td>International West</td>
</tr>
<tr>
<td>Mezzanine</td>
<td>ECW</td>
<td>International East</td>
</tr>
<tr>
<td>Mezzanine</td>
<td>MLO</td>
<td>Offices</td>
</tr>
<tr>
<td>Concourse</td>
<td>CLO</td>
<td>Offices</td>
</tr>
<tr>
<td>Concourse</td>
<td>WHR1</td>
<td>West Holdroom</td>
</tr>
<tr>
<td>Concourse</td>
<td>WSC1</td>
<td>West Sub-core</td>
</tr>
<tr>
<td>Concourse</td>
<td>WHR2</td>
<td>West Outboard Holdroom</td>
</tr>
<tr>
<td>Concourse</td>
<td>NWCC</td>
<td>NW Center Core</td>
</tr>
<tr>
<td>Concourse</td>
<td>SWCC</td>
<td>SW Center Core</td>
</tr>
<tr>
<td>Concourse</td>
<td>CC</td>
<td>Center Core</td>
</tr>
<tr>
<td>Concourse</td>
<td>SECC</td>
<td>Southeast Center Core</td>
</tr>
<tr>
<td>Concourse</td>
<td>NECC</td>
<td>Northeast Center Core</td>
</tr>
<tr>
<td>Concourse</td>
<td>EHR1</td>
<td>East Holdroom</td>
</tr>
<tr>
<td>Concourse</td>
<td>ESC1</td>
<td>East Sub-core</td>
</tr>
<tr>
<td>Concourse</td>
<td>EHR2</td>
<td>East Outboard Holdroom</td>
</tr>
<tr>
<td>Apron</td>
<td>AEH</td>
<td>East Holdroom</td>
</tr>
<tr>
<td>Apron</td>
<td>AECH</td>
<td>Commuter Facility</td>
</tr>
<tr>
<td>Basement</td>
<td>BB2W</td>
<td>West Basement</td>
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<tr>
<td>Basement</td>
<td>BB1W</td>
<td>Center Basement</td>
</tr>
<tr>
<td>Basement</td>
<td>BB1E</td>
<td>Center Basement</td>
</tr>
<tr>
<td>Basement</td>
<td>BB2E</td>
<td>East Basement</td>
</tr>
</tbody>
</table>

1006.3 CENTER CORE SMOKE CONTROL ZONES
Pressurization for retail tenant areas, located in the center core, is provided through the HVAC System. VAV terminal unit controllers that communicate through the respective temperature control panel. VAV terminal units open through temperature control programming via an input
from the fire alarm system. Coordinate with the Chapter 3 HVAC Systems portion of this standard for required VAV terminal unit controllers.

Exhaust is ducted from the tenant area ceiling plenum. Within the tenant area, the return air plenum acts as the route for smoke evacuation. Therefore openings in full height partitions above the ceiling area are required connecting all the tenant spaces. Openings shall be designed to assure adequate smoke removal of the tenant space and adjacent tenant spaces is in place at completion of the facility. If no ceiling is planned in a tenant space or adjacent spaces, ducted return must be designed connecting the adjacent tenant plenums. Provide return air registers within the ductwork sized to accommodate the smoke exhaust air quantity. Provide balancing dampers as required to balance the system. Coordinate with Chapter 3 HVAC Systems portion of this standard for required return air grille specifications.

1006.4 SUBCORE SMOKE CONTROL ZONES
The retail tenant areas located at the sub-cores of the concourse level are not part of the main sub-core smoke control zone. Draft stops shall be provided at the opening of the retail space into the public area. Pressurization and exhaust are provided via the main pressurization and exhaust fans serving the main sub-core area and are activated via devices located in the tenant area. Current programming for activation of the smoke control fans are as if the tenants areas are part of the sub-core smoke control zone. No individual smoke control pressurization or exhaust is provided specifically for the sub-core tenant areas.

1006.5 BASEMENT SMOKE CONTROL ZONES
Basement area smoke control pressurization and exhaust is provided through combination fans (VSCF). These fans operate as part of the normal HVAC system to provide supply air ventilation to the baggage handling areas located below the concourse. These fans provide smoke control pressurization or exhaust by positioning a series of dampers located upstream and downstream of each fan. These fans operate normally through their respective variable frequency drives (VFD) and through their respective by-pass cabinets for smoke control pressurization and exhaust. Smoke exhaust is automated, pressurization is performed manually.

SECTION 1007 - CONCOURSE B SMOKE CONTROL OPERATION OVERVIEW

1007.1 GENERAL
The following is a general description of the smoke control systems installed for specific areas in Concourse B. This information shall not be used as criteria for final smoke control design. Refer to the Smoke Control Diagrams and Smoke Control Matrices for specific Information.

1007.2 SMOKE CONTROL ZONES
Concourse B: The smoke control zones for Concourse-B are as follows: Established Smoke Control Zone Diagrams and updated Sequence of Operation Matrices are available from the DIA Mechanical Engineer or the DIA Life Safety Team.

<table>
<thead>
<tr>
<th>Level</th>
<th>Zone Identifier</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cab</td>
<td>APDF CAB</td>
<td>Tower</td>
</tr>
<tr>
<td>Level 9</td>
<td>APDF9</td>
<td>Tower</td>
</tr>
<tr>
<td>Level 8</td>
<td>APDF 8</td>
<td>Tower</td>
</tr>
<tr>
<td>Level 7</td>
<td>APDF 7</td>
<td>Tower</td>
</tr>
<tr>
<td>Level 6</td>
<td>APDF 6</td>
<td>Tower</td>
</tr>
<tr>
<td>Level 5</td>
<td>APDF 5</td>
<td>Tower</td>
</tr>
<tr>
<td>Level</td>
<td>Zone Identifier</td>
<td>Location</td>
</tr>
<tr>
<td>----------</td>
<td>-----------------</td>
<td>-----------------------------------------</td>
</tr>
<tr>
<td>Level 4</td>
<td>APDF 4</td>
<td>APDF Parts</td>
</tr>
<tr>
<td>Level 4</td>
<td>4FT</td>
<td>Center Core</td>
</tr>
<tr>
<td>Level 4</td>
<td>WSC4</td>
<td>West Red Carpet Club</td>
</tr>
<tr>
<td>Level 4</td>
<td>ESC4</td>
<td>East Red Carpet Club Concourse</td>
</tr>
<tr>
<td>Concourse</td>
<td>WHR3</td>
<td>West Outboard Holdroom</td>
</tr>
<tr>
<td>Concourse</td>
<td>WSC2</td>
<td>West Outboard Sub-core</td>
</tr>
<tr>
<td>Concourse</td>
<td>WHR2</td>
<td>West Mid Holdroom</td>
</tr>
<tr>
<td>Concourse</td>
<td>WSC1</td>
<td>West Inboard Sub-core</td>
</tr>
<tr>
<td>Concourse</td>
<td>WHR1</td>
<td>West Inboard Holdroom</td>
</tr>
<tr>
<td>Concourse</td>
<td>NWCC</td>
<td>NW Center Core</td>
</tr>
<tr>
<td>Concourse</td>
<td>SWCC</td>
<td>SW Center Core</td>
</tr>
<tr>
<td>Concourse</td>
<td>CC</td>
<td>Center Core</td>
</tr>
<tr>
<td>Concourse</td>
<td>SECC</td>
<td>Southeast Center Core</td>
</tr>
<tr>
<td>Concourse</td>
<td>NECC</td>
<td>Northeast Center Core</td>
</tr>
<tr>
<td>Concourse</td>
<td>EHR3</td>
<td>East Outboard Holdroom</td>
</tr>
<tr>
<td>Concourse</td>
<td>ESC2</td>
<td>East Outboard Sub-core</td>
</tr>
<tr>
<td>Concourse</td>
<td>EHR2</td>
<td>East Mid Holdroom</td>
</tr>
<tr>
<td>Concourse</td>
<td>ESC1</td>
<td>East Inboard Sub-core</td>
</tr>
<tr>
<td>Concourse</td>
<td>EHR1</td>
<td>East Inboard Holdroom</td>
</tr>
<tr>
<td>Concourse</td>
<td>ESC1</td>
<td>East Sub-core</td>
</tr>
<tr>
<td>Concourse</td>
<td>RJSB</td>
<td>Regional Jet Facility South Bridge</td>
</tr>
<tr>
<td>Apron</td>
<td>RJSH</td>
<td>Regional Jet Facility South Holdroom</td>
</tr>
<tr>
<td>Basement</td>
<td>BB8W</td>
<td>West Basement</td>
</tr>
<tr>
<td>Basement</td>
<td>BB7W</td>
<td>West Basement</td>
</tr>
<tr>
<td>Basement</td>
<td>BO6WS</td>
<td>West Basement Office</td>
</tr>
<tr>
<td>Basement</td>
<td>BO5WS</td>
<td>West Basement Office</td>
</tr>
<tr>
<td>Basement</td>
<td>BB6W</td>
<td>West Basement</td>
</tr>
<tr>
<td>Basement</td>
<td>BB5W</td>
<td>West Basement</td>
</tr>
<tr>
<td>Basement</td>
<td>BB4W</td>
<td>West Basement</td>
</tr>
<tr>
<td>Basement</td>
<td>BB1/3W</td>
<td>Center Basement</td>
</tr>
<tr>
<td>Basement</td>
<td>BB8E</td>
<td>East Basement</td>
</tr>
<tr>
<td>Basement</td>
<td>BB7E</td>
<td>East Basement</td>
</tr>
<tr>
<td>Basement</td>
<td>BO6ES</td>
<td>East Basement Office</td>
</tr>
<tr>
<td>Basement</td>
<td>BO5ES</td>
<td>East Basement Office</td>
</tr>
<tr>
<td>Basement</td>
<td>BB6E</td>
<td>East Basement</td>
</tr>
<tr>
<td>Basement</td>
<td>BB5E</td>
<td>East Basement</td>
</tr>
<tr>
<td>Basement</td>
<td>BB4E</td>
<td>East Basement</td>
</tr>
<tr>
<td>Basement</td>
<td>BB1/3E</td>
<td>Center Basement</td>
</tr>
</tbody>
</table>

**1007.3 CENTER CORE SMOKE CONTROL ZONES**

Pressurization for retail tenant areas is provided through the HVAC System. VAV terminal unit controllers that communicate through the respective temperature control panel. VAV terminal
units open through temperature control programming via an input from the fire alarm system. Coordinate with the Chapter 3 HVAC Systems portion of this standard for required VAV terminal unit controllers.

Exhaust is ducted from the tenant area ceiling plenum. Within the tenant area, the return air plenum acts as the route for smoke evacuation. Therefore openings in full-height partitions above the ceiling area are required connecting all the tenant spaces. Openings shall be designed to assure adequate smoke removal of the tenant space and adjacent tenant spaces is in place at completion of the facility. Sizing of openings shall not exceed a face velocity 200 fpm. If no ceiling is planned in a tenant space or adjacent spaces, ducted return must be designed connecting the adjacent tenant plenums. Provide return air registers within the ductwork sized to accommodate the smoke exhaust air quantity. Provide balancing dampers as required to balance the system. Coordinate with Chapter 3 HVAC Systems portion of this standard for required return air grille specifications.

1007.4 SUBCORE SMOKE CONTROL ZONES
The retail tenant areas located at the sub-cores of the concourse level are not part of the main sub-core smoke control zone. Draft stops shall be provided at the opening of the retail space into the public area. Pressurization and exhaust are provided via the main pressurization and exhaust fans serving the main sub-core area and are activated via devices located in the tenant area. Current programming for activation of the smoke control fans are as if the tenants areas are part of the sub-core smoke control zone. No individual smoke control pressurization or exhaust is provided specifically for the sub-core tenant areas.

1007.5 BASEMENT SMOKE CONTROL ZONES
Basement area smoke control pressurization and exhaust is provided through combination fans (VSCF). These fans operate as part of the normal HVAC system to provide supply air ventilation to the baggage handling areas located below the concourse. These fans provide smoke control pressurization or exhaust by positioning a series of dampers located upstream and downstream of each fan. These fans operate normally through their respective variable frequency drives (VFD) and through their respective by-pass cabinets for smoke control pressurization and exhaust. Smoke exhaust is automated, pressurization is performed manually.

SECTION 1008 - CONCOURSE C SMOKE CONTROL OPERATION OVERVIEW

1008.1 GENERAL
The following is a general description of the smoke control systems installed for specific areas in Concourse C. This information shall not be used as criteria for final smoke control design. Refer to the Smoke Control Diagrams and Smoke Control Matrices for specific Information.

1008.2 SMOKE CONTROL ZONES
Concourse C: The smoke control zones for Concourse-C are as follows: Established Smoke Control Zone Diagrams and updated Sequence of Operation Matrices are available from the DIA Mechanical Engineer or the DIA Life Safety Team.

<table>
<thead>
<tr>
<th>Level</th>
<th>Zone Identifier</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concourse</td>
<td>WHR1</td>
<td>West Holdroom</td>
</tr>
<tr>
<td>Concourse</td>
<td>WSC1</td>
<td>West Sub-core</td>
</tr>
<tr>
<td>Concourse</td>
<td>NWCC</td>
<td>NW Center Core</td>
</tr>
</tbody>
</table>
Concourse | SWCC | SW Center Core
--- | --- | ---
Concourse | CC | Center Core
Concourse | SECC | Southeast Center Core
Concourse | NECC | Northeast Center Core
Concourse | EHR1 | East Holdroom
Concourse | ESC1 | East Sub-core
Basement | BB1W | West Basement
Basement | BB1E | East Basement

**1008.3 CENTER CORE SMOKE CONTROL ZONES**
Pressurization for retail tenant areas is provided through the HVAC System. VAV terminal unit controllers that communicate through the respective temperature control panel. VAV terminal units open through temperature control programming via an input from the fire alarm system. Coordinate with the Chapter 3 HVAC Systems portion of this standard for required VAV terminal unit controllers.

Exhaust is ducted from the tenant area ceiling plenum. Within the tenant area, the return air plenum acts as the route for smoke evacuation. Therefore openings in full-height partitions above the ceiling area are required connecting all the tenant spaces. Openings shall be designed to assure adequate smoke removal of the tenant space and adjacent tenant spaces is in place at completion of the facility. Sizing of openings shall not exceed a face velocity 200 fpm. If no ceiling is planned in a tenant space or adjacent spaces, ducted return must be designed connecting the adjacent tenant plenums. Provide return air registers within the ductwork sized to accommodate the smoke exhaust air quantity. Provide balancing dampers as required to balance the system. Coordinate with Chapter 3 HVAC Systems portion of this standard for required return air grille specifications.

**1008.4 SUBCORE SMOKE CONTROL ZONES**
The retail tenant areas located at the sub-cores of the concourse level are not part of the main sub-core smoke control zone. Draft stops shall be provided at the opening of the retail space into the public area. Pressurization and exhaust are provided via the main pressurization and exhaust fans serving the main sub-core area and are activated via devices located in the tenant area. Current programming for activation of the smoke control fans are as if the tenants areas are part of the sub-core smoke control zone. No individual smoke control pressurization or exhaust is provided specifically for the sub-core tenant areas.

**1008.5 BASEMENT SMOKE CONTROL ZONES**
Basement area smoke control pressurization and exhaust is provided through combination fans (VSCF). These fans operate as part of the normal HVAC system to provide supply air ventilation to the baggage handling areas located below the concourse. These fans provide smoke control pressurization or exhaust by positioning a series of dampers located upstream and downstream of each fan. The center core VFCF fans operate normally through their respective variable frequency drives (VFD) and through their respective by-pass cabinets for smoke control pressurization and exhaust. All other VFCF fans are provide with constant volume controls and starters and operate at normal speed during smoke control pressurization and exhaust sequences. Smoke exhaust is automated, pressurization is performed manually.

**SECTION 1009 - AGTS/ BAGGAGE SMOKE CONTROL OPERATION OVERVIEW**

**1009.1 GENERAL**
The following is a general description of the smoke control systems installed for specific areas in AGTS/Baggage Tunnels. This information shall not be used as criteria for final smoke control design. Refer to the Smoke Control Diagrams and Smoke Control Matrices for specific Information.

### 1009.2 SMOKE CONTROL ZONES

AGTS/Baggage Tunnels: The smoke control zones for AGTS/Baggage Tunnels are as follows: Established Smoke Control Zone Diagrams and updated Sequence of Operation Matrices are available from the DIA Mechanical Engineer or the DIA Life Safety Team.

<table>
<thead>
<tr>
<th>AGTS/ Baggage Tunnels</th>
<th>Level</th>
<th>Zone Identifier</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 3</td>
<td>SZ-1/TT</td>
<td>Main Terminal AGTS</td>
<td></td>
</tr>
<tr>
<td>Level 3</td>
<td>SZ-1/BE</td>
<td>Main Terminal Baggage East</td>
<td></td>
</tr>
<tr>
<td>Level 3</td>
<td>SZ-1/BW</td>
<td>Main Terminal Baggage West</td>
<td></td>
</tr>
<tr>
<td>Level 3</td>
<td>SZ-2/TT</td>
<td>AOB AGTS</td>
<td></td>
</tr>
<tr>
<td>Level 3</td>
<td>SZ-2/BE</td>
<td>AOB Baggage East</td>
<td></td>
</tr>
<tr>
<td>Level 3</td>
<td>SZ-2/BW</td>
<td>AOB Baggage West</td>
<td></td>
</tr>
<tr>
<td>Level 3</td>
<td>SZ-3/TT</td>
<td>Concourse A AGTS</td>
<td></td>
</tr>
<tr>
<td>Level 3</td>
<td>SZ-3/BE</td>
<td>Concourse A Baggage East</td>
<td></td>
</tr>
<tr>
<td>Level 3</td>
<td>SZ-3/BW</td>
<td>Concourse A Baggage West</td>
<td></td>
</tr>
<tr>
<td>Level 3</td>
<td>SZ-4/TT</td>
<td>Concourse B AGTS</td>
<td></td>
</tr>
<tr>
<td>Level 3</td>
<td>SZ-4/BE</td>
<td>Concourse B Baggage East</td>
<td></td>
</tr>
<tr>
<td>Level 3</td>
<td>SZ-4/BW</td>
<td>Concourse B Baggage West</td>
<td></td>
</tr>
<tr>
<td>Level 3</td>
<td>SZ-5/TT</td>
<td>Concourse B AGTS</td>
<td></td>
</tr>
<tr>
<td>Level 3</td>
<td>SZ-5/BE</td>
<td>Concourse B Baggage East</td>
<td></td>
</tr>
<tr>
<td>Level 3</td>
<td>SZ-5/BW</td>
<td>Concourse B Baggage West</td>
<td></td>
</tr>
<tr>
<td>Level 3</td>
<td>SZ-6/TT</td>
<td>Concourse C AGTS</td>
<td></td>
</tr>
<tr>
<td>Level 3</td>
<td>SZ-6/BE</td>
<td>Concourse C Baggage East</td>
<td></td>
</tr>
<tr>
<td>Level 3</td>
<td>SZ-6/BW</td>
<td>Concourse C Baggage West</td>
<td></td>
</tr>
<tr>
<td>Level 3</td>
<td>SZ-7/TT</td>
<td>Concourse C AGTS</td>
<td></td>
</tr>
<tr>
<td>Level 3</td>
<td>SZ-7/BE</td>
<td>Concourse C Baggage East</td>
<td></td>
</tr>
<tr>
<td>Level 3</td>
<td>SZ-7/BW</td>
<td>Concourse C Baggage West</td>
<td></td>
</tr>
<tr>
<td>Level 3</td>
<td>SZ-8/TT</td>
<td>Maintenance AGTS</td>
<td></td>
</tr>
<tr>
<td>Level 3</td>
<td>SZ-8/BE</td>
<td>Maintenance Baggage East</td>
<td></td>
</tr>
<tr>
<td>Level 3</td>
<td>SZ-8/BW</td>
<td>Maintenance Baggage West</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>BAGGAGE TUNNEL</th>
<th>Level</th>
<th>Zone Identifier</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 3</td>
<td>W2</td>
<td>Term/Concourse A West</td>
<td></td>
</tr>
<tr>
<td>Level 3</td>
<td>W3</td>
<td>Concourse A/B West</td>
<td></td>
</tr>
<tr>
<td>Level 3</td>
<td>W4</td>
<td>Concourse B/C West</td>
<td></td>
</tr>
<tr>
<td>Level 3</td>
<td>E2</td>
<td>Term/Concourse A East</td>
<td></td>
</tr>
<tr>
<td>Level 3</td>
<td>E3</td>
<td>Concourse A/B East</td>
<td></td>
</tr>
<tr>
<td>Level 3</td>
<td>E4</td>
<td>Concourse B/C East</td>
<td></td>
</tr>
</tbody>
</table>
1009.3 ZONES
Smoke control systems are manual for the AGTS/Baggage Tunnels. Reversing-type fans are installed to provide pressurization or exhaust as commanded manually through the fire alarm system Color Graphics Panel (CGP). The existing fans are only sized for 4 ACH in supply and 80% in exhaust mode. These fans are also used for general ventilation. The baggage tunnel fans operate normally to provide supply air ventilation for the baggage tunnels connecting each concourse.

SECTION 1010 - CENTRAL PLANT

1010.1 GENERAL
The Central Plant is the only Terminal Area Building that has no smoke control, or full smoke detection. Future expansions to this building are not anticipated to require smoke control.

SECTION 1011 - SMOKE CONTROL DESIGN FOR TENANT SPACES

1011.1 GENERAL
The designer shall assure that smoke control systems for adjacent tenant spaces are not negatively impacted by the design and construction of the tenant space smoke control system.

SECTION 1012 - CONSTRUCTION DOCUMENTS

1012.1 GENERAL
The contract documents for smoke control systems shall include a minimum of:

A. A drawing(s) showing the smoke zones for all spaces of design and surrounding the area of design. Fire alarm system drawings to include: a matrix identifying the sequence of operation of all equipment in the smoke control zones. This matrix and existing smoke zone drawings are available from the DIA Mechanical Engineer.

B. A written sequence of operation describing how smoke control and HVAC system integration is to function during smoke control pressurization and exhaust sequence of operations.

C. The drawing(s) shall indicate all mechanical and electrical as-built conditions for areas of renovation work. The Engineer should perform a site observation confirming all existing conditions and equipment to be utilized for smoke control operations.

D. Schedules of all smoke control equipment.

E. DIA Specification sections 15951 and 16721, as well as specification sections to adequately define the smoke control equipment products and installation.

SECTION 1013 - SMOKE CONTROL SYSTEM TESTING

1013.1 GENERAL
Smoke Control Testing shall be performed by the Contractor in compliance with the Denver Building Department, Denver Fire Department and DIA requirements. The Contractor shall acquire for smoke testing the services of a Colorado Licensed Mechanical Engineer. Testing shall comply with DIA Specifications Section 15951 – Smoke Control Testing.

1013.2 RENOVATION WORK
When any portion of a smoke control zone is modified by a Tenant or Base Building Contract (new/removed equipment, new/removed walls, new/removed ceilings, etc.) the entire smoke control zone is required to be tested upon completion of the work.

END OF CHAPTER 10
CHAPTER 11
ENERGY ANALYSIS

SECTION 1101 - GENERAL

There are many factors unique to the airport terminal and other airport buildings that enter into the design of an energy efficient facility. These factors include architectural, mechanical and electrical considerations -- all interrelated.

The Denver International Airport terminal, concourses and other buildings shall include design features that emphasize energy conservation. Some of these features have been outlined earlier but will be summarized in this section for emphasis.

Buildings in excess of 10,000 square feet shall have a computer energy model performed to establish energy consumption. Energy budgets shall be established and shall meet the requirements of ASHRAE 90.1. This standard allows tradeoffs between mechanical and electrical systems and the building envelope. These tradeoffs shall supersede specific requirements presented in following discussion.

1101.1 CODES AND STANDARDS

All Energy Conservation Analyses shall meet the requirements of:

A. International Building Code
B. International Energy Conservation Code
C. ASHRAE 90.1

Where the requirements of this chapter or the Codes and Standards themselves deviate from one another, the more stringent of the two shall apply.

1101.2 LEADERSHIP IN ENERGY & ENVIRONMENTAL DESIGN (LEED)

The Consultant shall review the current LEED Rating System and develop design strategies for maximizing the project’s energy efficiency. Following the LEED Rating System, the Consultant and The City shall determine which level of LEED Green Building Certification is achievable for the project. Following this decision, the Consultant shall tailor the design documents to achieve this certification. The LEED Rating System document can be obtained at the following website: http://www.usgbc.org

SECTION 1102 - BUILDING ENVELOPE EVALUATION

The following represents a summary analysis of ASHRAE Standard 90A-1980 and 90.1. Applicable excerpts and specific requirements for The Denver International Airport are included. The Design Consultant shall refer to the above standards and the Model Energy Code for a complete review of his design and other issues which may not be addressed in this section. The Design Consultant shall coordinate these requirements with the architect. This section gives the design consultant criteria for completing an energy analysis during the design phase. The values presented are minimums. Actual "U" values shall be used in calculating building loads.
SECTION 1103 - U VALUES

1103.1 GLAZING
Window treatment is a major consideration in providing an energy efficient building shell. The glass shall be double glazing, heat absorbing type (some surfaces with reflective coatings). Internal or external shading may be required to reflect solar rays in the summer and permit utilizing the warming rays during the winter. A "U" value (winter) of 0.50 Btuh/sq.ft.ºF, or better shall be used in the glazing design. Maximum shading coefficient values shall be 0.3 for sloped surfaces, and 0.4 for vertical surfaces. Highly reflective glass is not permitted for airport facilities.

1103.2 WALLS
The walls of all facilities shall be well insulated to conserve energy. A "U" value of 0.10 Btuh/sq.ft.ºF, or better shall be used in the design. The architect shall design the ratio of "glass-to-wall" according to Table III.10.1. If the architect wishes to incorporate more glass, the "U" value of the opaque wall and/or the glass will have to be decreased accordingly to meet the "Uo" requirements as outlined in Table III.10.1.

Any building that is mechanically cooled shall have an Overall Thermal Transfer Value (OTTV) for the gross area of exterior walls above grade not exceeding 33.2 Btuh/sq.ft.

1103.3 ROOF
The roof of the facility shall be well insulated to conserve energy. A "U" value of 0.05 Btuh/sq.ft.ºF, or better shall be used in the design. If the design incorporates skylights, the architect shall remain in compliance with the "Uo" requirements by adhering to the allowable combinations of glass vs. opaque roof.

Any building that is heated shall have a combined thermal transmittance value (Uo) for roof/ceilings not exceeding 0.074 Btuh/sq.ft.ºF.

Any building that is mechanically cooled shall have a combined thermal transmittance value (Uo) for roof/ceilings not to exceed 0.074 Btuh/sq.ft.ºF and shall have an Overall Thermal Transfer Value (OTTV) for the gross area of a roof assembly not exceeding 8.5 Btuh/sq.ft.

Any building that is mechanically heated shall have a combined thermal transmittance value (Uo) for the gross area of exterior walls not exceeding: 0.32 Btuh/sq.ft.ºF for buildings over 3 stories in height; 0.265 Btuh/sq.ft.ºF for 3 stories and under.

1103.4 FLOORS OVER UNHEATED SPACES
For floors of heated spaces over unheated areas, the Uo value shall not exceed 0.05 Btuh/sq.ft.ºF. For floors over outdoor air (i.e. overhangs) the Uo value for heating shall meet the same requirements as for roofs, 0.074 Btuh/sq.ft.ºF. For floors over outdoor air not to exceed that which would be determined by the heating criteria.

1103.5 SLAB-ON-GRADE FLOORS
For slab-on grade floors, the thermal resistance of the insulation around the perimeter of the floor shall be \( R = 7.3 \text{ sq.ft.F/Btuh} \) for heated slabs and \( R = 5.15 \text{ sq.ft.F/Btuh} \) for unheated slabs. The insulation shall extend downward from the top of the slab for a minimum distance of 24 inches or downward to the bottom of the slab then horizontally beneath the slab for a minimum total distance of 24 inches.

**1103.6 ALTERNATIVES**

ASHRAE Standards do allow that the Uo or OTTV value for a component of the building envelope (such as the roof or the walls) can be increased above the code required value, if the Uo or OTTV value(s) for the other component(s) are decreased below the code required value, such that the total overall building combination Uo is still in compliance with the code. Refer to the ASHRAE 90.1 for applicable formulas for determining acceptable combinations of thermal transmittance areas.

A building designed to be both heated and/or cooled shall meet the more stringent of the heating or cooling requirements of the exterior envelope when requirements differ.

**1103.7 SUMMARY**

The evaluation of the building shell requirements for The Denver International Airport in accordance with ASHRAE Standards are summarized in the following table. This table indicates the allowable thermal values for walls and roofs (based upon 6283 annual heating degree days and a northern latitude of 39 degrees for Denver, Colorado).

Table III.10.1

<table>
<thead>
<tr>
<th>Building Element</th>
<th>Building Height</th>
<th>Seasonal Mode</th>
<th>Maximum Allowable Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walls</td>
<td>over 3 stories</td>
<td>Heating</td>
<td>Uo = 0.320 Btuh/sq.ft.ºF</td>
</tr>
<tr>
<td>Walls</td>
<td>3 stories and under</td>
<td>Heating</td>
<td>Uo = 0.265 Btuh/sq.ft.ºF</td>
</tr>
<tr>
<td>Roof &amp; Ceiling</td>
<td>-</td>
<td>Heating</td>
<td>Uo = 0.074 Btuh/sq.ft.ºF</td>
</tr>
<tr>
<td>Floors - over unheated areas</td>
<td>-</td>
<td>Heating</td>
<td>Uo = 0.050 Btuh/sq.ft.ºF</td>
</tr>
<tr>
<td>Floors - over outdoor air</td>
<td>-</td>
<td>Heating</td>
<td>Uo = 0.074 Btuh/sq.ft.ºF</td>
</tr>
<tr>
<td>Walls</td>
<td>-</td>
<td>Cooling</td>
<td>OTTV= 33.2 Btuh/sq.ft.ºF</td>
</tr>
<tr>
<td>Roof &amp; Ceiling</td>
<td>-</td>
<td>Cooling</td>
<td>Uo = 0.074 Btuh/sq.ft.ºF</td>
</tr>
<tr>
<td>Roof &amp; Ceiling</td>
<td>-</td>
<td>Cooling</td>
<td>OTTV= 8.5 Btuh/sq.ft.ºF</td>
</tr>
<tr>
<td>Floors - over unconditioned areas</td>
<td>Cooling</td>
<td>$U_o = 0.080 \text{ Btuh} / \text{sq.ft.F}$</td>
<td></td>
</tr>
<tr>
<td>----------------------------------</td>
<td>---------</td>
<td>------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Floors - over outdoor air</td>
<td>Cooling</td>
<td>$U_o = 0.074 \text{ Btuh/sq.ft.}^\circ\text{F}$</td>
<td></td>
</tr>
</tbody>
</table>

SECTION 1104 - BUILDING COMPONENTS

1104.1 DAYLIGHTING

The fenestrations shall provide natural light (daylighting) to reduce the electrical energy requirements during daytime hours. Automatic photo sensing controls can reduce artificial light levels when daylight is available through skylights and windows. An appropriate balance between skylight and lighting effects shall be made with the requirement of overall thermal efficiency. ASHRAE 90.1 provides a means to evaluate alternatives and trade-offs between daylighting and other energy conserving features. This shall be coordinated with the electrical design consultant.

1104.2 ENTRANCES

Building entrances require special consideration in airport facilities. A high volume of traffic is experienced at personnel entrances, baggage handling and service entrances. A high volume of air transfer also can occur at these locations. There are several reasons for this:

A. The building pressurization due to exhaust requirements.
B. Air pressure on doors and door openings from winds.
C. Stack effect due to building height.

To design for the alleviation of these problems the Design Consultant shall:

A. Provide sufficient outside air through the air handling systems to properly pressurize the facility.
B. Provide wind breaks and vestibules at the door entrances to protect direct blasts of wind from entering the building, including door heaters for winter conditions.

Vestibules in airport facilities are less effective than they might be in other applications, due to the high volume of traffic, and percentage of time both doors will be open during busy periods. However, properly sized vestibules will significantly reduce energy consumption in airport facilities during non-peak airport use.

1104.3 HIGH-BAY AREAS

High-bay ceiling areas shall be utilized to an energy advantage. It is proposed that supply air distribution be designed to permit stratification in the high-bay areas during the summer. The summer return air shall be drawn from the floor level. During winter months return air shall be pulled from near the ceiling, as high as possible, capturing stratified hot air and heat dissipated by lights and people. Vertical return air shafts with automatic motorized dampers incorporated into the control scheme shall provide this energy management feature.

SECTION 1105 - AIR LEAKAGE - ALL BUILDINGS
1105.1 WINDOWS
Windows shall be designed to limit air leakage; the air infiltration rate shall not exceed 0.34 cubic feet per min per foot of operable sash crack on exterior openings. Coordinate this requirement with the architect.

1105.2 SWINGING, REVOLVING OR SLIDING DOORS FOR NONRESIDENTIAL USE
Where these types of doors are used they shall be designed to limit air leakage; the air infiltration rate shall not exceed 11 cubic feet per minute per linear foot of door crack.

SECTION 1106 - HVAC SYSTEMS

1106.1 CONTROLS AND AUTOMATION
See Section Controls (Section III.5) and AHU Controls for each facility later in this standard.

1106.2 VARIABLE WATER VOLUME PUMPING (VWV)
Variable water volume pumping systems are based upon proper location of pressure transmitters (near the end of the piping loop) and variable speed pumps or staged pumps to provide only the system flow and pressures required to serve the actual cooling or heating load at a particular time. Variable water volume piping shall be employed to reduce energy consumption of hot and chilled water systems. Final design may include additional applications that could be designed with VWV pumping to advantage in reducing energy usage. This determination is left to the discretion of the Design Consultant (i.e. the condenser water systems).

1106.3 SIMULTANEOUS HEATING AND COOLING
The use of both heating and cooling simultaneously in order to achieve comfort conditions within a space will not be permitted. The Design Consultant shall review ASHRAE Standard 90.1 for exceptions, if necessary.

1106.4 OUTDOOR AIR RESET
Hot and chilled water supply temperatures shall be reset in relation to outdoor air temperature to save energy during other than design conditions.

SECTION 1107 - ENERGY RECOVERY
It is recommended that consideration be given to the use of recovery systems which will conserve energy (provided the amount expended is less than the amount recovered) when the energy transfer potential and the operating hours are considered. Outside air supply ducts should be located near exhaust ducts wherever possible to increase the economics of heat recovery.

SECTION 1108 - HEATING VENTILATING AND AIR-CONDITIONING (HVAC) EQUIPMENT

1108.1 EQUIPMENT EFFICIENCY
Primary criteria for the selection of major heating and cooling plant equipment shall be its efficiency of operation. Equipment shall be selected that exceeds the requirements of ASHRAE Standard 90.1.

1108.2 MINIMUM COP (COEFFICIENT OF PERFORMANCE)/EFFICIENCY LEVELS

Minimum COP and/or efficiency levels are established for HVAC system Equipment and HVAC System Components. It is intended that no lower values than those established in this Standard will be acceptable. It is further intended that where equipment of higher COP/Efficiency capability is known to be available on the open market, it will be the system Design Consultant's option to specify such higher efficiencies as he deems to be suitable.

Commercial/industrial furnaces and boilers:

<table>
<thead>
<tr>
<th>Types of equipment</th>
<th>Percent¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forced-air furnaces and low-pressure steam or hot-water boilers.</td>
<td>80</td>
</tr>
<tr>
<td>All other vented heating equipment</td>
<td>80</td>
</tr>
</tbody>
</table>

¹Combustion efficiency of commercial/industrial furnaces and boilers is defined as 100 percent minus stack losses in percent of heat input. Stack losses are:
1. Loss due to sensible heat in dry flue gas.
2. Loss due to incomplete combustion.
3. Loss due to sensible and latent heat in moisture formed by combustion of hydrogen in the fuel.

Table III.10.2

ELECTRICALLY DRIVEN HVAC SYSTEM EQUIPMENT

<table>
<thead>
<tr>
<th>Standard Rating Capacity</th>
<th>EER</th>
<th>COP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under 65,000 Btuh (19,050 W)</td>
<td>7.8</td>
<td>2.28</td>
</tr>
<tr>
<td>65,000 Btuh (19,050 W) and over</td>
<td>8.2</td>
<td>2.40</td>
</tr>
</tbody>
</table>

¹Refer to ASHRAE 90A for standard ratings.

²The Department of Energy has established required test procedures for single-phase air-cooled residential central air conditioners under 19 kW (65,000 Btuh) in capacity, which have been incorporated in ARI Standard 210-79. EER and COP values in this table are based on Test A of the DOE Test Procedures.
SECTION 1109 - INSULATION

1109.1 AIR-HANDLING DUCT SYSTEM INSULATION
The Design Consultant shall insulate ducts, plenums and enclosures as required by ASHRAE Standard 90.1.

1109.2 PIPING INSULATION
Piping installed to service buildings and within buildings shall be thermally insulated in accordance with ASHRAE Standard 90.1.

In general, piping insulation shall be fiberglass in interior installations. Insulation shall be provided with an all service jacket. Piping systems carrying fluids that will be below the ambient dewpoint temperature at any time shall have a vapor barrier.

SECTION 1110 - PLUMBING SYSTEMS

1110.1 GENERAL
Where possible, the Consultant shall investigate systems to reduce water consumption and waste discharge. The use and availability of ultra low flow (16 oz or less) flush valves and “powerless” infra-red faucets shall be investigated. These systems shall be reviewed and accepted in writing by the DIA Mechanical Engineer.

END OF CHAPTER 11
SECTION 1201 - GENERAL

This chapter is intended to be used by the Engineer for a basis of design. This section contains information on the original basis of design for existing facilities that may no longer comply with current adopted codes. The Engineer shall review the requirements below and notify the DIA Project Manager in writing if current codes conflict with the recommendations below.

SECTION 1202 - PASSENGER TERMINAL - TICKETING LEVEL

1202.1 DESIGN CONDITIONS:
   A. Summer: 78°F (50% RH Max) No Humidity Control
   B. Winter: 72°F No Humidity Control

1202.2 AIR HANDLING SYSTEMS

This area will be air conditioned with a variable air volume (VAV) system. See Section 301 for air handling system requirements.

The supply air ductwork system will consist of medium pressure duct work with variable volume terminal boxes. Each VAV box will have its own space temperature sensor controls tied to EMCS. The system will be sized to supply approximately 1.25 CFM per square foot at maximum flow. Return air shall be through plenum spaces where possible.

1202.3 PERIMETER SYSTEMS

The glass wall in the area will be conditioned by a forced air perimeter system. This system will be constant volume, heating and cooling. This system will be fan-powered VAV heating and cooling.

1202.4 AIR CURTAINS

Air curtains shall be provided for use on all main terminal entrances. Overhead fan-coil systems shall be used at each entrance with ceiling supply and low return in the vestibule area.

1202.5 OUTDOOR AIR REQUIREMENTS

Outside air shall be brought in through the air handling unit.

See Section 303 for ventilation requirements.

1202.6 VENTILATION RATES

Recommended outside air ventilation rates shall be as follows:
   A. All areas: 10 CFM per person

These values shall be based on terminal peak load occupancy.

1202.7 FILTRATION
Outside air shall be filtered with, as a minimum, the use of 2” dry type pre-filter section having a minimum rating of MERV 7, 12” dry type filter section having a minimum rating of MERV 13 and a 12” filter section for future removable mixed media (IE: carbon/potassium permanganate) filter section.

1202.8 AIR HANDLING UNIT CONTROLS
Provide control logic to permit the following:

A. Position outside air dampers, return air dampers, and exhaust dampers. The outside air dampers shall be normally closed, and the return air dampers shall be normally open.

B. Off-peak setback of ventilation and temperatures (where appropriate).

C. Cooling coil controls.

D. Heating coil controls with preheat where required.

E. Monitor space and duct temperatures.

F. Equipment start/stop with equipment status.

G. Optimum start.

H. Alarms for the following:
   1. Fan failure.
   2. Space temperature out of specification.
   3. Smoke detection.
   4. Freeze thermostat shutdown.
   5. Filter Delta P, high limit.

I. Provide air flow measuring stations to measure outside air flow and supply air flow. Program automatic temperature controls to maintain outside air flow during all load conditions to meet ventilation requirements.

J. Controls shall be integrated with the EMCS.

1202.9 CENTRAL PLANT
Chilled water and hot water will be supplied from the central plant. Secondary pumping may be required for these facilities.

1202.10 PLUMBING REQUIREMENTS
All plumbing systems shall conform to the requirements of the Uniform Plumbing Code as adopted and modified by the City and County of Denver building code.

Plumbing design shall consider impact of future terminal expansion.

Provide plumbing fixtures for the physically handicapped.

See Chapter 8 of this standard for plumbing design parameters and basis of occupancy.

1202.11 FIRE PROTECTION
The fire protection system shall be provided in accordance with the latest editions of NFPA Standards and the building code of the City and County of Denver. The following description of fire protection requirements is based on NFPA and F. M. Global the current agency insurance underwriter.

A. Provide a wet-pipe and dry-pipe sprinkler systems for this area.
B. Provide Class I standpipe system.
C. Provide an extinguisher at each station in the enclosed areas.
D. Provide manual pull type fire alarm stations at exits.
E. All escalator and stair opening perimeters shall be provided with closely spaced sprinkler heads providing a water curtain.

1202.12 SMOKE CONTROL

All public and tenant areas shall be served by a separate smoke control system. Refer to Chapter 10 for requirements.

SECTION 1203 - PASSENGER TERMINAL - BAGGAGE CLAIM

1203.1 INDOOR DESIGN CONDITIONS:
A. Summer: 78ºF (50% RH Max) No Humidity Control
B. Winter: 72ºF No Humidity Control

1203.2 AIR HANDLING SYSTEMS

This area will be air conditioned with a variable air volume (VAV) system.

See Section 1202.2.

1203.3 PERIMETER SYSTEMS

The glass wall in the area will be conditioned by a forced air perimeter system. This system will be constant volume, variable temperature and use hot water heating coils. This system will be fan-powered VAV heating and cooling.

1203.4 AIR CURTAINS

Air curtains shall be provided for use on all main terminal entrances. Overhead fan-coil units shall be used at each entrance with ceiling supply and low return in the vestibule area.

1203.5 OUTDOOR AIR REQUIREMENTS

Outside air shall be brought in through the air handling unit. See Section 303 for ventilation requirements.

1203.6 VENTILATION RATES

Recommended average outside air ventilation rates shall be as follows:

A. All areas: 10 CFM per person

These values shall be based on terminal peak load occupancy.
1203.7 FILTRATION
Outside air shall be filtered, as a minimum, by the use of 2” dry type pre-filter section having a minimum rating of MERV 7, 12” dry type filter section having a minimum rating of MERV 13 and a 12” filter section for future removable mixed media (IE: carbon/potassium permanganate) filter section.

1203.8 AIR HANDLING UNIT CONTROLS
See Section 1202.8.

1203.9 CENTRAL PLANT
Chilled water and hot water will be supplied from the central plant. Secondary pumping may be required for these facilities.

1203.10 PLUMBING REQUIREMENTS
See Section 1202.10.

1203.11 FIRE PROTECTION
See Section 1202.11.

1203.12 SMOKE CONTROL
See Section 1202.12

SECTION 1204 - PASSENGER TERMINAL - ATRIUM

1204.1 INDOOR DESIGN CONDITIONS:
A. Summer: 78ºF (No Humidity Control)
B. Winter: 72ºF (No Humidity Control)

1204.2 AIR HANDLING SYSTEMS
Occupied Space: See Section 1202.2.

Great Hall Area: Provide constant volume variable temperature heating and cooling.

Return air shall be from the occupied space.

1204.3 OUTDOOR AIR REQUIREMENTS
Shall be introduced through the VAV system and the high bay atrium make-up air units.

1204.4 VENTILATION RATES
Recommended average outside air ventilation rates shall be as follows:
A. Office Areas: 20 CFM per person
B. Dining Areas: 20 CFM per person
C. Cocktail Lounges: 30 CFM per person
D. All other areas: 15 CFM per person
These values shall be based on terminal peak load occupancy.

**1204.5 FILTRATION**

Outside air shall be filtered, as a minimum, by the use of 2” dry type pre-filter section having a minimum rating of MERV 7, 12” dry type filter section having a minimum rating of MERV 13 and a 12” filter section for future removable mixed media (IE: carbon/potassium permanganate) filter section.

**1204.6 AIR HANDLING UNIT CONTROLS**

Occupied Space (VAV System): See Section 1102.8.

High Bay (Make-Up Air System):

A. Provide similar basic controls and alarms as indicated for VAV system.
B. Air volume shall be controlled by industrial grade differential pressure controllers (auto zeroing type) in the occupied space to maintain positive pressure.
C. Heating coil controls shall maintain a 65ºF leaving air temperature (adjustable).
D. Relief air fans shall be utilized for air relief and high bay ventilation to maintain a preset high bay space temperature.

**1204.7 CENTRAL PLANT**

Chilled water and hot water will be supplied from the central plant. Secondary pumping may be required for this area.

**1204.8 PLUMBING REQUIREMENTS**

See Section 1202.10.

**1204.9 FIRE PROTECTION**

See Section 1202.11.

**1204.10 SMOKE CONTROL**

Atrium area shall be served by a separate smoke control system. Refer to Chapter 10 for requirements.

**SECTION 1205 - PASSENGER TERMINAL - TRAIN STATION SECURITY**

**1205.1 INDOOR DESIGN CONDITIONS:**

A. Summer: 78°F
B. Winter: 72°F

**1205.2 AIR HANDLING SYSTEMS**

This area will be air conditioned with a variable air volume (VAV) system.

See Section 1102.2.

**1205.3 VENTILATION RATES**
Recommended average outside air ventilation rates shall be as follows:

A. Security Area: 15 CFM per person
B. Train Queuing Area: 15 CFM per person

These values shall be based on average terminal load occupancy.

1205.4 FILTRATION
Outside air shall be filtered, as a minimum, by the use of 2” dry type pre-filter section having a minimum rating of MERV 7, 12” dry type filter section having a minimum rating of MERV 13 and a 12” filter section for future removable mixed media (IE: carbon/potassium permanganate) filter section.

1205.5 AIR HANDLING UNIT CONTROLS
See Section 1102.8.

1205.6 CENTRAL PLANT
Chilled water and hot water will be supplied from the central plant. Secondary pumping may be required for units serving this area.

1205.7 PLUMBING REQUIREMENTS
See Section 1202.10.

1205.8 FIRE PROTECTION
See Section 1202.11.

1205.9 SMOKE CONTROL
All public areas shall be served by a separate smoke control system. Refer to Chapter 10 for requirements.

SECTION 1206 - PASSENGER TERMINAL - TRAIN STATION EXIT PAVILIONS

1206.1 DESIGN CONDITIONS:

A. Summer: 78°F (50% RH Max) No Humidity Control
B. Winter: 72°F No Humidity Control

1206.2 AIR HANDLING SYSTEMS
This area will be air conditioned with a variable air volume (VAV) system. See Section 1202.2.

1206.3 OUTDOOR AIR REQUIREMENTS
Outside air shall be brought in through the air handling unit. See Section 303 for ventilation requirements.

1206.4 VENTILATION RATES
Recommended average outside air ventilation rates shall be as follows:
A. Station Area: 15 CFM per person

These values shall be based on average terminal load occupancy.

1206.5 FILTRATION

Outside air shall be filtered, as a minimum, by the use of 2” dry type pre-filter section having a minimum rating of MERV 7, 12” dry type filter section having a minimum rating of MERV 13 and a 12” filter section for future removable mixed media (IE: carbon/potassium permanganate) filter section.

1206.6 AIR HANDLING UNIT CONTROLS

See Section 1202.8.

1206.7 CENTRAL PLANT

Chilled water and hot water will be supplied from the central plant. Secondary pumping may be required for units serving this area.

1206.8 PLUMBING REQUIREMENTS

See Section 1202.10.

1206.9 FIRE PROTECTION

See Section 1202.11.

1206.10 SMOKE CONTROL

All public areas shall be served by a separate smoke control system. Refer to Chapter 10 for requirements.

SECTION 1207 - PASSENGER TERMINAL - TRAIN STATION LOADING PLATFORMS

1207.1 DESIGN CONDITIONS:

A. Summer: 78°F (50% RH Max) No Humidity Control

B. Winter: 72°F No Humidity Control

1207.2 AIR HANDLING SYSTEMS

This area will be air conditioned with a variable air volume (VAV) system. See Section 1202.2.

1207.3 OUTDOOR AIR REQUIREMENTS

Outside air shall be brought in through the air handling unit. See Section 303 for ventilation requirements.

1207.4 VENTILATION RATES

Recommended average outside air ventilation rates shall be as follows:

A. Loading areas: 15 CFM per person

These values shall be based on average terminal load occupancy.
1207.5 FILTRATION
Outside air shall be filtered, as a minimum, by the use of 2" dry type pre-filter section having a
minimum rating of MERV 7, 12" dry type filter section having a minimum rating of MERV 13 and
a 12" filter section for future removable mixed media (IE: carbon/potassium permanganate) filter
section.

1207.6 AIR HANDLING UNIT CONTROLS
See Section 1202.8.

1207.7 CENTRAL PLANT
Chilled water and hot water will be supplied from the central plant. Secondary pumping may be
required for unit serving this area.

1207.8 PLUMBING REQUIREMENTS
See Section 1202.10.

1207.9 FIRE PROTECTION
See Section 1202.11.

SECTION 1208 - PASSENGER TERMINAL - CONCESSIONS AND SERVICES

1208.1 DESIGN CONDITIONS:
A. Summer: 78ºF (50% RH Max) No Humidity Control
B. Winter: 72ºF No Humidity Control

1208.2 AIR HANDLING SYSTEMS

1208.3 AIR HANDLING SYSTEMS
The base building air handling system has been designed to accommodate the following loads
for Restaurant, Food Courts, Office and Concession Spaces:
A. Basic Office, Retail, Airline Tenant: Exterior Load + 1.00 CFM/SF
B. Restaurant Tenant: Exterior + 1.25 CFM/SF for seating area. Kitchen to be
   conditioned with tenant supplied make-up air system.
C. Bar Tenant: Exterior load + 1.25 CFM/SF
D. Food Court Tenant: Exterior load + 1.25 CFM/SF for seating areas. Source of
   make-up air will be by each tenant and coordinated between DIA and each tenant.

The Tenant shall provide a complete HVAC system to meet loads that exceed the requirements
listed above. The Tenant shall verify the heating and cooling loads from the perimeter, adjoining
structures and adjacent spaces affecting the Tenant area. All Tenant areas in the Terminal are
in the interior spaces and are unaffected by the perimeter heating /cooling loads.

1208.4 OUTDOOR AIR REQUIREMENTS
In general, outside air shall be brought in through the base building air handling unit and/or the kitchen ventilation system. The tenant HVAC shall make-up a minimum of 90% of what is exhausted from the space.

**1208.5 KITCHEN EXHAUST**

All kitchens shall be air conditioned. The exhaust requirements will be determined by the cooking exhaust hoods installed within the facility. The kitchen exhaust system shall be designed in accordance with NFPA 96, "Standard for the Installation of Equipment for the Removal of Smoke and Grease-Laden Vapors from Commercial Cooking Equipment."

**1208.6 VENTILATION RATES**

The existing system ventilation was designed in accordance with American Society of Heating, Refrigeration and Air Conditioning Engineers Standard (ASHRAE) 62-1989, "Ventilation for Acceptable Indoor Air Quality". All new design for proper ventilation shall be in accordance with the recommendations of the American Society of Heating, Refrigeration and Air Conditioning Engineers Standard ASHRAE 62-2004 and IMC, "Ventilation for Acceptable Indoor Air Quality" or requirements of local building code, whichever is more stringent. Minimum ventilation rates:

<table>
<thead>
<tr>
<th>Space</th>
<th>Min Ventilation</th>
<th>Min Occupancy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smoking Areas:</td>
<td>60 CFM per person</td>
<td>70 people per 1,000 SF</td>
</tr>
<tr>
<td>Dining Areas:</td>
<td>20 CFM per person or 1.5 SF per SF</td>
<td></td>
</tr>
<tr>
<td>Cocktail Lounges:</td>
<td>25 CFM per person</td>
<td></td>
</tr>
<tr>
<td>Kitchen Areas:</td>
<td>2.5 CFM per SF</td>
<td></td>
</tr>
<tr>
<td>All other Areas:</td>
<td>10 CFM per person</td>
<td></td>
</tr>
</tbody>
</table>

The Engineer shall use the values above or the requirements of the local building code, whichever is more stringent.

**1208.7 FILTRATION**

Outside air shall be filtered, as a minimum, by the use of 2” dry type pre-filter section having a minimum rating of MERV 7, 12” dry type filter section having a minimum rating of MERV 13 and a 12” filter section for future removable mixed media (IE: carbon/potassium permanganate) filter section.

**1208.8 AIR HANDLING UNIT CONTROLS**

See Section 1202.8.

**1208.9 CENTRAL PLANT**

Chilled water and hot water will be supplied from the central plant. Secondary pumping may be required for unit serving this area.

**1208.10 PLUMBING REQUIREMENTS**

See Section 1202.10.

Provide grease trap interceptors for kitchen areas.

Provide gas-fired hot water heating system for kitchen requirements.
1208.11 FIRE PROTECTION

The fire protection system shall be provided in accordance with the latest editions of NFPA Standards and the building code for the City and County of Denver. The following description of fire protection requirements is based on NFPA.

A. Provide a wet-pipe sprinkler system for this area.
B. Provide Class I standpipe system.
C. Provide an extinguisher at each station in the enclosed areas.
D. Provide manual pull type fire alarm station at exits.
E. All escalator and stair opening perimeters shall be protected by providing closely spaced sprinkler heads to provide a water curtain.
F. Provide a pre-engineered carbon dioxide extinguishing system for the kitchen exhaust hoods in accordance with NFPA 12, "Standard on Carbon Dioxide Extinguishing Systems." The system shall be capable of automatic detection with local or remote manual actuation. Accessories shall be installed for mechanical or electrical gas line shut-off applications. System shall be listed with Underwriters Laboratories, Inc. (Exception alternate extinguishing system types which are acceptable to the Denver Fire Prevention Bureau are allowed in lieu of CO2 but must complete all necessary steps as outlined)

1208.12 SMOKE CONTROL

All public and tenant areas shall be served by the base building smoke control system. Refer to Chapter 10 for requirements.

SECTION 1209 - PASSENGER TERMINAL - REST ROOMS

1209.1 DESIGN CONDITIONS:

A. Summer: 78°F (No Humidity Control)
B. Winter: 72°F (No Humidity Control)

1209.2 AIR HANDLING SYSTEMS

This area will be air conditioned with a variable air volume (VAV) system.

Normally, supply air will be provided by the same air handling unit serving adjacent spaces.

1209.3 TOILET EXHAUST

The ventilation rate for all toilet room facilities shall be 2.0 CFM per square foot of floor area or 15 air changes per hour, whichever is greater. Toilets serving concourse and bag claim areas shall have ventilation rates of 2.5 CFM per square foot or 18 air changes per hour.

1209.4 FILTRATION

Outside air shall be filtered, as a minimum, by the use of 2" dry type pre-filter section having a minimum rating of MERV 7, 12" dry type filter section having a minimum rating of MERV 13 and a 12" filter section for future removable mixed media (IE: carbon/potassium permanganate) filter section.
1209.5 CONTROLS
Provide control logic to permit the following:
   A. Space temperature.

1209.6 CENTRAL PLANT
Chilled water and hot water will be supplied from the central plant.

1209.7 PLUMBING REQUIREMENTS
See Section 1202.10.

Fixture count requirements shall be determined by the following:
   A. Projected terminal occupancy.
   B. Local code requirements.
   C. Thirty-three percent of the passengers and fifteen percent of visitors will use concourse facilities. Fifteen percent of passengers and visitors will use terminal facilities.
   D. The ratio of men to women is estimated at 55 percent male/45 percent female.
   E. Urinals shall be utilized in lieu of water closets to the maximum ratio allowed by code.
   F. Facilities for the physically handicapped shall be provided in the terminal public rest rooms.
   G. All domestic hot and cold water piping within conditioned areas shall be insulated. All piping subjected to freezing temperatures shall be insulated.
   H. All lavatory faucets in public and private toilet rooms shall be provided with flow restriction devices on all outlets. Except for faucets on physically handicapped fixtures.

The following is a partial list of plumbing fixtures required for this area:
   A. Lavatories shall be wall hung or counter mounted.
   B. Lavatories for the physically handicapped can be wall hung or counter mounted with offset grid drain for wheelchairs.
   C. Water closets, standard and handicapped, shall be "blow out" type.
   D. Stop valves shall be provided on all fixtures including water coolers.
   E. Urinals.
   F. Floor drains and cleanouts.
   G. All water coolers in public areas shall be barrier free bi-level type.
   H. Showers.

1209.8 FIRE PROTECTION
   A. Single facilities larger than 1500 Square feet requires fire sprinkler and fire alarm systems per the requirements of Denver Fire Prevention Bureau, F.M. Global and
SECTION 1210 - PASSENGER TERMINAL - GROUND TRANSPORTATION LEVEL

1210.1 DESIGN CONDITIONS:
A. Summer: 78°F (50% RH Max.) No Humidity Control
B. Winter: 72°F No Humidity Control

1210.2 AIR HANDLING SYSTEMS
This area will be air conditioned with a variable air volume (VAV) system.
See Section 1202.2.

1210.3 PERIMETER SYSTEMS
The glass wall in the area will be conditioned by a forced air perimeter system. This system will
be constant volume heating and cooling. This system will be fan-powered VAV heating and
cooling.

1210.4 OUTDOOR AIR REQUIREMENTS
Outside air shall be brought in through the air handling unit.
See Section 303 for ventilation requirements.

1210.5 VENTILATION RATES
Recommended average outside air ventilation rates shall be as follows:
A. All areas: 10 CFM per person

These values shall be based on terminal peak load occupancy.

1210.6 FILTRATION
Outside air shall be filtered, as a minimum, by the use of 2” dry type pre-filter section having a
minimum rating of MERV 7, 12” dry type filter section having a minimum rating of MERV 13 and
a 12” filter section for future removable mixed media (IE: carbon/potassium permanganate) filter
section.

1210.7 AIR HANDLING UNIT CONTROLS
See Section 1202.8.

1210.8 CENTRAL PLANT
Chilled water and hot water will be supplied from the central plant. Secondary pumping may be
required for unit serving this area.

1210.9 PLUMBING REQUIREMENTS
See Section 1202.10.

1210.10 FIRE PROTECTION
See Section 1202.11.
SECTION 1211 - PASSENGER TERMINAL - RENTAL CAR LEVEL

1211.1 DESIGN CONDITIONS:
   
   A. Summer:  78ºF (50% RH Max.) No Humidity Control
   
   B. Winter:  72ºF No Humidity Control

1211.2 AIR HANDLING SYSTEMS
This area will be air conditioned with a variable air volume (VAV) system.
See Section 1202.2.

1211.3 PERIMETER SYSTEMS
The glass wall in the area will be covered by a forced air perimeter system. This system will be
constant volume, heating and cooling. This system will be fan-powered VAV heating and
cooling.

1211.4 OUTDOOR AIR REQUIREMENTS
Outside air shall be brought in through the air handling unit.
See Section 303 for ventilation requirements.

1211.5 VENTILATION RATES
Recommended average outside air ventilation rates shall be as follows:
   
   A. Office areas:          10 CFM per person
   
   B. Public areas:          10 CFM per person

These values shall be based on terminal peak load occupancy.

1211.6 FILTRATION
Outside air shall be filtered, as a minimum, by the use of 2" dry type pre-filter section having a
minimum rating of MERV 7, 12" dry type filter section having a minimum rating of MERV 13 and
a 12" filter section for future removable mixed media (IE: carbon/potassium permanganate) filter
section.

1211.7 AIR HANDLING UNIT CONTROLS
See Section 1202.8.

1211.8 CENTRAL PLANT
Chilled water and hot water will be supplied from the central plant. Secondary pumping may be
required for this area.

1211.9 PLUMBING REQUIREMENTS
See Section 1202.10.

1211.10 FIRE PROTECTION
See Section 1202.11.
SECTION 1212 - PASSENGER TERMINAL - BAGGAGE HANDLING LEVEL

1212.1 INDOOR DESIGN CONDITIONS:
   A. Summer: 95ºF (50% RH Max) No Humidity Control
   B. Winter: 40ºF No Humidity Control

1212.2 AIR HANDLING SYSTEMS
This area will be air tempered with constant volume direct-fired air-handling system interlocked with propeller exhaust fans.

See Section 1202.2.

1212.3 EVAPORATIVE COOLING
Where the four-pipe distribution system is unavailable and acceptable air quality is available, evaporative cooling may be utilized (no back-up refrigeration unit) in lieu of refrigeration. Evaporative cooling may be the indirect or direct method of operation. By "acceptable" air quality, the air must be free of jet fuel exhaust fumes.

1212.4 OUTDOOR AIR REQUIREMENTS
Outside air shall be brought in through the air handling unit.
See Section 303 for ventilation requirements.

1212.5 VENTILATION RATES
Recommended average outside air ventilation rates shall be as follows:
   A. All areas: 4 ACH

These values shall be based on terminal peak load occupancy.

1212.6 FILTRATION
Outside air shall be filtered, as a minimum, by the use of 2” dry type pre-filter section having a minimum rating of MERV 7, 12” dry type filter section having a minimum rating of MERV 13 and a 12” filter section for future removable mixed media (IE: carbon/potassium permanganate) filter section.

1212.7 AIR HANDLING UNIT CONTROLS
See Section 1202.8.

1212.8 CENTRAL PLANT
Chilled water and hot water will be supplied from the central plant. Secondary pumping may be required for these facilities.

1212.9 PLUMBING REQUIREMENTS
See Section 1202.10.

1212.10 FIRE PROTECTION
See Section 1202.11.
SECTION 1213 - PASSENGER TERMINAL - BAGGAGE HANDLING LEVEL – BAGGAGE SCREENING AREAS.

1213.1 DESIGN CONDITIONS:
   A. Summer: 78ºF (50% RH Max) No Humidity Control
   B. Winter: 72ºF No Humidity Control

1213.2 AIR HANDLING SYSTEMS
The existing air handling systems in the baggage handling areas is not designed to maintain office environment conditions.

Screening areas, which require year-round conditioning, may be connected to the central plant chilled water system for cooling and heating. Gas-fired DX units may also be used.

1213.3 OUTDOOR AIR REQUIREMENTS
In general, each space must provide outside air in accordance with the latest version of the Mechanical Code and ASHRAE Standard 62.

1213.4 VENTILATION RATES
All new design for proper ventilation shall be in accordance with the recommendations of the American Society of Heating, Refrigeration and Air Conditioning Engineers Standard ASHRAE 62-2004 and IMC, "Ventilation for Acceptable Indoor Air Quality" or requirements of local building code, whichever is more stringent. Minimum ventilation rates:

The Engineer shall use the values above or the requirements of the local building code, whichever is more stringent.

1213.5 FILTRATION
Outside air shall be filtered, as a minimum, by the use of 2" dry type pre-filter section having a minimum rating of MERV 7, 12" dry type filter section having a minimum rating of MERV 13 and a 12" filter section for future removable mixed media (IE: carbon/potassium permanganate) filter section.

1213.6 AIR HANDLING UNIT CONTROLS
See Section 1202.8.

1213.7 CENTRAL PLANT
Chilled water and hot water may be supplied from the central plant. Secondary pumping may be required for these areas.

1213.8 PLUMBING REQUIREMENTS
See Section 1202.10.

1213.9 FIRE PROTECTION
See Section 1202.11.
SECTION 1214 - PASSENGER TERMINAL – TENANT SPACES (RESTAURANT, FOOD COURTS, OFFICE AND CONCESSION SPACES)

1214.1 DESIGN CONDITIONS:
   A. Summer: 78°F (50% RH Max) No Humidity Control
   B. Winter: 72°F No Humidity Control

1214.2 AIR HANDLING SYSTEMS
The base building air handling system has been designed to accommodate the following loads for Restaurant, Food Courts, Office and Concession Spaces:
   A. Basic Office, Retail, Airline Tenant: Exterior Load + 1.00 CFM/SF
   B. Restaurant Tenant: Exterior + 1.25 CFM/SF for seating area. Kitchen to be conditioned with tenant supplied make-up air system.
   C. Bar Tenant: Exterior load + 1.25 CFM/SF
   D. Food Court Tenant: Exterior load + 1.25 CFM/SF for seating areas. Source of make-up air will be by each tenant and coordinated between DIA and each tenant.

The Tenant shall provide a complete HVAC system to meet loads that exceed the requirements listed above. The Tenant shall verify the heating and cooling loads from the perimeter, adjoining structures and adjacent spaces affecting the Tenant area. All Tenant areas in the Terminal are in the interior spaces and are unaffected by the perimeter heating /cooling loads.

1214.3 PERIMETER SYSTEMS
The glass wall in the area will be conditioned by the base building system.

1214.4 OUTDOOR AIR REQUIREMENTS
In general, outside air shall be brought in through the base building air handling unit and/or the kitchen ventilation system. The tenant HVAC shall make-up a minimum of 90% of what is exhausted from the space.

1214.5 VENTILATION RATES
The existing system ventilation was designed in accordance with American Society of Heating, Refrigeration and Air Conditioning Engineers Standard (ASHRAE) 62-1989, "Ventilation for Acceptable Indoor Air Quality". All new design for proper ventilation shall be in accordance with the recommendations of the American Society of Heating, Refrigeration and Air Conditioning Engineers Standard ASHRAE 62-2004 and IMC, "Ventilation for Acceptable Indoor Air Quality" or requirements of local building code, whichever is more stringent. Minimum ventilation rates:

<table>
<thead>
<tr>
<th>Space</th>
<th>Min Ventilation</th>
<th>Min Occupancy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smoking Areas:</td>
<td>60 CFM per person</td>
<td>70 people per 1,000 SF</td>
</tr>
<tr>
<td>Dining Areas:</td>
<td>20 CFM per person or 1.5 SF per SF</td>
<td></td>
</tr>
<tr>
<td>Cocktail Lounges:</td>
<td>25 CFM per person</td>
<td></td>
</tr>
<tr>
<td>Kitchen Areas:</td>
<td>2.5 CFM per SF</td>
<td></td>
</tr>
<tr>
<td>All other Areas:</td>
<td>10 CFM per person</td>
<td></td>
</tr>
</tbody>
</table>
The Engineer shall use the values above or the requirements of the local building code, whichever is more stringent.

All kitchen areas shall have a separate exhaust fan.

1214.6 KITCHEN EXHAUST

All kitchens shall be air conditioned. The exhaust requirements will be determined by the cooking exhaust hoods installed within the facility. The kitchen exhaust system shall be designed in accordance with NFPA 96, "Standard for the Installation of Equipment for the Removal of Smoke and Grease-Laden Vapors from Commercial Cooking Equipment."

1214.7 FILTRATION

Outside air shall be filtered, as a minimum, by the use of 2" dry type pre-filter section having a minimum rating of MERV 7, 12" dry type filter section having a minimum rating of MERV 13 and a 12" filter section for future removable mixed media (IE: carbon/potassium permanganate) filter section.

1214.8 AIR HANDLING UNIT CONTROLS

See Section 1202.8.

1214.9 CENTRAL PLANT

Chilled water and hot water connections are not available for tenants in this area.

1214.10 PLUMBING REQUIREMENTS

See Section 1202.10.

1214.11 FIRE PROTECTION

See Section 1202.11.

SECTION 1215 - PASSENGER TERMINAL – ELECTRICAL ROOMS

1215.1 DESIGN CONDITIONS:
   A. Summer: 95°F No Humidity Control
   B. Winter: 95°F No Humidity Control
   C. Maintain positive space pressure for dust control.

1215.2 AIR HANDLING SYSTEMS

This facility will be air conditioned with single zone system or connected to base building system.

Single zone units shall consist of a centrifugal, non-overloading supply air fan with fan speeds selected for sound control. Air handling units shall contain and a throwaway filter section. Supply and return air shall be ducted in a low pressure type system.
See Section 301 for air handling system requirements.

1215.3 OUTDOOR AIR REQUIREMENTS

No required

1215.4 FILTRATION

Outside air or air from a dirty area (baggage tunnel, parking garages, apron, etc) shall be filtered, as a minimum, by the use of 2” dry type pre-filter section having a minimum rating of MERV 7.

1215.5 AIR HANDLING UNIT CONTROLS

See Section 1202.8.

1215.6 CENTRAL PLANT

Chilled water connections are available for conditioning equipment, but shall not be run inside the electrical room.

1215.7 PLUMBING REQUIREMENTS

See Section 1202.10.

1215.8 FIRE PROTECTION

No sprinkler system shall be installed. Provide two-hour rated room to meet requirements of NPFA 13. Refer to DSM 5 for fire alarm requirements.

SECTION 1216 - PASSENGER TERMINAL – TELECOMMUNICATIONS AND UPS ROOMS

1216.1 DESIGN CONDITIONS:

- Summer: 68°F, 65% RH max
- Winter: 68°F
- Maintain positive space pressure for dust control.

1216.2 AIR HANDLING SYSTEMS

This facility will be air conditioned with single zone DX system.

Single zone units shall consist of a centrifugal, non-overloading supply air fan with fan speeds selected for sound control. Air handling units shall contain and a throwaway filter section. Supply and return air shall be ducted in a low pressure type system.

See Section 301 for air handling system requirements.

1216.3 OUTDOOR AIR REQUIREMENTS

No required

1216.4 FILTRATION
Outside air or air from a dirty area (baggage tunnel, parking garages, apron, etc) shall be filtered, as a minimum, by the use of 2” dry type pre-filter section having a minimum rating of MERV 7.

1216.5 AIR HANDLING UNIT CONTROLS
See Section 1202.8.

1216.6 CENTRAL PLANT
Due to the critical nature of these spaces and the seasonal global temperature reset, chilled water shall not be used.

1216.7 PLUMBING REQUIREMENTS
See Section 1202.10.

1216.8 FIRE PROTECTION
No sprinkler system shall be installed. Provide two-hour rated room to meet requirements of NPFA 13. Refer to DSM 5 for fire alarm requirements.

SECTION 1217 - INTERNATIONAL CONCOURSE

1217.1 DESIGN CONDITIONS:
A. Summer: 74°F (No Humidity Control)
B. Winter: 72°F

1217.2 AIR HANDLING SYSTEMS
This area will be air conditioned with a variable air volume (VAV) system.
See Section 1202.2.

1217.3 PERIMETER SYSTEMS
The glass walls in the area will be conditioned by a forced air perimeter system. This system will be variable volume with a minimum set point, and use hot chilled water reheat coils. Sill or overhead diffusers will be used (providing overhead diffusers are not over 9 ft. 6 in. above finished floor).

Consideration should be given to utilization of fan powered boxes on the perimeter which would allow the primary air to be shut-off with no load while maintaining air circulation.

1217.4 AIR CURTAINS
Overhead fan-coil units shall be used at each jetway entrance. The fan-coil units shall be activated whenever the door is opened with a 30 second time delay and the supply air temperature controlled from a space thermostat.

1217.5 OUTDOOR AIR REQUIREMENTS
Outside air shall be brought in through the air handling unit.

1217.6 TOILET EXHAUST
The ventilation rate for all toilet room facilities shall be 2.5 CFM per square foot of floor area or 18 air changes per hour (whichever is greater).

1217.7 KITCHEN EXHAUST
All kitchens shall be air conditioned. The exhaust levels will be determined by the cooking exhaust hood requirements within the facility. The kitchen exhaust system shall be designed in accordance with NFPA 96, "Standard for the Installation of Equipment for the Removal of Smoke and Grease-Laden Vapors from Commercial Cooking Equipment." Consideration shall be given to make up air units for large hood requirements.

1217.8 VENTILATION RATES
Recommended average outside air ventilation rates shall be as follows:

A. Office Areas: 10 CFM per person
B. Dining Areas: 20 CFM per person
C. Cocktail Lounges: 25 CFM per person
D. Public & Hold Room Areas: 10 CFM per person

These values shall be based on terminal peak load occupancy.

1217.9 FILTRATION
Outside air shall be filtered, as a minimum, by the use of 2” dry type pre-filter section having a minimum rating of MERV 7, 12” dry type filter section having a minimum rating of MERV 13 and a 12” filter section for future removable mixed media (IE: carbon/potassium permanganate) filter section.

1217.10 AIR HANDLING UNIT CONTROLS
See Section 1202.8.

1217.11 CENTRAL PLANT
Chilled water and hot water will be supplied from the central plant for building heating and cooling. A secondary chilled water pumping circuit shall be provided for this facility.

1217.12 PLUMBING REQUIREMENTS
See Section 1202.10. The basis for plumbing fixture count is based on the following criteria:

A. Projected concourse occupancy.
B. Local code requirements.
C. Thirty-three percent of the passengers and fifteen percent of visitors shall use concourse facilities.
D. The ratio of men to women is estimated at 55 percent male/45 percent female.
E. Urinals shall be utilized in lieu of water closets to the maximum ratio allowed by code.
F. Facilities for the physically handicapped shall be provided in the terminal public rest
rooms.
All domestic hot and cold water and storm drainage piping within conditioned areas shall be insulated. All piping subjected to freezing temperatures shall be insulated.

All lavatory faucets in public and private toilet rooms shall be provided with flow restriction devices on all outlets. Except for faucets on physically handicapped fixtures.

The following is a partial list of plumbing fixtures required for this area:

G. Lavatories shall be wall hung or counter mounted.
H. Lavatories for the physically handicapped can be wall hung or counter mounted with offset grid drain for wheelchairs.
I. Water closets, standard and handicapped, shall be "blow out" type.
J. Stop valves shall be provided on all fixtures including water coolers.
K. Urinals.
L. Floor drains and cleanouts.
M. All water coolers in public areas shall be barrier free bilevel type.
N. Showers.
O. Sand traps and oil separators.
P. Industrial waste sewer system.
Q. Hot water heater.
R. All domestic water connections, to mechanical systems, shall be protected from backflow.

1217.13 FIRE PROTECTION
The fire protection system shall be provided in accordance with the latest editions of NFPA Standards and building code of the City and County of Denver. The following description of fire protection requirements is based on NFPA.

A. Provide a wet-pipe sprinkler system for this area.
B. Provide a Class I standpipe system (unless concourse width exceeds 100 feet) with extinguishers throughout the area.
C. Provide manual pull type fire alarm station at exits.
D. All escalator and stair opening perimeters shall be protected by providing closely spaced sprinkler heads to provide a water curtain.
E. Single facilities larger than 1500 Square feet requires fire sprinkler and fire alarm systems per the requirements of Denver Fire Prevention Bureau, F.M. Global and NFPA.

1217.14 SMOKE CONTROL
All public and tenant areas shall be served by a separate smoke control system. Refer to Chapter 10 for requirements.

SECTION 1218 - DOMESTIC CONCOURSE
1218.1 DESIGN CONDITIONS:
   A. Summer: 74ºF (No Humidity Control)
   B. Winter: 72ºF

1218.2 AIR HANDLING SYSTEMS
This area will be air conditioned with a variable air volume (VAV) system.

See Section 1202.2.

1218.3 PERIMETER SYSTEMS
The glass walls in the area will be conditioned by a forced air perimeter system. This system
will be variable volume with a minimum set point, and use hot and chilled water coils. Sill or
overhead diffusers will be used (providing overhead diffusers are not over 9 feet 6 inches above
finished floor).

Consideration should be given to utilization of fan powered boxes on the perimeter which would
allow the primary air to be shut-off with no load while maintaining air circulation.

1218.4 AIR CURTAINS
Overhead fan-coil units shall be used at each jetway entrance. The fan-coil units shall be
activated whenever the door is opened with a 30 second time delay and the supply air
temperature controlled from a space thermostat.

1218.5 OUTDOOR AIR REQUIREMENTS
Outside air shall be brought in through the air handling unit.
See Section 303 for ventilation requirements.

1218.6 TOILET EXHAUST
The ventilation rate for all toilet room facilities shall be 2.5 CFM per square foot of floor area or
18 air changes per hour, whichever is larger.

1218.7 KITCHEN EXHAUST
All kitchens shall be air conditioned. The exhaust levels will be determined by the cooking
exhaust hood requirements within the facility. The kitchen exhaust system shall be designed in
accordance with NFPA 96, "Standard for the Installation of Equipment for the Removal of
Smoke and Grease-Laden Vapors from Commercial Cooking Equipment." Consideration shall
be given to make up air units for large hood requirements.

1218.8 VENTILATION RATES
Recommended average outside air ventilation rates shall be as follows:

A. Office Areas: 10 CFM per person
B. Dining Areas: 20 CFM per person
C. Cocktail Lounges: 25 CFM per person
D. Public & Hold Room Areas: 10 CFM per person
These values shall be based on terminal peak load occupancy.

1218.9 FILTRATION
Outside air shall be filtered, as a minimum, by the use of 2” dry type pre-filter section having a minimum rating of MERV 7, 12” dry type filter section having a minimum rating of MERV 13 and a 12” filter section for future removable mixed media (IE: carbon/potassium permanganate) filter section.

1218.10 AIR HANDLING UNIT CONTROLS
See Section 1202.8.

1218.11 CENTRAL PLANT
Chilled water and hot water will be supplied from the central plant for building heating and cooling. A secondary chilled and hot water pumping circuit shall be provided for this facility.

1218.12 PLUMBING REQUIREMENTS
See Section 1202.10.

The basis for plumbing fixture count is based on the following criteria:

A. Projected concourse occupancy.
B. Local code requirements.
C. Thirty-three percent of the passengers and fifteen percent of visitors shall use concourse facilities.
D. The ratio of men to women is estimated at 55 percent male/45 percent female.
E. Urinals shall be utilized in lieu of water closets to the maximum ratio allowed by code.
F. Facilities for the physically handicapped shall be provided in the terminal public rest rooms.

All domestic hot and cold water and storm drainage piping within conditioned areas shall be insulated. All piping subjected to freezing temperatures shall be insulated.

All lavatory faucets in public and private toilet rooms shall be provided with flow restriction devices on all outlets. Except for faucets on physically handicapped fixtures.

The following is a partial list of plumbing fixtures required for this area:

A. Lavatories shall be wall hung or counter mounted.
B. Lavatories for the physically handicapped can be wall hung or counter mounted with offset grid drain for wheelchairs.
C. Water closets, standard and handicapped, shall be "blow out" type.
D. Stop valves shall be provided on all fixtures including water coolers.
E. Urinals.
F. Floor drains and cleanouts.
G. Water coolers shall be barrier free bi-level type in public areas.
H. Showers.
I. Sand traps and oil separators.
J. Industrial waste sewer system.
K. Hot water heater.

All domestic water connections, to mechanical systems, shall be protected from backflow.

**1218.13 FIRE PROTECTION**

See Section 1202.11.

**1218.14 CONCOURSE B EAST REGIONAL JET FACILITY**

The base building HVAC systems for Concourse B Regional Jet Facility do not have extra capacity for tenant spaces. All tenants shall provide stand alone HVAC systems for each space. Roof mounted equipment is acceptable in this area provided that it meets minimum code clearances. Locations of exhaust fans and exhaust openings shall be approved in writing by the DIA Mechanical Engineer.

**SECTION 1219 - DOMESTIC CONCOURSE – TENANT SPACES (RESTAURANT, FOOD COURTS, OFFICE AND CONCESSION SPACES)**

**1219.1 DESIGN CONDITIONS:**

A. Summer: 74°F (50% RH Max) No Humidity Control

B. Winter: 72°F No Humidity Control

**1219.2 AIR HANDLING SYSTEMS**

The base building air handling system has been designed to accommodate the following loads for Restaurant, Food Courts, Office and Concession Spaces:

A. Basic Office, Retail, Airline Tenant: Exterior Load + 1.00 CFM/SF

B. Restaurant Tenant: Exterior + 1.25 CFM/SF for seating area. Kitchen to be conditioned with tenant supplied make-up air system.

C. Bar Tenant: Exterior load + 1.25 CFM/SF

D. Food Court Tenant: Exterior load + 1.25 CFM/SF for seating areas. Source of make-up air will be by each tenant and coordinated between DIA and each tenant.

E. Concourse B Regional Jet Facility: No Tenant HVAC (hydronic on airside) accommodations have been made. Tenant shall provide a complete stand-alone HVAC system.

The Tenant shall provide a complete HVAC system to meet loads that exceed the requirements listed above. The Tenant shall verify the heating and cooling loads from the perimeter, adjoining structures and adjacent spaces affecting the Tenant area.

**1219.3 PERIMETER SYSTEMS**

The glass wall in the area will be conditioned by the base building system.
1219.4 OUTDOOR AIR REQUIREMENTS

In general, outside air shall be brought in through the base building air handling unit and/or the kitchen ventilation system. The tenant HVAC shall make-up a minimum of 90% of what is exhausted from the space.

1219.5 VENTILATION RATES

The existing base building system ventilation was designed in accordance with American Society of Heating, Refrigeration and Air Conditioning Engineers Standard (ASHRAE) 62-1989, "Ventilation for Acceptable Indoor Air Quality". All new design for proper ventilation shall be in accordance with the recommendations of the American Society of Heating, Refrigeration and Air Conditioning Engineers Standard ASHRAE 62-2004 and IMC, "Ventilation for Acceptable Indoor Air Quality" or requirements of local building code, whichever is more stringent. Minimum ventilation rates:

<table>
<thead>
<tr>
<th>Space</th>
<th>Min Ventilation</th>
<th>Min Occupancy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smoking Areas:</td>
<td>60 CFM per person</td>
<td>70 people per 1,000 SF</td>
</tr>
<tr>
<td>Dining Areas:</td>
<td>20 CFM per person or 1.5 SF per SF</td>
<td></td>
</tr>
<tr>
<td>Cocktail Lounges:</td>
<td>25 CFM per person</td>
<td></td>
</tr>
<tr>
<td>Kitchen Areas:</td>
<td>2.5 CFM per SF</td>
<td></td>
</tr>
<tr>
<td>All other Areas:</td>
<td>10 CFM per person</td>
<td></td>
</tr>
</tbody>
</table>

The Engineer shall use the values above or the requirements of the local building code, whichever is more stringent.

All kitchen areas shall have a separate exhaust fan.

1219.6 KITCHEN EXHAUST

All kitchens shall be air conditioned. The exhaust requirements will be determined by the cooking exhaust hoods installed within the facility. The kitchen exhaust system shall be designed in accordance with NFPA 96, "Standard for the Installation of Equipment for the Removal of Smoke and Grease-Laden Vapors from Commercial Cooking Equipment."

1219.7 FILTRATION

Outside air shall be filtered, as a minimum, by the use of 2" dry type pre-filter section having a minimum rating of MERV 7, 12" dry type filter section having a minimum rating of MERV 13 and a 12" filter section for future removable mixed media (IE: carbon/potassium permanganate) filter section.

1219.8 AIR HANDLING UNIT CONTROLS

See Section 1202.8.

1219.9 CENTRAL PLANT

Chilled water and hot water connections are not available for tenants in this area.

1219.10 PLUMBING REQUIREMENTS

See Section 1202.10.
1219.11 FIRE PROTECTION
See Section 1202.11.

1219.12 SMOKE CONTROL
All public and tenant areas shall be served by a separate smoke control system. Refer to Chapter 10 for requirements.

SECTION 1220 - DOMESTIC CONCOURSE – ELECTRICAL ROOMS

1220.1 DESIGN CONDITIONS:
A. Summer: 95°F No Humidity Control
B. Winter: 95°F No Humidity Control
C. Maintain positive space pressure for dust control.

1220.2 AIR HANDLING SYSTEMS
This facility will be air conditioned with single zone system or connected to base building system.

   Single zone units shall consist of a centrifugal, non-overloading supply air fan with fan speeds selected for sound control. Air handling units shall contain a throwaway filter section. Supply and return air shall be ducted in a low pressure type system.

   See Section 301 for air handling system requirements.

1220.3 OUTDOOR AIR REQUIREMENTS
   No required

1220.4 FILTRATION
   Outside air or air from a dirty area (baggage tunnel, parking garages, apron, etc) shall be filtered, as a minimum, by the use of 2” dry type pre-filter section having a minimum rating of MERV 7.

1220.5 AIR HANDLING UNIT CONTROLS
   See Section 1202.8.

1220.6 CENTRAL PLANT
   Chilled water connections are available for conditioning equipment, but shall not be run inside the electrical room.

1220.7 PLUMBING REQUIREMENTS
   See Section 1202.10.

1220.8 FIRE PROTECTION
   No sprinkler system shall be installed. Provide two-hour rated room to meet requirements of NPFA 13. Refer to DSM 5 for fire alarm requirements.
SECTION 1221 - DOMESTIC CONCOURSE – TELECOMMUNICATIONS AND UPS ROOMS

1221.1 DESIGN CONDITIONS:
   A. Summer: 68°F, 65% RH max
   B. Winter: 68°F
   C. Maintain positive space pressure for dust control.

1221.2 AIR HANDLING SYSTEMS
This facility will be air conditioned with single zone DX system.

Single zone units shall consist of a centrifugal, non-overloading supply air fan with fan speeds selected for sound control. Air handling units shall contain and a throwaway filter section. Supply and return air shall be ducted in a low pressure type system.

See Section 301 for air handling system requirements.

1221.3 OUTDOOR AIR REQUIREMENTS
No required

1221.4 FILTRATION
Outside air or air from a dirty area (baggage tunnel, parking garages, apron, etc) shall be filtered, as a minimum, by the use of 2” dry type pre-filter section having a minimum rating of MERV 7.

1221.5 AIR HANDLING UNIT CONTROLS
See Section 1202.8.

1221.6 CENTRAL PLANT
Due to the critical nature of these spaces and the seasonal global temperature reset, chilled water shall not be used.

1221.7 PLUMBING REQUIREMENTS
See Section 1202.10.

1221.8 FIRE PROTECTION
No sprinkler system shall be installed. Provide two-hour rated room to meet requirements of NPFA 13. Refer to DSM 5 for fire alarm requirements.

SECTION 1222 - CONTROL TOWER

1222.1 DESIGN CONDITIONS:
   A. Summer: 78ºF (No Humidity Control)
       74ºF for Control Cab
   B. Winter: 72ºF (Humidification in electronic equipment spaces only).
1222.2 AIR HANDLING SYSTEMS
This facility will be air conditioned with single zone systems. Each unit shall consist of a centrifugal, non-overloading supply air fan with fan speeds selected for sound control. Air handling units shall contain cooling and heating coils (includes cooling only units), an optional electronic air filter section, and a throwaway filter section. Provide a mixed air plenum for outside air and return air duct damper connections on units 2000 CFM and above. Heating coils shall be located upstream of the cooling coils with space in between the two coil sections to enable access for maintenance and inspection.

Supply and return air shall be ducted in a low pressure type system.

See Section 301 for air handling system requirements.

1222.3 PERIMETER SYSTEMS
In the control cab the glass wall will be covered by a forced air perimeter system. This system will be constant volume, variable temperature. It shall utilize sill diffusers to counteract down drafts and provide good air circulation.

1222.4 COMPUTER AND ELECTRONIC EQUIPMENT ROOMS
Computer rooms, which require year-round cooling, may be connected to the central plant chilled water system for cooling. In addition, they shall have their own DX cooling system for winter operation. The system shall have factory installed and wired controls for chilled water and DX cooling coils, heating coils, dehumidification and humidification. The unit shall have an electric, steam generating humidifier with controls to limit space humidity to 50 percent maximum.

1222.5 OUTDOOR AIR REQUIREMENTS
Outside air shall be brought in through the air handling unit. Fresh air ventilation shall be provided in accordance with the latest revision to ASHRAE Standard 62. Locate outside air intakes high and away from vehicle or jet exhaust, to the greatest extent possible.

1222.6 TOILET EXHAUST
The ventilation rate for all toilet room facilities shall be 2.0 CFM per square foot of floor area.

1222.7 VENTILATION RATES
Recommended average outside air ventilation rates shall be as follows:

A. Office Areas: 15 CFM per person
B. Control Cab Areas: 25 CFM per person

1222.8 FILTRATION
Outside air shall be filtered with dry-type filter media with an Atmospheric Dust Spot Efficiency (ASHRAE) of at least 80 percent. Outside air should be filtered, as a minimum, by the use of 2" dry type pre-filter section having a minimum rating of MERV 7, 12" dry type filter section having a minimum rating of MERV 13 and a 12" filter section for future removable mixed media (IE: carbon/potassium permanganate) filter section.

1222.9 AIR HANDLING UNIT CONTROLS
Provide control logic to permit the following:

A. Position outside air dampers, return air dampers, and exhaust dampers. The outside air and exhaust air dampers shall be normally closed, and the return air dampers shall be normally open.
B. Cooling coil controls with temperature reset.
C. Heating coil controls with temperature reset.
D. Monitor space and duct temperatures. (Monitor only from EMCS)
E. Equipment start/stop with equipment status.
F. Alarms for failure of the following:
   1. Fan failure.
   2. Space temperature out of specification.
   3. Smoke detection.
   4. Freeze thermostat shutdown.
   5. Filter Delta P.

1222.10 PLUMBING REQUIREMENTS

All plumbing systems shall conform to the requirements of the Uniform Plumbing code as adopted and modified by the City and County of Denver building code. See Chapter 8 of this standard for plumbing design parameters. The following is a partial list of plumbing fixtures required for this area:

A. Lavatories - wall hung or counter mounted.
B. Water closets, standard and handicapped.
C. Stop valves on all fixtures.
D. Urinals.
E. Floor drains and cleanouts.
F. Water Coolers.

1222.11 FIRE PROTECTION

The fire protection system shall be provided in accordance with the latest editions of NFPA Standards and City and County of Denver building codes. The following description of fire protection requirements is based on NFPA.

A. Provide a wet-pipe sprinkler system for all areas unless specific requirements prohibit use in electronic equipment areas. In these cases, utilize Halon systems mentioned below.
B. Intergen or FM-200 systems in the above defined mentioned below. The system shall have manual and automatic actuation, warning alarms, flashing signs indicating halon discharge, backup systems, and all other fittings and appurtenances necessary for NFPA compliance.
C. Provide a Class I standpipe system with extinguisher at each station in the area.
D. Provide manual pull type fire alarm stations at exits.
1222.12 SMOKE CONTROL
Smoke control is not required for this area

SECTION 1223 - HOTEL

1223.1 DESIGN CONDITIONS:
   A. Summer: 74°F (50% RH Max.)
   B. Winter: 72°F (No Humidity Control)

1223.2 AIR HANDLING SYSTEMS
Meeting Rooms, Restaurant, Public Areas:
These areas will be air conditioned with variable air volume (VAV) systems. Each unit shall consist of a centrifugal, non-overloading supply air fan with fan speeds selected in the lower range for sound control. In addition, systems shall contain cooling and heating coil sections (includes cooling only units), an electronic air filter section ("Cosa-Tron" or equal), a throwaway bag-type filter section, and air blender section to eliminate air stratification, and a mixed air plenum for outside air and return air duct damper connections.

The supply air ductwork system will consist of low pressure ductwork with variable volume terminal boxes. Each VAV box will have its own temperature sensor and controls tied to the EMCS. The system will be sized to supply approximately 1.25 CFM per square foot at maximum flow. Return air shall be through ceiling plenums where possible.

Guest Rooms:
Each room shall contain its own fan-coil unit (not through-the-wall units). The fan coil unit shall have manually adjusted speed controls. The heating and cooling coils will modulate flow to maintain the room thermostat setting. Provide with dry-type throw-away filters. Fan coil units shall be furnished and installed to provide an NC-35 noise level in the room.

Kitchens:
Provide constant volume air handling units with the same unit components mentioned above for the VAV air handling units.

See Section 301 for air handling system requirements.

1223.3 PERIMETER SYSTEMS
Any expanse of glass wall in the area shall be conditioned by a forced air perimeter system. This system should utilize sill diffusers to counteract down-drafts during cold weather.

1223.4 AIR CURTAINS
Air curtains shall be provided for use at main entrances. Overhead fan-coil units shall be used at each entrance.

1223.5 OUTDOOR AIR REQUIREMENTS
See Section 303 for ventilation requirements.

Outside air shall be brought in through the air handling units. Guest room floors shall have a separate make-up air unit to pressurize the corridors and guest rooms.
1223.6 TOILET EXHAUST
The ventilation rate for all toilet room facilities shall be 2.0 CFM per square foot of floor area, or 15 air changes per hour, whichever is greater.

1223.7 KITCHEN EXHAUST
All kitchens shall be air conditioned. The exhaust requirements will be determined by the cooking exhaust hoods within the facility. The kitchen exhaust system shall be designed in accordance with NFPA 96, "Standard for the Installation of Equipment for the Removal of Smoke and Grease-Laden Vapors from Commercial Cooking Equipment."

1223.8 VENTILATION RATES
Recommended average outside air ventilation rates shall be as follows:

A. Office Areas: 10 CFM per person
B. Dining Areas: 15 CFM per person
C. Cocktail Lounges: 20 CFM per person
D. Meeting Rooms & Public Areas: 15 CFM per person
E. Guest Rooms: 2.5 Air changes per hour
F. Other Areas: 15 CFM per person

1223.9 FILTRATION
Outside air shall be filtered with dry-type filter media with an Atmospheric Dust Spot Efficiency (ASHRAE) of at least 50 percent. Outside air should be filtered, as a minimum, by the use of 2" dry type pre-filter section having a minimum rating of MERV 7, 12" dry type filter section having a minimum rating of MERV 13 and a 12" filter section for future removable mixed media (IE: carbon/potassium permanganate) filter section.

1223.10 AIR HANDLING UNIT CONTROLS
Provide control logic to permit the following:

A. Position outside air dampers, return air dampers, and exhaust dampers. The outside air dampers shall be normally closed, and the return air dampers shall be normally open.
B. Off-peak setback of ventilation.
C. Cooling coil controls.
D. Heating coil controls with preheat where required.
E. Reset of cold deck temperature during low load.
F. Monitor space and duct temperatures.
G. Equipment start/stop with equipment status.
H. Optimum start.
I. Alarms for failure of the following:
   1. Fan failure.
2. Space temperature out of specification.
3. Smoke detection.
4. Freeze thermostat shutdown.
5. Filter pressure drop.
J. Provide air flow measuring stations to measure outside air flow and supply air flow. Program automation controls to maintain outside air flow during all load conditions to meet ventilation requirements.
K. Controls may be integrated with the EMCS.

1223.11 CENTRAL PLANT
Chilled water and hot water will be supplied from the central plant. Secondary pumping may be required for this facility.

1223.12 PLUMBING REQUIREMENTS
All plumbing systems shall conform to the requirements of the Uniform Plumbing Code as adopted and modified by the City and County of Denver building code.

See Chapter 8 of this standard for plumbing design parameters.

1223.13 FIRE PROTECTION
The fire protection system shall be provided in accordance with the latest editions of NFPA Standards and City and County of Denver building codes. The following description of fire protection requirements is based on NFPA.

A. Provide a wet-pipe sprinkler system for this area.
B. Provide a Class III standpipe system with fire department valve and extinguishers.
C. Provide an automatic detection system, with audible alarms in each room.
D. Provide local and remote annunciation.
E. Provide an extinguisher at each station in the enclosed areas.
F. Single facilities larger than 1500 Square feet requires fire sprinkler and fire alarm systems per the requirements of Denver Fire Prevention Bureau, F.M. Global and NFPA.
G. Provide manual pull type fire alarm stations at exits and stairwells.
H. All escalator and stair opening perimeters shall be protected.
I. Provide ventilation pressurization and smoke control system for high rise buildings.

SECTION 1224 - STRUCTURED PARKING

1224.1 VENTILATION SYSTEMS
Areas enclosed with little exposure to outside, shall be ventilated with constant volume fans. Each unit shall consist of a centrifugal, non-overloading supply air fan with fan speeds selected minimize noise. Supply fans will require a throwaway filter section.
The ductwork system will consist of a main trunk duct with exhaust registers. The system will be sized to exhaust a minimum of 500 CFM per parking space in accordance with "Industrial Ventilation, A Manual of Recommended Practice," latest Edition.

1224.2 FILTRATION
The exhaust air shall be filtered before entering the exhaust fan. The dry-type filter media shall have an Atmospheric Dust Spot Efficiency (ASHRAE) of at least 15 percent.

1224.3 EXHAUST FAN CONTROLS
The exhaust fans shall be controlled by a remote automation system.

Control Functions:
- A. Equipment start/stop with equipment status.
- B. Fan failure alarm.
- C. Provide CO monitors to control fan operation.

1224.4 PLUMBING REQUIREMENTS
All plumbing systems shall conform to the requirements of the building code for the City and County of Denver.

The floor drainage system shall be designed for the discharge rate of the fire protection system.

The following is a partial list of plumbing fixtures required for this area:
- A. Floor drains and cleanouts.
- B. Sand traps and oil separators.

1224.5 FIRE PROTECTION
The fire protection system shall be provided in accordance with the latest editions of NFPA Standards and City and County of Denver building codes. The following description of fire protection requirements is based on NFPA.

- A. Provide a dry-pipe sprinkler system for this area.
- B. Provide a Class I dry-pipe, standpipe system.
- C. Single facilities larger than 1,500 square feet require fire sprinkler and fire alarm systems per the requirements of Denver Fire Prevention Bureau, F.M. Global and NFPA.
- D. On level 1, 2, and the part of level 3 where there is no alternate bagage conveyors the dry pipe systems extends 75' from entrance doors. On level 4 the dry pipe systems extends though out the driving lanes in front of the doors. On level 5 the dry systems cover the entire covered area. All covered drive lanes on all structures have either dry systems or heated blind spaces with dry pendent heads. (Exception is the passage

SECTION 1225 - PARKING TOLL PLAZA

1225.1 DESIGN CONDITIONS:
A. Summer: 74°F (No Humidity Control)
B. Winter: 72°F (No Humidity Control)

1225.2 AIR HANDLING SYSTEMS
This facility will be air conditioned with a single zone system.

Each unit shall consist of a centrifugal, non-overloading supply air fan with fan speeds selected for sound control. In addition, systems shall contain DX cooling system, a throwaway filter section, and a mixed air plenum for outside air and return air duct damper connections. Heat pump units should be considered if gas is not available.

1225.3 OUTDOOR AIR REQUIREMENTS
Outside air shall be brought in through the air handling unit.

1225.4 TOILET EXHAUST
The ventilation rate for all toilet room facilities shall be 2.0 CFM per square foot of floor area.

1225.5 VENTILATION RATES
Recommended average outside air ventilation rates shall be as follows:
   A. All areas: 15 CFM per person

1225.6 FILTRATION
Outside air shall be filtered with dry-type filter media with an Atmospheric Dust Spot Efficiency (ASHRAE) of at least 50 percent. Filters with 4” dry type pre-filter section having a minimum rating of MERV 10 shall be provided.

1225.7 AIR HANDLING UNIT CONTROLS
The air handling units shall be controlled by a space thermostat. The outside air damper shall be opened when the supply fan is running, and closed when it is off.

Provide control logic to permit the following:
   A. Position outside air dampers and return air dampers. The outside air and exhaust air dampers shall be normally closed, and the return air dampers shall be normally open.
   B. Monitor space temperatures.
   C. Equipment start/stop.

1225.8 PLUMBING REQUIREMENTS
All plumbing systems shall conform to the requirements of the Uniform Plumbing Code as adopted and modified by the City and County of Denver building code. See Chapter 8 of this standard for plumbing design parameters. The following is a partial list of plumbing fixtures required for this area:
   A. Lavatories - wall hung or counter mounted.
   B. Water closets.
C. Stop valves - provided on all fixtures including water coolers.
D. Floor drains and cleanouts.
E. Water coolers.

1225.9 FIRE PROTECTION
The fire protection system shall be provided in accordance with the latest editions of NFPA Standards.
A. Provide an extinguisher in the area.

SECTION 1226 - OFFICE BUILDING

1226.1 DESIGN CONDITIONS:
A. Summer: 74ºF (No Humidity Control)
B. Winter: 72ºF

1226.2 AIR HANDLING SYSTEMS
These areas will be air conditioned with variable air volume (VAV) systems. Each unit shall consist of a centrifugal, non-overloading supply air fan selected for sound control. In addition, systems shall contain cooling and heating coil sections (includes cooling only units), an electronic air filter section ("Cosa-Tron" or equal), if required, a throwaway dry-type filter section, and a mixed air plenum for outside air and return air duct damper connections.

See Section 301 for air handling system requirements.

The supply air ductwork system will consist of low pressure ductwork with variable volume terminal boxes. The system will be sized to supply a maximum of 1.25 CFM per square foot. Return air shall be through ceiling plenums where practical.

Dual duct perimeter systems utilizing separate VAV air handling units for heating and cooling may be considered.

1226.3 PERIMETER SYSTEMS
All perimeter glass walls shall be conditioned by a forced air perimeter system. This system will be constant volume heating and cooling. Utilize sill diffusers to counteract down-drafts during cold weather. Perimeter finned tubed heating systems are an acceptable alternative, as is the dual-duct system mentioned above.

1226.4 COMPUTER ROOMS
Computer rooms, which require year-round cooling, will be connected to the central plant chilled water system for summer cooling and/or provide a DX cooling system for winter operation, if required by the DIA Mechanical Engineer. The system shall have factory installed and wired controls for chilled water cooling coils, heating coils, dehumidification and humidification. The unit shall have an electric, steam generating humidifier with controls to limit space humidity. Design conditions shall be:
A. Summer: 68ºF, 65% RH max
B. Winter: 68ºF
C. Maintain positive space pressure for dust control.

In remote areas where chilled water is not available, the computer room unit shall have a dedicated, dual circuit refrigeration system with remote condensing units located on the roof and electric reheat coils.

1226.5 AIR CURTAINS
Air curtains shall be provided for use on all main entrances. Overhead fan-coil units shall be used at each entrance.

1226.6 OUTDOOR AIR REQUIREMENTS
Outside air shall be brought in through the air handling units. See Section 303 for ventilation requirements.

1226.7 TOILET EXHAUST
The ventilation rate for all toilet room facilities shall be 2.0 CFM per square foot of floor area.

1226.8 VENTILATION RATES
Recommended average outside air ventilation rates shall be as follows:

A. Office Areas: 15 CFM per person (Non-Smoking Areas)
B. Dining Areas: 20 CFM per person (Non-Smoking Areas)
C. Conference Rooms: 25 CFM per person (Non-Smoking Areas)

1226.9 FILTRATION
Outside air shall be filtered with dry-type filter media with an Atmospheric Dust Spot Efficiency (ASHRAE) of at least 60 percent. Air should be brought in at the roof or penthouse level wherever possible in an attempt to use the highest quality air available. As a minimum, outside air is to be filtered by the use of 2” dry type pre-filter section having a minimum rating of MERV 7, 12” dry type filter section having a minimum rating of MERV 13 and a 12” filter section for future removable mixed media.

1226.10 AIR HANDLING UNIT CONTROLS
Provide control logic to permit the following:

A. Position outside air dampers, return air dampers, and exhaust dampers. The outside air dampers shall be normally closed, and the return air dampers shall be normally open.
B. Off-peak setback of ventilation.
C. Cooling coil controls.
D. Heating coil controls with preheat where required.
E. Reset of cold deck temperature during low load. (For constant volume units.)
F. Monitor space and duct temperatures.
G. Equipment start/stop with equipment status.
H. Optimum start.
I. Alarms for failure of the following:
   1. Fan failure.
   2. Space temperature out of specification.
   3. Smoke detection.
   4. Freeze thermostat shutdown.
   5. Filter pressure drop.

J. Provide air flow measuring stations to measure outside air flow and supply air flow. Program automation controls to maintain outside air flow during all load conditions to meet ventilation requirements.

K. Controls shall be integrated with the EMCS.

1226.11 PLUMBING REQUIREMENTS
See Chapter 8 of this standard for plumbing design parameters.

The following is a partial list of plumbing fixtures required for this area:
   A. Lavatories - wall hung or counter mounted.
   B. Lavatories for the physically handicapped - wall hung or counter mounted with offset grid drain for wheelchairs.
   C. Water closets, standard and handicapped, shall be a "blow out" type.
   D. Stop valves - provided on all fixtures including water coolers.
   E. Urinals.
   F. Floor drains and cleanouts.
   G. All water coolers in public areas shall be barrier free bi-level type.

All domestic water connections, to mechanical systems, including lawn sprinkling systems, shall be protected from backflow.

1226.12 CENTRAL PLANT
Chilled water and hot water will be provided from the central plant. A secondary chilled water and hot water pipe loop shall be provided. Offices remote from the central plant will have their own central chilled water system and hot water boiler.

1226.13 FIRE PROTECTION
The fire protection system shall be provided in accordance with the latest editions of NFPA Standards and the building code of the City and County of Denver. The following description of fire protection requirements is based on NFPA.
   A. Provide a wet-pipe sprinkler system for this area.
   B. Provide Class I standpipe system.
   C. Provide an extinguisher at each station in the enclosed areas.
   D. Provide manual pull type fire alarm stations at exits.
   E. Single facilities larger than 1,500 square feet require fire sprinkler and fire alarm
systems per the requirements of Denver Fire Prevention Bureau, F.M. Global and NFPA.

F. All escalator and stair opening perimeters shall be provided with closely spaced sprinkler heads providing a water curtain.

1226.14 SMOKE CONTROL

All elevator and refuge areas shall be served by a separate smoke control system. Refer to Chapter 10 for requirements.

SECTION 1227 - CENTRAL POWER PLANT FACILITIES

1227.1 DESIGN CONDITIONS:

A. Summer: Ventilation only in plant area.
   74°F in control room, lunch and locker rooms, offices, etc.

B. Winter: 65°F in plant, 72°F in control room, lunch and locker rooms, offices, etc.

1227.2 OFFICE/CONTROL ROOM SYSTEMS

The office, control room, lunch room and locker room areas shall be air conditioned with single zone systems.

Each unit shall consist of a centrifugal, non-overloading supply air fan with fan speeds selected for sound control. In addition, systems shall contain cooling and heating coils, a throwaway filter section, and a mixed air plenum for outside air and return air duct damper connections. See Section 301 for air handling system requirements. Ductwork shall be for low pressure system.

1227.3 PLANT/SHOP SYSTEM

The main plant areas shall be heated and ventilated only. Provide exhaust fans in the main mechanical equipment areas during the cooling season. Exhaust fans shall be centrifugal, or prop type, non-overloading with fan speeds selected for increased life and sound control. Makeup air for exhaust system shall be introduced through an air handling unit with a filter, control damper, heating section and louver plenum. The outside air shall be filtered with dry-type filter media with an Atmospheric Dust Spot Efficiency (ASHRAE) of at least 30 percent. The exhaust system shall be designed to provide the minimum ventilation rate during the periods cooling is not required.

1227.4 HEATING SYSTEM

The main mechanical equipment areas shall be heated with hot water unit heaters.

1227.5 OUTDOOR AIR REQUIREMENTS

Outside air for the conditioned spaces shall be brought in through the air handling units and make-up air units.

1227.6 TOILET EXHAUST

The minimum ventilation rate for all toilet room facilities shall be 2.0 CFM per square foot of floor area and 1.0 CFM per square foot of locker area.

1227.7 VENTILATION RATES
Recommended average outside air ventilation rates shall be as follows:

A. Office and Other Conditioned Areas: 15 CFM per person
B. Plant areas: 3 Air changes per hour (winter) minimum
   12 Air changes per hour (summer) minimum
C. Utility Tunnel: 2 ACH continuous operation

1227.8 AIR HANDLING UNIT CONTROLS

Provide control logic to permit the following:

A. Position outside air dampers and return air dampers. The outside air and exhaust air dampers shall be normally closed, and the return air dampers shall be normally open.
B. Cooling coil controls.
C. Heating coil controls with preheat where required.
D. Monitor space and duct temperatures.
E. Equipment start/stop with equipment status.
F. Optimal start.
G. Alarms for failure of the following:
   1. Fan failure.
   2. Space temperature out of specification.
   3. Smoke detection.
   4. Freeze thermostat shutdown.
   5. Filter differential pressure.
H. The following control functions shall be programmed into the exhaust fan system:
   1. Position the outside air dampers. The outside air dampers shall be normally closed. When the exhaust fan is running, the outside air damper shall be open. When the exhaust fan is off, the outside air damper shall be closed.
   2. Exhaust fan start/stop with equipment status. Exhaust fan start/stop shall be a function of the mechanical equipment room space temperature. Energize the exhaust fans when space temperature is greater than 85 degrees F.
I. The unit heaters shall be started and stopped based on space temperature. When the space temperature is lower than 65 degrees F, the unit heaters shall be energized. The control valve on the unit heater shall be modulated based on space temperature.
J. The automation control system shall be provided with additional slave panels to control the single zone air handling unit, the exhaust fans and the unit heaters, as necessary. Tie into the EMCS.

1227.9 PLUMBING REQUIREMENTS

See Chapter 8 of this manual for plumbing design parameters. The following is a partial list of plumbing fixtures required:
A. Lavatory faucets.
B. Lavatories.
C. Lavatories for the physically handicapped.
D. Water closets.
E. Stop valves provided on all fixtures.
F. Urinals.
G. Floor drains and cleanouts.
H. Showers.
I. Sand traps and oil separators.
J. Water Coolers.
K. Sinks.

All domestic water connections, to mechanical systems, shall be protected from backflow.

1227.10 FIRE PROTECTION
The fire protection system shall include the following:
A. Provide wet pipe sprinkler system.
B. Provide a Class I standpipe system with extinguisher at each station in the enclosed areas.
C. Provide manual pull type fire alarm station at exits.
D. Single facilities larger than 1,500 square feet require fire sprinkler and fire alarm systems per the requirements of Denver Fire Prevention Bureau, F.M. Global and NFPA.

1227.11 SMOKE CONTROL
No smoke control is required for this area

SECTION 1228 - MAINTENANCE FACILITY

1228.1 DESIGN CONDITIONS:
A. Summer: Conditioned Spaces 74°F
   Shop Areas - Vent only
B. Winter: Conditioned Spaces 72°F
   Shop Areas - 70°F

1228.2 CONDITIONED SYSTEMS
The office and break room area shall be air conditioned with a single zone system.

Each unit shall consist of a centrifugal, non-overloading supply air fan with fan speeds selected for sound control. In addition, systems shall contain cooling and heating coils, a throwaway filter section, and a mixed air plenum for outside air and return air duct damper connections. See Section 301 for air handling system requirements.
For small, single office areas that might be air-conditioned: Thru-the-wall packaged units may be used in lieu of air handling unit systems.

Provide a low pressure ductwork system.

**1228.3 PLANT/SHOP SYSTEM**

The main plant areas shall be heated and ventilated only. Provide exhaust fans in the main mechanical equipment areas during the cooling season. Exhaust fans shall be centrifugal, or prop type, non-overloading with fan speeds selected for extended life and sound control. Makeup air for exhaust system shall be introduced through an air handling unit with a filter, control damper and louver plenum. The outside air shall be filtered with dry-type filter media with an Atmospheric Dust Spot Efficiency (ASHRAE) of at least 30 percent. The exhaust system shall be designed to provide the minimum ventilation rate during the periods cooling is not required.

**1228.4 OUTDOOR AIR REQUIREMENTS**

Outside air for the conditioned spaces shall be brought in through the air handling unit or make-up air unit.

**1228.5 TOILET EXHAUST**

The ventilation rate for all toilet room facilities shall be 2.0 CFM per square foot of floor area.

**1228.6 VENTILATION RATES**

Recommended average outside air ventilation rates shall be as follows:

- **A. Office Areas:** 15 CFM per person
- **B. Maintenance Areas:**
  - 3 Air Changes/Hour (Winter)
  - 12 Air Changes/Hour (Summer)

**1228.7 FILTRATION**

Outside air shall be filtered with dry-type filter media with an Atmospheric Dust Spot Efficiency (ASHRAE) of at least 30 percent. Filters with 4” dry type pre-filter section having a minimum rating of MERV 10 shall be provided.

**1228.8 AIR HANDLING UNIT CONTROLS**

Provide control logic to permit the following:

- **A.** Position outside air dampers and return air dampers. The outside air and exhaust air dampers shall be normally closed, and the return air dampers shall be normally open.
- **B.** Cooling coil controls.
- **C.** Heating coil controls with preheat where required.
- **D.** Monitor space and duct temperatures.
- **E.** Equipment start/stop with equipment status.
- **F.** Optimal start.
G. Alarms for failure of the following:
   1. Fan failure.
   2. Space temperature out of specification.
   3. Smoke detection.
   4. Freeze thermostat shutdown.
   5. Filter Differential pressure.

H. The following control functions shall be programmed into the exhaust fan system:
   1. Position the outside air dampers. The outside air dampers shall be normally closed. When the exhaust fan is running, the outside air damper shall be open. When the exhaust fan is off, the outside air damper shall be closed.
   2. Exhaust fan start/stop with equipment status. Exhaust fan start/stop shall be a function of the mechanical equipment room space temperature. Energize the exhaust fans when space temperature is greater than 85 degrees F.

I. The unit heaters shall be started and stopped based on space temperature. When the space temperature is lower than 65 degrees F, the unit heaters shall be energized. The control valve on the unit heater shall be modulated based on space temperature.

The automation control system shall be provided with additional slave panels to control the single zone air handling unit, the exhaust fans and the unit heaters, as necessary. Tie into the EMCS.

1228.9 PLUMBING REQUIREMENTS

See Chapter 8 of this manual for plumbing design parameters. The following is a partial list of plumbing fixtures required:

   A. Lavatory faucets.
   B. Lavatories.
   C. Lavatories for the physically handicapped.
   D. Water closets.
   E. Stop valves provided on all fixtures.
   F. Urinals.
   G. Floor drains and cleanouts.
   H. Showers.
   I. Sand traps and oil separators.
   J. Water Coolers.
   K. Sinks.

All domestic water connections, to mechanical systems, shall be protected from backflow.

1228.10 FIRE PROTECTION

The fire protection system shall be as follows:
A. Provide a wet-pipe sprinkler system for larger maintenance facilities (over 20,000 sq. ft.).
B. Provide a dry-pipe system in areas subject to freezing conditions. See Section 9 of this manual for fire protection requirements.
C. Single facilities larger than 1,500 square feet require fire sprinkler and fire alarm systems per the requirements of Denver Fire Prevention Bureau, F.M. Global and NFPA.

1228.11 SMOKE CONTROL
No smoke control is required for this area

1228.12 EVAPORATIVE COOLING
Where the four-pipe distribution system is unavailable and acceptable air quality is available, total evaporative cooling may be utilized (no back-up refrigeration unit) in lieu of refrigeration for offices and for added comfort in frequently used and populated shop areas. Evaporative cooling should be the indirect/direct method of operation. By "acceptable" air quality, the air must be free of jet fuel exhaust fumes. The indirect/direct method of evaporative cooling uses both indirect and direct evaporative cooling methods to produce cool, conditioned supply air.

SECTION 1229 - AIR CARGO FACILITY

1229.1 DESIGN CONDITIONS
   A. Summer: Conditioned Spaces 74°F
      Shop Areas - Vent only
   B. Winter: Conditioned Spaces 72°F
      Shop Areas - 70°F

1229.2 CONDITIONED SYSTEMS
The office and break room area shall be air conditioned with a single zone system.

Each unit shall consist of a centrifugal, non-overloading supply air fan with fan speeds selected for sound control. In addition, systems shall contain cooling and heating coils, a throwaway filter section, and a mixed air plenum for outside air and return air duct damper connections. See Section 301 for air handling system requirements.

Provide a low pressure ductwork system.

1229.3 WAREHOUSE SYSTEM
The main storage areas shall be heated and ventilated only. Provide exhaust fans for ventilation during the cooling season. Exhaust fans shall be centrifugal, or prop type, non-overloading with fan speeds selected for increased life and sound control. Makeup air for exhaust system shall be introduced through an air handling unit with a filter, control damper and louver plenum. The outside air shall be filtered with dry-type filter media with an Atmospheric Dust Spot Efficiency (ASHRAE) of at least 30 percent. The exhaust system shall be designed to provide the minimum ventilation rate during the periods cooling is not required.

1229.4 AIR CURTAINS
Air curtains shall be provided for use on all main service entrances. Overhead fan-coil units shall be used at each entrance. These units should be indirect gas fired.

1229.5 OUTDOOR AIR REQUIREMENTS
Outside air for the conditioned spaces shall be brought in through the air handling unit and make-up air unit.

1229.6 TOILET EXHAUST
The ventilation rate for all toilet room facilities shall be 2.0 CFM per square foot of floor area.

1229.7 VENTILATION RATES
Recommended average outside air ventilation rates shall be as follows:

A. Office Areas: 15 CFM per person
B. Warehouse Areas: 2 Air Changes/Hour (Minimum)

1229.8 FILTRATION
Outside air shall be filtered with dry-type filter media with an Atmospheric Dust Spot Efficiency (ASHRAE) of at least 30 percent. Filters with 4” dry type pre-filter section having a minimum rating of MERV 10 shall be provided.

1229.9 AIR HANDLING UNIT CONTROLS
Provide control logic to permit the following:

A. Position outside air dampers and return air dampers. The outside air and exhaust air dampers shall be normally closed, and the return air dampers shall be normally open.
B. Cooling coil controls.
C. Heating coil controls with preheat where required.
D. Monitor space and duct temperatures.
E. Equipment start/stop with equipment status.
F. Optimal start.
G. Alarms for failure of the following:
   1. Fan failure.
   2. Space temperature out of specification.
   3. Smoke detection.
   4. Freeze thermostat shutdown.
H. The following control functions shall programmed into the exhaust fan system:
   1. Position the outside air dampers. The outside air dampers shall be normally closed. When the exhaust fan is running, the outside air damper shall be open. When the exhaust fan is off, the outside air damper shall be closed.
   2. Exhaust fan start/stop with equipment status. Exhaust fan start/stop shall be a function of the mechanical equipment room space temperature. Energize the
exhaust fans when space temperature is greater than 85 degrees F.

I. The unit heaters shall be started and stopped based on space temperature. When the space temperature is lower than 65 degrees F, the unit heaters shall be energized. The control valve on the unit heater shall be modulated based on space temperature.

The automation controls system shall be provided with additional slave panels to control the single zone air handling unit, the exhaust fans and the unit heaters, as necessary. Tie to the EMCS.

1229.10 PLUMBING REQUIREMENTS

See Chapter 8 of this manual for plumbing design parameters. The following is a partial list of plumbing fixtures required:

A. Lavatory faucets.
B. Lavatories.
C. Lavatories for the physically handicapped.
D. Water closets.
E. Stop valves provided on all fixtures.
F. Urinals.
G. Floor drains and cleanouts.
H. Showers.
I. Sand traps and oil separators.
J. Water Coolers.
K. Sinks.

All domestic water connections, to mechanical systems, shall be protected from backflow.

1229.11 FIRE PROTECTION

The fire protection system shall be as follows:

A. Provide a wet-pipe sprinkler system will be designed to protect the particular type of usage.
B. Provide a hose station with extinguisher at each station in the enclosed areas, as required.
C. Provide manual pull type fire alarm station as required.
D. Single facilities larger than 1,500 square feet require fire sprinkler and fire alarm systems per the requirements of Denver Fire Prevention Bureau, F.M. Global and NFPA.

See Section 9 of this manual for fire protection requirements.

1229.12 SMOKE CONTROL

No smoke control is required for this area
SECTION 1230 - AIRCRAFT HANGERS

1230.1 DESIGN CONDITIONS:

A. Summer: Conditioned spaces: 74°F
   Shop Areas: Ventilation only or 74°F
   Hangars: No conditioning required

B. Winter: Conditioned spaces: 72°F
   Shop Areas: 70°F
   Hangars: 68°F

1230.2 VENTILATION SYSTEMS

The office and some shop areas may be air conditioned with a single zone system.

Each unit shall consist of a centrifugal, non-overloading supply air fan with fan speeds selected for sound control. In addition, systems shall contain cooling and heating coils, a throwaway filter section, and a mixed air plenum for outside air and return air duct damper connections. See Section 301 for air handling system requirements.

Provide a low pressure ductwork system.

1230.3 SHOP AND HANGAR SYSTEM

The main shop areas shall be heated and ventilated only with unit heaters. Provide exhaust fans for ventilation during the cooling season. Exhaust fans shall be centrifugal, or prop type, non-overloading with fan speeds selected for increased life and sound control. Makeup air for exhaust system shall be introduced through a make-up air unit with a filter, control damper and louver plenum. The outside air shall be filtered with dry-type filter media with an Atmospheric Dust Spot Efficiency (ASHRAE) of at least 30 percent. The exhaust system shall be designed to provide the minimum ventilation rate during the periods cooling is not required.

The hangar area will be heated and ventilated by one of the following systems:

A. Low intensity vented, gas-fired, infrared system for small hangars, not over 30' high.
B. High-bay unit heaters for large hangars.
C. Air rotation system, utilizing air-handling units that circulate air through the high-bay and back to the low-level air handlers.

Provide ventilation at all hangar low points (e.g. wheel pits, etc.).

1230.4 OUTDOOR AIR REQUIREMENTS

Outside air shall be brought in through the air handling or make-up air units. See Section 303 for ventilation system requirements.

1230.5 TOILET EXHAUST

The ventilation rate for all toilet room facilities shall be 2.0 CFM per square foot of floor area.
1230.6 VENTILATION RATES
Recommended average outside air ventilation rates shall be as follows:

A. Office Areas: 15 CFM per person
B. Shop Areas:* 4 Air changes/hour (minimum)
C. Hangar Areas:* Depends on function

*These values shall be based on ventilation or exhaust requirements depending on usage or operations in the space.

Special ventilation and filtration will be required if painting will be done in the shops or hangar.

1230.7 FILTRATION
Outside air shall be filtered with dry-type filter media with an Atmospheric Dust Spot Efficiency (ASHRAE) of at least 60 percent for office areas. Filters with 4” dry type pre-filter section having a minimum rating of MERV 10 shall be provided.

1230.8 CONTROLS

A. Air Handling Units:
   1. Off-peak setback of ventilation.
   2. Cooling coil controls.
   3. Heating coil controls with preheat where required.
   4. Monitor space and duct temperatures.
   5. Equipment start/stop with equipment status.
   6. Optimal start.
   7. Economizer controls.
   8. Alarms for failure of the following:
      a. Fan failure.
      b. Space temperature out of specification.
      c. Smoke detection.
      d. Freeze thermostat shutdown.

B. Exhaust Fans:
   1. Position the outside air dampers. The outside air dampers shall be normally closed. When the exhaust fan is running, the outside air damper shall be open. When the exhaust fan is off, the outside air damper shall be closed.
   2. Exhaust fan start/stop with equipment status. Exhaust fan start/stop shall be a function of the mechanical equipment room space temperature. Energize the exhaust fans when space temperature is greater than 85 degrees F.

C. Unit Heaters:
   1. The unit heaters shall be started and stopped based on space temperature. When the space temperature is lower than 65 degrees F, the unit heaters shall be energized. The control valve on the unit heater shall be modulated.
based on space temperature.

D. Infra-Red Heaters:
   1. Units shall cycle to maintain space temperature set point.

The automation controls system shall be provided with additional slave panels to control the single zone air handling unit, the exhaust fans and the unit heaters, as necessary. Tie to the EMCS.

1230.9 PLUMBING REQUIREMENTS

See Chapter 8 of this manual for plumbing design parameters. The following is a partial list of plumbing fixtures required:

A. Lavatory faucets.
B. Lavatories.
C. Lavatories for the physically handicapped.
D. Water closets.
E. Stop valves provided on all fixtures.
F. Urinals.
G. Floor drains and cleanouts.
H. Showers.
I. Sand traps and oil separators.
J. Water Coolers.
K. Sinks.

All domestic water connections, to mechanical systems, shall be protected from backflow.

1230.10 FIRE PROTECTION

The fire protection system shall be as follows:

A. Provide a foam water deluge system in the hangar, as required by size.
B. Provide a wet-pipe sprinkler system in the shops and offices and smaller hangars.
C. Provide a Class I standpipe system with extinguisher at each station in the enclosed areas.
D. Provide manual pull type fire alarm stations at exits.
E. Evaluate need of fire pumps and water storage tanks. Provide as required.
F. Provide monitor nozzles as required.
G. Single facilities larger than 1,500 square feet require fire sprinkler and fire alarm systems per the requirements of Denver Fire Prevention Bureau, F.M. Global and NFPA.
H. Provide all necessary detection and actuation for the above noted systems with appropriate monitoring by the fire alarm system
See Section 9 for fire protection design requirements.

1230.11 EVAPORATIVE COOLING:

Where the four-pipe distribution system is unavailable and acceptable air quality is available, total evaporative cooling may be utilized (no back-up refrigeration unit) in lieu of refrigeration for offices and for added comfort in frequently used and populated shop areas. Evaporative cooling should be the indirect/direct method of operation. By "acceptable" air quality, the air must be free of jet fuel exhaust fumes. The indirect/direct method of evaporative cooling uses both indirect and direct evaporative cooling methods to produce cool, conditioned supply air.

SECTION 1231 - FLIGHT KITCHEN

1231.1 DESIGN CONDITIONS

A. Summer: 74°F
B. Winter: 72°F

1231.2 AIR HANDLING SYSTEMS

This area will be air conditioned with a single zone system, constant volume systems. (VAV is an acceptable alternative if it is determined several zones are required.)

Each unit shall consist of a centrifugal, non-overloading supply air fan with fan speeds selected for sound control. In addition, systems shall contain cooling and heating coils (includes cooling only units), a throwaway filter section, and a mixed air plenum for outside air and return air duct damper connections.

See Section 301 for air handling system design requirements.

1231.3 OUTDOOR AIR REQUIREMENTS

Outside air shall be brought in through the air handling unit. See Section 303 for ventilation requirements.

1231.4 TOILET EXHAUST

The ventilation rate for all toilet room facilities shall be 2.0 CFM per square foot of floor area.

1231.5 KITCHEN EXHAUST

All kitchens shall be air conditioned. The exhaust requirements will be determined by the cooking and exhaust hoods installed within the facility. The kitchen exhaust system shall be designed in accordance with NFPA 96, "Standard for the Installation of Equipment for the Removal of Smoke and Grease-Laden Vapors from Commercial Cooking Equipment."

1231.6 VENTILATION RATES

Recommended average outside air ventilation rates shall be as follows:

A. Office and Other Areas: 15 CFM per person
B. Kitchen: Based on Exhaust Requirement

1231.7 FILTRATION
Outside air shall be filtered with dry-type filter media with an Atmospheric Dust Spot Efficiency (ASHRAE) of at least 60 percent. Filters with 4” dry type pre-filter section having a minimum rating of MERV 10 shall be provided.

1231.8 AIR HANDLING UNIT CONTROLS

Provide control logic to permit the following:

A. Position outside air dampers, return air dampers, and exhaust dampers. The outside air and exhaust air dampers shall be normally closed, and the return air dampers shall be normally open. Provide economizer cycle.

B. Off-peak setback of ventilation. Interlock the exhaust system with the air handling unit's damper controls. When the exhaust fan is off, reduce the amount of outside air and increase the amount of return air.

C. Cooling coil controls.

D. Heating coil controls with preheat where required.

E. Monitor space and duct temperatures.

F. Equipment start/stop with equipment status.

G. Optimal start.

H. Maintain positive pressure in food preparation area.

I. Alarms for failure of the following:
   1. Fan failure.
   2. Space temperature out of specification.
   3. Smoke detection.
   4. Freeze thermostat shutdown.
   5. Filter differential pressure.

J. Controls shall be integrated with EMCS.

1231.9 PLUMBING REQUIREMENTS

See Chapter 8 of this manual for plumbing design parameters. The following is a partial list of plumbing fixtures required for this facility.

A. Lavatory faucets - provided with flow restriction.

B. Lavatories - wall hung or counter mounted.

C. Lavatories for the physically handicapped - wall hung or counter mounted with offset grid drain for wheelchairs.

D. Water closets, standard and handicapped - "blow out" type.

E. Stop valves - provided on all fixtures.

F. Urinals.

G. Floor drains and cleanouts.

H. Water coolers - barrier free blevel type.
I. Sand traps and oil separators.
J. Water Coolers
K. Sinks.
L. Hot water heaters.

All domestic water connections, to mechanical systems, including lawn sprinkling systems, shall be protected from backflow.

**1231.10 FIRE PROTECTION**

The fire protection system shall be as follows:

A. Provide a wet-pipe sprinkler system for this area.
B. Provide a pre-engineered carbon dioxide extinguishing system for the kitchen exhaust hoods in accordance with NFPA 12, "Standard on Carbon Dioxide Extinguishing Systems." The system shall be capable of automatic detection with local or remote manual actuation. Accessories shall be installed for mechanical or electrical gas line shut-off applications. System shall be listed with Underwriters Laboratories, Inc.
C. Single facilities larger than 1,500 square feet require fire sprinkler and fire alarm systems per the requirements of Denver Fire Prevention Bureau, F.M. Global and NFPA.

See Section 9 for fire protection requirements.

**SECTION 1232 - SNOW REMOVAL EQUIPMENT FACILITY**

**1232.1 DESIGN CONDITIONS:**

A. Summer: Conditioned Spaces 74°F Shop Areas - Vent only
B. Winter: Conditioned Spaces 72°F Shop Areas - 70°F

**1232.2 CONDITIONED SYSTEMS**

The office and break room area shall be air conditioned with a single zone system.

Each unit shall consist of a centrifugal, non-overloading supply air fan with fan speeds selected for sound control. In addition, systems shall contain cooling and heating coils, a throwaway filter section, and a mixed air plenum for outside air and return air duct damper connections. See Section 301 for air handling system requirements.

For small, single office areas that might be air-conditioned: Thru-the-wall packaged units may be used in lieu of air handling unit systems.

Provide a low pressure ductwork system.

**1232.3 PLANT/SHOP SYSTEM**
The main plant areas shall be heated and ventilated only. Provide exhaust fans in the main mechanical equipment areas during the cooling season. Exhaust fans shall be centrifugal, or prop type, non-overloading with fan speeds selected for extended life and sound control. Makeup air for exhaust system shall be introduced through an air handling unit with a filter, control damper and louver plenum. The outside air shall be filtered with dry-type filter media with an Atmospheric Dust Spot Efficiency (ASHRAE) of at least 30 percent. The exhaust system shall be designed to provide the minimum ventilation rate during the periods cooling is not required.

Low intensity infra-red heating may be used in the equipment bays as an alternative heating method.

**1232.4 OUTDOOR AIR REQUIREMENTS**

Outside air for the conditioned spaces shall be brought in through the air handling unit or make-up air unit.

**1232.5 TOILET EXHAUST**

The ventilation rate for all toilet room facilities shall be 2.0 CFM per square foot of floor area.

**1232.6 VENTILATION RATES**

Recommended average outside air ventilation rates shall be as follows:

A. Office Areas: 15 CFM per person

B. Ventilated Areas: 3 air changes/hour (minimum)

**1232.7 FILTRATION**

Outside air shall be filtered with dry-type filter media with an Atmospheric Dust Spot Efficiency (ASHRAE) of at least 30 percent for office areas. Filters with 4” dry type pre-filter section having a minimum rating of MERV 10 shall be provided.

**1232.8 AIR HANDLING UNIT CONTROLS**

Provide control logic to permit the following:

A. Position outside air dampers and return air dampers. The outside air and exhaust air dampers shall be normally closed, and the return air dampers shall be normally open.

B. Cooling coil controls.

C. Heating coil controls with preheat where required.

D. Monitor space and duct temperatures.

E. Equipment start/stop with equipment status.

F. Optimal start.

G. Alarms for failure of the following:

1. Fan failure.

2. Space temperature out of specification.

3. Smoke detection.
The following control functions shall be programmed into the exhaust fan system:

1. Position the outside air dampers. The outside air dampers shall be normally closed. When the exhaust fan is running, the outside air damper shall be open. When the exhaust fan is off, the outside air damper shall be closed.

2. Exhaust fan start/stop with equipment status. Exhaust fan start/stop shall be a function of the mechanical equipment room space temperature. Energize the exhaust fans when space temperature is greater than 85 degrees F.

The unit heaters shall be started and stopped based on space temperature. When the space temperature is lower than 65 degrees F, the unit heaters shall be energized. The control valve on the unit heater shall be modulated based on space temperature.

The automation control system shall be provided with additional slave panels to control the single zone air handling unit, the exhaust fans and the unit heaters, as necessary. Tie into the EMCS.

1232.9 PLUMBING REQUIREMENTS

See Chapter 8 of this manual for plumbing design parameters. The following is a partial list of plumbing fixtures required:

A. Lavatory faucets.
B. Lavatories.
C. Lavatories for the physically handicapped.
D. Water closets.
E. Stop valves provided on all fixtures.
F. Urinals.
G. Floor drains and cleanouts.
H. Showers.
I. Sand traps and oil separators.
J. Water Coolers.
K. Sinks.

All domestic water connections, to mechanical systems, shall be protected from backflow.

1232.10 FIRE PROTECTION

The fire protection system shall be as follows:

A. Provide fire hose stations with carbon dioxide extinguisher in cabinets throughout the area.

B. Single facilities larger than 1,500 square feet require fire sprinkler and fire alarm systems per the requirements of Denver Fire Prevention Bureau, F.M. Global and NFPA.
See Section 9 of this manual for fire protection requirements.

1232.11 EVAPORATIVE COOLING:

Where the four-pipe distribution system is unavailable and acceptable air quality is available, total evaporative cooling may be utilized (no back-up refrigeration unit) in lieu of refrigeration for offices and for added comfort in frequently used and populated shop areas. Evaporative cooling should be the indirect/direct method of operation. By "acceptable" air quality, the air must be free of jet fuel exhaust fumes. The indirect/direct method of evaporative cooling uses both indirect and direct evaporative cooling methods to produce cool, conditioned supply air.

SECTION 1233 - FIRE CRASH RESCUE FACILITY

1233.1 DESIGN CONDITIONS:

A. Summer: Conditioned Spaces 74°F
   Shop Areas - Vent Only

B. Winter: Conditioned Spaces 72°F
   Shop Areas - 70°F

1233.2 CONDITIONED SYSTEMS

The office and break room area shall be air conditioned with a single zone system.

Each unit shall consist of a centrifugal, non-overloading supply air fan with fan speeds selected for sound control. In addition, systems shall contain cooling and heating coils, a throwaway filter section, and a mixed air plenum for outside air and return air duct damper connections. See Section 301 for air handling system requirements.

For small, single office areas or sleeping/residential type areas that might be air-conditioned: Thru-the-wall packaged units may be used in lieu of air handling unit systems.

Provide a low pressure ductwork system.

1233.3 VEHICLE/MAINTENANCE SYSTEMS

The main plant areas shall be heating and ventilated only. Provide exhaust fans in the main mechanical equipment areas during the cooling season. Exhaust fans shall be centrifugal, or prop type, non-overloading with fan speeds selected for extended life and sound control. Makeup air for exhaust system shall be introduced through an air handling unit with a filter, control damper and louver plenum. The outside air shall be filtered with dry-type filter media with an Atmospheric Dust Spot Efficiency (ASHRAE) or at least 30 percent. The exhaust system shall be designed to provide the minimum ventilation rate during the periods cooling is not required.

1233.4 OUTDOOR AIR REQUIREMENTS

Outside air for the conditioned spaces shall be brought in through the air handling unit or make-up air unit.

1233.5 TOILET EXHAUST
The minimum ventilation rate for all toilet room facilities shall be 2.0 CFM per square foot of floor area.

1233.6 KITCHEN EXHAUST
All kitchens shall be air conditioned. The exhaust requirements will be determined by the cooking and exhaust hoods installed within the facility. The kitchen exhaust system shall be designed in accordance with NFPA 96, "Standard for the Installation of Equipment for the Removal of Smoke and Grease-Laden Vapors from Commercial Cooking Equipment."

1233.7 VENTILATION RATES
Recommended average outside air ventilation rates shall be as follows:

A. Office Areas: 15 CFM per person
B. All other areas: 4 air changes/hour minimum
   12 air changes/hour (summer) minimum

1233.8 FILTRATION
Outside air shall be filtered with dry-type filter media with an Atmospheric Dust Spot Efficiency (ASHRAE) of at least 50 percent. Filters with 4" dry type pre-filter section having a minimum rating of MERV 10 shall be provided.

1233.9 CONTROLS
Provide control logic to permit the following:

A. Position outside air dampers and return air dampers. The outside air damper shall be normally closed, and the return air dampers shall be normally open.
B. Cooling coil controls.
C. Heating coil controls with preheat where required.
D. Monitor space and duct temperatures.
E. Equipment start-stop with equipment status.
F. Optimal start.
G. Alarms for failure of the following:
   1. Fan failure.
   2. Space temperature out of specification.
   3. Smoke detection.
   4. Freeze thermostat shutdown.
   5. Filter differential pressure.
H. The following control functions shall be programmed into the exhaust fan system:
   1. Position the outside air dampers. The outside air dampers shall be normally closed. When the exhaust fan is running, the outside air damper shall be open. When the exhaust fan is off, the outside air damper shall be closed.
   2. Exhaust fan start/stop with equipment status. Exhaust fan start/stop shall be a function of the mechanical equipment room space temperature. Energize the
exhaust fans when space temperature is greater than 82 degrees F.

I. The unit heaters shall be started and stopped based on space temperature. When the space temperature is lower than 65 degrees F, the unit heaters shall be energized. The control valve on the unit heater shall be modulated based on space temperature.

J. The automation control system shall be provided with additional slave panels to control the single zone air handling unit, the exhaust fans and the unit heaters, as necessary. Tie to EMCS.

1233.10 PLUMBING REQUIREMENTS

See Chapter 8 of this manual for plumbing design parameters. The following is a partial list of plumbing fixture required:

A. Lavatory faucets.
B. Lavatories.
C. Lavatories for the physically handicapped.
D. Water closets.
E. Stop valves provided on all fixtures.
F. Urinals.
G. Floor drains and cleanouts.
H. Showers.
I. Sand traps and oil separators.
J. Water coolers.
K. Sinks.

All domestic water connections, to mechanical systems, shall be protected from backflow.

1233.11 FIRE PROTECTION

The fire protection system shall be as follows:

A. Provide fire extinguishers in cabinets throughout the area.
B. Single facilities larger than 1,500 square feet require fire sprinkler and fire alarm systems per the requirements of Denver Fire Prevention Bureau, F.M. Global and NFPA.

See Section 9 of this manual for fire protection requirements.

1233.12 EVAPORATIVE COOLING

Where the four-pipe distribution system is unavailable and acceptable air quality is available, total evaporative cooling may be utilized (no back-up refrigeration unit) in lieu of refrigeration for offices and for added comfort in frequently used and populated shop areas. Evaporative cooling should be the indirect/direct method of operation. By "acceptable" air quality, the air must be free of jet fuel exhaust fumes. The indirect/direct method of evaporative cooling uses both indirect and direct evaporative cooling methods to produce cool, conditioned supply air.
SECTION 1234 - RENTAL CAR SUPPORT FACILITY

1234.1 DESIGN CONDITIONS

A. Summer: Conditioned spaces 74°F  
   Shop Areas Ventilation only

B. Winter: Conditioned Spaces 72°F  
   Shop Areas 70°F

1234.2 VENTILATION SYSTEMS

The office and break room area shall be air conditioned with a single zone system.

Each unit shall consist of a centrifugal, non-overloading supply air fan with fan speeds selected for sound control. In addition, systems shall contain cooling and heating coils, a throwaway filter section, and a mixed air plenum for outside air and return air duct damper connections. See Section 301 for air handling system requirements.

For small, single office areas that might be air-conditioned: Thru-the-wall packaged units may be used in lieu of air handling unit systems.

Provide a low pressure ductwork system.

1234.3 MAINTENANCE/SHOP SYSTEM

The main plant areas shall be heating and ventilated only. Provide exhaust fans in the main mechanical equipment areas during the cooling season. Exhaust fans shall be centrifugal, or prop type, non-overloading with fan speeds selected for extended life and sound control. Makeup air for exhaust system shall be introduced through an air handling unit with a filter, control damper and louver plenum. The outside air shall be filtered with dry-type filter media with an Atmospheric Dust Spot Efficiency (ASHRAE) or at least 30 percent. The exhaust system shall be designed to provide the minimum ventilation rate during the periods cooling is not required.

1234.4 OUTDOOR AIR REQUIREMENTS

Outside air for the conditioned spaces shall be brought in through the air handling unit or make-up air unit.

1234.5 TOILET EXHAUST

The minimum ventilation rate for all toilet room facilities shall be 2.0 CFM per square foot of floor area.

1234.6 VENTILATION RATES

Recommended average outside air ventilation rates shall be as follows:

A. Office Areas: 15 CFM per person

B. All other areas: 4 air changes/hour minimum
   12 air changes/hour (summer) minimum

1234.7 FILTRATION
Outside air shall be filtered with dry-type filter media with an Atmospheric Dust Spot Efficiency (ASHRAE) of at least 30 percent. Filters with 4” dry type pre-filter section having a minimum rating of MERV 10 shall be provided.

1234.8 CONTROLS

Provide control logic to permit the following:

A. Position outside air dampers and return air dampers. The outside air damper shall be normally closed, and the return air dampers shall be normally open.

B. Cooling coil controls.

C. Heating coil controls with preheat where required.

D. Monitor space and duct temperatures.

E. Equipment start-stop with equipment status.

F. Optimal start.

G. Alarms for failure of the following:
   1. Fan failure.
   2. Space temperature out of specification.
   3. Smoke detection.
   4. Freeze thermostat shutdown.
   5. Filter differential pressure.

H. The following control functions shall be programmed into the exhaust fan system:
   1. Position the outside air dampers. The outside air dampers shall be normally closed. When the exhaust fan is running, the outside air damper shall be open. When the exhaust fan is off, the outside air damper shall be closed.
   2. Exhaust fan start/stop with equipment status. Exhaust fan start/stop shall be a function of the mechanical equipment room space temperature. Energize the exhaust fans when space temperature is greater than 80 degrees F.

I. The unit heaters shall be started and stopped based on space temperature. When the space temperature is lower than 65 degrees F, the unit heaters shall be energized. The control valve on the unit heater shall be modulated based on space temperature.

J. The automation control system shall be provided with additional slave panels to control the single zone air handling unit, the exhaust fans and the unit heaters, as necessary. Tie to the EMCS.

1234.9 PLUMBING REQUIREMENTS

See Chapter 8 of this manual for plumbing design parameters. The following is a partial list of plumbing fixture required:

A. Lavatory faucets.

B. Lavatories.

C. Lavatories for the physically handicapped.
D. Water closets.
E. Stop valves provided on all fixtures.
F. Urinals.
G. Floor drains and cleanouts.
H. Showers.
I. Sand traps and oil separators.
J. Water coolers.
K. Sinks.

All domestic water connections, to mechanical systems, shall be protected from backflow.

**1234.10 FIRE PROTECTION**

The fire protection system shall be as follows:

A. Provide a dry-pipe sprinkler system for unheated areas.
B. Provide fire hose station (as required) with carbon dioxide extinguisher in cabinets throughout the area.
C. Single facilities larger than 1,500 square feet require fire sprinkler and fire alarm systems per the requirements of Denver Fire Prevention Bureau, F.M. Global and NFPA.

See Section 9 of this manual for fire protection requirements.

**1234.11 EVAPORATIVE COOLING**

Where the four-pipe distribution system is unavailable and acceptable air quality is available, total evaporative cooling may be utilized (no back-up refrigeration unit) in lieu of refrigeration for offices and for added comfort in frequently used and populated shop areas. Evaporative cooling should be the indirect/direct method of operation. By "acceptable" air quality, the air must be free of jet fuel exhaust fumes. The indirect/direct method of evaporative cooling uses both indirect and direct evaporative cooling methods to produce cool, conditioned supply air.

**SECTION 1235 - AUTO SERVICE STATION**

**1235.1 DESIGN CONDITIONS**

A. Summer: Conditioned spaces 74°F
   Shop Areas Ventilation only
B. Winter: Conditioned Spaces 72°F
   Shop Areas 70°F

**1235.2 CONDITIONED SYSTEMS**

The office and break room area shall be air conditioned with a single zone system.

Each unit shall consist of a centrifugal, non-overloading supply air fan with fan speeds selected for sound control. In addition, systems shall contain cooling and heating coils, a throwaway filter
section, and a mixed air plenum for outside air and return air duct damper connections. See Section 301 for air handling system requirements.

For small, single office areas that might be air-conditioned: Thru-the-wall packaged units may be used in lieu of air handling unit systems.

Provide a low pressure ductwork system.

1235.3 SHOP SYSTEM
The main plant areas shall be heating and ventilated only. Provide exhaust fans in the main mechanical equipment areas during the cooling season. Exhaust fans shall be centrifugal, or prop type, non-overloading with fan speeds selected for extended life and sound control. Makeup air for exhaust system shall be introduced through an air handling unit with a filter, control damper and louver plenum. The outside air shall be filtered with dry-type filter media with an Atmospheric Dust Spot Efficiency (ASHRAE) or at least 30 percent. The exhaust system shall be designed to provide the minimum ventilation rate during the periods cooling is not required.

1235.4 OUTDOOR AIR REQUIREMENTS
Outside air for the conditioned spaces shall be brought in through the air handling unit or make-up air unit.

1235.5 TOILET EXHAUST
The minimum ventilation rate for all toilet room facilities shall be 2.0 CFM per square foot of floor area.

1235.6 AUTOMOBILE EXHAUST SYSTEM
The maintenance area shall be equipped with a constant volume exhaust system. The system will consist of a centrifugal, non-overloading, exhaust fan with fan speeds selected for sound control and equipment life.

The ductwork system will consist of a main trunk duct with flexible duct take-offs for connection to the vehicles exhaust tailpipes. Provisions will be made for vehicles with both single and dual exhaust systems. The system will be sized to exhaust a minimum of 100 CFM per vehicle with an engine horsepower less than 200 HP and 200 CFM per vehicle with an engine horsepower greater than 200 HP. The design shall comply with "Industrial Ventilation, A Manual of Recommended Practice," latest Edition.

1235.7 VENTILATION RATES
Recommended average outside air ventilation rates shall be as follows:

A. Office Areas: 15 CFM per person
B. All other areas: 4 air changes/hour minimum
   12 air changes/hour (summer) minimum

1235.8 FILTRATION
Outside air shall be filtered with dry-type filter media with an Atmospheric Dust Spot Efficiency (ASHRAE) of at least 30 percent. Filters with 4” dry type pre-filter section having a minimum rating of MERV 10 shall be provided.

1235.9 CONTROLS
Provide control logic to permit the following:

A. Position outside air dampers and return air dampers. The outside air damper shall be normally closed, and the return air dampers shall be normally open.

B. Cooling coil controls.

C. Heating coil controls with preheat where required.

D. Monitor space and duct temperatures.

E. Equipment start-stop with equipment status.

F. Optimal start.

G. Alarms for failure of the following:
   1. Fan failure.
   2. Space temperature out of specification.
   3. Smoke detection.
   4. Freeze thermostat shutdown.

H. The following control functions shall be programmed into the exhaust fan system:
   1. Position the outside air dampers. The outside air dampers shall be normally closed. When the exhaust fan is running, the outside air damper shall be open. When the exhaust fan is off, the outside air damper shall be closed.
   2. Exhaust fan start/stop with equipment status. Exhaust fan start/stop shall be a function of the mechanical equipment room space temperature. Energize the exhaust fans when space temperature is greater than 80 degrees F.

I. The unit heaters shall be started and stopped based on space temperature. When the space temperature is lower than 65 degrees F, the unit heaters shall be energized. The control valve on the unit heater shall be modulated based on space temperature.

J. The automation control system shall be provided with additional slave panels to control the single zone air handling unit, the exhaust fans and the unit heaters, as necessary. Tie to the EMCS.

1235.10 PLUMBING REQUIREMENTS
See Chapter 8 of this manual for plumbing design parameters. The following is a partial list of plumbing fixture required:

A. Lavatory faucets.

B. Lavatories.

C. Lavatories for the physically handicapped.

D. Water closets.
E. Stop valves provided on all fixtures.
F. Urinals.
G. Floor drains and cleanouts.
H. Showers.
I. Sand traps and oil separators.
J. Water coolers.
K. Sinks.

All domestic water connections, to mechanical systems, shall be protected from backflow.

**1235.11 FIRE PROTECTION**

The fire protection system shall be provided as follows:

A. Provide fire hose station with carbon dioxide extinguisher in cabinets throughout the area.
B. Single facilities larger than 1,500 square feet require fire sprinkler and fire alarm systems per the requirements of Denver Fire Prevention Bureau, F.M. Global and NFPA.

See Section 9 for fire protection requirements.

**1235.12 EVAPORATIVE COOLING**

Where the four-pipe distribution system is unavailable and acceptable air quality is available, total evaporative cooling may be utilized (no back-up refrigeration unit) with an indirect/direct method of operation.

**SECTION 1236 - AIRCRAFT FUELING CONTROL FACILITY**

**1236.1 DESIGN CONDITIONS**

A. **Summer:** Conditioned spaces 74°F
   Shop Areas  Ventilation only

B. **Winter:** Conditioned Spaces 72°F
   Shop Areas  70°F

**1236.2 CONDITIONED SYSTEMS**

The office and break room area shall be air conditioned with a single zone system.

Each unit shall consist of a centrifugal, non-overloading supply air fan with fan speeds selected for sound control. In addition, systems shall contain cooling and heating coils, a throwaway filter section, and a mixed air plenum for outside air and return air duct damper connections. See Section 301 for air handling system requirements.

For small, single office areas that might be air-conditioned: Thru-the-wall packaged units may be used in lieu of air handling unit systems.

Provide a low pressure ductwork system.
1236.3 MAINTENANCE/SHOP SYSTEM

The main plant areas shall be heating and ventilated only. Provide exhaust fans in the main mechanical equipment areas during the cooling season. Exhaust fans shall be centrifugal, or prop type, non-overloading with fan speeds selected for extended life and sound control. Makeup air for exhaust system shall be introduced through an air handling unit with a filter, control damper and louver plenum. The outside air shall be filtered with dry-type filter media with an Atmospheric Dust Spot Efficiency (ASHRAE) or at least 30 percent. The exhaust system shall be designed to provide the minimum ventilation rate during the periods cooling is not required.

1236.4 OUTDOOR AIR REQUIREMENTS

Outside air for the conditioned spaces shall be brought in through the air handling unit or make-up air unit.

1236.5 TOILET EXHAUST

The minimum ventilation rate for all toilet room facilities shall be 2.0 CFM per square foot of floor area.

1236.6 VENTILATION RATES

Recommended average outside air ventilation rates shall be as follows:

A. Office Areas: 15 CFM per person
B. All other areas: 4 air changes/hour minimum
   12 air changes/hour (summer) minimum

1236.7 VEHICLE EXHAUST SYSTEM

The maintenance area shall be equipped with a constant volume exhaust system. The system will consist of a centrifugal, non-overloading, exhaust fan with fan speeds selected for sound control and equipment life.

The ductwork system will consist of a main trunk duct with flexible duct take-offs for connection to the vehicles exhaust tailpipes. Provisions will be made for vehicles with both single and dual exhaust systems. The system will be sized to exhaust a minimum of 100 CFM per vehicle with an engine horsepower less than 200 HP and 200 CFM per vehicle with an engine horsepower greater than 200 HP. The design shall comply with "Industrial Ventilation, A Manual of Recommended Practice," latest Edition.

1236.8 FILTRATION

Outside air shall be filtered with dry-type filter media with an Atmospheric Dust Spot Efficiency (ASHRAE) of at least 30 percent. Filters with 4” dry type pre-filter section having a minimum rating of MERV 10 shall be provided.

1236.9 CONTROLS

Provide control logic to permit the following:

A. Position outside air dampers and return air dampers. The outside air damper shall be normally closed, and the return air dampers shall be normally open.
B. Cooling coil controls.
C. Heating coil controls with preheat where required.
D. Monitor space and duct temperatures.
E. Equipment start-stop with equipment status.
F. Optimal start.
G. Alarms for failure of the following:
   1. Fan failure.
   2. Space temperature out of specification.
   3. Smoke detection.
   4. Freeze thermostat shutdown.
   5. Filter differential pressure.
H. The following control functions shall be programmed into the exhaust fan system:
   1. Position the outside air dampers. The outside air dampers shall be normally closed. When the exhaust fan is running, the outside air damper shall be open. When the exhaust fan is off, the outside air damper shall be closed.
   2. Exhaust fan start/stop with equipment status. Exhaust fan start/stop shall be a function of the mechanical equipment room space temperature. Energize the exhaust fans when space temperature is greater than 85 degrees F.
I. The unit heaters shall be started and stopped based on space temperature. When the space temperature is lower than 65 degrees F, the unit heaters shall be energized. The control valve on the unit heater shall be modulated based on space temperature.
J. The automation control system shall be provided with additional slave panels to control the single zone air handling unit, the exhaust fans and the unit heaters, as necessary. Tie to the EMCS.

1236.10 PLUMBING REQUIREMENTS

See Chapter 8 of this manual for plumbing design parameters. The following is a partial list of plumbing fixture required:
A. Lavatory faucets.
B. Lavatories.
C. Lavatories for the physically handicapped.
D. Water closets.
E. Stop valves provided on all fixtures.
F. Urinals.
G. Floor drains and cleanouts.
H. Showers.
I. Sand traps and oil separators.
J. Water coolers.
K. Sinks.

All domestic water connections, to mechanical systems, shall be protected from backflow.

1236.11 FIRE PROTECTION

The fire protection system shall be provided in accordance with the latest editions of NFPA Standards and local codes. The following description of fire protection requirements is based on NFPA. Local fire and code officials must be contacted to verify their concurrence with the proposed system.

A. Provide an automatic heat detection system for this area.
B. Provide a fire hose station extinguisher at each station in the enclosed areas.
C. Single facilities larger than 1,500 square feet require fire sprinkler and fire alarm systems per the requirements of Denver Fire Prevention Bureau, F.M. Global and NFPA.

See Section 9 for fire protection requirements.

1236.12 EVAPORATIVE COOLING

Where acceptable air quality is available, total evaporative cooling may be utilized (no back-up refrigeration unit) with an indirect/direct method of operation.

SECTION 1237 - GENERAL AVIATION FACILITIES

1237.1 DESIGN CONDITIONS

A. Summer: Conditioned spaces: 74°F
   Shop Areas: Ventilation only or 74°F
   Hangars: No conditioning required

B. Winter: Conditioned spaces: 72°F
   Shop Areas: 70°F
   Hangars: 68°F

1237.2 AIR HANDLING SYSTEMS

The office and break room area shall be air conditioned with a single zone system.

Each unit shall consist of a centrifugal, non-overloading supply air fan with fan speeds selected for sound control. In addition, systems shall contain cooling and heating coils, a throwaway filter section, and a mixed air plenum for outside air and return air duct damper connections. See Section 301 for air handling system requirements.

For small, single office areas that might be air-conditioned: Thru-the-wall packaged units may be used in lieu of air handling unit systems.

Provide a low pressure ductwork system.

1237.3 SHOP AND HANGAR SYSTEM
The main shop areas shall be heated and ventilated only with unit heaters. Provide exhaust fans for ventilation during the cooling season. Exhaust fans shall be centrifugal, or prop type, non-overloading with fan speeds selected for increased life and sound control. Make-up air for exhaust system shall be introduced through a make-up air unit with a filter, control damper and louver plenum. The outside air shall be filtered with dry-type filter media with an Atmospheric Dust Spot Efficiency (ASHRAE) of at least 30 percent. The exhaust system shall be designed to provide the minimum ventilation rate during the periods cooling is not required.

The hangar area will be heated and ventilated by one of the following systems:

A. Low intensity vented, gas-fired, infrared system for small hangars, not over 30' high.
B. High-bay unit heaters for large hangars.
C. Air rotation system utilizing air-handling units that circulate air through the high-bay and back to the low-level air handlers.

Provide ventilation at all hangar low points (e.g. wheel pits, etc.).

1237.4 OUTDOOR AIR REQUIREMENTS
Outside air shall be brought in through the air handling or make-up air units. See Section 303 for ventilation system requirements.

1237.5 TOILET EXHAUST
The minimum ventilation rate for all toilet room facilities shall be 2.0 CFM per square foot of floor area.

1237.6 VENTILATION RATES
Recommended average outside air ventilation rates shall be as follows:

A. Office Areas: 15 CFM per person
B. Shop Areas:* 4 air changes/hour (minimum)
C. Hangar Areas:* Depends on function

*These values shall be based on ventilation or exhaust requirements depending on usage or operations in the space.

1237.7 FILTRATION
Outside air shall be filtered with dry-type filter media with an Atmospheric Dust Spot Efficiency (ASHRAE) of at least 30 percent. Filters with 4” dry type pre-filter section having a minimum rating of MERV 10 shall be provided.

1237.8 CONTROLS
Air Handling Units:

A. Off-peak setback of ventilation.
B. Cooling coil controls.
C. Heating coil controls with preheat where required.
D. Monitor space and duct temperatures.
E. Equipment start/stop with equipment status.
F. Optimal start.
G. Economizer controls.
H. Alarms for failure of the following:
   1. Fan failure.
   2. Space temperature out of specification.
   3. Smoke detection.
   4. Freeze thermostat shutdown.
I. Position the outside air dampers. The outside air dampers shall be normally closed. When the exhaust fan is running, the outside air damper shall be open. When the exhaust fan is off, the outside air damper shall be closed.
J. Exhaust fan start/stop with equipment status. Exhaust fan start/stop shall be a function of the mechanical equipment room space temperature. Energize the exhaust fans when space temperature is greater than 85 degrees F.
K. The unit heaters shall be started and stopped based on space temperature. When the space temperature is lower than 65 degrees F, the unit heaters shall be energized. The control valve on the unit heater shall be modulated based on space temperature. Units shall cycle to maintain space temperature set point.

The automation controls system shall be provided with additional slave panels to control the single zone air handling unit, the exhaust fans and the unit heaters, as necessary. Tie to the EMCS.

1237.9 PLUMBING REQUIREMENTS

See Chapter 8 of this manual for plumbing design parameters. The following is a partial list of plumbing fixture required:

A. Lavatory faucets.
B. Lavatories.
C. Lavatories for the physically handicapped.
D. Water closets.
E. Stop valves provided on all fixtures.
F. Urinals.
G. Floor drains and cleanouts.
H. Showers.
I. Sand traps and oil separators.
J. Water coolers.
K. Sinks

All domestic water connections, to mechanical systems, shall be protected from backflow.
1237.10 FIRE PROTECTION

The fire protection system shall be as follows:

A. Single facilities larger than 1,500 square feet require fire sprinkler and fire alarm systems per the requirements of Denver Fire Prevention Bureau, F.M. Global and NFPA.

B. Provide a dry-pipe sprinkler system. Wet-pipe acceptable in shops and offices.

C. Provide fire hose stations with extinguisher at each station in the enclosed areas.

See Section 9 for fire protection requirements.

1237.11 EVAPORATIVE COOLING

Where acceptable air quality is available, total evaporative cooling may be utilized (no back-up refrigeration unit) with an indirect/direct method of operation.

SECTION 1238 - COMMUNICATIONS CENTER

1238.1 DESIGN CONDITIONS

A. Summer: 74°F (50% RH Max)
B. Winter: 72°F

1238.2 AIR HANDLING SYSTEMS

This facility will be air conditioned with a variable air volume (VAV) system.

Each unit shall consist of a centrifugal, non-overloading supply air fan with fan speeds selected for sound control. In addition, system shall contain cooling and heating coil sections (includes cooling only units), an electronic air filter section, a throwaway filter section, air blender section to eliminate air stratification, and a mixed air plenum for outside air and return air duct damper connections. See Section 301 for air handling system requirements.

The supply air ductwork system will consist of low pressure ductwork with variable volume terminal boxes. Each VAV box will have its own controls tied to the EMCS. The system will be sized to supply approximately 1.25 CFM per square foot at maximum flow.

1238.3 COMPUTER AND ELECTRONIC EQUIPMENT ROOMS

Electronic equipment rooms, which require year-round cooling, may be connected to the central plant chilled water system for cooling; in addition they shall have their own DX cooling system for winter operation. The system shall have factory-installed and wired controls for chilled water and DX cooling coils, heating coils, dehumidification and humidification. The unit shall have an electric, steam generating humidifier with controls to limit space humidity to 60 percent maximum.

1238.4 OUTDOOR AIR REQUIREMENTS

Outside air shall be brought in through the air handling units. See Section 303 for ventilation requirements.

1238.5 TOILET EXHAUST
The minimum ventilation rate for all toilet room facilities shall be 2.0 CFM per square foot of floor area.

1238.6 VENTILATION RATES
Recommended average outside air ventilation rates shall be as follows:

A. Office Areas: 15 CFM per person

1238.7 FILTRATION
Outside air shall be filtered with dry-type filter media with an Atmospheric Dust Spot Efficiency (ASHRAE) of at least 60 percent. As a minimum outside air is to be filtered by the use of 12” dry type pre-filter section having a minimum rating of MERV 7, 12” dry type filter section having a minimum rating of MERV 13 and a 12”.

1238.8 AIR HANDLING UNIT CONTROLS
Provide control logic to permit the following:

A. Position outside air dampers and return air dampers. The outside air and exhaust air dampers shall be normally closed, and the return air dampers shall be normally open.
B. Off-peak setback of ventilation.
C. Cooling coil controls.
D. Heating coil controls with preheat where required.
E. Reset of cold deck temperature during low load.
F. Monitor space and duct temperatures.
G. Equipment start/stop with equipment status.
H. Optimum start.
I. Alarms for failure of the following:
   1. Fan failure.
   2. Space temperature out of specification.
   3. Smoke detection.
   4. Freeze thermostat shutdown.
   5. Filter differential pressure.
J. Provide air flow measuring stations and install them to measure outside air flow and supply air flow. Program DDC to maintain outside air flow during all loads conditions to meet code ventilation requirements.
K. Controls shall be integrated with the EMCS.

1238.9 PLUMBING REQUIREMENTS
See Chapter 8 for plumbing design parameters.

A. A partial listing of plumbing fixture requirements is as follows: Lavatory faucets - be provided with flow restriction devices.
B. Lavatories - wall hung or counter mounted.
C. Lavatories (for the physically handicapped) - wall hung or counter mounted with offset grid drain for wheelchairs.
D. Water closets (standard and handicapped) - a "blow out".
E. Stop valves - provided on all fixtures.
F. Urinals.
G. Floor drains and cleanouts.
H. Water coolers.

All domestic water connections, to mechanical systems, including lawn sprinkling systems, shall be protected from backflow.

1238.10 FIRE PROTECTION
The fire protection system shall be provided as follows:

A. Provide a wet-pipe sprinkler system unless prohibited in areas having electronic equipment.
B. Provide an automatic detection system in areas not sprinklered establish and verify any requirements for the areas above dropped ceiling/ ceiling plenums require detection systems.
C. Establish with the Denver Fire Prevention Bureau any alternate system types (FM-200)
D. Provide extinguishers in cabinets throughout the area.

See Section 9 for fire protection requirements.

SECTION 1239 - SECURITY GUARD HOUSE

1239.1 DESIGN CONDITIONS
A. Summer: 74°F
B. Winter: 72°F

1239.2 AIR HANDLING SYSTEMS
This facility will be air conditioned with a single zone system.

Each unit shall consist of a centrifugal, non-overloading supply air fan with fan speeds selected for sound control. In addition, systems shall contain DX cooling and heating coils, a throwaway filter section, and a mixed air plenum for outside air and return air duct damper connections. Heat pump systems should be considered if natural gas is not available.

1239.3 OUTDOOR AIR REQUIREMENTS
Outside air shall be brought in through the air handling unit.

1239.4 TOILET EXHAUST
The ventilation rate for all toilet room facilities shall be 2.0 CFM per square foot of floor area.

**1239.5 VENTILATION RATES**
Recommended average outside air ventilation rates shall be as follows:

A. All Areas: 15 CFM per person

**1239.6 FILTRATION**
Outside air shall be filtered with dry-type filter media with an Atmospheric Dust Spot Efficiency (ASHRAE) of at least 30 percent. Filters with 4” dry type pre-filter section having a minimum rating of MERV 10 shall be provided.

**1239.7 PLUMBING REQUIREMENTS**
All plumbing systems shall conform to the requirements of the Uniform Plumbing Code as adopted and modified by the City and County of Denver building code. See Chapter 8 of this standard for plumbing design parameters. The following is a partial list of plumbing fixtures required for this area:

A. Lavatories - wall hung or counter mounted.
B. Water closets.
C. Stop valves - provided on all fixtures including water coolers.
D. Floor drains and cleanouts.
E. Water coolers.

**1239.8 FIRE PROTECTION**
The fire protection system shall be provided as follows:

A. Provide an extinguisher.

See Section 9 for fire protection requirements.

**1239.9 AIR HANDLING UNIT CONTROLS**
Provide control logic to permit the following:

A. Position outside air dampers and return air dampers. The outside air and exhaust air dampers shall be normally closed, and the return air dampers shall be normally open.
B. Heating and cooling coil controls.
C. Monitor space and duct temperatures.
D. Equipment start/stop with equipment status.
E. Alarms for failure of the following:
   1. Fan failure.
   2. Space temperature out of specification.
   3. Freeze thermostat shutdown.

**SECTION 1240 - WAREHOUSE FACILITY**
1240.1 DESIGN CONDITIONS

A. Summer: Conditioned spaces: 74°F
   Storage Areas: Ventilation only

B. Winter: Conditioned Spaces: 72°F
   Storage Areas: 70°F

1240.2 CONDITIONED SYSTEMS

The office and break room area shall be air conditioned with a single zone system.

Each unit shall consist of a centrifugal, non-overloading supply air fan with fan speeds selected for sound control. In addition, systems shall contain cooling and heating coils, a throwaway filter section, and a mixed air plenum for outside air and return air duct damper connections. See Section 301 for air handling system requirements.

Provide a low pressure ductwork system.

1240.3 WAREHOUSE SYSTEM

The main storage areas shall be heated and ventilated only. Provide exhaust fans for ventilation during the cooling season. Exhaust fans shall be centrifugal, or prop type, non-overloading with fan speeds selected for increased life and sound control. Makeup air for exhaust system shall be introduced through an air handling unit with a filter, control damper and louver plenum. The outside air shall be filtered with dry-type filter media with an Atmospheric Dust Spot Efficiency (ASHRAE) of at least 30 percent. The exhaust system shall be designed to provide the minimum ventilation rate during the periods cooling is not required.

1240.4 AIR CURTAINS

Air curtains shall be provided for use on all main service entrances. Overhead fan-coil units shall be used at each entrance. These units should be indirect gas fired.

1240.5 OUTDOOR AIR REQUIREMENTS

Outside air for the conditioned spaces shall be brought in through the air handling unit and make-up air unit.

1240.6 TOILET EXHAUST

The ventilation rate for all toilet room facilities shall be 2.0 CFM per square foot of floor area.

1240.7 VENTILATION RATES

Recommended average outside air ventilation rates shall be as follows:

A. Office Areas: 15 CFM per person

B. Warehouse Areas: 2 Air Changes/Hour (Minimum)

1240.8 FILTRATION

Outside air shall be filtered with dry-type filter media with an Atmospheric Dust Spot Efficiency (ASHRAE) of at least 30 percent. Filters with 4" dry type pre-filter section having a minimum rating of MERV 10 shall be provided.
1240.9 AIR HANDLING UNIT CONTROLS

Provide control logic to permit the following:

A. Position outside air dampers and return air dampers. The outside air and exhaust air dampers shall be normally closed, and the return air dampers shall be normally open.

B. Cooling coil controls.

C. Heating coil controls with preheat where required.

D. Monitor space and duct temperatures.

E. Equipment start/stop with equipment status.

F. Optimal start.

G. Alarms for failure of the following:
   1. Fan failure.
   2. Space temperature out of specification.
   3. Smoke detection.
   4. Freeze thermostat shutdown.

H. The following control functions shall programmed into the exhaust fan system:
   1. Position the outside air dampers. The outside air dampers shall be normally closed. When the exhaust fan is running, the outside air damper shall be open. When the exhaust fan is off, the outside air damper shall be closed.
   2. Exhaust fan start/stop with equipment status. Exhaust fan start/stop shall be a function of the mechanical equipment room space temperature. Energize the exhaust fans when space temperature is greater than 85 degrees F.

I. The unit heaters shall be started and stopped based on space temperature. When the space temperature is lower than 65 degrees F, the unit heaters shall be energized. The control valve on the unit heater shall be modulated based on space temperature.

The automation controls system shall be provided with additional slave panels to control the single zone air handling unit, the exhaust fans and the unit heaters, as necessary. Tie to the EMCS.

1240.10 PLUMBING REQUIREMENTS

See Chapter 8 of this manual for plumbing design parameters. The following is a partial list of plumbing fixtures required:

A. Lavatory faucets.

B. Lavatories.

C. Lavatories for the physically handicapped.

D. Water closets.

E. Stop valves provided on all fixtures.

F. Urinals.
G. Floor drains and cleanouts.
H. Showers.
I. Sand traps and oil separators.
J. Water Coolers.
K. Sinks.

All domestic water connections, to mechanical systems, shall be protected from backflow.

**1240.11 FIRE PROTECTION**

The fire protection system shall be as follows:

A. Provide a wet/dry-pipe sprinkler system which shall be designed to protect the particular type of usage including density suitable for antiquated storage type and method.
B. Provide a hose station with extinguisher at each station in the enclosed areas, as required.
C. Provide manual pull type fire alarm station as required.
D. Provide rack storage fire protection system as required or increased overhead densities suitable for the commodities stored.

See Section 9 of this manual for fire protection requirements.

**SECTION 1241 - BULK STORAGE FACILITY (UREA AND SAND STORAGE)**

**1241.1 DESIGN CONDITIONS**

A. Summer: Vent Only
B. Winter: Vent Only

**1241.2 VENTILATION SYSTEM**

The bulk storage facility shall be ventilated to remove dust particles. Provide exhaust fans for ventilation year round. Exhaust fans shall be centrifugal, or propeller type, non-overloading with fan speeds selected for increased life. Makeup air for exhaust system shall be introduced through a wall mounted louver with bird screen. Provide unit heaters as required for minimal heating of space.

**1241.3 VENTILATION RATE**

Minimum ventilation rate shall be 2 cfm/ft².

**1241.4 EXHAUST FAN CONTROLS**

Exhaust fan shall operate year round to provide for the removal of dust particles from the Bulk Storage Facility.

Alarm for failure shall include:

A. Fan failure.
1241.5 UNIT HEATER CONTROLS

Unit heaters shall operate to maintain space at 50 degrees F. Unit heaters shall be started and stopped based on space temperature. When the space temperature is lower than 50 degrees F, the unit heaters shall be energized.

END OF CHAPTER 12