Volume 1 – Electrical Design Manual

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PREFACE

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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SECTION 101 - ELECTRICAL SYSTEM CRITERIA

The electrical systems for all facilities at the Denver International Airport are to be based on the use of proven design techniques. These techniques shall utilize the latest state-of-the-art developments which exist in readily available equipment and components. Designs shall be simple and straight-forward with the design criteria of the highest priority being the safety, convenience and comfort of the traveling public.

Systems must be serviceable, maintainable and at the same time provide flexibility for future addition and/or modification. They must be easy to operate and stable throughout their life. Above all, they must serve the public well. All equipment installations, including all their components, must be accessible for adjustment and maintenance. Ample space must be provided to permit removal and replacement of any and all equipment items. Systems and components shall be provided with provisions for central monitoring, control, and diagnosis.

Airport facilities are dynamic in that changes, additions, and modifications are to be anticipated and electrical systems may have to be altered to accommodate these changes. Future state-of-the-art technology may make system modifications and/or additions desirable. Flexibility in system design will be the key to allow the changes that are an integral part of a modern air transportation facility.

Energy cost savings and conservation shall also be criteria in the design of electrical systems. Facility designs must comply with the energy conservation budgets and goals included in these standards. Life cycle cost valuation and first costs are important consideration throughout the design process from concept to final design and through construction.

SECTION 102 - UTILITY DESCRIPTIONS

102.1 NORMAL ELECTRICAL POWER

The primary power distribution system for the new Denver International Airport (DIA) is based on the Excel Energy (Xcel) supplied 25,000 volt, wye, grounded, three phase system, with a primary selective and looped distribution system.

The 25,000 volt feeders will emanate from four new redundant 230 kV to 25kV Xcel owned 50 MVA substation located off of the airport site. One substation is located north of the site and one located south of the site. The substations receive power from a main 230 kV overhead distribution grid which includes multiple power source generation points.

At each substation, redundant transformers feeding the breaker buses are utilized. Four dedicated primary feeders extend from the substation’s 25 kV switch gear to the airport site. These four 25kV feeders from each substation (total of eight feeders) shall form redundant sources of power for the airport site. Emergency power is not available for these substations.

The primary selective feeders are run in an underground concrete-encased duct bank and manhole system located within predetermined utility corridors. These feeders extend through primary switchgear to form a subdistribution system for primary power service to airport facility transformers.
102.2 COMMUNICATIONS
Telephone system service(s) will be provided throughout the airport. Generally, communications service will be provided to each facility and/or facility tenant at a designated service point near or in the facility. Determination of this designated service point will be on a case-by-case basis. Interior facility and tenant communication systems may be privately owned or leased as determined on a case-by-case basis.

102.3 ALARM SYSTEMS
Alarms in facilities such as fire, security and energy management and control system (EMCS) will report alarm conditions to the airport central alarm station at the Communications Center.

102.4 SECURITY SYSTEM
The security system shall be controlled from the central security control center with independent power and redundant CPU capacity integrated with the card access and CCTV.

SECTION 103 - DESIGN PARAMETERS

103.1 ELECTRICAL EQUIPMENT RATINGS
All electrical equipment selected shall have a minimum capability for installation in 40 degrees C ambient temperature. Equipment shall be designed and rated for installation at a minimum of 5400 feet elevation above mean sea level and in a seismic 1 zone. Voltage ratings are defined as:

A. Low Voltage = 0 – 1000 volts phase-to-phase.
B. Medium Voltage = 1001-72,500 volts phase to phase.
C. High Voltage = 72,501-242,000 volts phase-to-phase.

All equipment that contains a microprocessor that is not powered from an uninterruptible power supply, shall be specified to have a line side transient surge suppressor. This can be in the form of a surge suppression receptacle for pug-in equipment, or a hard-wired surge suppression module for hard wired equipment. Where a number of circuits supplied from a panelboard require surge suppression, the surge suppressor can be a hard wired package at the panelboard to protect the entire panelboard.

103.2 EXCESS CAPACITY
Electrical power distribution systems and components shall be designed to provide a minimum load growth of 25 percent without the need for modifications or additions to the electrical system. Special cases may require provisions for larger growth such as the central plant.

103.3 VOLTAGE DROP
Electrical power distribution feeder and branch circuits shall be designed to have a maximum cumulative voltage drop, from source to load including all system components of 5 percent. Feeder shall be allowed a maximum of 2 percent voltage drop and branch circuits shall be allowed a maximum of 3 percent voltage drop.
Transformers, motor starters and feeder shall be designed to limit motor starting voltage drop to 15 percent at the motor terminals and to one percent at the motor feeder source motor control center or panelboard (0.5 percent voltage drop on loads that cycle on and off frequently).

### 103.4 SHORT CIRCUIT CURRENT

Electrical power distribution systems shall be designed and components selected to limit the short circuit current available to the lowest economical level. The design goal is to limit the available short circuit current in systems rated 208Y/120 volts to 10,000 amperes or less. The design of systems rated 480Y/277 volts shall have as a goal (as much as is practical, possible and cost effective) the limiting of the available short circuit current to below 14,000 amperes, or the standard ratings of the equipment.

### 103.5 POWER FACTOR

Electrical power distribution systems shall be designed and components selected to maintain the system power factor at the highest economical level. The design goal is to maintain a system power factor at 95 percent or better but in no case should it be allowed to fall below 90 percent. In general, motors 15 horsepower and larger should have capacitors to correct the power factor to 95 percent (unless the facility's power factor is corrected by a synchronous motor or a central power factor controller).

END OF CHAPTER 1
CHAPTER 2
INTERIOR ELECTRICAL POWER DISTRIBUTION SYSTEMS

SECTION 101 - GENERAL

101.1 SCOPE
This section includes specific design guidance for the selection and application of equipment and materials to be included in interior electrical systems. This section also presents requirements for bid document preparation.

101.2 CRITERIA
These standards are developed, in part, from publications of the latest edition of the following codes, standards and guides:

A. American Society of Testing and Material (ASTM) Standards


C. Certified Ballast Manufacturers (CBM) Standards

D. Electrical Testing Laboratory (ETL) Standards

E. Electronic Industries Association (EIA) Standards

F. Federal Communications Commission (FCC) Rules and Regulations

G. National Electrical Manufacturers Association (NEMA) Standards

H. National Fire Protection Association (NFPA) Standards:
   1. NFPA 20, "Installation of Centrifugal Fire Pumps"
   2. NFPA 70, "National Electrical Code" (NEC) as adopted and amended by the Denver Building Code, Chapter 59.
   3. NFPA 71, "Installation, Maintenance and Use of Signaling Systems for Central Station Service"
   4. NFPA 72A, "Installation, Maintenance, and Use of Local Protective Signaling Systems for Guard's Tour, Fire Alarm and Supervisory Service"
   5. NFPA 72B, "Installation, Maintenance, and Use of Auxiliary Protective Signaling Systems for Fire Alarm Service"
   6. NFPA 72C, "Installation, Maintenance, and Use of Remote Station Protective Signaling Systems"
   7. NFPA 72D, "Installation, Maintenance, and Use of Proprietary Protective Signaling Systems"
   8. NFPA 72E, "Automatic Fire Detectors"
   10. NFPA 72G, "Installation, Maintenance, and Use of Notification Appliances for Protective Signaling Systems"

12. NFPA 78, "Lightning Protection Code"

13. NFPA 90A, "Installation of Air Conditioning and Ventilating Systems"


15. NFPA 409, "Aircraft Hangars"

16. NFPA 415, "Standard on Airport Terminal Buildings, Fueling Ramp Drainage, and Loading Walkways"

I. Institute of Electrical and Electronics Engineers (IEEE) Standards:

1. IEEE 141 "Recommended Practice for Electric Power Distribution for Industrial Plants"

2. IEEE 142 "Recommended Practice for Grounding Industrial and Commercial Power Systems"

3. IEEE 241 "Recommended Practice for Electric Power Systems in Commercial Buildings"

4. IEEE 242 "Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems"

5. IEEE 446 "Recommended Practice for Emergency and Standby Power Systems"

J. Underwriters Laboratories, Inc. (UL) Standards and "Product Directories"

K. Insulated Cable Engineers Association (ICEA) Standards

L. Factory Mutual (FM) "Approved Guide," and FM "Loss Prevention Data"

M. Illuminating Engineering Society (IES) Lighting Handbook

N. Department of Labor, "Occupational Safety and Health Standards, "Title 29, Code of Federal Regulations (CFR), Part 1910"

O. General Services Administration, Federal Supply Service, "Federal Standards" and "Federal Specifications"


101.3 DESIGN APPROACH

Careful planning and design of electrical systems are necessary to assure that initial and projected power requirements are satisfied. Systems design shall result in the supply of dependable power for present and anticipated future needs. The designs shall also provide an optimized safety for normal operating and maintenance procedures. System options relative to conservation and cost of energy shall be carefully evaluated. The National Electrical Code (NEC), ANSI/NFPA-70, as adopted and amended by the Denver Building Code, establishes minimum standards that shall be followed. Where more stringent requirements are contained in this section, these requirements shall take precedence. All references to the National Electrical Code or NEC shall be defined as: NFPA-70, as adopted and amended by the Denver Building Code Chapter 59, and as amended by this Manual 5. Electrical system materials and equipment shall conform to applicable standards of those organizations listed above. Manufacturer's recommendations shall also be considered.
All power from distribution panels to panel boards to the final point of terminal shall be located on the same floor and the same smoke zone. Routes may go through other floors, but at no time shall feed other floors. The purpose of this service criterion is to simply power shutoff for the Fire Department in an emergency situation.

101.4 DESIGN ANALYSIS REQUIREMENTS

Electrical system design analysis shall accompany each progress submittal and shall be a complete, written record of the following data:

A. Brief statement of the particular design objectives.

B. Design approach - selection of major component types, equipment space locations and power sources.

C. Calculated estimates of connected and demand loads.

D. Equipment and material selections based on the applicable design standard requirements. Provide verification of availability from "repetitive manufacturing" sources.

E. Provide voltage drop calculations. For motor circuits, provide motor running and motor starting voltage drop calculations.

F. Provide short-circuit current calculations and a preliminary protective coordination study for the system. The preliminary protective coordination study shall consist of verification that all components specified can be selectively coordinated. The final protective coordination study shall be performed by another separate Design Consultant. The design analysis shall include simplified single-line diagram in support of fault current study. Show all equivalent resistances, reactances, interrupting capacities and the power source available fault.

G. Calculate necessary wire and cable sizes required that will not be damaged by the short circuit currents available.

Design analysis includes calculation of estimated electrical loads and the diversified power demand resulting from those loads plus an anticipated future load growth. Those calculations, proposed equipment electrical ratings, dimensional data and manufacturer's catalog information together with a preliminary one-line diagram are part of the design analysis (design notes) submitted at "concept" progress review. Design development submittal shall expand the "concept" design to include preliminary sizing of service entrance and main feeders. The design analysis for the "60% completion" review also includes a preliminary system fault current (short circuit) and "worst-case" voltage drop analysis. The design analysis shall be updated and expanded with each subsequent submittal, progressing to a thorough verification of final design conclusions.

101.5 CONSTRUCTION DRAWING REQUIREMENTS

Electrical system drawings are prepared in accordance with Manual I - Standards Drawing Format. Separate floor plans shall be provided for:

A. Power

B. Lighting

C. Fire alarm, public address systems, telephone, communication, CCTV and security systems.(Exception: Combinations of lighting, power and communications shall be allowed on smaller facilities and shall be handled on a case-by-case basis.)
Floor plans indicate conduit routing for main electrical services, power distribution and power feeders to equipment requiring 1" and larger conduit. Conduit and circuiting for lighting and small power apparatus are shown schematically. Location of conduit runs are provided by notations and legend symbol. All conduit runs are identified by scheduled circuit number on the plans. Conduit and conductor sizes are provided only in the panelboard schedules. Complete schedules are provided on the drawings for each panelboard in accordance with the examples included in the Appendix.

Detail (1/4" scale) plans shall be provided for mechanical and electrical equipment rooms and other area of concentrated work.

The project plans shall also include large scale details for all equipment installations that cannot be adequately delineated in plan review. The required details shall include typical raceway mounting, raceway connection, motor connections, lighting fixture mounting, grounding and lightning protection installations.

101.6 FACILITY PLANNING

Facility planning shall include consideration for operating and maintenance requirements for electrical systems and equipment for the life of the facility. Safety of life for facility occupants, the public, operating and maintenance personnel and protection of property are the most important factors in the planning and design of the electrical systems. Simplicity of systems and equipment operation shall be a principal objective. Design of the electrical system shall include considerations for preventive maintenance, and for repair, test, and replacement of equipment. Safe accessibility for inspection and repair are important considerations in selecting and locating equipment. Space needs to be provided for inspection, adjustment, and repair. The space shall also be clean, well-lighted, dry, and ventilated. The equipment should be located such that replacement, as well as repairs, can be accomplished without the need for dismantling or removing other equipment.

101.7 SYSTEM PLANNING

System planning, and equipment selections, shall include maintenance considerations, consideration of energy conservation objectives to maximize efficient energy usage, and to minimize energy losses within the electrical system, on a life cycle cost effective basis.

101.8 ENERGY MANAGEMENT SYSTEMS AND DEVICES

A. In the planning and design of interior electrical systems, compatibility with energy management systems (and devices) and the potential benefits from their use shall be considered.

B. Criteria on energy analysis requirements are contained in Mechanical Design Standards, Manual 4.

SECTION 102 - MATERIALS AND EQUIPMENT

102.1 CONDUCTORS

Conductors for interior electrical systems shall be copper.

Conductors for power and lighting branch circuits shall be No. 12 AWG, minimum.

Conductors for electrical control circuits shall be No. 14 AWG, minimum. Conductor sizes for remote-control signalling and power limited circuits, fire protection signalling systems, and communication circuits, shall be in accordance with NEC Articles 725, 760 and 800.

UPS and power conditioning equipment distribution system multi-phase shared neutral conductors that feed computers, microprocessors, non-linear loads and high frequency switching power supplies shall be sized a minimum of 150-percent of the phase conductor's ampacity.
Electrical branch circuit and interior supply-side circuit conductors shall be suitably color coded. This coding or labeling shall identify voltage levels, the grounded conductors, the equipment grounding conductors, and ungrounded single-phase or poly-phase conductors. The color coding for electrical systems are shown below.

A. For 240/120-volt, single-phase, systems:

<table>
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<tr>
<th>Grounded neutral</th>
<th>White</th>
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<tr>
<td>Grounding conductors</td>
<td>Green or bare when not routed in conduit</td>
</tr>
<tr>
<td>One hot (ungrounded) conductor</td>
<td>Black</td>
</tr>
<tr>
<td>One hot (ungrounded) conductor</td>
<td>Red</td>
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B. For 208Y/120-volt, 3-phase, systems:

<table>
<thead>
<tr>
<th>Grounded neutral</th>
<th>White</th>
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<tbody>
<tr>
<td>Grounding conductors</td>
<td>Green or bare when not routed in conduit</td>
</tr>
<tr>
<td>Phase A (ungrounded) conductor</td>
<td>Black</td>
</tr>
<tr>
<td>Phase B (ungrounded) conductor</td>
<td>Red</td>
</tr>
<tr>
<td>Phase C (ungrounded) conductor</td>
<td>Blue</td>
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</tbody>
</table>

C. For 480Y/277-volt, 3-phase, systems:

<table>
<thead>
<tr>
<th>Grounded neutral</th>
<th>Gray</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grounding conductors</td>
<td>Green or bare when not routed in conduit</td>
</tr>
<tr>
<td>Phase A (ungrounded) conductor</td>
<td>Brown</td>
</tr>
<tr>
<td>Phase B (ungrounded) conductor</td>
<td>Orange</td>
</tr>
<tr>
<td>Phase C (ungrounded) conductor</td>
<td>Yellow</td>
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D. For 4160-volt, 3-phase systems:

<table>
<thead>
<tr>
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<th>Bare</th>
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<td>Phase A (ungrounded) conductor</td>
<td>Brown</td>
</tr>
<tr>
<td>Phase B (ungrounded) conductor</td>
<td>Orange</td>
</tr>
<tr>
<td>Phase C (ungrounded) conductor</td>
<td>Yellow</td>
</tr>
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102.2 RACEWAYS
Selection and installation of raceways, elbows, couplings, and other fittings shall be in accordance with the provisions of the National Electrical Code, with the following restrictions:

A. Neither aluminum conduit nor electric metallic tubing (EMT) shall be embedded in concrete or buried in earth.

B. Only noncombustible raceways shall penetrate fire-rated walls, floors, or ceilings. Raceway penetrations shall be suitably sealed to maintain the established fire ratings.

C. Wireways (NEC Article 362) shall not be wall or partition mounted at elevations less than 4-feet above floor level unless suitable protection against physical damage is provided.

Conduit that is installed in exposed, open locations, such as an atrium (where there is not a way to route the conduit concealed) shall be routed behind structural members and painted the same color as the structural members to "conceal" the conduit from view as much as is possible.

Where circuits are routed through millwork, the circuits shall be routed in conduit and concealed inside of the millwork. Coordinate conduit installation with the millwork fabricator.

Do not allow EMT to be used when exposed in equipment rooms. Do not allow exposed EMT to be installed lower than 8 feet above the floor.

Conduit and under floor duct systems which are embedded in concrete or masonry shall be adequate in number and capacities for the initial and projected facility requirements. Embedded conduits shall be not less than 3/4 inch in size.

Galvanized rigid steel conduit shall be used in all areas except where EMT and aluminum conduit are allowed. Galvanized rigid steel conduit shall be PVC coated where in direct contact with concrete.

Electric metallic tubing (EMT) shall be considered for indoor non-hazardous locations (except where the conduit would be subject to physical damage, corrosion damage and including the use restrictions above).

Provide a pull rope in all conduit left empty.

Use wireways only for exposed work. Do not fill wireways over 20 percent of their cross sectional areas. For special conditions, see the National Electrical Code.

Use under floor duct systems for multiple purpose distribution in large office and business machine areas. Power, signaling, and telephone systems shall each be run in separate cells and through compartmented junction boxes. Plan cell layouts to permit rearrangement of partitions and room layouts without revisions to under floor duct systems, other than relocation of outlets and wiring. Plan cell layouts so that no cells shall occur at partitions or on module lines. To avoid congestion in feeder ducts, provide parallel conduit feeders, usually 1-1/4 inches, from panels or closets to load areas. Select cell sizes based on wiring requirements providing for future area applications and load growth. Use the following sizes: (a) minimum cross sectional area of ducts - 3.3 square inches, (b) maximum spacing between feeder ducts - 50 feet and (3) minimum concrete cover over ducts - 3/4 inch. Insert and junction sizes are based on required wiring capacity and minimum bending radius of largest wire or cable to be installed.

A cellular floor system is the same as an under floor duct system, except that the minimum cross sectional area of the duct is 9 square inches.

Rigid plastic PVC conduit NEMA EPC-40 shall be used for underground and installation below slab on grade. PVC conduit shall transition to PVC coated galvanized rigid steel five feet outside of buildings and where it passes through foundations.

PVC conduit routed outdoors below grade shall be encased in red concrete. All PVC conduit shall have PVC coated galvanized rigid steel 90 degree bends and risers. PVC conduit installed below slabs on grade shall be encased in red concrete when structurally required and when the conduit contains electric service cables.
102.3 PANELBOARDS AND CIRCUIT BREAKERS

Panelboards rated 600V and below used for lighting and power distribution should be of the dead front type in NEMA 1 general purpose enclosures, or in higher NEMA-rated enclosures as required for the conditions to be encountered. Bus work shall be tin-plated copper. Bus current density shall not exceed 1000 amperes per square inch.

Segregate mechanical equipment loads on the power panelboards as much as is practical. Lighting panelboards and small power panelboards shall be utilized only for lighting and small power (respectively) as much as is practical.

Branch circuit breakers should be of the bolt-on, thermal magnetic, molded case type; with a minimum trip rating of 15 amperes and a minimum interrupting rating of 10,000 amperes (and larger as required by application). All single-pole circuit breakers in lighting panelboards shall be UL rated switching duty (SWD). The use of molded case circuit breakers in panelboards should be limited to no greater than the 1,200 ampere trip-rating size.

Where molded case circuit breakers of the "systems type" of from 1,200 to 4,000 ampere trap-rating sizes are to be used, they should be of the drawout type, with contacts accessible for inspection and replacement, and with suitable ground fault protection features and adjustable solid-state trip elements.

102.4 LOW VOLTAGE SWITCHGEAR AND SWITCHBOARDS

Low voltage switchgear and switchboards are of the dead-front type, floor mounted, free-standing, metal-enclosed type, insulated case circuit breaker equipped. Circuit breakers shall be stationary or draw-out mounting. (Draw-out mounting shall be used when required by design considerations and where required by the Owner.) "Space only" cubicles and appropriate bus provisions are installed for future protective device additions, as necessary, with provisions to accommodate designed load growth. Circuit breakers shall be lockable in the open position. Bus work shall be tin-plated copper with silver-plated connection joints. Bus current density shall not exceed 1000 amperes per square inch.

102.5 LOW VOLTAGE MOTOR CONTROL

Low voltage motor controls, normally, shall be of the magnetic, across-the-line type. Reduced voltage type starters shall be used when stating results in more than a 15 percent transient voltage dip. Reduced voltage starters shall be used when supplied from limited power source such as an emergency engine generator. Manual controllers may be used, within the limitations imposed by the NEC, where appropriate. Motor control centers having motor circuit protectors and motor controllers mounted in a single assembly shall be used where several motors are grouped in a particular area (i.e. mechanical equipment rooms). Bus work shall be tin plated copper with silver plated connection joints. Bus current density shall not exceed 1000 amperes per square inch.

Generally, motors having greater than 1/2 horsepower rating shall be three-phase.

102.6 4,160-VOLT SWITCHGEAR

The 4,160-volt switchgear shall be of the indoor metal-clad type utilizing vacuum circuit breakers in a two-high arrangement. The switchgear shall consist of incoming line, tie, auxiliary compartments and feeder circuit breaker units as required. Compartments shall be provided as required to accommodate indicated auxiliary equipment. The indicated number of active and spare circuit breakers shall be provided. The equipment shall be completely assembled, wired and tested at the factory, ready for installation when received at the site. All interfacing and required field connections shall be tagged and labeled to correspond to the interconnection diagrams. Unit denoted for "spare" shall consist of items of all equipment indicated including the power circuit breakers. Circuit breakers, instrument transformers, instruments, instrument switches, and relays shall be provided for equipped space or future units. Continuous current rating of future units shall be as required. Switchgear shall be vented according to the manufacturer's standard practice. Intake openings shall be screened and filtered. Exhaust openings need be screened only. Bus bars shall be tin-plated copper except joints and connections shall be silver plated. Maximum bus current density shall be 1,000 amperes per square inch.
Provide each circuit breaker with a local digital metering package that will also communicate with a digital monitoring system, that will record and remotely indicate (via telephone modem) to a central PC (personal computer) the following: amperes of all three phases, voltage of all three phases, kW, kVA, kVAR, power factor, kWH, kVARH, frequency, breaker static trip settings, peak kW, time of peak kW, programmable audible alarm limits, breaker status, date and time of breaker trip, and date and time when amperes exceeded programmable limits.

102.7  UNIT SUBSTATIONS

Unit substations shall be of the double-ended, indoor, metal-enclosed type. All metal-enclosed switchgear, primary load-interrupter switches, fuses, bus bars, structure supports, insulators, transformers, and all other component parts shall be manufactured and constructed in conformance with the latest publications of NEMA Standards PB2, SG6, TR1 and TR27. Each cubicle shall be a self-supporting, independently constructed unit.

Compartment doors shall be provided with handles with padlocking provisions. Rear access panels shall be hinged with bolt fasteners. General and modular arrangement of the unit substations including all of its component parts, shall be in conformance with the standard design of the equipment manufacturer, unless specifically noted otherwise hereinafter or on the drawings. The completed unit substation assemblies shall be available for the Owner's inspection at the manufacturer's plant before shipment. The manufacturer shall submit satisfactory test data to prove operation and performance of the unit substations in accordance with the intent of this specification. The unit substations shall be provided with leveling and alinement channels for the securing of the substation. All bus bars shall be copper with tin-plated joints with a maximum current density of 1,000A per square inch with a conductivity factor of 98 percent. Cubicles shall be properly ventilated to limit the conductor temperature rise to 149 degrees F (65 degrees C) over an ambient of 122 degrees F (50 degrees C). The continuous-rated main bus shall be properly braced for the full system short circuit as required. The main bus shall be supported on NEMA rated insulators for the voltage class, and shall have a continuous coating of PVC. Each cubicle shall contain 1/4-inch (6-mm) by 3-inch (7.6-mm) silver-plated, copper ground bus accessible for connection to the ground system and provided with at least one lug for such connections. All permanent bus connections shall have a minimum of two bolts per connection. The maximum size shipping section shall not exceed 9 feet (2.7 meters) in length.

Provide each circuit breaker with a local digital metering package that will also communicate with a digital monitoring system, that will record and remotely indicate (via telephone modem) to a central PC (personal computer) the following: amperes of all three phases, voltage of all three phases, kW, kVA, kVAR, power factor, kWH, kVARH, frequency, transformer temperature, breaker static trip settings, peak kW, time of peak kW, programmable audible alarm limits, breaker status, date and time of breaker trip, and date and time when amperes exceed programmable limits.

102.8  4,160-VOLT MOTOR CONTROL

The 4,160-volt motor control shall be provided from line-ups of NEMA Class E2 motor controllers feed from a common bus. Each controller section shall be provided with a quick-make, quick-break, fused isolation switch. Controllers shall be vacuum break, fused contactor type, providing a minimum of 400 mVA, 3-phase, symmetrical interrupting rating at 4800 volts. Controllers shall be load rated and arranged in one or two high lineup depending on size and type of contactor and motor to be controlled. Enclosures shall be compartmented into a low-voltage control compartment with separate door, high-voltage compartment with separate interlocked door, ac bus compartment with protective barriers and cable entrance compartment. Each controller shall provide single-phase protection. Controls for synchronous motors shall be reduced voltage auto-transformer type.

Induction motors rated 4,160-volt, 250 horsepower and smaller shall be squirrel cage, high power-factor type and controlled for across-the-line starting. Induction motors larger than 250 horsepower and less than 800 horsepower shall be provided with part winding (two-step control), primary reactor, auto-transformer or star-delta type controller. Motors larger than 800 horsepower shall be synchronous, brushless type and provided with auto transformer-type, reduced-voltage motor control.
Provide each circuit breaker with a local digital metering package that will also communicate with a digital monitoring system, that will record and remotely indicate (via telephone modem) to a central PC (personal computer) the following: amperes of all three phases, voltage of all three phases, kW, kVA, kVAR, power factor, kWh, kVARh, frequency, breaker static trip settings, peak kW, time of peak kW, programmable audible alarm limits, breaker status, date and time of breaker trip, and date and time when amperes exceed programmable limits.

102.9 UNINTERRUPTIBLE POWER SUPPLY (UPS)
Uninterruptible power supply shall be included to provide conditioned power to the following loads:

1. Communications equipment.
2. Computer equipment.
4. Telephone and electronic systems.
5. AGTS control room.

The UPS shall contain the rectifier/battery charger, pulse-width-modulated inverter, no-break automatic static bypass transfer switch and maintenance bypass switch. The UPS shall be sized such that the total single phase load does not exceed 75 percent of the UPS rated three-phase load. The UPS shall be sized for a minimum 10 percent of spare capacity for future loads. The load supplied by the UPS shall be designed such that the maximum phase imbalance shall not exceed 20 percent. All UPS loads shall be designed to have isolated ground receptacles or isolated ground hard wired terminations. In general, motors and incandescent lighting shall not be supplied from UPS systems because of the electrical spikes and noise generated by switching these types of loads. The UPS should be located as close to the load as is practical. The UPS distribution system multi-phase, shared neutral conductors that feed computers, microprocessors, non-linear loads and high frequency switching power supplies shall be sized a minimum of 150-percent of the phase conductor's ampacity. If an isolation transformer is used, the transformer shall be derated for harmonics, temperature and altitude.

102.10 RECEPTACLES
All electrical receptacles shall be specification grade and standard NEMA configuration types.
All electronic equipment shall be provided with isolated ground receptacles.
All plug-in equipment containing a microprocessor shall be provided with an isolated ground surge suppression receptacle.

SECTION 103 - INSTALLATIONS

103.1 DESIGN
The design of all installation shall be in accordance with NEC and codes and ordinances of the City of Denver, as the minimum requirement. Exterior and interior installations shall be coordinated with the architectural designs. The local electrical utility is Public Service Company of Colorado (PSCo).

103.2 SYSTEMS
The following systems will be utilized:

A. Utility primary feeders - in general, shall be 25 kV, three-phase, 60-hertz.
B. Multiple service facilities will be provided with metered, main secondary switchgear for 480Y/277 or 208Y/120 volt, grounded distribution circuits.
C. Single service facilities shall be provided with utility service. Transformers shall be provided by the utility. All such secondary services shall be planned to accommodate utility metering equipment.

D. Building main power distribution will be 480Y/277 or 208Y/120 volt as required, three-phase. Provide main power distribution switchboard for feeders to miscellaneous power and HVAC system load concentrations; lighting system distribution panels; motor control centers; and dry-type 480-208Y/120 volt three-phase transformers (if required) and panelboards for small power and receptacle loads. Mechanical HVAC loads shall be segregated from lighting and small power (convenience receptacle) systems where practical.

E. Central plant distribution will be 4,160 volt, three phase.

103.3 SERVICES

Service locations shall be determined to minimize the length of entrance conductors and be readily accessible from building exterior. Service entrances shall be installed underground.

Main service equipment shall be located in a nonhazardous, well-lighted, clean, dry, corrosion-free, ventilated and accessible space. Equipment shall be properly identified by labeling or stenciling at the time of installation. Where indoor transformer-switchgear vaults, indoor emergency power equipment rooms, or other large indoor equipment installations are included in the facility, they shall be so located to provide direct access to outside open areas for ease of equipment installation, removal, ventilation and in such manner that replacement (as well as repairs) can be accomplished without the need for dismantling or removing other equipment.

Metering requirements, equipment shall be provided, and metering equipment locations shall be coordinated with the supplying utility company. Each tenant space shall be individually metered. Factors affecting metering requirements will include the applicable utility rate structure, class of service, power demand penalties, power factor penalties, and other conditions of the service agreement.

Service disconnect devices shall be located as close as practical to the point of service entrance. Switching and switchgear facilities and arrangements shall satisfy the system flexibility requirements with minimum operating complexity.

Transformers provided for service to or within the facility shall be kept to the minimum necessary, consistent with initial and projected facility loads and operating continuity or other critical requirements. Standard unit-type substations shall be used, where feasible, for power transformer installations. Power transformers shall be equipped with integral forced air fan cooling, or suitable provisions for adding forced air cooling with temperature indicators and alarm features.

Power and distribution transformers shall be furnished with standard high voltage winding taps for voltage adjustment purposes. Duplicate transformers in a double-ended transformer/switchgear arrangement, should be provided where operating continuity requirements or other critical requirements dictate the needs. Due consideration shall be given to transformer maintenance requirements over the life of the facility.

103.4 EMERGENCY POWER SYSTEMS

Emergency power systems, or "standby systems" (if legally required), shall conform to requirements in Article 700, "Emergency Systems" Article 701, "Legally Required Standby Systems," of the National Electrical Code, as appropriate. The systems shall also conform to applicable requirements in NFPA 101, "Life Safety Code" and shall also be as required in regard to practical need. Design should conform to IEEE Standard 446, "Recommended Practice for Emergency and Standby Power Systems."

A. Where emergency generators are required, combustion diesel (or natural gas) engine-generator sets shall be provided.
B. These types of equipment shall be carefully sized to satisfy not only the requirements for safeguarding health, life, property, and critical operations, but also to provide effective security of the facilities.

Emergency power and lighting conduit and boxes shall be painted red.

In the absence of generated emergency power, supply to essential services, such as alarm and building egress lighting systems, fire pump equipment and essential telecommunications services may be connected to the normal power service by providing a separate disconnect switch and over-current protection on the line side (incoming side) of the main power service disconnect(s). (The only exceptions to this requirement are smoke exhaust fans and elevators which must be provided with an engine generator for emergency power.)

103.5 WIRING SYSTEMS

All wiring methods and materials shall comply with the National Electrical Code (NEC). Electrical materials and equipment shall also conform to applicable standards of the Underwriters' Laboratories Inc. (UL), or other recognized testing agencies or laboratories, to the maximum extent practicable.

Wiring systems shall be designed so that all components operate within their capacities and with a 25-percent allowance for anticipated load growth.

Emergency circuits shall not be run in the same conduit or raceway with normal circuits. Consideration shall be given to complete physical separation of routing. Emergency power and emergency lighting conduit and boxes shall be painted red.

Feeder circuit voltage drops should not exceed 2 percent.

Branch circuit voltage drops should not exceed 3 percent.

The Design Consultant shall oversize neutral conductors as required to compensate for the heating effects of 3rd order harmonics generated by single-phase, high-frequency switching power supplies contained in electronic microprocessor and computer equipment.

Transformer loading shall be derated for harmonics, maximum ambient temperature and an altitude of 5400 feet above mean sea level. Project design loads shall not utilize any of a transformer's capacity that is derived from forced air fan cooling. (This will be reserved for future loads.) Design all transformers, transformer primary (and secondary) feeders, panelboards, switchboards and associated feeders for a minimum of 25 percent capacity for future loads. Where a transformer supplies a 100 percent induction motor load, the transformer capacity shall be as indicated in the table below.

<table>
<thead>
<tr>
<th>HP</th>
<th>Minimum Three-Phase Transformer kVA*</th>
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<td>75</td>
<td>112.5</td>
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<td>100</td>
<td>112.5</td>
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</table>
*Increase by 15 percent if motor service factor = 1.15.

Increase by 20 percent if started more than once per hour.

Where a transformer supplies motor and non-motor loads, the largest motor's rated horsepower shall not exceed 20 percent of the transformer's rated kVA.

Motor stating voltage drop shall not exceed 1 percent at source panelboard, switchboard, switchgear or substation terminals and 15-percent at motor terminals.

103.6 SYSTEM PROTECTION

Circuit breakers, fuses and related protection equipment shall be so selected, sized and sequenced in their operation as to limit damage to system components and power interruptions within the facility when abnormal conditions such as overloads, voltage surges and electrical short circuits occur. The protective equipment shall have adequate load current capacities and adequate fault current interrupting ratings for the initial and projected loads and available short circuit currents. For design guidance, see IEEE Standard 242, "Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems," IEEE Standard 141, "Recommended Practice for Electric Power Distribution for Industrial Plants," and IEEE Standard 241, "Recommended Practice for Electric Power Systems in Commercial Buildings."

Where the available short circuit currents in new facilities will present problems that cannot be technically or economically resolved by the use of currently-available circuit breakers and switchgear, the use of short circuit current reducing methods such as those listed below shall be considered:

A. Provide current-limiting fuses for general reduction of short circuit duty. Determine the maximum let-through current from the fuse characteristics curves, considering both light load and full load conditions. The effective value of the maximum current so determined will serve as the basis for determining the interrupting ratings of other protection equipment on the load side of the current-limiting fuses.

B. Provide current-limiting reactors, high impedance busway, or obtain the additionally-needed impedance by the strategic selection of circuit lengths and cable sizes. The additional system voltage drops attendant with the use of these methods shall be given proper consideration.

Requirements for ground fault protection, as well as over current and phase-to-phase fault protection, shall be provided. Article 230-95, "Ground Fault Protection of Equipment," of the National Electrical Code, requires that ground fault protection be provided for solidly grounded wye electrical services of more than 150 volts to ground, but not exceeding 600 volts phase-to-phase, for each service or feeder disconnecting means rated 1000 amperes or more, with two listed exceptions. This requirement most specifically applies to 480Y/277-volt grounded systems. See Article 230-95 for this, and for other associated requirements that need to be satisfied where ground fault protection is provided.

In locations where the provision of electrical receptacles and use of low voltage equipment result in inherent personnel shock hazards from the possible line-to-ground passage of current through the human body, ground-fault circuit-interrupters (GFCI) shall be provided in accordance with the National Electrical Code.

C. These devices shall be UL listed and capable of detecting the passage of currents to ground and interrupt the circuit or circuits at a sufficiently short millisecond interrupting time to protect human life.

D. Particularly hazardous areas include those where electrical tools, appliances, fixed electrical equipment, portable electrical equipment are used, and where there is a probability of physical contact with fixed electrical ground points or surfaces by equipment
operators. The most common are kitchen areas, bathrooms, and other areas where installations of sinks, plumbing, workbenches, etc., provide exposed electrical ground points and surfaces; particularly in basement areas and wherever moist or wet conditions exist within buildings or in adjacent outside areas; and at outdoor receptacles within 6'-6" of grade level.

103.7 LIGHTNING PROTECTION

Criteria for lightning protection of buildings, structure and protection of incoming power services, are contained in Chapter 4 "Lightning Protection Systems" of this standard.

103.8 ENERGY CONSERVATION MEASURES

The following measures shall be given consideration and adopted wherever practical in the design and construction of electrical systems. This listing is not necessarily complete, and other electrical energy conservation methods that are determined to have a safe and practical application should also be considered.

A. Use higher distribution voltages, consistent with code and other safety requirements.

B. Increase feeder and branch circuit conductor sizes, to reduce energy losses in service lines to utilization equipment (where cost effective).

C. Reduce the length of branch circuit runs by locating power distribution centers as close as practical to the loads.

D. Provide three-phase utilization equipment, rather than single-phase equipment.

E. Install electrical service entrance equipment as near as possible to the epicenter of the electrical load.

F. Design for balanced loads in three-phase systems (and correct experienced unbalances during preoperational inspection and tests).

G. Design for an overall facility load power factor of 95 percent (90 percent minimum). Provide capacitors on motors and other inductive loads that require power factor correction. Provide power factor controllers for motors with widely varying loads.

H. Motor-driven equipment should be designed to start in an unloaded condition, to reduce starting power requirements. Two-speed or variable speed motors should be considered for HVAC applications to reduce energy consumption during non-peak or off-duty hours.

I. Provide highest practical standard voltage motors (e.g., 460-volt instead of 230 or 200-volt).

J. Provide high efficiency electric motors, and power and distribution transformers.

K. Local lighting controls. Lumen depreciation compensated dimming and daylight compensated dimming.

L. The Design Consultant shall perform life cycle cost analysis on all proposed energy conserving measures. The Design Consultant shall review the cost analysis and the payback period with the Project Management Team for possible inclusion of the energy conserving measure into the project.

M. Design ventilation and cooling systems for the required maximum ambient temperature of sensitive electronic and electrical equipment.
END OF CHAPTER 2
CHAPTER 3
GROUNDING SYSTEMS

SECTION 301 - GENERAL

301.1 SCOPE
This section is intended for design guidance in the selection of materials and methods of installation to provide system and equipment grounding. Emphasis is placed on the safe operation of electrical systems provided, by a measured, acceptable grounding system installed in a protected and accessible manner for future testing.

301.2 CRITERIA
These standards are developed in part, from requirements contained in publications of the following references:

A. American Society for Testing and Materials (ASTM):
   1. B8 – Concentric-Lay Stranded-Copper Conductors, Hard, Medium-Hard, or Soft.

B. National Electrical Code (NEC).


D. National Fire Protection Association (NFPA):
   1. NFPA No. 78 – Lightning Protection Code.

E. Underwriters’ Laboratories, Inc. (UL):
   1. 467 – Electrical Grounding and Bonding Equipment

F. Institute of Electrical and Electronic Engineers (IEEE):

301.3 DESIGN APPROACH
All separately derived electrical systems are grounded at the source and if remote, at each service entrance to separate premises. Equipment grounding systems shall provide electrical continuity between all noncurrent-carrying metallic parts of the system and shall have one common grounding electrode with the system ground.

System grounding for the central security control center shall be an isolated ground system for the central computer center (CCC).

System grounds are provided as follows for alternating current systems:

A. Single-phase, 3-wire: the neutral conductor is grounded.

B. Multiphase system having one wire common to all phases: the neutral conductor is grounded.
C. Grounding electrode systems including the bonding (interconnection) of all the following elements applicable at each building or facility served:

1. Metal underground water pipe in direct contact with earth for a minimum distance of 10 feet, without joints, immediately adjacent to the ground conductor connection.

2. Structural steel framework of building where effectively bonded members are connected by copper conductors to driven ground rods.

3. Perimeter ground grids of buried copper (or galvanized steel in corrosive soil) conductors and driven ground rods.

4. Driven ground rods of copper-clad steel of a minimum diameter of ¾ inch and length of 10 feet.

Design calculations for design of perimeter ground grids shall be in accordance with IEEE Standard 8-1976, Art. 42 – Analytical Expression for Resistance of Grounding Systems. System and equipment grounding shall be in accordance with the National Electrical Code. The voltage difference between noncurrent-carrying metal parts and ground shall be essentially zero to minimize personnel hazards. Equipment ground conductors shall be sized large enough to allow sufficient current to flow to trip the short circuit protection devices. Grounding conductors shall also have adequate capacity to carry the maximum available fault current without damage and be large enough to withstand possible physical and corrosive damage. Ground resistance should be low as practicable, and in no case exceed generally accepted values for the application. For reference, see IEEE Standard #142, “Recommended Practice for Grounding Industrial and Commercial Power Systems.”

The CCC isolated ground system shall be a low impedance ground, 3 ohms or less.

301.4 DESIGN TASK CATEGORIES

Design tasks require three basic attentions:

A. Effective grounding of the system neutral at the point of service.

B. Insuring continuity of the equipment grounding system throughout the facility.

C. Providing a grounding electrode conductor and grounding electrode system which provides a suitable low resistance to earth ground.

D. Provide static grounding grids for the access flooring located within the central security control center.

301.5 DESIGN ANALYSIS REQUIREMENTS

A. Uniform presentation of grounding methods and materials.

B. Calculations shall be included for grounding grids or counterpoise configurations.

C. Selection of grounding electrodes, conductor size, its physical protection and connection to electrode system.

D. Selection of equipment grounding conductors for each segment of the system based on the requirements of the N.E.C.
E. Provision for adequately grounding equipment requiring flexible conduit or cord connections.

F. Provision for ground fault interruption at services and protective devices at other utilization points in accordance with N.E.C.

SECTION 302 - MATERIALS

302.1 GENERAL

Grounding materials shall be selected from the following types:

A. Grounding conductors – insulated green-colored, copper conductor. Solid in sizes No. 10 AWG and smaller and stranded in larger sizes. In lieu of green insulation for #4 AWG and larger size conductors, 1-inch wide green-color plastic tape shall be applied at each end and at all pull and junction boxes. Buried conductor used in grids and for riser connections to building steel shall be bare, stranded soft drawn copper, minimum size of 4/0 AWG.

B. Ground Rods – Copper-clad steel or hardened copper-alloy (sectional type if required) with pointed end – 3/4 inch in diameter and 10 feet long (minimum).

C. Connection Materials – Cable to cable and cable to rod connections shall be made using exothermic-welding-type process. Connections to equipment shall be exothermic-welding-type or copper alloy connectors attached with silicon bronze bolts and lock washers.

D. Protective Tape Wrapping – Rubber type.

E. Nonmagnetic, clap type cable supports.

F. Connection to water line – cast bronze clamp with silicon, bronze bolts and nuts. Provide with ground hub for conduit termination.

G. Ground Bus Bar – 98 percent IACs copper with maximum rated current density of 1000 amperes per square inch.

H. Coatings – Coal tar compound.

I. Grounding Receptacles - Ground receptacles shall have cast bronze body suitable for flush floor mounting with brass ground stud, cover cap and chain. Body shall have ¾ inch thread for threading onto a ground rod with suitable stud connector and clip.

J. The CCC isolated ground shall consist of a 20-foot length of 2.125-inch outside diameter Type K copper with u-bolt pressure plate.

SECTION 303 - INSTALLATIONS

303.1 GENERAL

Grounding systems installations requirements shall be described and delineated in detail. Provide for system inspection before covering connection on buried work. Except where
conditions otherwise prohibit, all exposed non-current carrying metallic parts of equipment
connected to or operated by the electrical system shall be included in the equipment grounding
system. Provide for grounding of metallic raceway systems, grounding conductor of the system.
Provide a “green” insulated ground conductor for all circuits that are feeders to panel boards,
switchboards, motor control centers, transformers, 480-volt (and higher) motor circuits and all
isolated ground circuits. The Design Consultant shall evaluate the length of all other feeder and
branch circuit conduit, the conduit impedance and their short-circuit protection to determine if an
equipment ground conductor is required for safe operation during a ground fault. Provide
bonding across (or within) all flexible conduit and expansion couplings (and fittings).

303.2 SYSTEM GROUND

The neutral conductor of the supply system (including secondary neutral of all power and control
power transformers) shall be solidly grounded at the main service equipment and extended to
the point of entrance of the metallic water service and grounding electrode. Connection to the
water pipe shall be made with a suitable ground clamp. Where flanged water pipes are
encountered, grounding connection shall be made on the street side of the flange connection.
Metallic water service shall be grounded as described by NFPA. Where there are no metallic
water services to the building, system ground connection shall be made only to driven ground
rods. A building outer perimeter ground grid shall be provided if required to obtain sufficiently
low resistance. System grounding conductor shall be in conduit and continuous, without splice
or joint, to the electrode connection.

303.3 EQUIPMENT GROUNDING

System shall provide an insulated, green-colored, equipment grounding conductor for all
feeders to panel boards, switchboards, motor control centers, transformers, 480-volt (and
higher) motor branch circuits, and all isolated grounds. This conductor shall be separate from
the electrical system neutral conductor. For conductors #4 AWG and larger, the wire can be
identified by a 1-inch wide band of green tape at each end and at each pull and junction box.

303.4 BUILDING GROUND ELECTRODE SYSTEMS

Building grounding electrode grid systems shall comply with requirements of Article 250 of the
National Electrical Code. Connections to the grounding grid and ground rods shall be made
with exothermic welded joints.

303.5 EQUIPMENT GROUND BUS

A separate equipment ground bus shall be provided in each panel board, switchgear assembly
and switchboard for the grounding and bonding of the equipment grounding conductors. The
equipment ground bus required in each panel board shall be sized in conformance with the
requirements of the NEC. Non-current-carrying metal parts of electric equipment shall be
effectively grounded by solid bonding to the equipment ground bus. The equipment ground bus
in the unit substations and 480-volt switchgear shall be bonded to both the system neutral
water-service ground, and to the ground grid systems. The equipment ground bus shall be of
flat tinned copper in one piece. Connection and splices shall be of the pressure-connector type.

303.6 OTHER GROUNDING SYSTEM INSTALLATIONS

Provide for the proper installation of other grounding system components as follows:

A. Wire and cable:
1. Install using as few joints as possible.
2. Protect against abrasion by several wrappings of rubber tape at all points where cable leaves concrete in exposed areas.
3. Suitable protect cable against damage during construction.
4. Replace or suitably repair cable, if damaged before final acceptance.

B. In exposed installations:
1. Route runs in conduit.
2. Route along the webs of columns and beams, and in corners where possible for maximum physical protection.
3. Support at intervals of 3 feet or less with nonmagnetic clamp-type supports.

C. In Buried Installations:
1. Lay in the bottom of trench or in other excavations at least 18 inches below finished grade.
2. Maintain clearance of at least 12 inches from all underground metal piping or structures, except where connections thereto are specifically indicated.
3. Chemically degrease and dry completely before welding.
4. Apply one coat of coal tar coating at 15 mils dry film thickness to all exothermic-welded connections to be buried.

D. Make connections to equipment as follows:
1. Make up clean and tight to assure a low-resistance connection.
2. Install so as not to be susceptible to mechanical damage during operation or maintenance of equipment.
3. Provide direct copper connection to buried ground grid system.

E. Ground Rods:
1. Install rods as indicated by driving and not by drilling or jetting. Except CCC isolated ground shall be drilled.
2. Drive rods into unexcavated portion of the earth where possible.
3. Where rods must be installed in excavated areas, drive rods into earth after compaction of backfill is completed.
4. Drive to a depth such that top of rods will be approximately 18 inches below final grade, or subgrade, and connect main grid ground cable thereto.

F. Metallic Conduit Grounds:
1. Where conduit enters cable tray, adequately ground to cable tray, with a cable tray conduit clamp and a conduit grounding bushing connected to the ground cable in the tray. Adequately and properly ground all terminal points and wherever isolated from equipment or grounded steel.
2. Where extending into switchgear or other floor-mounted equipment from
below, connect to metallic conduit grounding bushing and equipment ground bus (or frame if there is no bus).

3. Where extending into a manhole, handhole or cable trench, connect to the ground riser or cable at that structure using grounding bushings.

G. Cable Tray and Rack Grounds:
   1. Ground at proper intervals.
   2. Ground all continuous runs as well as isolated section at least at one point.

H. Manhole Grounds:
   1. Ground all hardware to ground rod extensions in manholes with bare copper unless indicated otherwise.
   2. Connect manhole ground rods to the underground duct system ground conductors.

I. Medium Voltage Box Grounds:
   1. Ground all medium voltage pull and junction boxes by direct copper connection to the buried ground grid system.

J. Grounding Bus:

   Insulate and support grounding bus at proper intervals.

K. Ground fence enclosure at each post with connectors designed for this application. Install flexible braid straps across all hinge points and gates for fence enclosures.

L. Ground all motor frames larger than 75 hp and associated equipment enclosures to the ground grid.

   Ground all 480-volt (and higher) motors with “identified” ground conductors in addition to conduit system. Route in conduit with phase conductors.

M. Lightning Arrester Grounds: Where three arresters are mounted together on the same structure or transformer, connect them to a riser loop ground cable, connected at each end to the buried ground grid. Do not enclose in magnetic conduit or permit close magnetic encirclement of conductors.

N. Computer and telephone equipment shall be provided with isolated ground receptacles.

O. Other miscellaneous electronic systems shall be provided with isolated ground receptacles.

P. Each section of wireway shall be grounded a minimum of one time or every 10 feet, whichever is more.

Q. A bare copper 500 MCM grounding conductor shall be looped between each perimeter building expansion joint and bonded to structural steel on each side of the expansion joint.
END OF CHAPTER 3
CHAPTER 4
LIGHTNING PROTECTION SYSTEMS

SECTION 401 - GENERAL

401.1 SCOPE
This section is intended as design guidance for the provision of lightning protection systems for all types of structures other than structures used for the production, handling, or storage of ammunition, explosives, flammable liquids or gases, or explosive ingredients. Requirements for materials and procedures for special or unusual design shall be added as necessary for specific facilities.

401.2 CRITERIA
All designs shall be according to the latest edition of these criteria, or according to this section, whichever is more stringent:

A. National Fire Protection Association (NFPA) Publications:
   1. NFPA 70 - National Electrical Code (NEC) as adopted and amended by the Denver Building code.
   2. NFPA 780 - Standard for the Installation of Lightning Protection

B. Underwriters’ Laboratories Inc. (UL) Publication
   1. UL 96 - Lightning Protection Components
   2. UL 96A - Installation Requirements for Lightning Protection Systems
   3. UL 467 - Grounding and Bonding Equipment

401.3 DESIGN APPROACH
Most existing DIA structures were originally constructed with a Lightning Protection System.

All new structures at DIA shall be provided with a Lightning Protection System. The Designer shall inquire of the DIA Project Manager whether Lightning Protection will be required on the specific structure; Lightning Protection shall be required unless the Designer is instructed otherwise, in writing, by the DIA Project Manager.

For design work on existing structures, whether the existing structure has Lightning Protection or not, the Designer shall also seek guidance from the DIA Project Manager. The Project Manager shall instruct the Designer, in writing, whether to add Lightning Protection or to upgrade existing Lightning Protection.

Lightning Protection System design shall be considered at the earliest stages of design, so that the system can be functionally and aesthetically incorporated with all other design features.

Lightning Protection shall be designed to comply with standards listed in “401.2 Criteria”, and any other appropriate code or standard. Lightning Protection systems shall generally be designed and installed according to UL 96A, such that a UL Master Label can be granted. In some cases, due to architectural or other features, a Master Label may not be possible; in these cases, the Lightning Protection System design shall nevertheless be designed, as closely as
feasible, according to the requirements and intent of UL96A, and NFPA780. Variations from Master Label requirements shall be discussed with and approved by the DIA Project Manager.

### 401.4 DESIGN ANALYSIS REQUIREMENTS

In addition to the requirements of Design Standards Manual 1, designs require a uniform presentation of factors considered as follows:

A. Dimensioned plan and elevation of structure or structure element to be protected.

B. Placement of air terminals.

C. Conductor routing and size.

D. Location and type of conductor supports.

E. Location of bonding to service entrances to building steel etc.

F. Provisions for its physical protection of components.

G. Location and type of grounding electrodes, test wells, counterpoise, etc.

H. Calculations of the approximate resistance of electrode system to earth ground.

I. Provision for field measurement of resistance.

J. Detail drawings as needed for clarity of design.

### SECTION 402 - MATERIALS

#### 402.1 GENERAL

Use materials as described in the documents listed in previous sections. The following requirements are in addition to those:

Copper shall be the material of choice for all Lightning Protection Systems at DIA. Where roofing system or other building components may be galvanically incompatible with copper lightning protection system components (such as galvalume parapet caps), the lighting protection system shall be designed and configured to prevent direct contact of the copper with such component. Aluminum lightning protection components may be used only to protect aluminum building components or equipment where no UL Listed fittings exist to prevent direct contact of the lightning protection component with such surface.

All counterpoise (loop) conductors shall be minimum 2/0, with minimum strand size 17 AWG.

Ground rods shall be minimum of ¾” diameter, 10’ length, copper clad.

### SECTION 403 - INSTALLATIONS

#### 403.1 GENERAL

Where feasible and appropriate, DIA encourages the use of structural steel as the down conductor, as allowed by UL96A; the intent being to minimize the possibility of damage to the
conductors, as well as to improve aesthetics. Design shall ensure that all structural steel is electrically continuous and that all metallic components are bonded, either inherently or through approved bonding connections.

In addition to the ground rods required by previous sections and by other requirements of this section, a ground rod shall be included at every change of direction of the building footprint, unless accepted by the DIA Project Manager.

A test well shall be installed to allow future access to each ground rod for testing and inspection purposes. The test well and cover must meet the maximum traffic ratings required for the anticipated use of the area.

A counterpoise loop conductor shall interconnect all ground rods. The ground rods and counterpoise shall be approximately 3 feet outside of the foundation (at least 2 feet), and the counterpoise shall be buried approximately 30” below final grade.

Exothermic welds are required for all connections below grade.

Design of the Lightning Protection System shall consider likely damage that may occur to components, and a means shall be designed to avoid and/or easily repair that damage.

Roof top metal light-masts and other such appurtenances shall be bonded to the lightning protection system. Any luminaire or other fixture less than 3/16” in thickness shall be fitted with an air terminal and bonded appropriately to the mast.

END OF CHAPTER 4
SECTION 501 - GENERAL

501.1 SCOPE
This section includes design guidance for the selection and application of indoor and outdoor lighting equipment. Emphasis is placed on equipment quality (maintainability) and efficient use of energy integrating aesthetically with architectural design. Lighting systems are developed to provide comfortable visibility with adequate intensities for safe and effective task accomplishment. It is the intention that lighting designs integrate with architectural and other planning objectives to the maximum extent practical.

501.2 CRITERIA
These standards are developed, in part, from requirements contained in publications of the following references:

A. American national Standards Institute (ANSI)
B. Certified Ballast Manufacturers (CBM)
C. Illuminating Engineering Society (IES)
D. National Fire Protection Association (NFPA)
E. National Electrical Code (NEC)
F. National Electrical Manufacturer's Association (NEMA)
G. Reflector and Lamp Manufacturer's (RLM) Standards Institute
H. Underwriters' Laboratories, Inc. (UL)

501.3 DESIGN APPROACH
Design computations for lighting levels shall be zonal cavity or equivalent sphere illumination (ESI) methods for all applications, except floodlighting. Floodlighting, special lighting techniques and emergency lighting shall be calculated with the point-to-point method. Complex geometric spaces shall require glare analysis (light source and wall luminance), source color matching and point-to-point calculations. Lighting levels shall be in general accordance with the Lighting Handbook published by IES.

501.4 STANDARDIZATION OF EQUIPMENT
Basic lighting equipment types, light sources and fixture components shall be standardized to effect an optimum of installation, operating and maintenance costs. Designs for special purpose of special effect lighting requiring non-standard fixtures shall be carefully selected to avoid difficult maintenance attentions and availability of replacement components.

501.5 DESIGN TASK CATEGORIES
Design tasks have two basic equipment application categories defined as follows:
A. Interior – Environmentally controlled spaces within buildings.

B. Exterior – Non controlled environments within structures or outdoors and regularly exposed to the elements of dust, low temperature, and high humidity.

501.6 DESIGN STANDARDS NOMENCLATURE
The use of the following standard nomenclature is applied herein and is encouraged throughout the design development.

A. Large area – common purpose area with uniform ceiling height, construction and having floor areas generally 1,200 square feet (or larger). This description excludes corridors, passageways and other narrow space utilizations generally less than 16 feet in width.

B. General area lighting – application of design technique affording an average, overall illuminance with the application of uniform, regularly spaced luminaries (unless stated elsewhere in Manual 5).

C. Supplementary lighting – provisions for a relatively small area of lighting with the objective of requiring higher lighting levels for particular seeing tasks. Special task lighting levels are limited to 5 times that of the general surroundings. Lighting for merchandise may be up to 10 times that of the general surroundings.

D. Special task lighting – provisions for a relatively small area of lighting with the objective of requiring higher lighting levels for particular seeing tasks. Special task lighting levels are limited to 5 times that of the general surroundings. Lighting for merchandise may be up to 10 times that of the general surroundings.

E. Special effect lighting – design to accentuate size, shape, color, enhance and coordinate the aesthetics of a space (and objects) within the space.

F. Normal mounting height – a space affording a fixture mounting height of 14’-0” or less. (Mounting height is defined as the height above the finished floor level to the bottom of the luminaire whether surface mounted, recess mounted or suspended.)

G. Low-bay area – a space requiring fixture mounting height greater than 14 feet and less than 28 feet.

H. High-bay area – a space requiring fixture mounting height of 28 feet and greater.

I. Photometrics – luminaire performance data consisting of candela values and zonal cavity coefficient of utilization table.

501.7 DESIGN ANALYSIS REQUIREMENTS
Designs require a uniform presentation of each lighting task calculation. Format for the design analysis is included in the Appendix. The calculations shall be accompanied with copies of catalog or other manufacturer’s data for the equipment. Data shall include photometrics, fixture dimensions and descriptions of construction and component conformance with these standards.
Point-by-point illuminance calculations shall be submitted for each non-repetitive lighting design task. Other calculations listed under 501.3 may be requested. The Design Consultant shall anticipate daylight component and shall assist in the coordination of architectural elements to eliminate direct and reflected glare from either natural or electric light sources. The designs shall be developed from an appraisal of all of the factors involved. This shall include a knowledge of interiors finished, interior designs and desired color appreciation. Design for the main terminal building and concourses must be responsive to the following separate objectives which must be satisfied with a minimum of conflict:

A. General area illumination  
B. Emergency (egress and exit) illumination  
C. Illumination signage (airport information and tenant displays).  
D. Special task illumination  
E. Special effect illumination

Design shall address discomfort glare, both direct and reflected (glare shall be minimized) based on an evaluation of each lighting ambient. Fixture “visual comfort probability” (VCP) values for applicable room size and mounting heights are presented in the photometric data shall be used for this evaluation.

Design illuminance levels shall generally conform to the recommendations of the IES. However, the contribution of all light sources present in a particular area of design shall be appreciated. (See specific design guidelines for public area of the main terminal complex 503.5).

Perform zonal cavity or ESI calculations when applicable. Perform point-to-point calculations for flood lighting applications, emergency lighting applications and other applications involving non-uniform lighting.

SECTION 502 - EQUIPMENT

502.1 GENERAL

Equipment types and lamp source selected for the various applications shall be selected on the basis of fixture efficiency and economical adaptation to the particular lighting task.

502.2 EQUIPMENT

For general requirements, fixtures shall be of standard, high-efficiency, commercial grade. Emphasis shall be placed on aesthetics, performance and energy efficiency of fixtures, selected on the basis of minimum life-cycle costs and satisfaction of visual task requirements. Proper consideration shall be given to glare and color rendition.

For fixtures located in exits, stairways, ramps, elevators, and landings, the diffusers and lenses shall be of noncombustible materials.

Electromagnetic ballasts shall be UL listed, thermally protected, and shall conform to CBM-ETL (Certified Ballast Manufacturers – Electrical Testing Laboratory) requirements.

Exit and emergency lighting systems shall be provided in accordance with NFPA Code no. 101, “Safety to Life from Fire in Buildings and Structures.” In addition, limited emergency lighting shall be provided for outdoor walkways, parking lots and parking structures.
Fluorescent lamp electromagnetic ballasts shall be of the high-power factor type. Electromagnetic ballasts installed indoors in non-air-conditioned and air-conditioned spaces shall be low-energy full-light-output-premium type. The electromagnetic ballast case shall not exceed 194 degrees F (90 degrees C) when operated in a 158 degrees F (70 degrees C) heat box. The test shall be conducted at a minimum of 86 degrees F (30 degrees C) with CBM/ETL and UL testing procedures. Electromagnetic ballasts shall be guaranteed not to overheat capacitor insulating oil beyond manufacturer’s warranty limit. The electromagnetic ballasts shall be Class “P” with automatic resetting thermal protectors.

The Design Consultant shall calculate the payback for utilizing electronic rather than electromagnetic fluorescent ballasts, for each application. If the calculated payback period is less than the minimum requirement of the Project Management Team, then electronic ballast shall be utilized.

Fluorescent electronic solid-state, high-frequency, ballast shall be capable of operation standard fluorescent lamps and shall not reduce the lamp life. The ballast shall operate the lamp at a frequency of 20-35 KHz with no detectable flicker. The ballast shall be Class P thermally protected, high power factor type (90% or higher), sound rated "A" or better, contain no PCB's, be UL listed and ETL tested. The electronic ballast shall meet EMI and RFI specifications for FCC regulations, Part 15J and will not interfere with delicate electronic equipment. Electronic ballasts shall consume a minimum of 25 percent fewer watts than the core-and-coil ballasts without reducing the lamp lumen output. The light fixture lamp holders shall be those recommended by the electronic ballast manufacturer.

Fluorescent lamp ballast for fixtures installed in exterior spaces shall be high power factor, Class P, cold weather ballasts capable of satisfactory lamp operation down to -20 degree F.

All fluorescent lamps shall have a correlated color temperature of 3500 degrees Kelvin.

Metal-halide and high-pressure sodium lamp ballast shall be of the high-power factor, constant-wattage type and shall be contained within a common enclosure with the fixture assembly. The ballast shall be provided with thermal protection in the primary windings. The ballasts shall be compatible with the voltage characteristics of the system. The ballasts shall compensate for an input voltage range of plus or minus 10 percent and shall be capable of withstanding a maximum line voltage dip of 40 to 50 percent for a period of 4 seconds. The HID ballasts shall be of the high-ambient temperature type suitable for applications in spaces up to 150 degrees F (65 degrees C).

Lamp holders or industrial, strip and other open type fluorescent fixtures shall be of the type requiring forced movement along the longitudinal axis of the lamp for insertion and removal of the lamp.

Accessories such as straps, mounting plates, nipples, brackets, cord and plugs, special hangers and receptacles necessary for proper installation shall be specified to be furnished with the fixtures.

**SECTION 503 - INSTALLATIONS**

**503.1**

Lighting designs shall provide for economical installation and maintenance costs. Installation in low and high bay areas shall anticipate the method of access, such as, portable elevating platforms or top relamping in areas accessible from above.

Ceiling fixtures shall be coordinated with and suitable for installation in, or, or from the ceiling type provided. Installation and support of fixtures shall be in accordance with NFPA 70 and
manufacturer’s recommendations. Surface-mounted fixtures shall be suitable for fastening to the structural support for ceiling panels.

Suspended fixtures shall be provided with swivel hangers in order to insure a plumb installation. Pendants 4 feet or longer shall be braced to limit swinging. Single-unit suspended fluorescent fixtures shall have twin-stem for wiring at one point, and a tubing or rod suspension provided for each length of chassis including one at each end. Minimum distance between adjacent tubing or stems shall be 8 feet. Rod shall not be less than \( \frac{1}{2} \) inch diameter.

Recessed fixtures shall have adjustable fittings to permit alignment with ceiling panels. Recessed fixtures installed in fire-resistive type of suspended ceiling construction shall have the same fire rating as the ceiling or shall be provided with fireproofing boxes having materials of the same fire rating as the ceiling panels, in conformance with the Building Materials Directory of Underwriters Laboratories, Inc.

503.2

Metal halide or fluorescent lighting shall be provided in areas where finer visual tasks are performed. Large area, general lighting, where color rendition is of secondary concern, shall utilize high-pressure sodium luminaries for general ambient lighting. The following are some examples of such areas:

A. Central utility plant
B. Maintenance facilities
C. Air cargo facility
D. Aircraft hangars
E. Fire, crash and rescue facility
F. Rental Car support facilities
G. Parking structures
H. Large area, low and high-bay, general lighting (interior), where color rendition is of concern, fixtures shall be selected with metal halide lamps. Typical areas of application are as follows:

I. Terminal building passenger ticketing level, baggage claim level and atrium
J. Concourses
K. Train station exit pavilions, loading platform, train skids
L. Hotel lobbies

503.3 LARGE AREA, NORMAL MOUNTING HEIGHT LIGHTING

For finished interior spaces – terminal areas, offices, tenant spaces and other areas accessible to the public, recessed fluorescent type fixtures shall be utilized.
For interior maintenance and utility areas: surface and pendant mounted, open, industrial, fluorescent type fixtures shall be applied.

In maintenance and utility areas defined as an exterior space: closed, gasketed, surface and pendant mounted, industrial, fluorescent type fixtures shall be used.

503.4 CONSIDERATIONS FOR ENERGY CONSERVATION

Lighting system design shall consider the following list of energy conservation measures. The Design Consultant shall provide recommendations and supporting data for measures incorporated in the system.

A. Provide highly flexible manual/automatic switching systems that will permit turning off all unused or unnecessary lights. Consider connecting lighting system zones to a central supervisory control system when available in the building.

B. Install automatic photo-controls on lighting circuits which control interior lighting along exterior walls of facilities, where sunlight transmitted through windows will provide ample illumination without electric lighting. Automatic photo-controls should be set at 500 footcandles of outdoor illumination.

C. Design for luminaire relocation flexibility to meet changing operation requirements, and evaluate use of low-voltage switching systems (24 volts or lower) for flexible switching capability.

D. Provide multi-level ballasts to permit varying lumen output for fixtures.

E. Provide the most efficient luminaries, lamps and ballasts.

F. Provide luminaries having fluorescent lamps with higher lumens-per-watt output, such as those listed below, after giving proper consideration to lamp life, lamp costs and fixture costs.
   1. One 8-foot, 800ma, high-output lamp instead of three 4-foot, 430ma rapid-start lamps
   2. One 4-foot rapid-start lamp or one U-tube lamp instead of two 2-foot preheat lamps.
   3. Do not use reduced wattage lamps.

G. Design lighting for the tasks, and locate luminaries as directly over the task area as practical, within the limits of the luminaire supporting systems.

H. Use higher lighting circuit voltages (e.g., 277-volt systems), together with low voltage (24-volt) switching systems.

I. Provide more energy-efficient light sources (e.g., metal halide or high pressure sodium vapor). The new T-8 fluorescent lamps have produced more lumens per watt than the T-12 fluorescent lamps. Note that in the application of high-pressure sodium vapor, it is important to keep in mind that people will not perceive color warnings and other safety-related information in these lighting environments in the same manner as under incandescent or fluorescent lightning. These HID energy – conserving lamps do not have the same color-rendering properties as do some
traditional, but less energy efficient light sources. While incandescent lamps emit energy through the visible region of the spectrum, and the wave lengths produced result in easy recognition of the reds, greens, oranges, and blues; high-pressure sodium vapor lamps emit most of their energy in the yellow portion of the spectrum.

J. Evaluate use of greater contrast between task lighting (work station) and background lighting (work area), such as 8-to-1 and 10-to-1, consistent with safety and operation requirements.

503.5 SPECIFIC DESIGN GRUIDELINE FOR MAIN TERMINAL COMPLEX

The following guideline for the terminal lighting has been separated into various public areas with distinctive functions and environments. The average illuminance levels listed reflect the general design objective. The minimum acceptable illuminance levels are also listed for each area.

A. Main Circulation Area – Daytime

1. Eave = 100 fc average maintained for atrium
2. Eave min = 50 fc maintained
3. Ambiance/Qualitative Criteria
   a. Daylight ambient for an outdoor atmosphere, sunlight sparkle from natural or direct component electric sources. This direct component would be most suitable over trees and plantings. Maximize daylight potential and minimize direct sun component except over plants and trees.
   b. Minimize glare from direct component and glazed areas. Luminance ratios with adjacent surfaces should be no greater than 10:1, preferable 5:1. This should be accomplished through aiming and shielding of luminaries. Consideration shall be given to bi-level automatically switched (or dimmed) HID lighting systems.
   c. Keep surfaces reasonable “clean” and uncluttered through the selection of unobtrusive equipment placed at strategic locations. One exception would be luminaries intended as architectural features. These architectural luminaries should have minimal “brightness.”
   d. Source colors should be in keeping with outdoor atmosphere; possible a variety to correspond to the different times of the day.
   e. Diffuse, brightly illuminated ceiling, walls and other appropriate surfaces.

B. Main Circulation Area – Nighttime

1. Eave = 35 fc average maintained (minimum for heavy traffic areas)
2. Eave min = 20 fc maintained
3. Ambiance/Qualitative Criteria
   a. Create a smaller, more intimate, “human” scale conveyed through corresponding scale of lighting
b. Provide a soft ceiling glow which shall be achieved with unobtrusive luminaries to avoid the “cave” effect.

c. Provide a brighter light level below 20 feet, fairly uniform for safety, yet not a constant level in appearance for atmosphere.

d. Minimize reflections from the floor and glazing.

e. Sparkle shall be created through dramatic highlighting of trees, paintings, sculptures, and art work.

f. Minimize glare and brightness from any pedestrian-scale lighting.

g. Maintain adequate luminance ratios (5:1 or 10:1) between retail stores and adjacent surfaces, thus making them easily recognizable and attractive to enter.

h. Avoid visual “noise” that could compete with meaningful information such as signage, etc. Examples of this are highlighted, unattractive, meaningless objects or high glare lighting systems.

i. Provide an adequate inter-reflected component to soften shadowing, especially on people’s faces.

j. Lamp colors shall be warm in tone.

C. Ticket Counters

1. Eave = 70 fc average maintained

2. Eave min – 50 fc maintained

3. Qualitative Criteria

   a. Provide a highly uniform light level on the counters with a direct linear fluorescent lighting system above the counters.

   b. Provide adequate vertical brightness for improved people recognition, set apart from adjacent circulation areas.

   c. Minimize glare from electric lighting for both passengers and employees.

   d. Back wall company logos should be highlighted with a continuous linear wall wash yet shall not display veiling reflections on video display terminal (VDT) screens.

D. Baggage Claim

1. Eave = 50 fc average maintained

2. Eave min + 35 fc maintained

3. Qualitative Criteria

   a. Provide a fairly bright, uniform illumination with a good horizontal and vertical distribution for ease in identifying luggage and reading tags.

   b. Brighten the space and deemphasize the long lobby by using an indirect lighting system that creates a repeating pattern across the ceiling. Highlight soffits at both ends and allow them to go darker in
the middle. Provide metal halide direct/indirect luminaries for the columns.
c. Highlight wall-mounted art work.
d. Signage shall be easily recognizable and should contrast with the immediate surroundings.
e. Luminance ratios between baggage claim devices and art work shall be between 3:1 and 5:1.

E. Rental Car Counters
1. Eave – 70 fc average maintained
2. Eave min – 50 fc maintained
3. Qualitative Criteria
   a. See Ticket Counters (C).

F. Ground Transportation Centers
1. Eave = 50 fc average maintained
2. Eave min = 35 fc maintained
3. Qualitative Criteria
   a. Provide a sufficient contrast between signage and surroundings to aid in identification. Luminance ratios shall be between 3:1 and 5:1. Provide fluorescent direct and indirect systems. Illuminate vaulted ceiling sections, which shall add contrast to the flat sections of the ceiling.

G. Restrooms
1. Eave = 45 fc average maintained
2. Eave min = 35 fc maintained
3. Qualitative Criteria
   a. Create the perception of a clean, bright space by utilizing bright surfaces within general areas and stalls.
   b. Provide high uniformity throughout the space.
   c. Minimize direct glare and reflections in the mirrors.
   d. Provide a high vertical footcandle level at the mirrors.
   e. The source chosen shall have excellent color rendering characteristics, particularly for skin tones.

H. First Aid Rooms
1. Eave = 5 and 80 fc maintained.
2. Qualitative Criteria
   a. Provide a high uniform light level with bright surfaces in the examination area. Create subdued lighting with war color rendition
b. Provide adequate and uniform vertical illuminance for the administration of first aid.

I. Interior Space Features
1. Emin = 500-1,000 fc average maintained at the top of trees (a minimum of 8 hours per day).
2. Emin = 250 fc average maintained at base of trees (a minimum of 10 hours per day).
3. Emin = 50 – 200 (in general) for other plantings. Coordinate the lighting intensity for each application with the interior landscape Design Consultant. Also coordinate the direction of the lighting and control of the lighting with the interior landscape Design Consultant.
4. Provide clear metal halide lamps for all trees and plantings.
5. Qualitative Criteria
   a. Provide a strong direct component over tree canopies for part of the daytime. Metal halide is recommended.
   b. Provide subdued lighting level for the nighttime to proved a dormant period.
   c. Highlight vertical faces and underside of tree canopies (and shrubs) to create a dramatic effect.

J. Telephone Kiosks
1. Eave = 45 fc average maintained on counter.
2. Eave min = 35 fc maintained on counter.
3. Qualitative Criteria
   a. Provide a low glare system.
   b. Provide adequate vertical illumination on the telephones.
   c. Concealed source continuous fluorescent fixture at junction of planting bed and surrounding plaza areas, see architectural detail.

K. Information Booths
1. Eave = 50 fc average maintained (minimum)
2. Qualitative Criteria
   a. Create a sufficient contrast with the immediate surroundings by highlighting vertical surfaces for easy identification.

L. Seating Areas
1. Eave = 10 – 70 fc average maintained.
2. Qualitative Criteria
   a. Create the following different moods:
   b. Public area shall be fairly brightly illuminated (waiting groups,
people with children, etc.) Create a fairly bright atmosphere with uniform, ambient, bright vertical surfaces and some visual interest with color.

c. More subdued, intimate and private areas shall contain nonuniform lighting for reading, relaxing, sleeping, etc. Provide varying levels, or illumination for each activity, with some darker surfaces at strategic locations. Also provide some diffuse lighting for reading, writing, etc.

d. Add visual interest by highlighting art work, sculptures, etc.

M. AGT

1. Eave = 30 fc maintained on trains (minimum)
2. Eave = 15 fc maintained at boarding zones (minimum)
3. Qualitative Criteria
   a. On the train provide very uniform, brightly illuminated surfaces to promote the perception of a clean environment.
   b. Provide a low-glare system.
   c. Boarding zones shall be brightly illuminated vertical surfaces of the trains and signs, etc.
   d. The tracks are within the stations shall only be illuminated when the train is in the station.
   e. Reinforce the train station theme with wall-mounted, compact fluorescent (or dimmed incandescent) pedestrian luminaries mounted above signage. Provide recessed metal halide downlights along the underside of the atrium level barrier to supplement the ambient lighting from the indirectly illuminated roof above. Highlight and backlight obelisks, columns (in floor mounted lights can also be utilized) and arch forms along the upper wall (concealed linear neon can be utilized).
   f. Provide illumination for easy visual identification of signs, etc. – minimize visual “noise”.
   g. The AGT corridor lighting shall provide special interest for passengers.

N. Escalators

1. Eave = 40 fc average maintained at landings (minimum).
2. Eave min = 25 fc maintained.
   a. Qualitative Criteria
   b. Minimize vertical glare going up or down.
   c. Provide some indirect component of illumination to minimize shadows.
   d. Integrate the lighting with the main lobby. Highlight interior landscaping below escalators as a main focus area. Highlight
selected trees and plants with shielded accent lights, creating a natural shadowing effect.

O. Elevators
1. Eave = 25 fc average maintained
2. Qualitative Criteria
   a. Tamper-proof
   b. Minimize glare with combination of concealed and direct sources in the ceiling.
   c. Ceiling lighting shall also wash walls to enlarge the space.
   d. Do no use inefficient incandescent sources that will produce a large amount of heat.

P. Parking
1. Eave = 2 fc average maintained for surface parking.
2. Eave = 5 fc average maintained for parking structures.
3. Qualitative Criteria
   a. Minimize glare.

Q. Atriums
1. Eave = 10 fc maintained (nighttime)
2. Qualitative Criteria
   a. Create an “outdoor village at dusk” atmosphere with metal halide glowing “historic” pedestrian lights cast “pools” of light on the ground. Provide wall-mounted lights similar to those in the AGT area, except these will have concealed metal halide up-lights in addition to the compact fluorescent (or dimmed incandescent) direct down lights.
   b. The ceiling overhead shall be illuminated with metal halide floodlights to give a rosy hue at the “horizon” (ceiling perimeter) and a darker blue-violet overhead.
   c. Interior landscaped areas are the main attraction of the space. Metal halide concealed (or camouflaged) post-mounted area lights and ground-mounted floodlight shall highlight, bring out colors, emphasize textures and define overall shapes of the interior landscape, providing strong light/dark will stimulate an evening marketplace environment. All obstacles shall be illuminated so that safety is not compromised. Glowing storefronts shall spill light into the “streets.”

END OF CHAPTER 5
SECTION 601 - GENERAL

601.1 SCOPE
This section is intended to guide the Design Consultant in the area of Fire Detection and Alarm System design for the Denver International Airport. General criteria are set forth as well as drawing and design analysis requirements. The fire detection and alarm system shall be designed for the possible future integration with various other data, communication and alarm systems. Options available to the Design Consultant are also spelled out.

601.2 CRITERIA
The requirements contained in this section are based upon the National Fire Protection Association (NFPA), the International Building Code (IBC) the International Fire Code (IFC), as well as City and County of Denver Building and Fire Department Amendments. Specifically the fire detection and alarm systems shall conform to the appropriate year provisions of NFPA including but not limited to pamphlets 70, 72, 92A, 92B and 415. Specific requirements for each building type will come from this document as well as the appropriate sections of the documents listed above.

601.3 DRAWING REQUIREMENTS
The Design Consultant shall show all fire detection and alarm system requirements in the contract documents. As a minimum the drawings shall show the following.

A single-line diagram shall depict all control panels, initiating devices, indicating devices, HVAC interface functions, protection system activation devices, power connections and central alarm system communication interfaces. The diagram shall show the control panel zone to which each device or group of devices is connected. Capacities and available addresses must be verified.

Control schematic diagrams for air handling equipment shall show the appropriate contacts to provide the required interlocks with the fire alarm system or with individual smoke detectors.

Accurate floor plans shall be provided which show the location of all control panels and devices.

Preliminary single-line diagrams shall be provided with the schematic design review documents. At this stage, zone designations and wiring information need not be presented.

Preliminary floor plans shall be provided with the design development review documents. Fire detection and alarm system features may be combined on common floor plans with the lighting design for the facility. Control panel locations should be shown as well as a typical device layout for each functional type of space in the facility.

601.4 DESIGN ANALYSIS REQUIREMENTS
The Design Consultant shall provide a design analysis to substantiate the fire detection and alarm system design. The design analysis shall indicate the origin of facility specific fire detection system requirements. It shall also indicate the rated area of coverage for the type of detector used as well as any derating required for ceiling heights, etc. It shall also include rationale for the location and spacing of alarm indicating devices.
A Fire Alarm System Basis of Design shall be provided. It should have at least the following categories included. Building Description, Laws & Regulations, Design Responsibilities, Fire Alarm System Type, Design Methodology, Testing & Inspection, Equipment & Tools, Requirements for Submittals and End of Job Closeout

601.5 MORE STRINGENT DOCUMENT PROVISIONS

Should there be a conflict among the requirements of this document and the NFPA documents referenced above, the Design Consultant shall comply with the more stringent requirements.

SECTION 602 - INITIATING DEVICES

602.1 ADDRESSABLE HEAT DETECTORS

A heat detector is a device that detects abnormally high temperature or rate-of-temperature rise. Detectors may sense the rate of rise of air temperature, the combination of rate of rise of temperature and a fixed temperature, or a fixed temperature compensated by rate of rise.

Heat detectors are slower responding than smoke detectors, but are generally less expensive and less prone to false alarm. They are recommended where speed of detection and life safety are not of prime consideration. They also provide responsive performance where a high heat release fire might be expected. They can provide reliable performance in industrial areas which might be expected to cause false alarms with smoke detectors.

Heat detectors shall be utilized blow raised floors that contain electrical (or data) cable s and where the use of other type smoke detectors are prohibited because of high air velocities.

The Design Consultant must make the appropriate accommodations in accordance with NFPA 72E when applying heat detectors to derate for ceiling heights and take into account unusual ceiling configurations.

602.2 ADDRESSABLE SMOKE DETECTORS

A smoke detector is a device that detects the visible or invisible particles of combustion. Smoke detectors may be of the photoelectric type depending on the application. In-duct smoke detectors shall be the particles of combustion (products of combustion) type and installed where required by NFPA. Smoke detectors utilized shall be suitable for operation at 5,400 feet above mean sea level.

Smoke detectors are generally used where speed of detection and life safety are of primary concern. They may be used in conjunction with Halon suppression systems, when the suppression systems are required.

Air velocity, altitude, vapor of any kind, gas and fumes, all affect detector sensitivity. Ambient conditions such as air movement, ceiling lights, location of supply and return air diffusers shall be considered to assure proper design and optimum operating conditions.

602.3 ADDRESSABLE MANUAL STATIONS

A manual station is an initiating device which is operated manually at the discretion of the operator. Manual stations shall be double-action, breakglass type devices with key operated reset. They shall be addressable.

Manual pull stations in public areas shall also have an adjacent emergency telephone station for direct voice communication with the Communications Center.
602.4 ADDRESSABLE VALVE TAMPER SWITCHES
Supervise all control valves in either open or closed positions.

602.5 ADDRESSABLE WATER FLOW INDICATOR
For all wet-pipe and dry-pipe system zones there shall be an individual initiating zone. Water flow alarms may be other than sprinkler flow zones and shall be identified to the device connection and monitoring.

602.6 ADDRESSABLE PRESSURE SWITCH
For all dry-pipe systems, preaction and deluge systems: All dry-pipe systems shall each have their own alarm zone.

602.7 ADDRESSABLE ALARM PRESSURE SWITCH
For Halon systems: These suppression systems shall each have their own alarm zone.

602.8 ADDRESSABLE LOW AIR PRESSURE
For all dry-pipe pre-action systems and other supervised for integrity systems shall have low air switches.

602.9 ADDRESSABLE DRY OR WET CHEMICAL SYSTEM PRESSURE SWITCHES
For all kitchen hoods. In addition to control of the gas/utilities and the ventilation systems the hood systems shall send both trouble and alarm to the main fire alarm systems.

602.10 FIRE PUMPS
Supervise power on and pump run status from each fire pump and fire booster pump at the complex, in addition to the requirements by NFPA 20 for supervision.

602.11 APPLICATION MATRIX
The following application matrix indicates recommended options for the type of detector to use in various types of areas.

<table>
<thead>
<tr>
<th>Application:</th>
<th>Type of Detector:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Manual Station</td>
</tr>
<tr>
<td>Kitchens</td>
<td>X</td>
</tr>
<tr>
<td>Hotels</td>
<td>X</td>
</tr>
<tr>
<td>Atriums</td>
<td>X</td>
</tr>
<tr>
<td>Hangars</td>
<td>X</td>
</tr>
<tr>
<td>Retail Stores</td>
<td>X</td>
</tr>
<tr>
<td>Parking Structures</td>
<td>X (not part of alarm)</td>
</tr>
</tbody>
</table>
SECTION 603 - INDICATING DEVICES

603.1 AUDIBLE ALARMS
Audible alarm devices shall be used in all areas as required by applicable codes. The audible signal shall be significantly different from other signals and shall be per the requirements of NFPA 72A (See Design Chapter 7). In the terminal and concourse complex, the audible emergency voice communications will be generated by the Public Address system. All tenant spaces shall have a public address system.

In remote facilities, the audible alarms shall be horns.

603.2 VISUAL ALARMS
Visual alarms shall be provided in all areas where audible alarms are provided. They may be a separate unit and mounted adjacent to the audible alarm or provided as an integral combination with the audible device. They shall not be located inside of the fire command centers.

Horn strobes used for personnel alert not associated with the fire alarm system shall strobe a different color than the fire alarm system. No systems other than fire alarm shall strobe clear or white.

603.3 EMERGENCY PUBLIC ADDRESS
An emergency public address system shall be provided in public areas, including tenant areas, in accordance with NFPA 72F to assist in controlling emergency egress. The normal public address system shall be used for emergency purposes. The public address system shall be designed to be clearly heard by all occupants of the building.

Prerecorded or live voice announcements shall be preceded with an alert tone for a period of five to ten seconds.

SECTION 604 - ACTUATING DEVICES

604.1 WATER AND AQUEOUS FILM FORMING FOAM RELEASE
Water and AFFF release valves shall be specified to be furnished as part of the valve trip furnished by the fire protection system contractor. The specifications shall clearly indicate the coordination requirements between the fire detection system and the release valves when required.

604.2 CLEAN AGENT RELEASE
Clean Agent release devices shall be specified to be furnished as part of the Clean Agent system furnished by the fire protection system contractor. The specifications shall clearly indicate the coordination requirements between the fire detection system and the release
devices. Clean Agent control panels and detection devices shall be furnished by the fire protection system contractor in accordance with the fire detection system specifications.

604.3 HVAC SHUTDOWN

The fire detection system shall be interlocked to the start smoke evacuation fans and position dampers in the affected areas, as required. If duct smoke detectors are required by NFPA 90A they shall shutdown the HVAC unit, initiate the fire alarm (via smoke detector’s auxiliary alarm contacts) and be continuously supervised for trouble by the fire alarm system (via smoke detector trouble contact).

604.4 DOOR RELEASE

Fire alarm system shall deactivate door release magnets to close the doors and establish release for required controlled exit doors.

SECTION 605 - LOCAL CONTROL PANELS

Provide control panels for each local system for housing device and circuits necessary to perform required detection and protection system functions, and to service as test points and trouble service points. The control panels shall be designed to monitor sprinkler system flow switches and fire protection supervisory systems.

605.1 CIRCUIT SUPERVISION

Electrical supervision shall be provided as follows:

A. The wiring between the local fire alarm panels and all automatic fire detectors, manual pull stations, audible and visual signaling devices, actuation devices, tamper switches and flow switches.

B. Standby battery voltage and battery circuit continuity. Trouble alarm shall be sounded if battery voltage falls below 85 percent.

C. The ac power supply for the fire alarm panels.

D. The position of all panel control switches. The abnormal position of any switch, or any other disarrangement of this system shall cause the activation of the trouble signal.

605.2 COMMUNICATIONS

Local fire alarm control panels shall be provided with capability to communicate any alarm or trouble condition to the central system.

605.3 POWER SUPPLY

The local fire alarm control panels shall be designed to operate from 120 volt, 60-hertz, single-phase power source. They shall be provided with batter backup of sufficient capacity to allow system monitoring for a period as required by NFPA 72 and then with enough reserve capacity to actuate local alarms for five minutes.

SECTION 606 - GRAPHIC ANNUNCIATION PANELS
A graphic annunciation panels shall be provided at all of the fire command centers which shall indicate the location of the actuated detection or protection device. The annunciator shall contain emergency power controls (keyed on/off), applicable fire pump status and applicable fire pump trouble. The panel shall be located in the main entrance to the area and be accessible to fire protection authorities.

SECTION 607 - CENTRAL SYSTEM

All fire alarm and trouble signals at the airport will be monitored at the Communications Center. This location will be continuously manned. This central system will conform to NFPA 72D, Proprietary Protective Signaling Systems, it also reports to a remote monitoring station.

607.1 SYSTEM CONFIGURATION

The system may be a loop configuration. The system hardware shall allow for the future interface with an integrated data, communication and alarm system digital network using fiber-optic technology.

607.2 HARDWARE

The central system will be microprocessor based and capable of supporting initial and future remote signaling systems. The system shall be designed to be easily expandable over the life of the airport.

They system shall be designed to support a keyboard and color CRT for operator interface, graphic representation of the remote signaling locations, and an 80 column-wide dot matrix printer to record alarms and event on 9-1/2 inches wide by 11 inches long perforated continuous paper. Fire alarms shall be in red and trouble alarms shall be in black. Each alarm shall be described by a complete English description.

All central systems hardware shall be powered from the UPS.

607.3 COMMUNICATIONS

All communication circuits shall be supervised. Communication hardware and system shall allow for any point in alarm condition to be recognized by the central system within time limits determined by the authority having jurisdiction. The system shall be designed with redundant circuits such that the loss of one communication line will be annunciated, but will not result in the system being rendered inoperable.

607.4 POWER SUPPLY

The central system located in the Communications Center shall be designed to operator from 120 volt, 60-hertz, single-phase power source. It shall be provided with UPS power that is backed up by the emergency generator.

SECTION 608 - INSTALLATION

All fire alarm wiring shall be installed in conduit. Data cables shall not be installed in the same conduit as notification cables or power cables.

The design documents shall require that all fire alarm system equipment and material be installed and tested in accordance with the pertinent provisions of NFPA and NFPA 70, the “National Electrical Code.”

END OF CHAPTER 6
CHAPTER 7
PUBLIC ADDRESS SYSTEMS

SECTION 701 - GENERAL

701.1 SCOPE

This section is intended to guide the design engineer in the area of public address system design for the Denver International Airport. The public address system shall comply with NFPA 72F, “Installation, Maintenance and Use of Emergency Voice/Alarm Communications Systems.” General criteria is set forth as well as drawing and design analysis requirements.

Options available to the Design Consultant are also spelled out.

701.2 CRITERIA

The requirements contained in this section are based upon the Federal Communications Commission (FCC) rules and regulations, the Electronic Industries Association (EIA) publications, the Institute of Electrical and Electronics, Inc. (IEEE) standards, the National Fire Protection Association (NFPA) codes, and the American National Standards Institute, Inc. (ANSI) standards. Specific requirements for the public address system will come from this document as well as the appropriate sections of the documents listed above.

The Design Consultant of all the airport public address systems shall be an acoustical consultant experienced in the design of similar public address systems, for similar type facilities. The public address system shall provide fire alarm alert tones, evacuation signals and the entire system shall be in accordance with NFPA 72F, “Installation, Maintenance and Use of Emergency Voice/Alarm Communication Systems.”

701.3 DRAWING REQUIREMENTS

The Design Consultant shall show all public address system requirements in the contract documents. As a minimum, the drawings shall show the following:

A single-line diagram depicting all control panels, input devices, amplifiers, speakers, horns, and telephone and fire alarm system interfaces. The diagram shall show the paging zone to which each device or group of devices is connected.

Floor plans shall be provided which show the location of all control panels, amplifiers and devices.

Preliminary single-line diagrams shall be provided with the schematic design review documents. At this stage, zone designations and wiring information need not be presented.

Preliminary single-line diagrams shall be provided with the schematic design review documents. At this stage, zone designations and wiring information need not be presented.

Preliminary floor plans shall be provided with the design development review documents. At this stage, zone designations and wiring information need not be presented.

Public address system features may be combined on common floor plans with the telephone system design for each facility. Input device and control panel locations should be show as well as typical speaker layouts for each functional type of space in the facility.
701.4 DESIGN ANALYSIS REQUIREMENTS

The Design Consultant shall provide a design analysis to substantiate the public address system design. The design analysis shall indicate the origin of specific facility public address system requirements. It shall also indicate the rated area of coverage for the type of speakers used as well as calculations indicating the audible sound pressure throughout the space, power required from each speaker and amplifier sizing. The design analysis shall include catalog cuts of each selected equipment type.

701.5 MORE STRINGENT DOCUMENT PROVISION

Should there be a conflict among the requirement that this document and the documents referenced above, the Design Consultant shall comply with the more stringent requirements.

701.6 AMBIENT NOISE LEVELS

The following table of approximate ambient noise levels shall be used in public address system design.

<table>
<thead>
<tr>
<th>Application</th>
<th>Sound Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shop Average</td>
<td>85 dB</td>
</tr>
<tr>
<td>Holding Areas</td>
<td>70 dB</td>
</tr>
<tr>
<td>Retail Space</td>
<td>65 dB</td>
</tr>
<tr>
<td>Computer Room</td>
<td>60 dB</td>
</tr>
<tr>
<td>Office</td>
<td>55 dB</td>
</tr>
<tr>
<td>Restaurant</td>
<td>50 dB</td>
</tr>
<tr>
<td>Lobbies</td>
<td>45 dB</td>
</tr>
<tr>
<td>Hotel Room</td>
<td>40 dB</td>
</tr>
</tbody>
</table>

SECTION 702 - MICROPHONE STATIONS

Any microphone station within a facility shall be capable of being programmed into any zoned group. Microphone stations shall be capable of making emergency zone group announcements, terminal zone group announcements, local zone group announcements, and multi local group announcement.

A green LED will be provided at the microphone station to indicate that the zones are ready for announcement. A red LED will be provided at the microphone station to indicate that a selected zone is busy. The central control will queue the microphone to the busy zone and change the indication to green when the zone is free.

SECTION 703 - SPEAKERS

The public address system design will use a distributed speaker system layout. The design hearing height shall be 5 foot above the floor in general areas and 4 foot above the floor where permanent seating is provided. The public address system shall be designed to deliver announcements at five dBA above the highest expected ambient noise level or 15 dBA above the 24-hour average mean square noise level.

The Design Consultant shall show in the design analysis an elevation view showing speaker mounting height, spacing and the angle of dispersion. The Design Consultant shall also show
calculations to verify the power delivered to the speakers. Catalog cuts of the typical manufacturers’ data shall be provided in the design analysis.

SECTION 704 - AMPLIFIERS
Amplifier system design shall be modular, made up of 200 watt plug-in, replaceable modules. The system shall be configured so that loss of any one module card will not interrupt system performance appreciable. Amplifiers shall be of high performance.

The Design Consultant shall provide calculations in the design analysis which verify the power rating of the amplifiers.

SECTION 705 - MIXERS
The mixer is the piece of equipment which will have several inputs, variously selectable, and one common output which drives the amplifier. Each input should have volume control to allow adjustment of the strength of signal from each source, individually. A volume meter should be specified for the mixer to allow the operator to see the actual volume of sound being mixed.

SECTION 706 - CENTRAL CONTROLS
Central controls shall be located in the Communications Center.

Central controls shall be microprocessor-based programmable controls to allow maximum flexibility for the public address systems. The design shall require that the central control allow any microphone station to be programmed so that it is capable of addressing any or all zones. The control shall queue access requests into each paging zone to allow access in turn. It shall allow for digital recording and play back of announcements and allow prerecorded messages with control access for play, stop-play, record or monitor from any assigned microphone station. The system shall allow automatic ON/OFF switching of microphone stations based upon a real time clock. The entire system shall be internal to the control system and shall be provided with a 24-hour battery backup, capable of being fully recharge from 85-percent voltage in 48 hours.

Announcements shall have assignable priority levels such that high priority emergency announcements may interrupt lower priority announcements. The system shall require two levels of password security to protect system programming assignments. The system shall provide programmed automatic daily testing of the entire public address system. Systems used for fire annunciation shall have automatic testing compatible with NFPA 72F. A system which provides automatic gain control to compensate for transient, ambient noise shall be provided in public areas.

SECTION 707 - INSTALLATION
The public address system cables shall be installed in conduit and plenum rated cables can be installed in cable tray.

The design documents shall require that all public address system equipment and material be installed and tested in accordance with the pertinent provisions of NFPA and the National Electrical Code.

END OF CHAPTER 7
CHAPTER 8
TELEPHONE SYSTEMS

SECTION 801 - SCOPE
This section is intended to guide the Design Consultant in the area of telecommunications design for the many varied types of facilities and buildings at the Denver International Airport.

General criteria is set forth as well as drawing and design requirements. The telephone system shall be designed for the possible future integration with various other data, communication and alarm systems. Options available to the Design Consultant are also indicated.

SECTION 802 - CRITERIA
Basic telecommunications service will be provided to the airport buildings by the local utility, U.S. West Communications. Systems installed in each facility will be either an extension of the U.S. West Communications’ system or privately owned/leased system. Privately owned/leased systems and components must be manufactured to acceptable industry standards and also be compatible with the U.S. West Communications’ system. Raceways shall meet the requirements of Section 202 of this standard. The telecommunications system shall be designed for possible integration with various other data, communication and alarm systems.

SECTION 803 - DESIGN APPROACH
Telecommunications shall be provided in each facility to serve the specific communications needs of that facility. This would include the special communications needs of the building or system function as well as the needs of tenants and users of the facility and may include voice, data, and/or video communications services. Space allocations and design, mechanical and electrical services and premises wiring system shall all meet the specific requirements of the telecommunications system installed. Raceways to accommodate the required premises wiring shall be installed as part of the construction of the facility and shall meet the requirements of section 202.2 of this standard. Power requirements of the system and power requirements of all pay telephone credit card readers shall be coordinated with the telephone supplier.

Require a minimum of one pay telephone Telecommunication Device for the Deaf (TDDs) per terminal and concourse. (Preferable one TDD for every 15 pay telephones.) Also, require on pay telephone TDD at the Information Center and at the Travelers Aid Booth.

SECTION 804 - DRAWING REQUIREMENTS
The Design Consultant shall show all telecommunications system requirements in the contract documents. As a minimum the drawing shall show the following:

A. A single-line diagram to depict the telephone switching equipment, telephone instruments, telephone outlets, terminal cabinets, premises wiring and other system components.

B. Each system component shall be identified as to its type and location.

C. Floor plan drawings to show the location of each system component, outlet, instrument, and the distribution wiring.

END OF CHAPTER 8
CHAPTER 9
SECURITY SYSTEMS

CONTAINED IN MANUAL 2.

END OF CHAPTER 9
CHAPTER 10
CENTRAL CORRECTED CLOCK (MASTER CLOCK) SYSTEMS

SECTION 1001 - SCOPE
This section is intended to guide the Design Consultant in the area of master time keeping system design for the many varied types of buildings at the Denver International Airport. General criteria is set forth as well as drawing and design requirements. The clock system shall be designed for the possible future integration with various other data, communication and alarm systems. Options available to the Design Consultant are also indicated.

SECTION 1002 - CENTRAL CONTROL
The central control will be located in the Communications Center.

Master Time Keeping service will be provided in each facility where required by the tenant or user. The service shall be provided by use of a master time controller which provides a minute impulse and hourly supervision of indicating clocks.

The master shall be equipped with battery backup for 60 hours of reserve capacity.

The time signal distribution shall be by dedicated wiring and shall be made available to all areas of the terminal complex for initial and future use.

1002.1 INDICATING DEVICES
Indicating clocks shall be digital and shall be automatically regulated from the master time keeping system hourly for correction of minutes and seconds. Other devices shall be designed into the system to fit user requirements such as signaling time card systems.

SECTION 1003 - DRAWING REQUIREMENTS
The Design Consultant shall show all time keeping system requirements in the contract documents. As a minimum the drawings shall show the following:

A. A single-line diagram to depict the complete time keeping system including central control, booster stations, indicating devices, wiring and other system components.

B. Floor plan drawings shall show the location of each system component.

END OF CHAPTER 10
CHAPTER 11
ENTERTAINMENT TELEVISION SYSTEMS

SECTION 1101 - SCOPE
This section is intended to guide the Design Consultant in the area of entertainment television system design for the Denver International Airport. General criteria are set forth as well as drawing and design requirements. Options available to the Design Consultant are also indicated.

SECTION 1102 - DESIGN APPROACH
Entertainment television service shall be provided in each facility where required by the tenant or user. The service shall be provided by a third party vendor such as cable television company, broadcast company, or other similar commercial supplier. Accommodations shall be provided as part of the construction of the facility for the installation of system components and premises wiring. These accommodations are to include adequate equipment room space complete with the required mechanical and electrical services. Empty raceways are to be included for the installation of premises wiring.

In the designated disabled person waiting room, provide a minimum of one television (additionally one for every four televisions in the waiting room) with the closed captioning device for the hearing impaired.

SECTION 1103 - CRITERIA
Raceways shall meet the requirements of section 202.2 of this standard.

System and/or component antenna shall not be installed on the exterior of buildings or in any location that may be in the public view.

SECTION 1104 - DRAWING REQUIREMENTS
The Design Consultant shall show all entertainment television system requirements in the contract documents. As a minimum the drawings shall show the following:

A. A single-line diagram to depict the entertainment television system including receivers, amplifiers, outlets, terminal cabinets, raceways, and other similar system components.

B. Each system component shall be identified with its type and location.

C. Floor plan drawings to show the location of each system component, outlet, and the distribution raceways.

END OF CHAPTER 11
CHAPTER 12
FACILITY DESIGN DESCRIPTIONS

SECTION 1201 - PASSENGER TERMINAL

The passenger terminal electrical service will be provided by Public Service Company of Colorado (PSCo) at multiple points around the perimeter of the building. Secondary service (480Y/277 and/or 208Y/120 volt) will be provided by PSCo. Utility meters are owned by PSCo. The passenger terminal will be served through the city-owned secondary metering distribution equipment. Metered service will be taken at the city’s metering equipment to serve the general building systems and equipment. Tenant systems and equipment will be served by separate individually metered services for each tenant taken from the city’s metering equipment. Tenant service(s) will be extended by the tenant from the city’s metering equipment to the tenant’s main distribution panelboard located in their space.

Emergency electrical power will be provided from the central utility plant through a city-owned 4160 volt emergency distribution system. Transformation to, and distribution of, 480Y/277 and 208Y/120 volt emergency power to serve systems and equipment shall be provided, as required.

1201.1 TICKETING LEVEL

Normal electrical power for systems and equipment will be provided at 480Y/277 volts and 208Y/120 volts. Electrical service will be distributed throughout the space to serve heating, ventilation, and air conditioning (HVAC) equipment, smoke ventilation, lighting systems, elevators, escalators, baggage conveyors, passenger loading bridges, and general convenience power.

Emergency electrical power for systems and equipment will be provided at 480Y/277 volts and 208Y/120 volts. Emergency electrical power will be distributed throughout the space to serve elevators, exit & egress lighting, fire detection & alarm, security, communications, public address system, data systems, central corrected clock, EMCS, airline reservation ticketing equipment, airline computers, and flight information display (FID) equipment.

Lighting offices and other similar low ceiling spaces will be provided by use of recessed fluorescent luminaries. Decorative surface and recessed fluorescent luminaries will be used to light the counter areas. Metal halide luminaries will be used to light the large, open, high ceiling areas of the space. Industrial fluorescent luminaries will be used to light storage areas, equipment rooms, and similar spaces. Lighting control will be by use of local switching in offices and other non-public spaces. Ambient lighting control using stepped switching and/or dimming will be utilized in spaces where daylighting is possible. Microprocessor-based, remote controlled, low-voltage switching systems will be utilized for lighting control in all spaces where it can be justified by occupancy and life cycle cost analysis.

The interior space will be fire sprinklered and the fire sprinkler system shall be alarmed and supervised. Smoke detection will be provided in all non-sprinklered areas and in HVAC supply and return air systems, when required by NFPA 90A. Thermal detection devices will be installed in all non-sprinklered spaces when the use of smoke detectors is not appropriate due to the normal or expected presence of products of combustion. Manual, alarm-initiating devices will be installed in public and non-public spaces near exits. Public spaces will be provided with emergency telephones adjacent to fire alarm manual pull stations. The fire alarm system shall
be connected to the central airport fire alarm system. Evacuation alarms and announcements will be transmitted through the public address system.

A public address system will be installed throughout the areas to provide for general paging announcements and evacuation and alarm signals and announcements. The system in this area will be served from a central master system and zoned as required to accommodate local, general area, and system-wide paging announcements. Public address input stations will be installed throughout the ticket counters.

Communication raceway systems will be installed to provide for distribution of the telephone system throughout the space. The telephone distribution will provide service for telephones, courtesy telephones, data communication, and other telephone system related communications. A separate communication raceway system will be installed to provide for distribution of airline reservations, flight information, baggage information, and other airline data communication wiring.

The central corrected clock system will be distributed throughout the space. Clocks will be installed in convenient locations in the public areas.

The security system will be distributed throughout the space to monitor and/or alarm activities in the general public areas and other areas as is deemed appropriate and necessary. The security system shall be connected to the central airport security system.

1201.2 BAGGAGE CLAIM LEVEL

Normal electrical power for systems and equipment will be provided at 480Y/277 volts and 208Y/120 volts. Electrical power service will be distributed throughout the space to serve HVAC equipment, lighting systems, elevators, escalators, baggage conveyors and general convenience power.

Emergency electrical power for systems and equipment will be provided at 480Y/277 volts and 208Y/120 volts. Emergency electrical power will be distributed throughout the space to serve elevators, exit and egress lighting, fire detection and alarm, central corrected clock, EMCS, public address system, security, communications, data systems, airline reservations, flight information display (FID) equipment, and baggage information display (BID) systems.

Lighting of offices and other smaller, low-ceiling spaces will be provided by use of recessed fluorescent luminaries. Decorative surface and recessed fluorescent and metal halide luminaries will be used to light the main baggage claim areas. Industrial fluorescent and high-pressure sodium luminaries will be used to light the baggage and operations areas. Lighting control will be by use of local switching in offices and other non-public spaces. Ambient lighting control using stepped switching and/or dimming will be utilized in spaces where daylighting is possible. Microprocessor-based, remote-controlled, low-voltage switching systems will be utilized for lighting control in all spaces where it can be justified by occupancy and life cycle cost analysis.

The interior space will be fire sprinklered and the fire sprinkler system will be alarmed and supervised. Smoke detection will be provided in all non-sprinklered areas and in HVAC supply and return air systems, when required by NFPA 90A. Thermal detection devices will be installed in all non-sprinklered spaces where the used of smoke detectors are not appropriated due to the normal or expected presence of product of combustion. Manual, alarm-initiating
devices will be installed in public and non-public spaces near exits. Public spaces will be provided with emergency telephones adjacent to fire alarm manual pull stations. The fire alarm system shall be connected to the central airport fire alarm system. Evacuation alarms and announcements will be transmitted through the public address system.

A public address system will be installed throughout the area to provide for general paging announcements and evacuation and alarm signals and announcements. The system in this area will be served from a central master system and zoned as required to accommodate local, general area, and system wide paging announcements.

Communication raceway systems will be installed to provide for distribution of the telephone system throughout the space. The telephone distribution will provide service for telephones, courtesy telephones, data communication, and other telephone system related communications. A separate communication raceway system will be installed to provide for distribution of airline reservations, flight information, baggage information, and other airline data communication wiring.

The central corrected clock system will be distributed throughout the space. Clocks will be installed in convenient locations in the public areas.

The security system will be distributed throughout the space to monitor and/or alarm activities in the general public areas and other areas as is deemed appropriate and necessary. The security system shall be connected to the central airport security system.

**1201.3 ATRIUM**

Normal electrical power for systems and equipment will be provided at 480Y/277 volts and 208Y/120 volts. Electrical power service will be distributed throughout the space to serve heating, ventilation, and air conditioning equipment, lighting systems, elevators, escalators, and general convenience power.

Emergency electrical power for systems and equipment will be provided at 480Y/277 volts and 208Y/120 volts. Emergency electrical power will be distributed throughout the space to serve elevators, exit and egress lighting, fire detection and alarm, central corrected clock, EMCS, public address system, security, smoke ventilation, communications, data systems, and airline reservations and flight information display (FID) equipment.

Lighting of offices and other similar low-ceiling spaces will be provided by use of recessed fluorescent luminaries. Decorative surface and recessed fluorescent luminaries will be used to light the public low ceiling areas. Metal halide luminaries will be used to light the large, open, higher ceiling areas of the space. Industrial fluorescent luminaries will be used to light storage areas, equipment rooms and similar spaces. Lighting control will be by use of local switching in offices and other non-public spaces. Ambient lighting control using stepped switching and/or dimming will be utilized in spaces where daylighting is possible. Microprocessor-based, remote-controlled, low-voltage switching systems will be utilized for lighting control in all spaces where it can be justified by occupancy and life cycle cost analysis. Provide low voltage lighting for outdoor and water features.

The interior space will be fire sprinklered and the fire sprinkler system shall be alarmed and supervised. Smoke detection will be provided in all non-sprinklered areas and in the HVAC supply and return air systems, when required by NFPA 90A. Thermal detection devices will be
installed in all non-sprinklered spaces where the use of smoke detectors are not appropriate due to the normal or expected presence of products of combustion. Manual, alarm-initiating devices will be installed in public and non-public spaces near exits. Public spaces will be provided with emergency telephones adjacent to fire alarm manual pull stations. The fire alarm system shall be connected to the central airport fire alarm system. Evacuation alarms and announcements will be transmitted through the public address system.

Public address system will be installed throughout the area to provide for general paging announcements and evacuation and alarm signals and announcements. The system in this area will be served from a central master system and zoned as required to accommodate local, general area, and system-wide paging announcements.

Communication raceway systems will be installed to provide for distribution of the telephone system throughout the space. The telephone distribution will provide service for telephones, courtesy telephones, data communication, and other telephone system related communications. A separate communication raceway system will be installed to provide for distribution of airline reservations, flight information, baggage information, and other airline data communication wiring.

The central corrected clock system will be distributed throughout the space. Clocks will be installed in convenient locations in the public area.

The security system will be extended into and throughout the space to monitor and/or alarm activities in the general public areas and other areas as is deemed appropriate and necessary. The security system shall be connected to the central airport security system.

**1201.4 TRAIN STATION SECURITY**

Normal electrical power for systems and equipment will be provided at 480Y/277 volts and 208Y/120 volts. Electrical power service will be distributed throughout the space to serve HVAC equipment, lighting systems, and general convenience power.

Emergency electrical power for systems and equipment will be provided at 480Y/277 volts and 208Y/120 volts. Emergency electrical power will be distributed throughout the space to serve exit and egress lighting, fire detection and alarm, public address system, central corrected clock, security, EMCS, communications, data systems, and airline reservations and flight information equipment.

Lighting of offices and other similar, low ceiling spaces will be provided by use of recessed fluorescent luminaries. Decorative surface and recessed fluorescent luminaries will be used to light the public low ceiling areas. Metal halide luminaries will be used to light the large, open, high ceiling areas of the space. Industrial fluorescent luminaries will be used to light storage areas, equipment rooms and similar spaces. Lighting control will be by use of local switching in offices and other non-public spaces. Ambient lighting control using stepped switching and/or dimming will be utilized in spaces where daylighting is possible. Microprocessor-based, remote-controlled, low-voltage switching systems will be utilized for lighting control in all spaces where it can be justified by occupancy and life cycle cost analysis.

The interior space will be fire sprinklered and the fire sprinkler system shall be alarmed and supervised. Smoke detection will be provided in all non-sprinklered areas and in the HVAC supply and return air systems, when required by NFPA 90A. Thermal detection devices will be
installed in all non-sprinklered spaces where the use of smoke detectors are not appropriate due to the normal or expected presence of products to combustion. Manual, alarm-initiating devices will be installed in public and non-public spaces near exits. Public spaces will be provided emergency telephones adjacent to fire alarm manual pull stations. The fire alarm system shall be connected to the central airport fire alarm system. Evacuation alarms and announcements will be transmitted through the public address system.

A public address system will be installed throughout the area to provide for general paging announcements and evacuation and alarm signals and announcements. The system in this area will be served from a central master system and zoned as required to accommodate local, general area, and system-wide paging announcements.

Communication raceway systems will be installed to provide for distribution of the telephone system throughout the space. The telephone distribution will provide service for telephones, courtesy telephones, data communication, and other telephone system related communications. A separate communication raceway system will be installed to provide for distribution of airline reservations, flight information, baggage information, and other airline data communication wiring.

The central corrected clock system will be distributed throughout the space. Clocks will be installed in convenient locations in the public area.

The security system will be extended into and throughout the space to monitor and/or alarm activities in the general public areas and other areas as deemed appropriate and necessary. The security system shall be connected to the central airport security system.

**1201.5 TRAIN STATION EXIT PVILIONS**

Normal electrical power for systems and equipment will be provided at 480Y/277 volts and 208Y/120 volts. Electrical power service will be distributed throughout the space to serve HVAC equipment, lighting systems, elevators, escalators, and general convenience power.

Emergency electrical power for systems and equipment will be provided at 280Y/277 volts and 208Y/120 volts. Emergency electrical power will be distributed throughout the space to serve elevators, exit and egress lighting, fire detection and alarm, central corrected clock, EMCS, public address system, security, communications, data systems, and airline reservations and flight information equipment.

Lighting of offices and other similar low-ceiling spaces will be provided by use of recessed fluorescent luminaries. Decorative surface and recessed fluorescent luminaries will be used to light the public low-ceiling areas. Metal halide luminaries will be used to light the large, open, high ceiling areas of the space. Industrial fluorescent luminaries will be used to light storage areas, equipment rooms and similar spaces. Lighting control will be by use of local switching in offices and other non-public spaces. Ambient lighting control using stepped switching and/or dimming will be utilized in spaces where daylighting is possible. Microprocessor-based, remote controlled, low-voltage switching systems will be utilized for lighting control in all spaces where it can be justified by occupancy and life cycle cost analysis.

The interior space will be fire sprinklered and the fire sprinkler system shall be alarmed and supervised. Smoke detection will be provided in all non-sprinklered areas and in the HVAC supply and return air systems, when required by NFPA 90A. Thermal detection devices will be
installed in all non-sprinklered spaces where the use of smoke detectors are not appropriate due to the normal or expected presence of products of combustion. Manual, alarm initiating devices will be installed in public and non-public spaces near exits. Public spaces will be provided with emergency telephones adjacent to fire alarm manual pull stations. The fire alarm system shall be connected to the central airport fire alarm system. Evacuation alarms and announcements will be transmitted through the public address system.

A public address system will be installed throughout the area to provide for general paging announcements and evacuation and alarm signals and announcements. The system in this area will be served from a central master system and zoned as required to accommodate local, general area, and system-wide paging announcements.

Communication raceway systems will be installed to provide for distribution of the telephone system throughout the space. The telephone distribution will provide service for telephones, courtesy telephones, data communication, and other telephone system related communications. A separate communication raceway system will be installed to provide for distribution of airline reservations, flight information, baggage information, and other data communication wiring.

The central corrected clock system will be distributed throughout the space. Clocks will be installed throughout the space. Clocks will be installed in convenient locations in the public area.

The security system will be extended into and throughout the space to monitor and/or alarm activities in the general public areas and other areas as is deemed appropriate and necessary. The security system shall be connected to the central airport security system.

1201.6 TRAIN STATION LOADING PLATFORMS

Normal electrical power for systems and equipments will be provided at 480Y/277 volts and 208Y/120 volts. Electrical power service will be distributed throughout the space to serve HVAC equipment, lighting systems, elevators, escalators, and general convenience power.

Emergency electrical power for systems and equipment will be provided at 480Y/277 volts and 208Y/120 volts. Emergency electrical power will be distributed throughout the space to serve elevators, exit and egress lighting, fire detection and alarm, central corrected clock, public address systems, EMCS security, communications, data systems, and airline reservations and flight information equipment.

Lighting of offices and other similar low-ceiling spaces will be provided by use of recessed fluorescent luminaries. Decorative surface and recessed fluorescent luminaries will be used to light the public low-ceiling areas. Metal halide luminaries will be used to light the large, open, high ceiling areas of the space. Industrial fluorescent luminaries will be used to light storage areas, equipment rooms and similar spaces. Lighting control will be by use of local switching in offices and other non-public spaces. Ambient lighting control using stepped switching and/or dimming will be utilized in spaces where daylighting is possible. Microprocessor-based, remote-controlled, low-voltage switching systems will be utilized for lighting controlling all spaces where it can be justified by occupancy and life cycle cost analysis.

The interior space will be fire sprinklered and the fire sprinkler system shall be alarmed and supervised. Smoke detection will be provided in all areas and in the HVAC supply and return air systems, when required by NFPA 90A. Thermal detection devices will be installed in all non-
sprinklered spaces where the use of smoke detectors are not appropriate due to the normal or expected presence of products of combustion.

Manual, alarm-initiating devices will be installed in public and non-public spaces near exits. Public spaces will be provided with emergency telephones adjacent to fire alarm manual pull stations. The fire alarm system shall be connected to the central airport fire alarm system. Evacuation alarms and announcements will be transmitted through the public address system.

A public address system will be installed throughout the area to provide for general paging announcements and evacuation and alarm signals and announcements. The system in this area will be served from a central master system and zoned as required to accommodate local, general area, and system-wide paging announcements.

Communication raceways systems will be installed to provide for distribution of the telephone system throughout the space. The telephone distribution will provide service for telephones, courtesy telephones, data communication, and other telephone system related communications. A separate communication raceway system will be installed to provide for distribution of airline reservations, flight information, baggage information, and other data communication wiring.

The central corrected clock system will be distributed throughout the space. Clocks will be installed in convenient locations in the public area.

The security system will be extended into and throughout the space to monitor and/or alarm activities in the general public areas and other areas as is deemed appropriate and necessary. The security system shall be connected to the central airport security system.

1201.7 CONCESSIONS AND SERVICES

Normal electrical power for systems and equipment will be provided at 480Y/277 volts and 2208Y/120 volts. Separate, individually metered tenant electric service will be distributed throughout the space to serve the tenant spaces. Public area HVAC equipment, lighting systems, elevators, escalators, and general convenience power shall be from the city’s metered service.

Emergency electrical power for systems and equipment will be provided at 480Y/277 volts and 208Y/120 volts. Emergency electrical power will be distributed throughout the space to serve elevators, exit and egress lighting, fire detection and alarm, central corrected clock, public address system, EMCS, security, communications and data systems.

Lighting of offices and other similar low-ceiling spaces will be provided by use of recessed fluorescent luminaries. Decorative surface and recessed fluorescent luminaries will be used to light public low-ceiling areas. Metal halide luminaries will be used to light the large, open, high ceiling areas of the space. Industrial fluorescent luminaries will be used to light storage areas, equipment rooms and similar spaces. Incandescent and specialty lighting systems will be used for accent and architectural lighting functions. Lighting control will be by use of local switching in offices and other non-public spaces. Ambient lighting control using stepped switching and/or dimming will be utilized in spaces where daylighting is possible. Microprocessor-based, remote controlled, low-voltage switching systems will be utilized for lighting control in all spaces where it can be justified by occupancy and life cycle cost analysis.
The interior space will be fire sprinklered and the fire sprinkler system shall be alarmed and supervised. Smoke detection will be provided in all non sprinklered areas and in the HVAC supply and return air systems, when required by NFPA 90A. All kitchen hoods equipped with fixed carbon dioxide extinguishing systems shall have a system discharge pressure switch to automatically activate the fire alarm. Thermal detection devices will be installed in all non-sprinklered spaces where the use of smoke detectors are not appropriate due to the normal or expected presence of products of combustion. Manual, alarm-initiating devices will be installed in public and non-public spaces near exits. Public spaces will be provided with emergency telephones adjacent to fire alarm manual pull stations. The fire alarm system shall be connected to the central airport fire alarm system. Evacuation alarms and announcements will be transmitted through the public address system.

A public address system will be installed throughout the area to provide for general paging announcements and evacuation and alarm signals and announcements. The system in this area will be served from a central master system and zoned as required to accommodate local, general area, and system-wide paging announcements.

Communication raceway systems will be installed to provide for distribution of the telephone system throughout the space. The telephone distribution will provide service for telephones, courtesy telephones, data communications, and other telephone system related communications.

The central corrected clock system will be distributed throughout the space. Clocks will be installed in convenient locations in the public area.

The security system will be extended into and throughout the space to monitor and/or alarm activities in the general public areas and other areas as is deemed appropriate and necessary. The security system shall be connected to the central airport security system.

1201.8 RESTROOMS

Normal electrical power for systems and equipment will be provided at 480Y/277 volts and 208Y/120 volts. Electrical power service will be distributed throughout the space to serve HVAC equipment, lighting systems, shot air hand dryers, and general convenience power.

Emergency electrical power for systems and equipment will be provided at 480Y/277 volts and 208Y/120 volts. Emergency electrical power will be distributed throughout the space to serve exit and egress lighting, fire detection and alarm, public address system, EMCS, and security.

Lighting will be provided by use of recessed fluorescent luminaries. Lighting control will be by use of local switching in non-public spaces and local keyed switching in public spaces.

The interior space will be fire sprinklered and the fire sprinkler system shall be alarmed and supervised. Smoke detection will be provided in all areas and in the HVAC supply and return air systems, when required by NFPA 90A. The fire alarm system shall be connected to the central fire alarm system. Evacuation alarms and announcements will be transmitted through the public address system.

A public address system will be installed throughout the area to provide for general paging announcements and evacuation and alarm signals and announcements. The system in this
area will be served from a central master system and zoned as required to accommodate local, general area, and system-wide paging announcements.

1201.9 GROUND TRANSPORTATION LEVEL

Normal electrical power for systems and equipment will be provided at 480Y/277 volts and 208Y/120 volts. Emergency electrical power will be distributed throughout the space to serve elevators, exit and egress lighting, fire detection and alarm, central corrected clock, public address system, EMCS, security, communications, and data systems.

Lighting of offices and other similar spaces will be provided by use of recessed fluorescent luminaries. Decorative surface and recessed fluorescent luminaries will be used to light the open low-ceiling areas. Metal halide luminaries will be used to light the large, open high ceiling areas of the space. Industrial fluorescent luminaries will be used to light storage areas, equipment rooms and similar spaces. Lighting control will be by use of local switching in offices and other similar spaces. Ambient lighting control using stepped switching and/or dimming will be utilized in spaces where daylighting is possible. Microprocessor-based, remote-controlled, low-voltage switching systems will be utilized for lighting control in all spaces where it can be justified by occupancy and life cycle cost analysis.

The interior space will be fire sprinklered and the fire sprinkler system shall be alarmed and supervised. Smoke detection will be provided in all non-sprinklered areas and in the HVAC supply and the return air systems, when required by NFPA 90A. Thermal detection devices will be installed in all non-sprinklered spaces where the use of smoke detectors are not appropriate due to normal or expected presence of products of combustion. Manual alarm initiating devices will be installed in public and non-public spaces near exits. Public spaces will be provided emergency telephones adjacent to fire alarm manual pull stations. The fire alarm shall be connected to the central airport fire alarm system. Evacuation alarms and announcements will be transmitted through the public address system.

A public address system will be installed throughout the area to provide for general paging announcements and evacuation and alarm signals and announcements. The system in this area will be served from a central master system and zoned as required to accommodate local, general area, and system-wide paging announcements.

Communication raceway systems will be installed to provide for distribution of the telephone system throughout the space. The telephone distribution will provide service for telephones, data communication, and other telephone system related communications.

The central corrected clock system will be distributed throughout the space. Clocks will be installed in convenient locations in the public area.

The security system will be extended into and throughout the space to monitor and/or alarm activities in the general public areas and other areas as is deemed appropriate and necessary. The security system shall be connected to the central airport security system.

1201.10 RENTAL CAR LEVEL

Normal electrical power for systems and equipment will be provided at 480Y/277 volts and 208Y/120 volts. Electrical power service will be distributed throughout the space to serve HVAC equipment, lighting systems, escalators, elevators and general convenience power.
Emergency electrical power for systems and equipment will be provided at 480Y/277 volts and 208Y/120 volts. Emergency electrical power will be distributed throughout the space to serve elevators, exit and egress lighting, fire detection and alarm, central corrected clock, EMCS, public address system, security, communications, data systems, and airline reservations and flight information equipment.

Lighting of offices and other similar spaces will be provided by use of recessed fluorescent luminaries. Decorative surface and recessed fluorescent luminaries will be used to light the open low-ceiling areas. Metal halide luminaries will be used to light the large, open, high ceiling areas of the space. Industrial fluorescent luminaries will be used to light storage areas, equipment rooms and similar spaces. Ambient lighting control using stepped switching and/or dimming will be utilized in spaces where daylighting is possible. Microprocessor-based, remote-controlled, low-voltage switching systems will be utilized for lighting control in all spaces where it can be justified by occupancy and life cycle cost analysis.

The interior space will be fire sprinklered and the fire sprinkler system shall be alarmed and supervised. Smoke detection will be provided in all non-sprinklered areas and in the HVAC supply and return air systems, when required by NFPA 90A. Thermal detection devices will be installed in all non-sprinklered spaces where the use of smoke detectors is not appropriate due to the normal or expected presence to products of combustion. Manual alarm initiating devices will be installed in public and non-public spaces near exits. Public spaces will be provided with emergency telephones adjacent to fire alarm manual pull stations. The fire alarm system shall be connected to the central airport fire alarm system. Evacuation alarms and announcements will be transmitted through the public address system.

A public address system will be installed throughout the area to provide for general paging announcements and evacuation and alarm signals and announcements. The system in this area will be served from a central master system and zoned as required to accommodate local, general areas, and system-wide paging announcements.

Communication raceway systems will be installed to provide for distribution of the telephone system throughout the space. The telephone distribution will provide service for telephones, courtesy telephones, data communication, and other telephone system related communications.

The central corrected clock system will be distributed throughout the space. Clocks will be installed in convenient locations in the public area.

The security system will be extended into and throughout the space to monitor and/or alarm activities in the general public areas and other areas as is deemed appropriate and necessary. The security system shall be connected to the central airport security system.

SECTION 1202 - INERNATIONAL CONCOURSE

The electrical service will be provided by Public Service Company of Colorado at multiple points along the airside perimeter of the building. Secondary service (480Y/277 volts and/or 208Y/120 volts) will be provided through the city’s secondary metering type distribution equipment. Metered service will be taken at the city’s metering equipment to serve the general building systems and equipment. Tenant systems and equipment will be served by separate individually metered services for each tenant taken from the city’s metering equipment. Tenant service(s) will be extended by the tenant from the city’s metering equipment to the tenant’s main distribution panelboard located in their space. Electrical power service will be distributed...
throughout the facility to serve building and process system and equipment. Building systems and equipment includes HVAC equipment, lighting systems, elevators, escalators, motor-operated doors, fire detection and alarm system, public address system, central corrected clock system, security system, EMCS, general convenience power and other similar systems and equipment. Process systems and equipment includes computer systems, baggage conveyors, passenger loading bridges, aircraft ground power, preconditioned air systems, food preparation and other similar tenant systems and equipment.

Emergency electrical power will be provided from the central utility plant through a city-owned 4160 volt emergency distribution system. Transformation to and distribution of 480Y/277 volts and 208Y/120 volts emergency power to serve systems and equipment shall be provided as required. Emergency electrical power will be distributed throughout the facility to serve elevators, exit and egress lighting, fire detection and alarm, central corrected clock, public address system, EMCS, security, smoke ventilation communications, data systems, airline reservations, flight information display (FID) equipment and baggage information display (BID) systems.

Fluorescent luminaries will be used to light offices and other similar low-ceiling spaces. Fluorescent and metal halide luminaries will be used to light hold rooms and concourse corridors. Metal halide luminaries will be used to light the large, open, high ceiling areas of the facility. Incandescent luminaries will be used for special purpose and architectural accent lighting. Industrial fluorescent luminaries will be used to light storage areas, equipment rooms and similar spaces. Industrial fluorescent and high-pressure sodium luminaries will be used to light the baggage and operations areas. Recessed luminaries will be used to light the baggage and operations areas. Recessed luminaries shall be used in all finished areas. Lighting control will be by use of local switching in offices and other non-public spaces. Ambient lighting control using stepped switching and/or dimming will be utilized in spaces where daylighting is possible. Microprocessor-based, remote-controlled, low-voltage switching systems will be utilized for lighting control in all spaces where it can be justified by occupancy and life cycle cost analysis.

The interior space will be fire sprinklered and the fire sprinkler system shall be alarmed and supervised. Smoke detection will be provided in all non-sprinklered areas and in the HVAC supply and return air systems when required by NFPA 90A. Thermal detection devices will be installed in all non-sprinklered spaces where the use of smoke detectors are not appropriate due to the normal or expected presence of products of combustion. Manual alarm initiating devices will be installed in public and non-public spaces near exits. Public spaces will be provided with emergency telephones adjacent to fire alarm manual pull stations. The fire alarm system shall be connected to the central airport fire alarm system. Evacuation alarms and announcements will be transmitted through the public address system.

A public address system will be installed throughout the facility to provide for general paging announcements and evacuation and alarm signals and announcements. The system in this area will be served from a central master system and zoned as required to accommodate local, general area, and system-wide paging announcements. Public address input stations will be provided airline ticket lift counters at passenger loading bridge doorways.

Communication raceway systems will be installed to provide for distribution of the telephone system throughout the facility. The telephone distribution will provide service for telephones, courtesy telephones, data communication, and other telephone system related communications. A separate communication raceway system will be installed to provide for distribution of airline
reservations, flight information, baggage information, and other airline data communication wiring.

The central corrected clock system will be distributed throughout the facility. Clocks will be installed in convenient locations in the public area.

A security system will be installed throughout the facility to monitor and/or alarm activities in the general public areas and other areas as is deemed appropriate and necessary. The security system shall be connected to the central airport security system.

A raceway system will be installed to provide for distribution of an entertainment television system throughout the facility.

SECTION 1203 - DOMESTIC CONCOURSE

The electrical service will be provided by Public Service Company of Colorado at multiple points along the airside perimeter of the building. Secondary service (480Y/277 volts and/or 208Y/120 volts) will be provided through the city’s secondary metering type distribution equipment. Metered service will be taken at the city’s metering equipment to serve the general building systems and equipment. Tenant systems and equipment will be served by separate individually metered services for each tenant taken from the city’s metering equipment. Tenant service(s) will be extended by the tenant from the city’s metering equipment to the tenant’s main distribution panelboard located in their space. Electrical power service will be distributed throughout the facility to serve building and process systems and equipment includes HVAC equipment, lighting systems, elevators, escalators, motor operated doors, fire detection and alarm systems, public address system, central corrected clock system, security system, general convenience power, and other similar systems and equipment. Process systems and equipment includes computer systems, baggage conveyors, passenger loading bridges, aircraft ground power, preconditioned air systems, food preparation and other similar tenant systems and equipment.

Emergency electrical power in each domestic concourse will be provided at 480Y/277 volts from a diesel (or natural gas) engine generator(s) located in each domestic concourse. Emergency electrical power will be distributed throughout the facility to serve elevators, exit and egress lighting, fire detection and alarm, central corrected clock, public address system, EMCS, security communications, data systems, airline reservations, flight information display (FID) equipment, and baggage information display (BID) systems.

Fluorescent luminaries will be used to light offices and other similar low-ceiling spaces. Fluorescent and metal halide luminaries will be used to light hold rooms and concourse corridors. Metal halide luminaries will be used to light the large, open, high ceiling areas of the facility. Incandescent luminaries will be used for special purpose and architectural accent lighting. Industrial fluorescent luminaries will be used to light storage areas, equipment rooms and similar spaces. Industrial fluorescent and high-pressure sodium luminaries will be used to light the baggage and operations areas. Recessed luminaries shall be used in all finished areas. Lighting control will be by use of local switching in offices and other non-public spaces. Ambient lighting control using stepping switching and/or dimming will be utilized in spaces where daylighting is possible. Microprocessor-based, remote-controlled, low-voltage switching systems will be utilized for lighting control in all spaces where it can be justified by occupancy and life cycle cost analysis.
The interior space will be fire sprinklered and the fire sprinkler system shall be alarmed and supervised. Smoke detection will be provided in all non-sprinklered areas and in the HVAC supply and return air systems, when required by NFPA 90A. Thermal detection devices will be installed in all non-sprinklered spaces where the use of smoke detectors are not appropriate due to the normal or expected presence of products of combustion. Manual alarm initiating devices will be installed in public and non-public spaces near exits. Public spaces will be provided with emergency telephones adjacent to fire alarm manual pull stations. The fire alarm system shall be connected to the central airport fire alarm system. Evacuation alarms and announcements will be transmitted through the public address system.

A public address system will be installed throughout the facility to provide for general paging announcements and evacuation and alarm signals and announcements. The system in this area will be served from a central master system and zoned as required to accommodate local, general area, and system-wide paging announcements. Public address input stations will be provided airline ticket lift counters at passenger loading bridge doorways.

Communication raceway systems will be installed to provide for distribution of the telephone system throughout the facility. The telephone distribution will provide service for telephones, courtesy telephones, data communication, and other telephone system related communications. A separate communication raceway system will be installed to provide for distribution of airline reservations, flight information, baggage information, and other data communication wiring.

The central corrected clock system will be distributed throughout the facility. Clocks will be installed in convenient locations in the public area.

A security system will be installed throughout the facility to monitor and/or alarm all activities in the general public areas and other areas as is deemed appropriate and necessary. The security system shall be connected to the central airport security system.

A raceway system will be installed to provide for distribution of an entertainment television system throughout the facility.

**SECTION 1204 - AIR TRAFFIC CONTROL TOWER**

The electrical service will be provided by Public Service Company of Colorado at perimeter of the building. Secondary service (480Y/277 volts) will be provided through the FAA’s secondary metering type distribution equipment. Metered service will be taken at the FAA’s metering equipment to serve the general building and process systems and equipment. Electrical power service will be distributed throughout the facility to serve building and process systems and equipment. Building systems and equipment includes HVAC equipment, lighting systems, elevators, fire detection and alarm system, security system, general convenience and other similar systems and equipment. Process systems and equipment includes computer systems, aircraft monitoring systems, aircraft communication systems, airfield systems monitoring and control, and other similar systems and equipment.

Emergency electrical power will be provided by a separate dedicated diesel (or natural gas) engine generator(s) installed in the building. Electrical power generation shall be at 480Y/277 volts. Emergency electrical power will be distributed throughout the facility to serve elevators, exit and egress lighting, fire detection and alarm, security, smoke ventilation, communications,
data systems, and the building process systems and equipment determined to require emergency power.

Fluorescent luminaries will be used to light offices and other similar low-ceiling spaces. Incandescent luminaries will be used for special purpose and architectural accent lighting. Industrial fluorescent luminaries will be used to light storage areas, equipment rooms and similar spaces. Recessed luminaries will be utilized in all finished spaces. Lighting control will be by use of local switching in offices and other non-public spaces. Ambient lighting control using stepped switching and/or dimming will be utilized in spaces where daylighting is possible. Microprocessor-based, remote-controlled, low-voltage switching systems will be utilized for lighting control in all spaces where it can be justified by occupancy and life cycle cost analysis.

The interior space will be fire sprinklered and the fire sprinkler system shall be alarmed and supervised. Smoke detection will be provided in all non-sprinklered areas and in the HVAC supply and return air systems, when required by NFPA 90A. Thermal detection devices will be installed in all non-sprinklered spaces where the use of smoke detectors are not appropriate due to the normal or expected presence of products of combustion. Manual alarm initiating devices will be installed in public and non-public spaces near exits. Audible and visual alarms devices will be installed and throughout the space. The fire alarm system shall be connected to the central airport fire alarm system.

Communication raceway systems will be installed to provide for distribution of the telephone system throughout the facility. The telephone distribution will provide service for telephones, data communication, and other telephone system related communications. A separate communication raceway system will be installed to provide for distribution of FAA communications, data, and control wiring.

A local security system will be installed throughout the facility to monitor and/or alarm activities in the building. The security system shall be connected to the central airport security system.

SECTION 1205 - HOTEL

The electrical service will be provided by Public Service Company of Colorado at the perimeter of the building. Secondary service (480Y/277 volts) will be provided through the owner’s secondary metering type distribution equipment. Metered service will be taken at the owner’s metering equipment to serve the general building systems and equipment.

Electrical power service will be distributed throughout the facility to serve building and process systems and equipment. Building systems and equipment includes HVAC equipment, lighting systems, elevators, escalators, fire detection and alarm system, public address system, security system, general convenience power, and other similar systems and equipment. Process systems and equipment includes computer systems, kitchens, restaurants, and other similar systems and equipment.

Emergency electrical power will be provided by separate dedicated diesel (or natural gas) engine-generator(s) installed in the building. Electrical power generation will be at 480Y/277 volts. Emergency electrical power will be distributed throughout the facility to serve elevators, exit and egress lighting, fire detection and alarm, security, and smoke ventilation systems.

Fluorescent luminaries will be used to light offices and other similar low-ceiling spaces. Metal halide luminaries will be used to light the large, open, high ceiling areas of the facility.
Incandescent luminaries will be used for special purpose and architectural accent lighting. Industrial fluorescent luminaries will be used to light storage areas, equipment rooms and similar spaces. Recessed luminaries shall be used in all finished areas. Lighting control will be by use of local switching in all non-public areas. Ambient lighting control using stepped switching and/or dimming will be utilized in spaces where daylighting is possible. Microprocessor-based, remote-controlled, low-voltage switching systems will be utilized for lighting control in all spaces where it can be justified by occupancy and life cycle cost analysis.

The interior space will be fire sprinklered and the fire sprinkler system shall be locally alarmed and supervised. Smoke detection will be provided in all non-sprinklered areas, corridors, stairwells, guest rooms and in the HVAC supply and return air systems, when required by NFPA 90A. All kitchen hoods equipped with fixed carbon dioxide extinguishing systems shall have a system discharge pressure switch to automatically activate the fire alarm. Thermal detection devices will be installed in all non-sprinklered spaces where the use of smoke detectors are not appropriate due to the normal or expected presence of products of combustion. Manual alarm initiating devices will be installed in public and non-public spaces near exits. Audible and visual alarm devices will be installed throughout the facility. The local fire alarm system shall be connected the central airport fire alarm system.

Communication raceway systems will be installed to provide for distribution of the telephone system throughout the facility. The telephone distribution will provide service for telephones, courtesy telephones, data communication, and other telephone system related communications.

A local security system will be installed throughout the facility to monitor and/or alarm activities in the general public areas and other areas as is deemed appropriate and necessary. The security system shall be connected the central airport security system.

SECTION 1206 - SURFACE PARKING

Normal electrical power and the area lighting system will be provided by Public Service Company of Colorado.

Emergency electrical power will not be provided.

Pole-mounted, high-pressure sodium architectural grade luminaries will be used to light the area.

SECTION 1207 - STRUCTURED PARKING

The electrical service will be provided by Public Service Company of Colorado at multiple points around perimeter of the structure. Secondary service (480Y/277 volts) will be provided through the city’s secondary metering type distribution equipment. Metered service will be taken at the city’s metering equipment to serve the structure systems and equipment. Electrical power service will be distributed throughout the structure to serve systems and equipment. Transformation to and distribution of 208Y/120 volts to serve systems and equipment will be provided as required. Systems and equipment served includes lighting systems, elevators, security system, general convenience power, and other similar systems and equipment. Emergency electrical power will be provided from the central utility plant through a city-owned 4160 volt emergency distribution system. Transformation to and distribution of 480Y/277 volts and 208Y/120 volts emergency power to serve systems and equipment shall be provided as required.
Emergency electrical power will be distributed throughout the space to serve elevators, exit and egress lighting and security systems.

High pressure sodium luminaries will be used to light the areas of the structure. Lighting shall be photoelectrically controlled based on daylighting of the structure.

The structured parking shall be fully sprinklered with a dry-pipe system which shall be alarmed and supervised. Manual alarm-initiating devices will be installed near all exits. Audible and visual alarm devices will be installed throughout the facility.

A security system will be installed throughout the structure to monitor and/or alarm activities in the general public areas and other areas as is deemed appropriate and necessary. The security system shall be connected to the central security system.

**SECTION 1208 - PARKING TOLL PLAZA**

The electrical service will be provided by Public Service Company of Colorado at the perimeter of the building. Secondary service (480Y/277 volts) will be provided through the city’s secondary metering type distribution equipment. Metered service will be taken at the city’s metering equipment to serve the general building and process systems and equipment. Electrical power service (480Y/277 volts and 208Y/120 volts) will be distributed throughout the facility to serve building and process systems and equipment. Building systems and equipment includes HVAC equipment, lighting systems, fire detection and alarm system, security system, general convenience power, and other similar systems and equipment. Process systems and equipment includes computer systems, parking lot entrance and exit control, and other similar systems and equipment.

Emergency electrical power will be provided by use of battery backup systems for exit and egress lighting, fire detection and alarm, security, communications, and data systems.

Fluorescent luminaries will be used to light building spaces. Recessed luminaries will be utilized in all finished spaces.

Interior lighting control will be by use of local switching. Exterior lighting shall be controlled photoelectrically.

The interior space will be fire sprinklered and the fire sprinkler system shall be alarmed and supervised. Smoke detection will be provided in all non-sprinklered areas and in HVAC supply and return air systems, when required by NFPA 90A. Manual alarm initiating devices will be installed in spaces near exits. Audible and visual alarm devices will be installed throughout the facility. The fire alarm system shall be connected to the central fire alarm system.

Communication raceway systems will be installed to provide for distribution of the telephone system throughout the facility. The telephone distribution will provide service for telephones, data communication, and other telephone system related communications.

A security system will be installed throughout the facility to monitor and/or alarm all activities in the general public areas and other areas as is deemed appropriate and necessary. The security system shall be connected to the central security system.

**SECTION 1209 - OFFICE BUILDING**
The electrical service will be provided by Public Service Company of Colorado at the perimeter of the building. Secondary service (480Y/277 volts) will be provided through the owner’s secondary metering type distribution equipment. Metered service will be taken at the owner’s metering equipment to serve the general building systems and equipment. Electrical power service (480Y/277 and 208Y/120 volts) will be distributed throughout the facility to serve building and process systems and equipment. Building systems and equipment includes HVAC equipment, lighting systems, elevators, escalators, fire detection and alarm system, security system, general convenience power, and other similar systems and equipment. Process systems and equipment includes computer systems and other general office systems and equipment.

Emergency electrical power will be provided by a separate dedicated diesel (or natural gas) engine-generator(s) installed in the building. Generation will be at 480Y/277 volts. Distribution of 480Y/277 volts and 208Y/120 volts emergency power to serve systems and equipment shall be provided as required. Emergency electrical power will be distributed throughout the facility to serve elevators, exit and egress lighting, fire detection and alarm, security, and smoke ventilation systems (if required by building height).

Fluorescent luminaries will be used to light offices and other similar low-ceiling spaces. Metal halide luminaries will be used to light the large, open, high ceiling areas of the facility. Incandescent luminaries will be used for special purpose and architectural accent lighting. Industrial fluorescent luminaries will be used to light storage areas, equipment rooms and similar spaces. Recessed luminaries shall be used in all finished areas. Lighting control will be by use of local switching in all areas except lobby areas. Ambient lighting control using stepped switching and/or dimming will be utilized in spaces where daylighting is possible. Microprocessor-based, remote-controlled, low-voltage switching systems will be utilized for lighting control in all spaces where it can be justified by occupancy and life cycle cost analysis.

The interior space will be fire sprinklered and the fire sprinkler system shall be alarmed and supervised. Smoke detection will be provided in all non-sprinklered areas and in the HVAC supply and return air systems, when required by NFPA 90A. Thermal detection devices will be installed in all non-sprinklered spaces where the use of smoke detectors are not appropriate due to the normal or expected presence of products of combustion. Manual alarm initiating devices will be installed in public and non-public spaces near exits. Audible and visual alarm devices will be installed throughout the facility.

Communication raceway systems will be installed to provide for distribution of the telephone system throughout the facility. The telephone distribution will provide service for telephones, data communications, and other telephone system related communications.

A security system will be installed throughout the facility to monitor and/or alarm activities in the general public areas and other areas as is deemed appropriate and necessary. The security system shall be connected to the central airport security system.

**SECTION 1210 - CENTRAL UTILITY PLANT**

**1210.1 ELECTRICAL SERVICE AND DISTRIBUTION**

The central utility plant will be served from Public Service Company of Colorado at 4160 volts. The utility service arrangement shall provide two separate and independent utility metered sources of electrical power to the plant. The service feeders will be connected to opposite ends
of a double-ended main electrical service switchgear, the tie breaker will be operated normally open. Major central chilled water and steam-generating equipment, (large horsepower, chillers, pumps, fans, etc.) will be served directly at 4160 volts. Transformation to 480Y/277 volts and 208Y/120 volts will be provided to serve other central chilled-water and steam-generating auxiliary equipment and the general building systems.

Emergency electrical power will be provided by diesel (or natural gas) engine generators installed in the central plant. Multiple generating units will be synchronized and connected to a common 4160 volt bus. The central plant emergency electrical power needs will be served by transformation from this bus. Emergency electrical power will be distributed throughout the building to serve exit and egress lighting, fire detection and alarm EMCS and security systems. The terminal complex and international concourse emergency electrical power needs will be served by distribution of 4160 volts throughout the complex. A lineup of 4160 volt emergency switchgear will be utilized to provide separate distribution feeders for the different areas of the terminal complex. The emergency switchgear will be normally fed from the normal power electrical service switchgear such that when power is lost the generators will be started and the entire emergency electrical load will be transferred to the generators.

1210.2 BUILDING SYSTEMS

High-pressure sodium luminaries shall be used to light large high ceiling equipment areas of the plant. Fluorescent luminaries will be used to light offices, control rooms, and other similar low-ceiling areas. Recessed luminaries will be installed in finished areas. Lighting control shall be a local switching in offices and smaller spaces.

The interior space will be fire sprinklered and the fires sprinkler system shall be alarmed and supervised. Smoke detection will be provided in all office and control room areas and in the HVAC supply and return air systems, when required by NFPA 90A. Thermal detection devices will be installed in all non-sprinklered spaces where the use of smoke detectors are not appropriate due to the normal expected presence of products of combustion. Manual alarm initiating devices will be installed in all areas near exits. Audible and visual alarm devices will be installed throughout the facility. The fire alarm system shall be connected to the central airport fire alarm system.

The central EMCS shall be controlled and monitored from this location and the Communications Center.

Communication raceway systems will be installed to provide for distribution of the telephone system throughout the facility. The telephone distribution will provide service for telephones, data communication, and other telephone system related communications.

A security system will be installed throughout the facility to monitor and/or alarm activities in the general building areas and other areas as is deemed appropriate and necessary. The security system shall be connected to the central airport security system.

SECTION 1211 - MAINTENANCE FACITLY

The electrical service will be provided by Public Service Company of Colorado at the perimeter of the building. Secondary service (480Y/277 volts) will be provided through the owner’s secondary metering type distribution equipment. Metered service will be taken at the owner’s metering equipment to serve the general building and process systems and equipment. Electrical power service (480Y/277 and 208Y/120 volts) will be distributed throughout the facility.
to serve building and process systems and equipment. Building systems and equipment includes HVAC equipment, lighting systems, elevators, fire detection and alarm systems, security system, general convenience power, and other similar systems and equipment. Process systems and equipment includes computer systems, shop equipment, vehicle lifts, and other similar system and equipment.

Emergency electrical power will be provided by battery backup as required for each separate system or equipment item. Emergency electrical power will be provided to serve exit and egress lighting, fire detection and alarm, security, communications and data systems.

Fluorescent luminaries will be used to light offices and other similar low ceiling spaces. High-pressure sodium luminaries will be used to light the high ceiling maintenance areas of the facility. Industrial fluorescent luminaries will be used to light storage areas, equipment rooms and similar spaces. Recessed luminaries will be utilized in all finished spaces. Lighting control will be by use of local switching in offices and smaller spaces.

The interior space will be fire sprinklered and the fire sprinkler system shall be alarmed and supervised. Smoke detection will be provided in all non-sprinklered areas and in the HVAC supply and return air systems, when required by NFPA 90A. Thermal detection devices will be installed in all non-sprinklered spaces where the use of smoke detectors are not appropriate due to the normal or expected presence of products of combustion exits. Manual alarm initiating devices will be installed in all areas near exits. Audible and visual alarm devices will be installed throughout the facility. The fire alarm system shall be connected to the central airport fire alarm system.

Communication raceway systems will be installed to provide for distribution of the telephone system throughout the facility. The telephone distribution will provide service for telephones, data communication, and other telephone system related communications.

A security system will be installed throughout the space to monitor and/or alarm activities in the facility. The security system shall be connected to the airport central security system.

SECTION 1212 - AIR CARGO FACILITY

The electrical service will be provided by Public Service Company of Colorado at the perimeter of the building. Secondary service (480Y/277 volts) will be provided through the facility's secondary metering type distribution equipment. Electrical power service (480Y/277) and 208Y/120 volts) will be distributed throughout the facility to serve building and process systems and equipment. Building systems and equipment includes HVAC equipment, lighting systems, elevators, fire detection and alarm system, security system, general convenience power, and other similar systems and equipment. Process systems and equipment includes computer systems, material handling systems, and other similar systems and equipment.

Emergency electrical power will be provided by battery backup as required for each separate system or equipment item. Emergency electrical power will be provided to serve exit and egress lighting, fire detection and alarm, security communications and data systems.

Fluorescent luminaries will be used to light offices and other similar low-ceiling spaces. High-pressure sodium luminaries will be used to light the high ceiling areas of the facility. Industrial fluorescent luminaries will be used to light storage areas, equipment rooms and similar spaces.
Recessed luminaries will be utilized in all finished spaces. Lighting control will be by use of local switching in offices and smaller spaces.

The interior space will be fire sprinklered and the sprinkler system shall be alarmed and supervised. Smoke detection will be provided in all non-sprinklered areas and in the HVAC supply and return air systems serving these areas, when required by NFPA 90A. Thermal detection devices will be installed in all non-sprinklered spaces where the use of smoke detectors is not appropriate due to the normal expected presence of products of combustion. Manual alarm initiating devices will be installed in all areas near exits. Audible and visual alarm devices will be installed throughout the facility. The fire alarm system shall be connected to the central airport fire alarm system.

Communication raceway systems will be installed to provide for distribution of the telephone system throughout the facility. The telephone distribution will provide service for telephones, data communication, and other telephone system related communications.

A security system will be installed throughout the facility to monitor and/or alarm all activities in the facility. The security system shall be connected to the central airport security system.

SECTION 1213 - AIRCRAFT HANGARS

The electrical service will be provided by Public Service Company of Colorado at the perimeter of the building. Secondary service (480Y/277 volts) will be provided through the facility’s secondary metering type distribution equipment. Metered service will be taken at the facility’s metering equipment to serve the general building and process systems and equipment. Electrical power service (480Y/277 and 208Y/120 volts) will be distributed throughout the facility to serve building and process systems and equipment. Building systems and equipment includes HVAC equipment, lighting systems, elevators, fire detection and alarm system, security system general convenience power, and other similar systems and equipment. Process systems and equipment includes computer systems, show equipment, and other similar systems and equipment.

Emergency electrical power will be provided by a separate dedicated diesel (or natural gas) engine generator installed in the building. Generation will be at 480Y/277 volts and 208Y/120 volts emergency power to serve systems and equipment shall be provided as required. Emergency electrical power will be distributed throughout the facility to serve elevators, exit and egress lighting, fire detection and alarm security systems.

Fluorescent luminaries will be used to light offices, shops and similar low ceiling spaces. High-pressure sodium luminaries will be used to light the hangar bays and other high ceiling areas of the facility. Industrial fluorescent luminaries will be used to light storage areas, equipment rooms and similar spaces. Recessed luminaries will be utilized in all finished spaces. Lighting control will be by use of local switching in offices, shops and similar spaces.

Hangar offices, hangar shops and small hangar bays shall be equipped with a wet pipe sprinkler system. The interior space will be fire sprinklered and the fires sprinkler system shall be alarmed and supervised. Large hangar bays shall be equipped with a foam/water deluge system. Smoke detection will be provided in all non-sprinklered areas and in the HVAC supply and return air systems, when required by NFPA 90A. Thermal detection devices will be installed in all non-sprinklered spaces where the use of smoke detectors is not appropriate due to the normal or expected presence of products of combustion. Manual alarm initiating devices
will be installed in all areas near exits. The building fire protection sprinkler systems and foam/water deluge systems will be alarmed and supervised. Audible and visual alarms devices will be installed throughout the facility. The fire alarm system shall be connected to the central airport fire alarm system.

Communication raceway systems will be installed to provide for distribution of the telephone system throughout the facility. The telephone distribution will provide service for public telephones, private telephones, data communication, and other telephone system related communications.

A security system will be installed throughout the facility to monitor and/or alarm all activities in the facility. The security system shall be connected to the central airport security system.

**SECTION 1214 - FLIGHT KITCHENS**

The electrical service will be provided by Public Service Company of Colorado at the perimeter of the building. Secondary service (480Y/277 volts) will be provided through the facility’s secondary metering type distribution equipment. Metered service will be taken at the facility’s metering equipment to serve the general building and process systems and equipment. Building systems and equipment includes HVAC equipment, lighting systems, elevators, fire protection and alarm system, security system, general convenience power, and other similar systems and equipment. Process systems and equipment includes computer systems, kitchen equipment, and other similar systems and equipment.

Emergency electrical power will be provided by a separate dedicated diesel (or natural gas) engine-generator(s) installed in the building. Generation will be at 480Y/277 volts. Distribution of 480Y/277 volts and 208Y/120 volts emergency power to serve systems and equipment shall be provided as required. Emergency electrical power will be distributed throughout the facility to serve passenger elevators, exit and egress lighting, fire detection and alarm, security, communications, refrigerated food storage equipment and other designated critical systems and equipment.

Fluorescent luminaries will be used to light all areas of the facility. Recessed luminaries will be utilized in all finished spaces. Preferred lighting control will be use of local switching, EMCS control or other lighting control will be permitted.

The interior space will be fire sprinklered and the fire sprinkler system shall be alarmed and supervised. Smoke detection will be provided in all non-sprinklered areas and the HVAC supply and return air systems, when required by NFPA 90A. All kitchen hoods equipped with fixed carbon dioxide extinguished systems shall have a system discharge pressure switch to automatically activate the fire alarm. Thermal detection devices will be installed in all non-sprinklered spaces where the used of smoke detectors are not appropriate due to the normal or expected presence of products of combustion. Manual alarm initiating devices will be installed in all areas near exits. Audible and visual alarms devices will be installed throughout the facility. The fire alarm system shall be connected to the central airport fire alarm system.

Communication raceway systems will be installed to provide for distribution of the telephone system throughout the facility. The telephone distribution will provide service for telephones, data communication, and other telephone system related communications.
A security system will be installed throughout the facility to monitor and/or alarm activities in the facility. The security system shall be connected to the central airport security system.

**SECTION 1215 - SNOW REMOVAL EQUIPMENT FACILITY**

The electrical service will be provided by Public Service Company of Colorado at the perimeter of the building. Secondary service (480Y/277 volts) will be provided through the facility’s secondary metering type distribution equipment. Metered service will be taken at the facility’s metering equipment to serve the general building and process systems and equipment.

Electrical power service (480Y/277 and 208Y/120 volts) will be distributed throughout the facility to serve building and process systems and equipment. Building systems and equipment includes HVAC equipment, lighting systems, elevators, fire detection and alarm system, security system, general convenience power, and other similar systems and equipment. Process systems and equipment includes computer systems, shot equipment, vehicle lifts, and other similar system and equipment.

Emergency electrical power will be provided by batter backup as required for each separate system or equipment item. Emergency electrical power will be provided to serve exit and egress lighting, fire detection and alarm, security, communications, and data systems.

Fluorescent luminaries will be used to light office and other similar low ceiling spaces. High-pressure sodium luminaries will be used to light the high ceiling maintenance and vehicle storage areas of the facility. Industrial fluorescent luminaries will be used to light storage areas, equipment rooms and similar space. Recessed luminaries will be utilized in all finished spaces. Lighting control will be by use of local switching in offices and similar spaces.

The interior space will be fire sprinklered and the fire sprinkler system shall be alarmed and supervised. Smoke detection will be provided in all non-sprinklered areas and the HVAC supply and return air systems, when required by NFPA 90A. Thermal detection devices will be installed in all non-sprinklered spaces where the use of smoke detectors are not appropriate due to the normal or expected presence of products of combustion. Manual alarm initiating devices will be installed in all areas near exits. Audible and visual alarm devices will be installed throughout the facility. The fire alarm system shall be connected to the central airport fire alarm system.

Communication raceway systems will be installed to provide for distribution of the telephone system throughout the facility. The telephone distribution will provide service for telephones, data communications, and other telephone system related communications.

A security system will be installed throughout the space to monitor and/or alarm all activities in the facility. The security system shall be connected to the central airport security system.

**SECTION 1216 - FIRE CRASH RESCUE FACILITY**

The electrical service will be provided by Public Service Company of Colorado at the perimeter of the building. Secondary service (480Y/277 volts) will be provided through the facility’s secondary metering type distribution equipment. Metered service will be taken at the facility’s metering equipment to serve the general building and process systems and equipment.

Electrical power service (480Y/277 and 208Y/120 volts) will be distributed throughout the facility to serve building and process systems and equipment. Building systems and equipment includes HVAC equipment, lighting systems, elevators, fire detection and alarm system, security system, general convenience power, and other similar systems and equipment.
system, general convenience power, other similar systems and equipment and electric snow melting on approach ramps (if installed). Process systems and equipment includes computer systems, shop equipment, and other similar systems and equipment.

Emergency electrical power will be provided by a separate dedicated diesel (or natural gas) engine-generator installed in the building. Generation will be at 480Y/277 volts. Distribution of 480Y/277 volts and 208Y/120 volts emergency power to serve systems and equipment shall be provided as required. Emergency electrical power will be distributed throughout the space to serve elevators, exit and egress lighting, fire detection and alarm, security systems.

Fluorescent luminaries will be used to light offices and other similar low ceiling spaces. Fluorescent and high-pressure sodium luminaries will be used to light the high ceiling vehicle garage areas of the facility. Industrial fluorescent luminaries will be used to light storage areas, equipment rooms and similar spaces. Recessed luminaries will be utilized in all finished spaces. Lighting control will be by use of local switching in offices and similar spaces.

END OF CHAPTER 12