

**APPENDIX 4**  
**Life Safety Systems DSM**



LIVE LIFE. TRAVEL WELL.

## Design Standards Manual

Life Safety Systems

Denver International Airport

Airport Infrastructure Management

2016

EXIT



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## Preface

The Denver International Airport (DEN) Design Standards have been developed to ensure a unified and consistent approach to the thematic and technical design for DEN. These standards are for use and strict implementation by all Consultants under contract to DEN, to Tenants, and all other Consultants under contract to any other entity for the design of projects at DEN.

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 DEN.

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 DEN Maintenance and Engineering or Tenants of DEN.

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 DEN, the manuals must be utilized together and not separated from the Design Standards Manuals as a whole.

The Consultant shall not reproduce, duplicate in any manner, transmit to other consultants or other entities or use in conjunction with other projects without the express written consent of DEN.

## Chapter 1 - General

### Section 100 - Overview

The life safety systems for all facilities at DEN are to be based on the use of proven design techniques. These techniques shall utilize existing, readily available equipment and components. Designs shall conform to the design criteria listed herein, with the highest priority being the safety, well-being, and comfort of the traveling public.

Systems must be serviceable, maintainable and at the same time provide flexibility for future addition and modification. All equipment installation, including all their components, must be accessible for testing, adjustment and maintenance.

Airport facilities are dynamic. Life safety systems should be designed keeping in mind that changes, additions, and modifications to facilities will take place to adapt to changing business needs. Systems may need to be altered to accommodate these changes.

Life cycle cost valuation and first costs are important considerations throughout the design process from concept to final design and through construction.

### Section 101 - Common Terminology

The following terms are used throughout this DSM:

#### Concourse

Refers to the concourse buildings, which facilitate all passenger boarding and deplaning activities. DEN has three concourses: Concourse A, B and C

#### HTC

The Hotel and Transit Center, located at the south end of the Jeppesen Terminal. Includes:

- The Westin Hotel and conference center.
- The outdoor Plaza connecting the hotel to the Jeppesen Terminal on Level 5.
- The RTD Train platform and public transit center.

#### Mod

Building module. Both the Jeppesen Terminal and the Concourse Buildings are segmented into modules for the purposes of systems organization.

#### PLB

Passenger Loading Bridge. PLBs are enclosed, raised pedestrian tunnels that are directly attached to the concourse and provide a means to board and deplane aircraft. Includes both a fixed and a movable portion.

#### Terminal Complex

Refers to the main complex of buildings at DEN, including:

- The Jeppesen Terminal, North Terminal, and Parking Garages.
- The Airport Office Building (AOB).
- The Central Utility Plant (CUP).
- Concourses A, B and C.
- Automated Guideway Transit System (AGTS) and Baggage Tunnels.
- The Hotel and Transit Center (HTC).

## **Section 102 - System Definitions**

The Life Safety Design Standards Manual (DSM) contains design guidelines for the following systems:

### **102.1 Emergency Communications System**

The Emergency Communications System (ECS) installed in the Terminal Complex is comprised of a network of audio speakers, as well as visual textual notification systems. The ECS, together with the Fire Alarm system, provides audible and visual mass notification during emergency events.

### **102.2 Fire Detection and Alarm Systems**

Fire Detection and Alarm systems are utilized to provide automatic smoke and fire detection, as well as mass visual notification during emergency events. The Terminal Complex utilizes a networked Fire Alarm system with central controls, and operates in conjunction with the ECS. DEN facilities that are outside the Terminal Complex are also typically furnished with Fire Detection and Alarm systems.

### **102.3 Fire Protection Systems**

Fire Protection Systems are installed within facilities to mitigate the extent of fire damage and maximize the survivability of emergency events. Many DEN facilities and specialty areas are provided with Fire Protection Systems of various types.

### **102.4 Smoke Control Systems**

Smoke Control Systems are installed within the Terminal Complex in order to remove smoke from occupied areas, to enable occupants to exit to a safe area and minimize smoke-related hazards during emergency events.

**END OF CHAPTER**

## Chapter 2 - Emergency Communication Systems

### Section 200 - Emergency Communication Systems

#### 200.1 Scope

This chapter provides design guidance to the engineer in the area of the Emergency Communications System (ECS), which is utilized for both emergency communication and public address messaging at DEN. General criteria are set forth, as well as drawing and design analysis requirements.

#### 200.2 Acronyms

The following acronyms are used throughout this DSM:

CIS	Common Intelligibility Scale
STI	Speech Transmission Index

#### 200.3 Criteria

ECS shall be an In-building Mass Notification System as defined by NFPA 72.

DEN Fire Alarm signaling operates on a Presignal Function in accordance with NFPA 72 - 2010 (23.8.1.2) for public buildings. This function disables the automatic operation of the notification appliances, thereby requiring manual initiation for an evacuation. The Presignal/manual evacuation function shall be utilized in public airport terminal buildings (i.e., the Terminal, HTC Levels 1 – 4, and Concourses A, B, and C). Presignal shall not be utilized in the HTC Levels 5 – 15, AOB, Central Plant, or the AGTS Maintenance Facility, as those facilities continue to operate with automatic notification actuation.

The Fire Alarm system mostly relies on the public address system manufactured by Innovative Electronic Designs, Inc. (IED) for the audible portion of the ECS. Fire Alarm horns are only installed where ambient sound levels prohibit achieving intelligible voice messaging.

Intelligibility of the ECS is considered acceptable if at least 90 percent of the measurement locations within each space have a measured STI of not less than 0.45 (0.65 CIS) and an average STI of not less than 0.50 STI (0.70 CIS).

The requirements contained in this chapter are based upon the Federal Communications Commission (FCC) rules and regulations, the Electronic Industries Association (EIA) publications, IEEE standards, the NFPA codes, and the ANSI standards. Specific requirements for the ECS will come from this document as well as the appropriate sections of the International Building Code (IBC) and International Fire Code (IFC) as currently adopted and amended by the City and County of Denver. Note that in the 2016 Denver Amendments to IBC, Appendix S has specific requirements for airports, which are in addition to all other referenced standards.

The ECS Design Consultant shall be an acoustical consultant experienced in the design of similar systems, for similar type facilities. The ECS shall provide fire alarm alert tones, evacuation signals, and live voice announcements, both for emergency and normal business operations. The entire system shall be in accordance with the codes and standards referenced above.

#### 200.4 Drawing Requirements

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

- A. 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.
- B. Floor plans shall be provided which show the location of all control panels, amplifiers, speakers and other devices.



- C. 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.
- D. Preliminary floor plans shall be provided with the design development review documents. At this stage, zone designations and wiring information need not be presented.
- E. ECS features may be combined on common floor plans with other electrical or special system designs for each facility. Input device and control panel locations should be shown, as well as typical speaker layouts for each functional type of space in the facility.
- F. DEN master diagrams shall be updated and returned to the DEN Electrical Engineer at IFC and Record Document phases.

**200.5 Design Analysis Requirements**

The Design Consultant shall include in their design analysis report substantiation of the ECS design. Indicate the origin of specific facility ECS requirements. 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. Include catalog cuts of each selected equipment type.

For any acoustically distinguishable space (ASD) with ceilings greater than 15 feet high, the design analysis report shall include acoustic modeling of sound system performance including SPL distribution and predicted intelligibility.

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

**200.6 More Stringent Document Provision**

Should there be a conflict among the requirements presented in this document and the documents referenced above; the Design Consultant shall comply with the more stringent requirements.

**200.7 Ambient Noise Levels**

Any areas which have an ambient noise level exceeding the maximum sound level as specified by NFPA 72 shall be provided with supplemental means of notification (i.e. visual). The designer shall perform sound pressure level measurements within the work area during normal occupancy to determine the actual ambient noise level. The following table of approximate ambient noise levels shall be used as a reference in PA system design.

<b>Measured Average Ambient Noise Levels</b>	
<b>Application</b>	<b>Sound Level</b>
AGTS Tunnel	80 dBA
Baggage Tunnel	80 dBA
Mechanical Room	78 dBA
Holding areas	63 dBA
Retail space	63 dBA
Computer room	70 dBA
Office	52 dBA
Restaurant	71 dBA
Lobbies	60 dBA
Hotel room	52 dBA

**Section 201 - Microphone Stations**

- All new microphone stations shall be IP-based, connected via Ethernet to the ECS network.
- Microphone stations in the fire command center and in Airport Operation Centers (AOC) shall be capable of emergency level live voice announcements throughout the Terminal Complex.

- All fire command centers are furnished with ECS microphone stations, and graphical user interfaces to select paging zones.

### **Section 202 - Speakers**

The ECS design will use a distributed speaker system or line array layout as determined by the acoustical design. The design hearing height shall be 5 feet above the floor in general areas and 4 feet above the floor where permanent seating is provided. The ECS shall be designed to deliver public address announcements at 5 dBA above the design ambient noise level, and emergency announcements at the level specified in NFPA 72.

In the contract documents, the Design Consultant shall provide 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.

PLBs containing fixed walkways in excess of 100 feet in length shall be provided with intelligible ECS speaker coverage throughout the entire fixed walkway.

### **Section 203 - Amplifiers**

Amplifier system design shall be modular, made up of 2-channel, 400-watt plug-in, replaceable modules. The system shall be configured so that loss of any one module card will not appreciably interrupt system performance. New amplifiers shall be of the same manufacturer as the existing system.

### **Section 204 - Central Controls**

Each building in the Terminal Complex has computer-based central controller. Central controls are located in the Communications Rooms in each building. New central controllers should only be added as directed by the DEN Electrical Engineer.

Central controls shall be microprocessor-based programmable controls to allow maximum flexibility for the ECS. 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.

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 PA system. Systems used for fire alarm annunciation shall have automatic testing compatible with NFPA 72. A system that provides automatic gain control to compensate for transient, ambient noise shall be provided in public areas. Devices that are critical to system operation shall be monitored, and any failures shall trigger a supervisory notification indicated in the Fire Alarm control panel.

The Announcement Control System (ACS) shall manage announcements and messages using routed data on a standard Ethernet Network. The ACS shall manage dynamic requests for live and delayed announcements, pre-recorded and assembled messages, actions, defined events, and two-way full duplex intercom connections.

### **Section 205 - Visual Notification**

The ECS system will be supplemented visually by using the Flight Information Displays (FIDs), Gate Information Displays (GIDs), Baggage Information Displays (BIDs), and other displays to provide textual messaging. This concept is referred to as visible textual notification in NFPA 72.

LED text messaging appliances are installed in baggage tunnel and tug ramp areas. These devices may be required in high ambient noise environments.

Visual displays that are not used for ECS textual messaging may be required to be shunted to remove distraction during emergency events. Consult the DEN Electrical Engineer to determine requirements.

**Section 206 - ECS/Fire Alarm Interface**

The ECS shall be capable of prioritizing and broadcasting a 70-volt audio signal from the fire alarm system. It shall also be capable of sending microphone-level audio signal to the fire alarm system. Fire alarm announcements shall always take precedence over public address announcements.

**Section 207 - ECS Operational Plan**

DEN has developed a formal plan that provides a detailed review of system operation, infrastructure, interfaces, messages, and maintenance requirements of the ECS. Contact the DEN Electrical Engineer to obtain a copy of the ECS Operational Plan.

**END OF CHAPTER**

## Chapter 3 - Fire Alarm Systems

### Section 300 - Fire Detection and Alarm System

#### 300.1 Scope

This chapter provides guidance to the Design Consultant in the area of Fire Detection and Alarm System design for DEN. General criteria are set forth as well as drawing and design analysis requirements.

#### 300.2 Criteria

Fire detection and alarm systems are required to meet City and County of Denver requirements. Fire detection and alarm systems shall be provided in accordance with the latest editions of the standards and codes listed in the Standards and Criteria DSM, as well as the International Building Code (IBC) and International Fire Code (IFC) as currently adopted and amended by the City and County of Denver. Note that in the 2016 Denver Amendments to IBC, Appendix S has specific requirements for airports, which are in addition to all other referenced standards.

#### 300.3 Common Definitions

- A. Node – A fire alarm panel, graphic workstation, or other device on the fire alarm network that is responsible for network communication.

#### 300.4 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. 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 to which each device or group of devices is connected. Capacities and available addresses must be verified during the shop drawing process.
- B. Control schematic diagrams for air handling equipment shall be provided by the mechanical engineer and shall show the appropriate contacts to provide the required interlocks with the fire alarm system.
- C. Accurate floor plans shall be provided which show the location of all control panels and devices.
- D. Single-line diagrams shall be provided with the construction documents. At this stage, wiring information need not be presented. Wiring information shall be provided during the shop drawing process.
- E. 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 device layout for each functional type of space in the facility. Room and door numbers must be shown on floor plans as required by the Building Information Model (BIM). Refer to the BIM DSM, Section 306 - Drawing Standards Check.
- F. All design documents shall be signed and sealed by a Professional Engineer licensed in the State of Colorado.
- G. DEN master diagrams are available upon request from the DEN Electrical Engineer. Master diagrams shall be updated and returned to the DEN Electrical Engineer at IFC and Record Document phases.

### 300.5 Design Analysis Requirements

The Design Consultant shall provide a Fire Alarm System Basis of Design to substantiate the fire detection and alarm system design. The Fire Alarm System Basis of Design shall have at least the following categories included:

- A. Building description
- B. Laws and regulations
- C. Design responsibilities
- D. Fire alarm system type
- E. Design methodology
- F. Testing and inspection
- G. Equipment and tools
- H. Requirements for submittals
- I. End of job closeout

### 300.6 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 301 - Initiating Devices

### 301.1 Addressable Heat Detectors

Heat detection shall be provided as determined by the Design Analysis Report. The Design Consultant shall make appropriate accommodations in accordance with NFPA 72 when applying heat detectors to de-rate for ceiling heights and take into account unusual ceiling configurations.

### 301.2 Addressable Smoke Detectors

Smoke detectors shall be provided as determined by the Design Analysis Report. Smoke detectors shall be the addressable type and compatible with the fire alarm system. Conventional smoke detectors may be used in special conditions where addressable detectors are not compatible with the environmental or hazard condition present. Where required, combination smoke/heat detectors may be installed.

### 301.3 Addressable Manual Stations

Manual stations shall be provided as determined by the Design Analysis Report. Manual stations shall be double-action type devices with key operated reset and shall be addressable where permitted by ambient conditions. Where ambient conditions do not allow use of addressable stations, use non-addressable stations which are tied back to an I/O panel in a conditioned space where monitoring can take place.

### 301.4 Addressable Monitor Modules

Provide addressable monitor modules to monitor non-addressable devices including the following:

- A. Valve Tamper Switches  
Provide monitor devices for non-addressable valve tamper switches. Supervise the valve position as defined by the fire suppression system design (i.e., either open or closed position). Each valve tamper switch shall be individually monitored.
- B. Water Flow Indicator  
Provide monitor devices for non-addressable water flow indicators. Water flow indicators include paddle-type flow switches, pressure switches, and other types. Ensure sequence of operations

associated with water flow indication is consistent with protected areas (e.g., initiation of smoke control zones, limited area notification, elevator shunt trip, etc.).

C. Alarm Pressure Switch

For all dry-pipe systems, pre-action, and deluge systems, monitor alarm pressure switch for individual system annunciation.

D. Low Air Monitoring

For all dry-pipe and pre-action systems, provide piping supervision by means of low air pressure switches. Low air pressure switches shall be monitored by the fire alarm system.

E. Other Fire System Alarm Monitoring

Fire system alarm devices not associated with sprinkler systems include, but are not limited to, gaseous fire extinguishing systems, dry and wet chemical systems (including kitchen hood systems), foam systems, and other fire suppression or extinguishing systems. Provide means to individually monitor each non-addressable alarm devices.

### 301.5 Fire Pump Supervision

Supervise power and pump run status, from each fire pump and pressure maintenance (jockey) pump, in addition to the requirements in NFPA 20 for supervision.

## Section 302 - Notification Devices

### 302.1 Audible Alarms

A. Terminal Complex (Jeppesen Terminal, Concourses, AOB, Central Utility Plant, Hotel and Transit Center)

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 the DEN ECS Operational Plan, which can be obtained from the DEN Electrical Engineer. The audible notification shall occur through the Emergency Communication System (ECS). All public spaces, including tenant and airline spaces, shall have audible coverage through the ECS. Tone notifications (i.e., fire alarm audible devices) may be provided in non-public areas with high ambient noise levels.

B. Out-Buildings

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 72. Audible notification shall occur through fire alarm horn appliances, unless otherwise required by applicable code.

### 302.2 Visual Alarms

A. Terminal Complex (Jeppesen Terminal, Concourses, Hotel and Transit Center)

Visual appliances shall be provided in all areas in accordance with NFPA 72. Visual notification devices installed in public spaces, including tenant spaces, shall be white with red letters that read, ALERT. Visual notification devices installed in back-of-house spaces shall be red with white letters that read, ALERT. Candela rating shall be included on the design drawings.

The DEN Electrical Engineer shall determine if devices are to be conventional or addressable.

B. Out-Buildings

Visual appliances shall be provided in all areas in accordance with NFPA 72. Visual notification devices shall be red with white letters that read, FIRE. Candela rating shall be included on the design drawings.

### 302.3 Textual Visual Notification

- A. Terminal Complex (Jeppesen Terminal, Concourses, Hotel and Transit Center)

The Fire Alarm system will be supplemented visually by using the Flight Information Displays (FIDs), Gate Information Displays (GIDs), Baggage Information Displays (BIDs), and advertising displays to provide textual messaging. This concept is referred to as visible textual notification in NFPA 72.

LED text messaging appliances are installed in baggage tunnel and tug ramp areas. These devices may be required in high ambient noise environments.

- B. Out-Buildings

Not applicable.

## Section 303 - Fire Safety Functions

### 303.1 Clean Agent Release

Where required by the DEN Project Manager and DEN Risk Management, 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. Releasing systems shall be provided in accordance with the currently adopted City and County of Denver amendments to applicable codes.

### 303.2 HVAC Shutdown

Provide duct smoke detectors in accordance with applicable codes to shut down the associated HVAC unit. The duct smoke detectors shall initiate a supervisory condition on the fire alarm system. Where installed, combination fire/smoke dampers shall be individually controlled by the fire alarm system. HVAC unit shutdown and damper control shall be achieved by addressable fire alarm relay(s).

### 303.3 Door Release

Fire alarm system shall interrupt power to magnetic door holders to close the doors and establish release for required controlled exit doors. Doors shall be released consistent with the smoke control zones and security door release sequences may be considered Security Sensitive Information (SSI). Door release shall be achieved by addressable fire alarm relay(s).

### 303.4 Elevator Recall

Where elevators are installed, modified, or replaced, the fire alarm system shall provide elevator recall and shunt trip functions as applicable, per NFPA 72. Elevator interface(s) shall be achieved by addressable fire alarm relay(s).

### 303.5 Media Shunt

In tenants with private audio/visual systems or other visual advertising, media shunt shall be provided during emergency messaging activation. Media shunt shall be achieved by addressable fire alarm relay(s).

## Section 304 - System Configuration

### 304.1 Circuit Supervision

Circuit supervision shall be provided consistent with NFPA 72.

### 304.2 Circuit Survivability

To provide a higher level of survivability from fire and physical damage, a level of protection consistent with Level 1 pathway survivability per NFPA 72 shall be provided for the audible ECS pathways between the ECS controls to the speakers and for visual notification circuits to fire alarm visual appliances (strobes).

### 304.3 Power Supply

The fire alarm control panels shall be designed to operate from 120 volt, 60-hertz, single-phase power source. In buildings equipped with an emergency power source, connect fire alarm control panels to the emergency source. The fire alarm control panels shall be provided with battery 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 fifteen minutes. Provide UPS power with a minimum runtime of 4 hours for all graphic workstations.

### 304.4 Graphic Annunciation

#### A. Terminal Complex (Jeppesen Terminal, Concourses, Hotel and Transit Center)

Graphic annunciation shall be provided at all of the fire command centers via the Simplex TrueSite workstation that shall indicate the location of the actuated detection or protection device. All additions or modifications to the system, including floor plan changes, shall be incorporated into the workstation graphics.

#### B. Out-Buildings

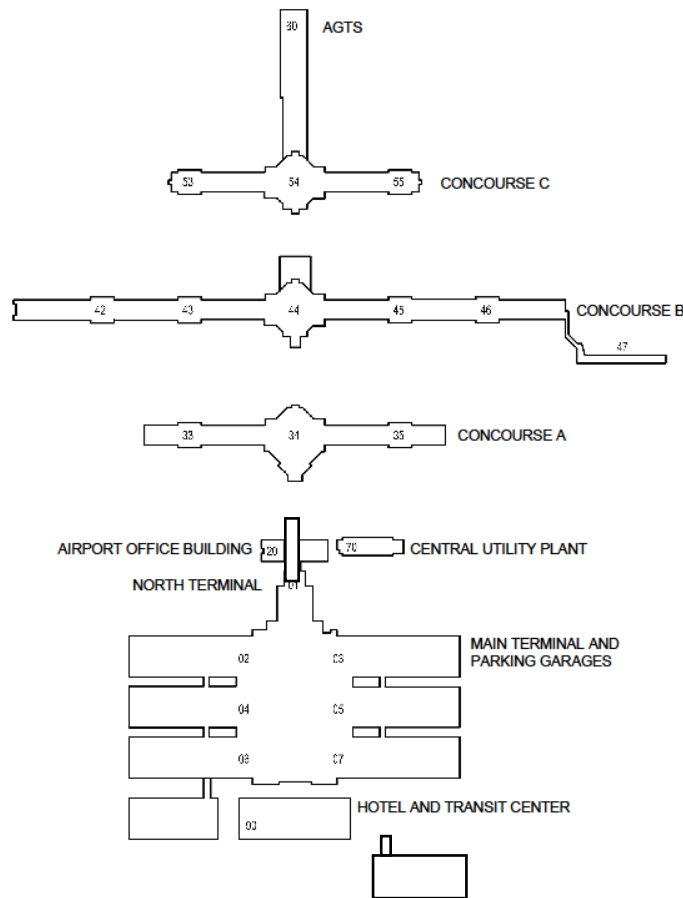
Graphic annunciation panels shall be provided in accordance with currently adopted City and County of Denver fire code amendments. The panel shall be located in the main entrance at an AHJ approved location.

### 304.5 System Configuration

#### A. Terminal Complex (Jeppesen Terminal, Concourses, Hotel and Transit Center)

The system is a single network for all fire alarm panels. The primary control components are the fire alarm control panel, which operate in a peer-to-peer node configuration and are distributed throughout the complex. The SimplexGrinnell computer based graphic display panels (i.e., TrueSite workstations) are individual nodes on the network.





Major expansions may require the addition of new nodes, with consultation between DEN Electrical Engineer and SimplexGrinnell.

**B. Out-Buildings**

In general, all out-buildings will be standalone fire alarm systems, with approved central station monitoring.

**304.6 Network Communications**

**A. Terminal Complex (Jeppesen Terminal, Concourses, Hotel and Transit Center)**

The fire alarm system for the terminal complex is a proprietary network that interlinks the fire command centers, including the graphic workstations provided in each fire command center. The fire alarm panels shall be part of this network and shall be capable of communicating through the network for both alarm reporting and command and control functions. Network communications shall be via Class-A fiber-optic or copper wiring in accordance with NFPA 72.

DEN fire alarm system shall be monitored directly by Denver Fire Department Dispatch through an AES Corporation wireless transceiver interface. An AES transceiver is provided within each primary building.

Fire Alarm network diagrams can be obtained from the DEN Electrical Engineer.

**B. Out-Buildings**

Not applicable.

**END OF CHAPTER**

## Chapter 4 - Fire Protection Systems

### Section 400 - General

Fire protection systems shall be provided in accordance with the currently adopted editions of the standards and codes listed in the DSMs and in the International Fire Code as adopted and amended by the City and County of Denver. IBCA Appendix S contains additional requirements. It shall represent all of the requirements of the agency Insurance Underwriters. The following description of fire protection requirements is based on NFPA codes.

### Section 401 - Related Work

Fire protection system design includes coordination with electrical design for proper placement of devices for initiation of alarm by the Fire Alarm System and initiation of the Smoke Control System as applicable. The devices include, but are not limited to; fire protection sprinkler flow switches, heat detectors, smoke detectors, beam detectors, alarm pressure switches, manual pull stations, and other alarm initiating devices.

The Design Engineer shall coordinate fire protection system design with the Architect.

### Section 402 - Drawing Requirements

Design documents shall be produced using BIM, as set forth in the BIM DSM instructions. All design documents shall contain the following at a minimum:

- A. Plans showing as-built fire-sprinkler layout of existing/new space.
- B. Plans location of existing and new sprinkler zone control valves.
- C. Building fire protection riser diagram identifying riser for modification to sprinkler zones of project impact.
- D. Building fire zone diagram identifying area of work and fire sprinkler zone impacts, including accurate depiction of sprinkler zone boundaries.
- E. DEN Specifications shall be edited as required for the specific scope of work.
- F. DEN master diagrams are available upon request from the DEN Electrical Engineer. Master diagrams shall be updated and returned to the DEN Electrical Engineer at IFC and Record Document phases.

### Section 403 - Fire Protection Systems (Terminal and Concourse Areas)

#### 403.1 Airport Terminal and Concourse Buildings

- A. All areas of the terminal complex shall be sprinklered in accordance with applicable codes and standards.
- B. All baggage handling conveyor openings shall be protected in accordance with NFPA 13 water curtain requirements.
- C. Exterior glass partitions surrounding foyer areas shall be protected with closed head sprinklers on 6-foot centers to provide a water curtain.

#### 403.2 Parking Garages

- A. Existing parking garages, modules 1, 2 and 3 on the east and west side of the terminal are provided with a dry-type sprinkler system. For projects affecting these areas, the existing systems shall be retained.

- B. Service drives shall have a dry-type sprinkler system, with the exception that existing concourse drive-thrus shall have wet pipe systems with dry style pendent heads
- C. On Levels 1, 2, and the part of Level 3 where there is no alternate baggage conveyors, the dry pipe systems extend 75' from entrance doors. On Level 4, the dry pipe systems extend throughout the driving lanes in front of the doors. On Level 5, the dry systems cover the entire covered area. All covered drive lanes on all structures have either dry systems or heated blind spaces with dry pendent heads.

### **403.3 Baggage Handling Areas**

Refer to IBCA Appendix S for fire protection requirements in baggage handling areas.

### **403.4 Other Facilities**

In general, single facilities larger than 1,500 Square feet require fire sprinkler and fire alarm systems per the requirements of Denver Fire Prevention Bureau, DEN insurance carrier, and NFPA.

## **Section 404 - Miscellaneous Requirements**

### **404.1 Standpipe System**

The terminal and concourse structures shall be protected by a hydraulically calculated wet standpipe system and fire extinguishers, as required by NFPA Standard 14 and NFPA 415, latest editions. The current fire code as amended by the Denver Fire Prevention Bureau requires NFPA 415 as well as current issue of applicable NFPA codes and standards. The Design Consultant shall specify the installing Contractor to perform hydraulic calculations based on final layout.

### **404.2 Kitchen Hood Systems**

Kitchen hood suppression systems shall comply with applicable sections of NFPA 17, 17A and 96, and UL 300.

### **404.3 Hydrants**

- A. For new facilities, hydrants shall be provided in accordance with the IFC, IFCA, and as directed by the Authority Having Jurisdiction (AHJ).
- B. Fire hydrants shall be provided in the short term parking areas and at each end of the enplaning and deplaning drives, installed in accordance with NFPA Standard 24 requirements, latest edition.
- C. A system of exterior fire hydrants or wall hydrants shall be provided on both sides of each concourse building and the airside of the International concourse.
- D. The use of sidewalk or wall hydrants shall be in accordance with NFPA 13 and 14 and shall be based on fire equipment access to the hydrants and as acceptable by the Denver Fire Prevention Bureau.

### **404.4 Water Supply**

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

- A. A fire pump system, if necessary, located in separate fire pump room in the main terminal building service level shall be provided. Installation shall conform to the currently adopted version of NFPA 20 and the IFC, as amended by the City and County of Denver.
- B. Water supply to the fire pumps for fire protection systems shall be taken from the service main ahead of the meter. Detailed design of these systems and design criteria for hydraulically calculated sprinkler and standpipe systems shall commence after consultation with local authorities and insurers.
- C. The fire pump room shall be sprinklered.

- D. Use only the current year's actual site fire pump tests data and City of Denver Water Department hydraulically provided information that is no older than 6 months for the hydraulic calculations basis.

#### **404.5 Pressure Reducing Valves**

Standpipe hose connections need to have Pressure Reducing Valves (PRVs) as defined by IFCA.

Where required, PRVs shall be provided in accordance with the International Fire Code as adopted and amended by the City and County of Denver.

#### **404.6 Foam Systems**

Provide foam water systems in aircraft hangars and at fuel tanks and fuel loading areas. Foam systems shall be Aqueous Film Forming Foam (AFFF).

#### **404.7 Coordination with Smoke Control Zones**

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

**END OF CHAPTER**

## Chapter 5 - Smoke Control Systems

### Section 500 - General

This chapter outlines specific requirements to be included in the overall mechanical system designs and specifications for issuance of construction documents suitable for bidding and permitting. These designs and specifications shall include engineered smoke control systems where applicable for specific locations. This chapter describes the smoke control system design requirements and criteria for specific locations and the scope of participation that is required by Design Professionals of Record.

Smoke control systems are provided in all Terminal Complex buildings including the Main and North Terminals, Concourses, Airport Office Building (AOB), AGTS Tunnels, Baggage Tunnels, Passenger Bridge from the North Terminal to Concourse A, Central Utility Plant (CUP) and the Hotel and Transit Center (HTC).

In general, the requirements of this chapter do not apply to out-buildings, unless specifically required by the Denver Building Code or the DEN Project Manager.

#### 500.1 Related Work

Smoke Control System Design includes coordination with the Electrical design for proper placement of devices for initiation of the smoke control sequence by the Fire Alarm System. The devices include, but are not limited to fire protection sprinkler flow switches, heat detectors, smoke detectors, beam detectors, alarm pressure switches, manual pull stations, and other alarm initiating devices.

Smoke Control System Design includes coordination with the sprinkler designer for application of the fire suppression system and interface to specific smoke control zoning as defined herein.

Coordinate with DEN Life Safety to determine fire alarm system device address availability for monitoring and control of the smoke control system.

#### 500.2 Quality Assurance

Design documents shall be prepared by or under the direct supervision of a Fire Protection Engineer Licensed in the State of Colorado, (Engineer). The Engineer shall be regularly engaged in the design and installation of smoke control systems of the type and complexity required for the application.

#### 500.3 Drawing Requirements

Design documents shall be produced using BIM, as set forth in the BIM DSM instructions. All design documents shall contain the following at a minimum:

- A. Written sequence of operation for smoke control.
- B. Smoke control zone diagrams.
- C. DEN master diagrams are available upon request from the DEN Electrical Engineer. Master diagrams shall be updated and returned to the DEN Electrical Engineer at IFC and Record Document phases.

### Section 501 - Design Criteria

#### 501.1 Standards

Smoke control design shall be performed in accordance with the currently adopted versions of:

- A. International Building Code (IBC)
- B. International Mechanical Code (IMC)
- C. International Fire Code (IFC)
- D. NFPA 92 – Standard for Smoke Control Systems (if applicable)

- E. Denver Amendments to the International Codes (specifically IBCA, Appendix S)
- F. Principles of Smoke Management, published by ASHRAE & SFPE (if applicable)
- G. Any requirements set forth by the DEN Project Manager.

### 501.2 General

Design shall comply with the requirements of the currently adopted City and County of Denver Building and Fire Code Amendments. In addition, the design shall comply with all applicable contract documents.

### 501.3 Equipment

All new smoke control system designs shall provide dedicated smoke control equipment for providing pressurization or exhaust. Heating, ventilation, and air conditioning (HVAC) systems associated with new facilities shall not be used for smoke control. Duct materials and ductwork shall be designed, in accordance with the adopted codes and standards, to convey smoke and withstand the maximum pressure (both positive and negative) provided by the smoke control pressurization or exhaust fans when operating in a smoke control mode. Pressurization and exhaust ductwork shall maintain their structural integrity during the entire period required for the system to operate.

Equipment including, but not limited to, fans, ductwork, balancing dampers, damper actuators, motors, etc., utilized for smoke control shall be suitable for the intended operating temperatures. Materials used for systems providing smoke control shall conform to applicable codes and DEN Specifications. Smoke control system components (e.g., fans and dampers) shall be UL listed for use in smoke control systems.

Renovation work in existing areas shall maintain the existing smoke control equipment and sequence, unless directed otherwise by the DEN Project Manager. Design requirements shall include evaluation and testing of existing smoke control equipment and sequence. Testing reports shall be submitted to the DEN Project Manager prior to proceeding with the design. Where existing HVAC equipment is utilized as a component of the smoke control system, the Engineer shall investigate alternatives to provide dedicated smoke control equipment with the DEN Mechanical Engineer and the DEN Life Safety Team.

### 501.4 Equipment/Zone Identification

The Engineer shall obtain equipment and zone identification from the DEN Mechanical Engineer.

In general, new smoke control equipment is identified by A-B-C

Identifier	Equipment
A	SEF for Smoke Exhaust Fan, SPF for Smoke Pressurization Fan, FSD for Fire/Smoke Damper, and SD for Smoke Damper
B	Alpha/Numerical Identifier for Fan or Damper location (obtain from DEN Mechanical Engineer)
C	Alpha/Numerical Identifier for Fan or Damper Number (obtain from DEN Mechanical Engineer)

Addition of smoke control equipment to an existing building shall follow fan and damper naming convention for the existing smoke control system. Smoke pressurization and exhaust fans serving the same area shall have the same numerical sequence. Smoke control equipment shall not be identified by any other method. Designer shall coordinate with other disciplines for naming conventions associated with fans and peripheral equipment, such as starters and disconnects, to ensure that a single system of identification is being applied to Smoke Control, HVAC, Electrical, and Fire Alarm drawings.

### 501.5 Design Criteria

Smoke control systems shall be provided for buildings, areas, or life safety components as required by applicable codes. Smoke control systems shall provide the quantity of air changes per hour, airflow, or pressure differential as required by the Denver Building and Fire Codes. Renovations of existing areas shall maintain the existing smoke control design. Smoke control zones shall be limited to maximum area as required by applicable codes. Tenant spaces shall be part of a predominant area smoke control zone, or provide separate smoke control zones, as determined by applicable codes.

Smoke control zone boundaries shall match sprinkler zone boundaries. Multiple sprinkler zones are permitted in a single smoke control zone. In no case shall a fire sprinkler zone cross any smoke control zone boundary. The mechanically operated supply and return exhaust systems serving smoke control zones shall be arranged to exhaust at the indicated rates when activated by the smoke detection and/or sprinkler system. In addition to other smoke zone area requirements, passenger holding areas not within the concourse (e.g. commuter facilities) shall be treated as a separate zone. Passenger holding areas within the concourse shall be treated as part of the concourse/passenger terminal public circulation space.

The smoke control system, both pressurization and exhaust systems, shall be capable of manual override operation from any Fire Command Center TSW as required by applicable codes.

Draft curtains shall be provided for multiple smoke zones that are not separated by a physical barrier as required by applicable codes.

### **501.6 Transfer Air**

Sizing of smoke exhaust transfer air openings shall include smoke exhaust air quantities as required by applicable codes and design criteria. Coordinate requirements for security grilles or barriers with DEN Mechanical Engineer.

### **501.7 Smoke Zone and Airflow Diagrams**

Existing smoke control zone diagrams, operating sequences, and airflow diagrams are available upon request from the DEN Electrical Engineer. These diagrams and matrices shall be used whenever a smoke test is required. These files shall only be modified when smoke control zones or equipment are added or modified. The Engineer shall update the DEN Smoke control diagrams and the smoke control matrix for the building of design and submit the updated electronic file to the DEN Mechanical Engineer, separate from the contract documents.

Building airflow diagrams are available for limited areas only and are in the process of being created for all areas. When the airflow diagram is available, the Mechanical Systems Design Engineer shall update the DEN airflow diagram for the building or area of design and submit the updated file to the DEN Mechanical Engineer, as a separate submittal.

### **501.8 System Initiation**

The sequence of operations provided on Fire Alarm Record Drawings includes all initiation and operational requirements, including whether One (1) or Two (2) initiation device(s) is/are required to activate automatic smoke control sequences for the associated smoke zone. Only automatic and/or water flow initiating devices dictate the area smoke control zone of operation. For area smoke control sequencing, manual pull stations act as confirming devices but do not dictate the smoke control zone activated. Smoke control sequences that include vertical pressurization activate from a single automatic or manual fire alarm initiating device. Refer to the fire alarm sequence of operation in the Fire Alarm Record Drawings for specific requirements to initiate building smoke control.

The firefighter's smoke control panel (FSCP) located in each Fire Command Center (FCC) shall provide manual control of all smoke control system equipment and sequencing. Manipulation of the FSCP shall override any automatic smoke control function. The FSCP is graphically depicted and controlled through computer based graphics display interfaces (Simplex TrueSite Workstations (TSW)), provided throughout the Main Complex. Manual smoke control panels are provided for the AGTS smoke control system in both AGTS control centers.

## **Section 502 - Terminal Smoke Control Operation Overview**

The following is a general description of the smoke control systems in place for specific areas in the Terminal. Refer to Fire Alarm Record Drawings for smoke control sequence of operations, fire alarm sequence of operation, and smoke zone information. The existing smoke control design approach for the Terminal includes exhausting the zone in alarm with 4 air changes per hour or 20,000cfm minimum from each smoke zone, and pressurizing vertical enclosures as required. Adjacent zones are not pressurized unless make-up air is determined to be necessary to prevent excessive negative pressure within the building. Smoke control exhaust for the main terminal, (with the exception of the Great Hall), is automatically initiated with the activation of two initiating devices in public areas and a single automatic initiating device in non-public areas. Smoke control pressurization of adjacent zones within the main terminal is initiated from the TSW in the FCC.

### 502.1 Great Hall

Sixty (60) dedicated, direct drive exhaust fans located at the top of the great hall tent near the tent support columns are used to exhaust the Great Hall. A hatch is located above the exhaust fans to protect the Great Hall from the outside environment. The exhaust fan hatches are automatically opened upon fan activation, but must be manually reset. Manually resetting or closing the hatch requires a man lift to access each exhaust fan hatch and requires a considerable amount of time to perform. As a result, exhausting the Great Hall is achieved by manual operation only.

### 502.2 Level 5 and 6 Ticketing, Baggage Claim, and Tenant Areas

Pressurization and exhaust for level 5 and 6 ticketing, tenant and baggage claim areas is accomplished with Twelve (12) dedicated exhaust fans and twelve (12) air handlers utilized for HVAC supply (six per smoke zone). Exhaust utilizes the return air plenum above the ceiling on levels 5 and 6. Pressurization utilizes supply ductwork networked above the ceiling in the air plenum and terminates at multiple locations on Level 5 and 6. Fire/smoke dampers located in the return air ductwork are used to isolate and exhaust the level or area in alarm.

Smoke control operation in tenant spaces shall comply with IBCA Appendix S.

### 502.3 Level 4 Train Platform

Pressurization and exhaust for the Train platforms, both inboard and outbound are accomplished by two (2) dedicated exhaust fans and two (2) air handlers utilized for HVAC supply located on level 4. Fire smoke dampers are used to exhaust either the out-bound or in-board train platform.

### 502.4 Levels 3 and 4 Mechanical Equipment, Baggage Handling, and Baggage Make-up

Smoke control for baggage areas located in the Main Terminals on Levels 3 and 4 utilize the baggage ventilation systems to serve as the exhaust systems for these zones. The baggage area heat-recovery/exhaust fans are enabled to provide smoke control exhaust. Dampers are installed in the heat recovery unit exhaust ductwork and operate as required to isolate and exhaust the defined smoke control zones.

Alternate baggage handling zones 7, 9, 10, 12, and 13 utilize the existing direct drive, ventilation exhaust fans to provide smoke control exhaust.

### 502.5 Offices Level 1

Return air fans located in the Level 1 mechanical rooms are used to provide smoke exhaust capabilities with relief air fans used to pressurize the adjacent space. The smoke control system design intent is to exhaust the area with a minimum of four (4) air changes per hour.

### 502.6 Vertical Pressurization

Existing stairway and elevator hoistway pressurization fans are provided for all elevators and egress stairways. Existing hoistway pressurization fans are installed serving both passenger and freight elevator hoistways greater than three floors of travel within the Main Terminal. Construction of new stairways where the landing is located more than 75 feet above the lowest level of fire department vehicle access shall be pressurized as required by IBCA Appendix S. Hoistways with a total rise of 75 feet or serving an occupiable floor located 75 feet above the lowest level of fire department vehicle access shall be mechanically pressurized in accordance with IBCA Appendix S.

## Section 503 - North Terminal Smoke Control Operation Overview

The following is a general description of the smoke control systems in place for specific areas in the North Terminal. Refer to Fire Alarm Record Drawings for smoke control sequence of operations, fire alarm sequence of operation, and smoke zone information. The existing smoke control design approach for the North Terminal includes exhausting the zone in an alarm with four (4) air changes per hour or 20,000cfm minimum. Pressurization for adjacent zones and/or floors is provided for levels 5, 6 and 7. Smoke control exhaust and adjacent zone pressurization for the North Terminal is automatically initiated with the activation of two initiating devices in public areas and a single automatic initiating device in non-public areas. All other smoke control zones



shall remain in normal operation unless commanded otherwise either automatically or manually through the fire alarm system.

### **503.1 Level 5, 6, and 7 International, Domestic, and Customs Areas**

International, Domestic, and Customs areas on Levels 5, 6, and 7 are provided with pressurization and exhaust through the return air fans and air handling units supplying the area. Isolation of exhaust and pressurization by floor is achieved through fire smoke dampers. Dedicated rooftop exhaust fans are installed for portions of the North Terminal Level 6 domestic corridor leading to the passenger bridge.

### **503.2 Level 4 Offices and Communications Areas**

The smoke control system serving Level 4 areas utilize return fans located in the Mechanical Rooms on level 4. The communications rooms located on the North end of level 4 are provided with clean agent fire extinguishing system. As a result, dampers located at the room boundary are closed on activation of an alarm device within the room, to minimize the leakage rate for these rooms.

### **503.3 Level 3 Baggage Tunnels**

Smoke control for baggage areas located at the north end of North Terminal Level 3 have dedicated smoke exhaust fans to serve as the smoke control exhaust for this area. These fans are physically installed under the AOB but are considered part of the North Terminal smoke control exhaust systems. Baggage tunnels shall have an exhaust rate of 4 air changes per hour minimum.

## **Section 504 - Passenger Bridge Smoke Control Operation Overview**

The following is a general description of the smoke control systems in place for the passenger bridge connecting the North Terminal to Concourse A. Refer to Fire Alarm Record Drawings for smoke control sequence of operations, fire alarm sequence of operation, and smoke zone information. The existing smoke control design approach for the Passenger Bridge includes exhausting the zone in an alarm with a minimum of 4 air changes per hour. The design objective for the passenger bridge is to contain smoke spread to the smoke zone of origin, and to the greatest extent possible limit the extent of smoke spread beyond the zone of fire origin.

### **504.1 Exhaust**

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

### **504.2 Pressurization**

The AHUs located in the roof level mechanical room, are used to provide smoke control pressurization for the passenger bridge. Smoke control pressurization is provided through the HVAC system supply distribution and is ducted to both levels and both sides of the bridge.

## **Section 505 - Airport Office Building (AOB) Smoke Control Operation Overview**

The following is a general description of the smoke control systems in place for specific areas in the AOB. Refer to Fire Alarm Record Drawings for smoke control sequence of operations, fire alarm sequence of operation, and smoke zone information. The existing smoke control design approach for the AOB includes exhausting the zone (floor) in an alarm and pressurizing vertical enclosures in accordance with the requirements for existing high-rise buildings. The general smoke exhaust system includes motorized combination fire/smoke dampers or a motorized smoke and a fire damper on each floor served by the system(s).

The return air fans located in the Level 11 mechanical room are used to provide smoke exhaust for the AOB. Smoke is exhausted through the above-ceiling return air plenum. The smoke exhaust for the floor of alarm is isolated via return/exhaust dampers located at the return airshafts on each floor. Level 4, 5A, and 5B parking and loading dock areas are exhausted by dedicated, direct drive fans provided on each floor.

General floor pressurization is provided through the dedicated building pressurization fans connecting to the main HVAC system duct risers at Level 5. VAV terminal unit controllers communicate through the respective

temperature control panel. VAV terminal units open through temperature control programming via an input from the fire alarm system. Coordinate with Chapter 3, for required VAV terminal unit controllers.

The refuge areas are provided with a single, dedicated exhaust fan. Fire smoke dampers are used to isolate and exhaust the appropriate area of refuge. The elevator hoistway pressurization system and fire smoke dampers are used to isolate and pressurize the appropriate refuge areas.

Dedicated stairway pressurization fans are installed for service to all existing public stairways.

## **Section 506 - Concourse A Smoke Control Operation Overview**

The following is a general description of the smoke control systems installed for specific areas in Concourse A. Refer to Fire Alarm Record Drawings for smoke control sequence of operations, fire alarm sequence of operation, and smoke zone information. The existing smoke control design approach for Concourse A includes exhausting the zone in an alarm with a minimum of four (4) air changes per hour or 20,000cfm (except the control tower) and as required, pressurizing vertical enclosures. Adjacent zones are not pressurized unless make-up air is determined to be necessary to prevent excessive negative pressure within the building. Make-up/supply air fans are modified for each smoke zone to attempt to create a slightly negative condition (i.e., more exhaust than make-up air). This approach is an attempt to contain the smoke to the original zone and to avoid the smoke being pushed into other building areas or even other buildings. Maintaining a slightly negative condition credits the large volume of the building to allow make-up from other areas and through normal building leakage. Smoke control exhaust for the Concourse A starts automatically with the activation of two initiating devices in public areas and a single initiating device in non-public areas.

### **506.1 Center Core and International Smoke Control Zones**

This section does not pertain to the passenger bridge (Refer to Section 1004) or the Level 3, International Walkway located between the Centercore and Subcores (Refer to Section 1006.3). Tenant areas less than 5,000sf in area, located on the Concourse and Mezzanine Levels of the Centercore are considered a part of the Centercore smoke zone (SZ-CC). Manual, dedicated smoke exhaust for these tenants is provided and shall be maintained. Draft curtains or equivalent are provided between the tenants' areas and the Centercore. If no ceiling is planned in a Tenant space or adjacent spaces, ducted return must be designed connecting the adjacent Tenant plenums. Provide return air registers within the ductwork sized to accommodate the smoke exhaust air quantity. Provide balancing dampers as required to balance the system. Coordinate with Chapter 3, for required return air grille specifications.

The Centercore smoke control zone utilizes dedicated rooftop exhaust fans at the Centercore ceiling. Centercore egress stairwells and elevator hoistways are pressurized.

### **506.2 Subcore, Holdroom, and International Walkway Smoke Control Zones**

Exhaust for smoke zones located on the Concourse and Mezzanine Levels are provided via the rooftop, direct drive exhaust fans. Level 4 and International walkways utilize a ceiling plenum or return air plenum with dedicated smoke exhaust fans for smoke evacuation. The retail Tenant areas located in the Subcore of the Concourse and Mezzanine Levels are not dedicated smoke control zone.

### **506.3 Basement Smoke Control Zones**

Basement area smoke control pressurization and exhaust is provided through dedicated exhaust fans and supply air through Ventilation Smoke Control Fans (VSCF). The VSCF fans operate as part of the normal HVAC system to provide supply air ventilation to the baggage handling areas located below the concourse. Single device initiation starts the exhaust fans for the zone in alarm and turns off the VSCF fans in the effected smoke zone.

### **506.4 Tenant Space Smoke Control Zones**

Tenant space smoke control zones shall comply with IBCA Appendix S.

### **506.5 Control Tower**

The control tower is the only area that is provided with six air changes per hour. Normal HVAC operations are maintained on adjacent floors during smoke control activation.

## Section 507 - Concourse B Smoke Control Operation Overview

The following is a general description of the smoke control systems installed for specific areas in Concourse B. Refer to Fire Alarm Record Drawings for smoke control sequence of operations, fire alarm sequence of operation, and smoke zone information. The existing smoke control design approach for Concourse B includes exhausting the zone in an alarm with four (4) air changes per hour or 20,000cfm minimum and as required, pressurizing vertical enclosures. Adjacent zones are not pressurized unless make-up air is determined to be necessary to prevent excessive negative pressure within the building. Make-up/supply air fans are modified for each smoke zone to attempt to create a slightly negative condition (i.e., more exhaust than make-up air). Maintaining a slightly negative condition credits the large volume of the building to allow make-up from other areas and through normal building leakage. Smoke control exhaust for Concourse B starts automatically with the activation of two initiating devices in public areas and a single automatic initiating device in non-public areas.

### 507.1 Center Core Smoke Control Zones

Tenant areas less than 5,000sf located on the Concourse and Mezzanine Levels of the Centercore are considered a part of the Centercore smoke zone (SZ-CC). Although, the tenant areas on the Concourse and Mezzanine levels are not separate smoke zones, manual, dedicated exhaust for these tenants are provided and shall be maintained. Draft curtain or equivalents are provided between the tenants' areas and the Centercore. In general, Centercore smoke control systems utilize a ceiling plenum or return air plenum with a dedicated smoke exhaust fans for smoke evacuation with the exception of the atrium smoke control zone (SZ-CC). Air plenum openings shall be designed to assure adequate smoke removal of the Tenant space. Sizing of openings shall not exceed a face velocity 200 fpm. If no ceiling is planned in a Tenant space or adjacent spaces, ducted return must be designed connecting the adjacent Tenant plenums. Provide return air registers within the ductwork sized to accommodate the smoke exhaust air quantity. Provide balancing dampers as required to balance the system. Coordinate with Chapter 3, for required return air grille specifications.

The Centercore smoke control zone utilizes dedicated rooftop exhaust fans at the Centercore ceiling. Centercore egress stairwells and elevator hoistways are pressurized.

### 507.2 Subcore and Holdroom Smoke Control Zones

Exhaust for smoke zones located on the Concourse and Mezzanine Levels are provided via rooftop, direct drive exhaust fans. Level 4 smoke zones utilize a ceiling plenum or return air plenum with dedicated smoke exhaust fans for smoke evacuation. The retail Tenant areas located in the Subcore of the Concourse and Mezzanine Levels are not part of the smoke control zone.

### 507.3 Basement Smoke Control Zones

Basement area smoke control pressurization and exhaust is provided through Ventilation Smoke Control Fans (VSCF). These fans operate as part of the normal HVAC system to provide supply air ventilation to the baggage handling areas located below the concourse. These fans provide smoke control pressurization or exhaust by positioning a series of dampers located upstream and downstream of each fan. These fans operate normally through their respective variable frequency drives (VFD) and through their respective by-pass cabinets for smoke control pressurization and exhaust. Refer to Section 1008 for AGTS and baggage tunnel smoke control system details.

### 507.4 Tenant Space Smoke Control Zones

Tenant space smoke control zones shall comply with IBCA Appendix S.

### 507.5 Control Tower

The control tower is the only area that is provided with six air changes per hour. Normal HVAC operations is maintained on adjacent floors during smoke control activation.

## Section 508 - Concourse C Smoke Control Operation Overview

The following is a general description of the smoke control systems installed for specific areas in Concourse C. Refer to Fire Alarm Record Drawings for smoke control sequence of operations, fire alarm sequence of operation, and smoke zone information. The existing smoke control design approach for Concourse C includes exhausting

the zone in an alarm with a minimum of 4 air changes per hour or 20,000cfm and as required, pressurizing vertical enclosures. Adjacent zones are not pressurized unless make-up air is determined to be necessary to prevent excessive negative pressure within the building. Make-up/supply air fans are modified for each smoke zone to attempt to create a slightly negative condition (i.e., more exhaust than make-up air). Maintaining a slightly negative condition credits the large volume of the building to allow make-up from other areas and through normal building leakage. Smoke control exhaust for Concourse C starts automatically with the activation of two initiating devices in public areas and a single automatic initiating device in non-public areas.

### **508.1 Center Core Smoke Control Zones**

Tenant areas located on the Concourse and Mezzanine Levels of the Centercore are considered a part of the Centercore smoke zone (SZ-CC). Although, the tenant areas on the Concourse and Mezzanine levels are not a separate smoke zone, manual, dedicated exhaust for these tenants are provided and shall be maintained. Draft curtain or equivalent is provided between the tenants' areas and the Centercore. In general, Centercore smoke control systems utilize a ceiling plenum or return air plenum with a dedicated smoke exhaust fans for smoke evacuation with the exception of the atrium smoke control zone (SZ-CC). Air plenum openings shall be designed to assure adequate smoke removal of the Tenant space. If no ceiling is planned in a Tenant space or adjacent spaces, ducted return must be designed connecting the adjacent Tenant plenums. Provide return air registers within the ductwork sized to accommodate the smoke exhaust air quantity. Provide balancing dampers as required to balance the system. Coordinate with Chapter 3, for required return air grille specifications.

The Centercore smoke control zone utilizes dedicated rooftop exhaust fans at the Centercore ceiling. Centercore egress stairwells and elevator hoistways are pressurized.

### **508.2 Subcore Smoke Control Zones**

Exhaust for smoke zones located on the Concourse and Mezzanine Levels are provided via rooftop, direct drive exhaust fans. Level 4 smoke zones utilize a ceiling plenum or return air plenum with a dedicated smoke exhaust fans for smoke evacuation. The retail Tenant areas located in the Subcore of the Concourse and Mezzanine Levels are not part of the smoke control zone.

### **508.3 Basement Smoke Control Zones**

Basement area smoke control pressurization and exhaust is provided through dedicated exhaust fans and supply air through Ventilation Smoke Control Fans (VSCF). The VSCF fans operate as part of the normal HVAC system to provide supply air ventilation to the baggage handling areas located below the concourse. Single device initiation starts the exhaust fans for the zone in alarm and turns off the VSCF fans in the effected smoke zone.

### **508.4 Tenant Space Smoke Control Zones**

Tenant space smoke control zones shall comply with IBCA Appendix S.

### **508.5 Control Tower**

The control tower is the only area that is provided with six air changes per hour. Normal HVAC operations are maintained on adjacent floors during smoke control activation.

## **Section 509 - AGTS Tunnel Smoke Control Operation Overview**

The following is a general description of the smoke control systems installed for specific areas in AGTS/Baggage Tunnels Refer to Fire Alarm Record Drawings for smoke control sequence of operations, fire alarm sequence of operation, and smoke zone information. The existing smoke control design approach for the AGTS and Baggage Tunnels includes exhausting the zone in an alarm with a minimum of 4 air changes per hour. Dedicated, reversible, direct drive fans provide pressurization and exhaust for the AGTS and Baggage Tunnels. As well as operation via the TSW, additional dedicated FSCP's located in the AGTS control centers are provided for manual control of the AGTS smoke control system. The AGTS smoke control system is provided with two operational phases depending on the anticipated smoke development from a fire: phase 1 is used to exhaust the zone in alarm. For a larger smoke producing fire, phase 2 used as directed by the incident commander to exhaust or pressurize zones as necessary to meet operational requirements.

### Section 510 - Central Utility Plant Smoke Control Operation Overview

The Central Utility Plant (CUP) is provided with a single exhaust fan in the Chiller Room. The exhaust fan is activated from a mushroom switch provided in the ground level CUP vestibule near the fire alarm control panel.

### Section 511 - Hotel/Transit Center Smoke Control Operation Overview

The following is a general description of the smoke control systems installed for specific areas in the Hotel Transit Center (HTC). Fire Alarm Record Drawings for smoke control sequence of operations, fire alarm sequence of operation, and smoke zone information are available upon request from the DEN Mechanical Engineer.

The smoke exhaust system includes motorized combination fire/smoke dampers or a motorized smoke and a fire damper on each floor of the building served by the system(s). The smoke exhaust system is sized to remove a minimum of five air changes per hour on the fire floor in Occupancy Groups A, B, E and M. The smoke exhaust system is sized to remove a minimum of fifteen air changes per hour in the typical floor corridors, the typical floor corridors/elevator lobbies, or the typical floor elevator lobbies in Occupancy Groups R-1, R-2, I-1 and I-3. Egress Stairwell pressurization is provided with a minimum pressure differential of 0.1 inches of water column from stairs to the fire floor. Elevator hoistway and machine rooms that are required to be pressurized are provided with 0.05 inches of water column greater than adjoining elevator lobbies. Elevator lobbies required to be pressurized maintain a minimum 0.05 inches of water column greater than the surrounding spaces. Area exhaust is achieved through a dedicated ducted exhaust system.

### Section 512 - Construction Documents

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

- A. Drawings showing the smoke zones for all spaces of design and surrounding the area of design. Fire alarm system drawings to include: a matrix identifying the sequence of operation of all equipment in the smoke control zones. This matrix and existing smoke zone drawings are available from the DEN Mechanical Engineer.
- B. A written sequence of operation describing how smoke control and HVAC system integration is to function during smoke control pressurization and exhaust sequence of operations.
- C. The drawings shall indicate all mechanical and electrical as-built conditions for areas of renovation work. The Engineer should perform a site observation confirming all existing conditions and equipment to be utilized for smoke control operations.
- D. Schedules of all smoke control equipment.
- E. DEN Technical Specification sections required to adequately define the smoke control equipment products and installation.
- F. Deferred smoke control shop drawing and design documentation submission in accordance with IFCA Appendix S.

### Section 513 - Smoke Control System Testing

Smoke Control Testing shall be performed by the Contractor and witnessed by the design Engineer of Record (EoR) in accordance with the adopted Denver Fire Code Amendments, Denver Building Department, Denver Fire Department, and DEN requirements. The Contractor shall utilize a Colorado Licensed Fire Protection Engineer for witnessed certification testing.

#### 513.1 Renovation Work

When any portion of a smoke control zone is modified by a Tenant or Base Building Contract (new/removed equipment, new/removed walls, new/removed ceilings, etc.) the smoke control zone(s) affected and the immediately adjacent zone(s) are required to be tested and certified by the Engineer of Record upon completion of the work.

**End of Chapter**

## Chapter 6 - Passenger Loading Bridge Requirements

### Section 600 - Overview

This chapter describes life safety requirements specific to passenger loading bridges (PLBs).

### Section 601 - Scope

The requirements of this chapter shall apply to any PLB installed in the concourses.

### Section 602 - Criteria

The design shall comply with NFPA 415 and IBCA.

### Section 603 - Ventilation

Ventilate the fixed walkway (where present) and full length of loading bridge at 4 air changes per hour. Ventilation shall be served from a Concourse VAV with heat. The VAV shall be interlocked with the concourse gate door and allow VAV operation at 100% design airflow whenever door is opened and for a period of five (5) minutes after door is closed. Ductwork shall be mounted to the roof of the fixed walkway (or rotunda, where directly attached to the building) and extend to a minimum distance of three-fourths the overall length of the fixed walkway or rotunda.

In the event the Concourse AHU does not have the capacity for an additional VAV to serve the fixed walkway, an existing VAV serving the building perimeter zone will be used. In this instance only, dampers will be installed in the ductwork to isolate operation between the perimeter zone and fixed walkway. The VAV and dampers shall be interlocked with the concourse gate door. In normal operation, the damper to the fixed walkway will be closed and the damper to the perimeter system will be open. Whenever the concourse gate door is opened and for a period of five (5) minutes after door is closed, the damper to the fixed walkway will be open and the damper to the perimeter system will be closed and the VAV will operate at 100% design airflow.

The VAV unit and ductwork will not require a duct smoke detector as the Concourse AHU already has required smoke detection.

### Section 604 - Equipment Shutdown

Standalone HVAC equipment provided to condition the space within a PLB shall comply with the currently adopted edition of the International Mechanical Code (IMC).

### Section 605 - Fire Alarm Requirements for PLBs

Fire Alarm visual notification (i.e. strobes) shall be provided in all PLBs where emergency communication is provided.

The concourse gate door shall be equipped with a magnetic door hold open device, to allow for aircraft boarding. The magnetic door hold open device shall be controlled by the fire alarm system.

### Section 606 - ECS Requirements for PLBs

Emergency Communication shall be provided in all fixed PLB walkways 100 feet or more in length, as measured from the concourse gate door to the rotunda.

**END OF CHAPTER**

