DENVER INTERNATIONAL AIRPORT

DESIGN STANDARDS MANUAL

Life Safety Systems

Design, Engineering and Construction

Revised: Q4 2023

Included Technical Specification Requirements	Manual
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Division 03: Concrete	Civil
Division 04: Masonry	Structural
Division 05: Metals	Architecture
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Summary of Revisions

The following tables list revisions to the Life Safety DSM within the past year.

2023 Revisions

Fourth Quarter

Reference	Revision Description
3.11.4 Conduit and Wire	Added conduit and wire information
4.5.4 Conduit Color & Wire Integrity	Added conduit and wire information
Table 5-1: Smoke Control Equipment Identification	Changed FSE- to SEE-
6.7 Beverage Dispensing Carbon Dioxide Emergency Alarm Systems	Added Fire Code Amendments reference
7.7 Electrical Power	Added calculations format information
8.8 Electrical Power	Added calculations format information
11.2 Fire Pump	Added section

Second Quarter

Reference	Revision Description
Throughout	Minor punctuation and grammar changes
1.5.1 A/E Construction Drawings	Added reference to adopted code
1.5.2 Shop Drawings (Installer)	Added reference to adopted code
1.6.1 Denver Building Code Amendments	Added additional standards to the list
2.6.1 Building Description	Added needed information for storage areas
Table 2-1: Sprinkler Design Density Table	Updated density requirements to be more in-line with NFPA 13
2.6.5 Piping/Valves	Added design requirements for dry valves
2.7.2 Dry System	Added requirement for Dry System & nitrogen
4.1 Scope	Added ECS information
4.4 Drawing Requirements	Moved and added to drawing requirements
4.11 Loudspeakers	Added DEN Life Safety approved speaker information

Second Quarter (Continued)

Reference	Revision Description
Section 211313: Wet Pipe Sprinkler Systems	Added new spec section for wet pipe sprinkler systems

2022 Revisions

Fourth Quarter

Reference	Revision Description
Throughout	Minor punctuation and grammar changes
1.6.1 Denver Building Code Amendments	Added standard on Aircraft hangers
2.6.5 Piping	Added new section on piping
2.7.9 Foam Systems	Updated foam system
3.4.3 A/E 90% Drawings	Added information on fire alarms and settings
4.4.4 Conduit	Added new section

Second Quarter

Reference	Revision Description
Throughout	Minor punctuation and grammar changes
1.5.7.5 Zone Name	Updated requirements
2.5.5 Interim System Documents	New section
Table 2-1: Sprinkler Design Density Table	Updated Passenger and Public /Passenger Areas information
3.4.4 Fire Alarm System Interim Drawings	New section
3.6.4 Duct Detectors	Revised content
4.7 ECS Interim Documents	New section
8.8 Electrical Power	Updated requirements
9.4.1 Passenger Loading Bridges	Updated requirements

2021 Revisions

Fourth Quarter

Reference	Revision Description
4.2 System Description	Revised requirements

Fourth Quarter

Reference	Revision Description
1.7 Daylighting, 1.7.1 Daylighting Design Standard – General Description	Revised to latest editions of referenced standards

Revision Notation: Revisions made to this Manual during this revision cycle are annotated as shown in the example below:

A vertical line in the left-hand margin is used to annotate paragraphs that have been added or revised in the current publication. Revisions may include items such as new requirements, clarification of existing requirements, or removal of requirements that no longer apply to projects. Revision annotation is applied to each publication individually; revisions made in past publications are not annotated in subsequent publications.

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Purpose of Design Standards Manuals

The 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 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 DEN.

This Design Standards Manuals (DSM) for DEN has 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. Content contained in this Manual shall not be copied in any bidding or construction documents, except where specifically instructed to do so. 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 other DSMs. To understand the overall thematic and design standards for DEN, the applicable manuals must be utilized together and not separated from the Design Standards Manuals.

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.

NOTE: This document is optimized for duplex (double-sided) printing.

VARIANCE FROM DEN DESIGN STANDARDS MANUALS

Requests for non-conformance or variance from DEN Design Standards manuals, for any DEN or Tenant Projects, must be formally submitted using the online DSM Variance Request form at the following website:

DEN DSM Variance Request Form

Variance requests may or may not be approved by DEN and response will be communicated to the requestor.

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Chapter 1 - General

1.0 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.

If there is a conflict between this document and the Adopted Codes, Codes shall always take precedence. However, there are situations where this document may contain a more stringent requirement, exceeding the code. In this case, the more stringent requirement shall apply.

1.1 General

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

Airport facilities are dynamic. Life safety systems are designed such that changes, additions, and modifications to facilities take place to adapt to changing business needs. Systems will 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.

All occupied buildings on DEN property shall be sprinklered.

All Life Safety System circuits shall be installed in conduit. The color of the conduit is determined by the specific system of which it is a part.

1.2 Common Terms

The following terms are used throughout this DSM:

Table 1-1: Common Terms

Term	Abbr.	Definition
City		City of Denver
City and County of Denver	CCD	City and County of Denver
Concourse	CCx	Refers to the buildings where all passenger boarding, and deplaning activities take place. DEN has three concourses: A, B, and C.
Fixed Walkway, Passenger Loading Bridges	PLB	An enclosed, fixed connector that extends from an airport concourse gate to a loading bridge for allowing passengers aircraft/concourse access without direct exposure to the elements.

Table 1-1: Common Terms (Continued)

Term	Abbr.	Definition
Hotel and Transit Center	HTC	The HTC is located at the south end of the Jeppesen Terminal. The HTC consists of the following three areas: • 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.
Jet Bridge, Jetway, or Passenger Loading Bridge	PLB	An enclosed, movable connector that extends from an airport concourse gate or fixed walkway to an aircraft allowing passengers.
Modules	Mods	Both the Jeppesen Terminal and the Concourse Buildings are segmented into building modules for the purposes of systems organization.
Node		A fire alarm panel, graphic workstation, ECS rack equipment or RES rack equipment or other device on the Life Safety networks that is responsible for network communication.
Terminal Complex	TML	The Terminal Complex is the main complex of buildings at DEN. The Terminal Complex includes, including: • The Jeppesen Terminal, north terminal, and parking garages. (Great Hall) • The Airport Office Building (AOB) • The Central Utility Plant (CUP) • Concourses A, B, and C • Automated Guideway Transit System (AGTS) and baggage tunnels • HTC • PLB

1.3 System Definitions

This section describes the different life safety systems detailed in this DSM.

1.3.1 Fire Protection Systems

Fire protection (FP) systems are sprinkler systems installed within facilities to mitigate the extent of fire damage and to maximize occupant survivability during emergency events. Many DEN facilities and specialty areas are provided with various types of fire protection systems.

1.3.2 Fire Alarm and Detection System

Fire alarm and detection (FA) 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 other systems as needed. DEN facilities that are outside the Terminal Complex are typically furnished with independent Fire Alarm and Detection Systems.

1.3.3 Emergency Communication System

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

1.3.4 Smoke Control System

Smoke control (SC) systems are installed within the Terminal Complex to remove smoke from occupied areas, to enable occupants to exit to a safe area, and minimize smoke-related hazards during emergency events.

1.3.5 Emergency Alarm System

Emergency alarm systems (EAS) are utilized to provide indications and warnings of emergency situations involving hazardous materials. DEN uses these systems for beverage dispensing, inert gas applications, and in certain compressed gas storage applications.

1.3.6 Radio Enhancement System

Radio enhancement system (RES) or distributed antenna system (DAS) is utilized by both the Fire Department and the Airlines for critical movement of people and equipment.

1.3.7 Two-way Communication System

A two-way communication system (TCS) geared towards Areas of Rescue or Elevator Lobbies that do not have direct access to an exit of the building.

1.3.8 Kitchen Hood Systems

Kitchen hood (KH) systems are fire protection systems installed within kitchen facilities to mitigate the extent of fire damage and to maximize occupant survivability during emergency events.

1.3.9 Clean Agent Systems

Clean agent (CA) systems are non-water-based fire protection systems installed within critical areas to mitigate the extent of fire damage and to maximize occupant survivability during emergency events.

1.3.10 Emergency Fuel Shut Off

The emergency fuel shut off (EFSO) system is a fuel system shut off for aircraft, diesel, or gasoline fuel systems, done in such a way that it is performed in an emergency. Refer to the Fueling Systems DSM for details. The EFSO system is considered an Emergency Alarm System and shall follow all applicable requirements set forth in the International Fire Code and the currently adopted Denver Building Code Amendments.

1.3.11 Infrequently Used Systems

Infrequently used systems, are systems within DEN, that might affect DFD response time.

1.4 System Design

Life safety systems are an integral part of DEN operations. When modifying existing spaces or constructing new spaces, the designer shall consider the impact of all aspects of the design on life safety systems. The designer shall consider indirect impacts to the systems listed in 1.3 System Definitions, including, but not limited to, the following:

A. Changes in occupancy type.
B. Reconfiguration of walls and/or spaces.
C. Installation of bulky or noisy equipment that may affect visual or audible notification.

D. Multimedia installations in public areas, such as dynamic advertising displays.

1.5 Design

For ease of understanding and submittal, drawings have been split into three categories, A/E Construction, Shop, and Interim. All portions of Life Safety Systems contained within this manual shall be fully designed, detailed, and specified in the Contract Documents. Below is the breakout of those drawings to comply with Code requirements.

1.5.1 A/E Construction Drawings

These drawings are submitted to the City Building Department and receive a *LOG* number and, upon approval, obtain a *CommCon* number for approved construction. These drawings shall have a Life Safety design level to include all devices that either initiate an emergency situation or notify the public of an emergency situation. The design shall be code compliant to the appropriate codes adopted by the City at the time the drawings are completed.

In accordance with current adopted code.

1.5.2 Shop Drawings (Installer)

These drawings are submitted to the City as a deferred submittal, per Denver Building Code Amendments, to obtain the appropriate Fire permit for construction. These drawings shall take the design of the A/E team and apply the appropriate technical information to provide an appropriate and complete installation of the submitted system. Drawings shall contain all information needed to comply with Denver Fire Department (DFD) requirements as listed in Appendix N.

In accordance with current adopted code.

1.5.3 Interim Drawings

These drawings are done by the contractors as part of their means and methods to final construction. This drawing details a level of protection during the demolition and construction of the work area while progressing to the final product. Since the Airport is an open-for-business facility, a minimum level of protection is required for all areas and systems affected by construction.

1.5.4 More Stringent Document Requirements

If there is a conflict among the requirements of this document, the International Building Code (IBC), International Fire Code (IFC), National Fire Protection Association Standards (NFPA), and Denver Building Code Amendments (DBCA) documents referenced above, the Design Consultant shall comply with the more stringent requirements.

1.5.5 Reviews

All levels of drawings shall be reviewed by the DEN Life Safety Engineer prior to issuance as a “Construction Drawing” or submitted to the Permit Counter.

1.5.6 Drawing Format

All design submittals shall be developed in BIM. Comply with all applicable requirements in the Standards and Criteria and Digital Facilities and Infrastructure (DFI) DSMs.

1.5.7 Zone Designation / Nomenclature

All Fire and Smoke Zones shall have a unique equipment designation. As of 2020, DEN modified the original scheme for tagging all Life Safety Zones.

These new naming conventions standardize the naming and numbering of all DEN Life Safety Zones. All DEN Life Safety Zones shall contain a numbering system according to the criteria outlined below. Any deviation from the

naming convention must receive written approval from the DEN Life Safety Engineer before implementation. The naming convention outlined below should be fully coordinated with the requirements of tagging in the BIM model. Refer to the DFI DSM. It is expected that the design team presents the proposed names according to this section.

The components used to identify equipment depend on the location and requirements of the project. The DEN naming system consists of five standard components and one optional component, as shown in Table 1-2: Fire and Smoke Zone Designation Level.

Table 1-2: Fire and Smoke Zone Designation Level

Building	_	Level	_	Core Area	_	Zone Type	_	Zone Name
LLL	_	NN	_	NL	_	LLL	_	NN

L = Alphabetical Character
N = Numerical Character

1.5.7.1 Building Abbreviation

The three-character abbreviation for each building shall be used to designate the location of equipment. This abbreviation is assigned by DEN, for example, TML = Terminal, AOB = Airport Office Building, CCx = Concourse x, where x is the alpha designation of the concourse, e.g., A, B, C, etc.

CCB	_	03	_	6E	_	SZ	_	42

1.5.7.2 Building Level

The building level is a two-digit indicator used to further refine the location of equipment. This abbreviation is assigned by DEN; for example, 00 is the Basement Level, 02 is the Concourse Level, etc.

CCB	_	**03**	_	6E	_	SZ	_	42

1.5.7.3 Building Section

The building module is a two-digit designator that combines the building module and direction. It shall be used to further refine the location of equipment. This abbreviation is assigned by DEN; for example: 3W is module 3 West.

CCB	_	03	_	**6E**	_	SZ	_	42

1.5.7.4 Zone Type Abbreviation

The two-character abbreviation for each piece of equipment shall be used to designate the type of Zone. Zone abbreviations are. When DEN-designated abbreviations do not fulfill the two or three characters, e.g., SZ = Smoke Zone, FZ = Sprinkler Zone, FZX = Dry Sprinkler Zone, the designator shall omit any additional characters.

CCB	_	03	_	6E	_	**SZ**	_	42

1.5.7.5 Zone Name

This single or multi-character designation identifies the specific device or area within each zone. This takes into account subzones that may exist within a larger zone. Gates shall be designated with Gxx as the gate number.

CCB	_	03	_	6E	_	SZ	_	**42**

1.6 Referenced Codes and Standards

The versions of Codes and Standards are what is adopted by CCD at the time the project submits their drawings for permit.

1.6.1 Denver Building Code Amendments

A. International Building Code
B. International Mechanical Code
C. International Fire Code
D. International Electrical Code
E. National Fire Protection Association Standards
   a. NFPA 3 – Standard for Commissioning of Fire Protection and Life Safety Systems
   b. NFPA 4 – Standard for Integrated Fire Protection and Life Safety System Testing
   c. NFPA 10 – Standard for Portable Fire Extinguishers
   d. NFPA 11 – Standard for Low-, Medium-, and High-Expansion Foam
   e. NFPA 12 – Standard on Carbon Dioxide Extinguishing Systems
   f. NFPA 13 – Standard for the Installation of Sprinkler Systems
   g. NFPA 14 – Standard for the installation of Standpipe and Hose Systems
   h. NFPA 17 – Standard for Dry Chemical Extinguishing Systems
   i. NFPA 17A – Standard for Wet Chemical Extinguishing Systems
   j. NFPA 20 – Standard for the Installation of Stationary Pumps for Fire Protection
   k. NFPA 25 – Standard for the Inspection, Testing and Maintenance of Water-Based Fire Protection Systems
   l. NFPA 30 – Flammable and Combustible Liquids
   m. NFPA 30A – Motor Fuel Dispensing Facilities and Repair Garages
   n. NFPA 70 – National Electrical Code
   o. NFPA 72 – National Fire Alarm and Signaling Code
   p. NFPA 90A – Standard for the Installation of Air-Conditioning and Ventilating Systems
   q. NFPA 90B – Standard for the Installation of Warm Air Heating and Air-Conditioning Systems
   r. NFPA 92– Standard for Smoke Control Systems
   s. NFPA 92A – Standard for Smoke Control Systems Utilizing Barriers and Pressure Differences
   t. NFPA 92B – Standard for Smoke Control Systems in Malls, Atria and Large Spaces
   u. NFPA 96 – Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations
   v. NFPA 101 – Life Safety Code
   w. NFPA 110 – Standard for Emergency and Standby Power Systems
   x. NFPA 111 – Standard on Stored Electrical Energy Emergency & Standby Power Systems
   y. NFPA 130 – Standard for Fixed Guideway Transit and Passenger Rail Systems
   z. NFPA 409 – NFPA 409 – Standard on Aircraft Hangars
   aa. NFPA 415 – Standard on Airport Terminal Buildings, Fueling Ramp Drainage and Loading Walkways
   ab. NFPA 2001 – Standard on Clean Agent Fire Extinguishing Systems

End of Chapter

Chapter 2 - Fire Protection System

2.0 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 IFC as adopted and amended by CCD. IBC Amendments, Appendix S contains additional requirements. It shall represent all the requirements of the agency Insurance Underwriters. The following description of fire protection requirements is based on NFPA codes.

2.1 Scope

This chapter provides design guidance to the Engineer in the area of Fire Protection Systems, which is utilized for all systems that extinguish a fire by activating a sprinkler or detector, or a combination of both.

2.2 System Description

These systems provide immediate suppression to a detected fire. The suppressant may include more than one medium. The typical medium used is water and may be activated by several different methods.

2.3 Criteria

Fire Protection Systems shall meet CCD requirements. Fire Protection Systems shall be provided in accordance with the latest adopted editions of the codes and standards listed in the DSM. Note that in the Denver Amendments to IBC, Appendix S has specific requirements for airports, which are in addition to all other referenced standards.

These systems shall have a means and method of detecting a fire product and, upon a specific setting of the detection devices or series of devices, resulting in a fire retardant applied in the area. These systems shall operate automatically and independently of any other detection or suppressant system in the area.

2.4 Tenant Spaces

Tenant spaces of 5,000 square feet in gross area or more are required to be served by an independent sprinkler zone. The tenant sprinkler zone shall be a single zone, originating back to the supply pipe, and shall not be part of another zone for annunciation.

2.5 Drawing Requirements

Refer to 1.5.1 A/E Construction Drawings to 1.5.6 Drawing Format.

2.5.1 A/E 30% Drawings

The A/E 30% drawing should contain the design density of the areas identified by room or area, as well as the required Architectural drawings.

2.5.2 A/E 60% Drawings

The A/E 60% drawings should contain the information in 2.5.1 A/E 30% Drawings and the following information:

A. The identification of the Fire Zone
B. The new layout area or the new zone that is created for the remodeled area
C. The locations of sprinkler for the NFPA 13 required layout

2.5.3 A/E 90% Drawings

The A/E 90% drawings should contain the information in 2.5.1 A/E 30% Drawings, 2.5.2 A/E 60% Drawings and the following information:

A. The identification of sprinklers in the locations they are presented with details to the type, pendant, upright, or sidewall.
B. A note from the EoR that they are confident that the calculations for the area are adequate for supply.

2.5.4 Design Documents

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

A. Plans showing an as-built fire-sprinkler layout of existing/new space.
B. Plans the 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 a fire zone diagram identifying the area of work and fire sprinkler zone impacts, including an 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 Life Safety Engineer. Master diagrams shall be updated and returned to the DEN Electrical Life Safety Engineer at IFC and Record Document phases.

2.5.5 Interim System Documents

Sprinklers in the area of construction shall remain operational per 2019 NFPA 13 Chapters 9 and 10. If there is a ceiling, when the ceiling is demolished the, sprinklers in the area are to be turned up to comply with NFPA 13. The Denver fire suppression permit can be obtained via a Scope of Work letter signed by a NICET III or higher detailing the existing condition and the interim condition. Drawings shall be provided that indicate the area where sprinklers will be turned up. The intent is to have the demolition and interim conditions as a single submittal which is a Fire walkthrough E-permit.

2.5.6 Sequence of Operation

For public area sprinkler zones, activation of these zones shall activate the Smoke Control system for the same zone.

2.6 Design Analysis Requirements

2.6.1 Building Description

Building Descriptions are taken from the A/E drawings to indicate the building this system is being designed for.

A. Building Name
B. Construction Type
C. Occupancy Types
   • If storage, the product expected to be stored in the area.
D. Area Name (or Tenant)
E. Level of Hydraulic Design density

2.6.2 Applicable Codes

The list of Codes or documents that this system is required to follow for the shop drawings.

2.6.3 Design Responsibility

The Engineer of Record for the Shop Drawings shall retain design responsibility. Shop drawings must be signed and sealed by a professional engineer licensed in the state of Colorado, as required by DBCA. National Institute for Certification in Engineering Technologies (NICET) signature is allowed only as applicable per DFD Policy.

2.6.4 Sprinkler Design Densities

Spaces at DEN shall adhere to specific sprinkler design densities as indicated in Table 2-1: Sprinkler Design Density Table.

Table 2-1: Sprinkler Design Density Table

Space	Design Density	Specific Density (GPM/Sq Ft)
Concourse		
Basement	OH2	0.20 / 1,500
Apron	OH2	0.20 / 1,500
Offices	LH	0.10 / 1,500
Passenger	OH1	0.15 / 1,500
Offices	LH	0.10 / 1,500
Retail Services	OH2	0.20 / 2,000
Restaurant Sitting	OH2	0.20 / 1,500
Restaurant Food Prep	OH2	0.20 / 1,500
Open Stair / Escalators		0.30 gpm / linear foot
Electrical Rooms	OH2	0.20 / 1,500
Baggage Handling Areas	OH2	0.25 / 3,800
Vehicle Storage	OH2	0.20 / 1,500
Terminal		
Lobby / Retail / Service	OH2	0.20 / 2,000
Offices	LH	0.10 / 1,500
Public / Passenger Areas	OH1	0.15 / 1,500
Restaurant Sitting	OH2	0.20 / 1,500
Restaurant Food Prep	OH2	0.20 / 1,500
Open Stair / Escalators		0.30 gpm / linear feet
Electrical Rooms	OH2	0.20 / 1,500
Baggage Handling Areas	EX1	0.25 / 3,800
Great Hall / Atrium	NR	IBC 404.3(2)
Parking Complex	OH2	0.20 / 1,500
Central Utility Plan	OH2	0.20 / 1,500
Utility Plant	OH2	0.20 / 1,500
AGTS		

Table 2-1: Sprinkler Design Density Table (Continued)

Space	Design Density	Specific Density (GPM/Sq Ft)
AGTS Platform	OH2	0.20 / 1,500
AGTS Deluge		0.30 gpm / linear foot
Baggage Tunnel	OH2	0.20 / 1,500
Utility Tunnel	OH2	0.20 / 1,500
Airport Office Building		
Office / Public	LH	0.10 / 2,500
Parking	OH2	0.20 / 1,500
Loading Dock	Dry	0.15 / 3,500
Mechanical	OH2	0.20 / 1,500
ARFF Facilities		
General	OH2	0.20 / 1,500
Storage	OH2	0.20 / 1,500
Fuel Farm Facilities		
Service Building	OH2	0.20 / 1,500
Operations Facility	OH2	0.20 / 1,500

2.6.5 Piping / Valves

Sprinkler piping shall follow:

A. 2-inch and smaller piping shall be scheduled 40 and threaded
B. 2.5 inch and larger piping can be scheduled 10 piping
C. Dry trip sprinkler shall be installed with a dual tamper configuration. One tamper on the incoming wet side of the valve and one installed immediately after the valve on the dry side. Both tamper valves are to be monitored as a single point on the Fire Alarm System.
D. Installation locations of proposed sprinkler valves to be coordinated with DEN Life Safety department prior to submittal of documents.
E. Main Drain, Inspector's Test, and other valve locations, where water is to be discharged, shall have piping installed to route water to the nearest floor drain or sump pump location.

2.6.6 Pump Water Flow Meter

The flow for the fire pump assembly shall be mounted prior to the input of the jockey pump to avoid any mistaken flow alarms. The jockey pump has the ability to supply enough water to move the meter and cause an inadvertent alarm condition.

2.7 Associated Systems

2.7.1 Sprinkler System

This system is considered a wet system since the pipes are constantly filled with water, and the system is Hydraulically Calculated.

2.7.2 Dry System

This system is similar to the wet system above, except that the pipes are filled with nitrogen until an action charges the system with water. This, too, is hydraulically calculated.

All dry systems shall utilize a nitrogen generation system.

If 50% or more of a dry zone is modified, it shall convert to a nitrogen system.

2.7.3 Deluge System

This system is similar to the wet systems except that the initiation of the water flow is based upon detection or manual activation in the area. The sprinklers do not have any devices holding back water at that function is performed at the valve location. When this type system activates, all the sprinkler orifices in the area flow water at the same time.

2.7.4 Standpipe Systems

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 DFD Prevention Bureau, requires NFPA 415 as well as the current issue of applicable NFPA codes and standards. The Design Consultant shall specify the installing Contractor to perform hydraulic calculations based on the final layout.

2.7.5 Kitchen Hood Systems

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

2.7.6 Hydrants

For new facilities, hydrants shall be provided in accordance with the IFC, IFC Amendments, and as directed by the Authority Having Jurisdiction (AHJ).

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.

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.

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 DFD Prevention Bureau.

2.7.7 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 CCD 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 test data and Denver Water Department hydraulically provided information that is no older than six months for the hydraulic calculations basis.

2.7.8 Pressure Reducing Valves

Standpipe hose connections which need to have Pressure Reducing Valves (PRVs) as defined by IFC Amendments. Where required, PRVs shall be provided in accordance with the IFC as adopted and amended by the CCD.

2.7.9 Foam Systems

Provide foam water systems in aircraft hangars and at fuel tanks and fuel loading areas. Foam systems shall be Synthetic Florine Free Foam (3F).

2.7.10 Coordinated 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.

2.7.11 Clean Agent Suppression Systems

The provision of non-water-based suppression designed for and installed in locations where the introduction of water is detrimental to the mission of the airport or producing a hazard to the occupants of the space.

2.7.12 Other Facilities

In general, single facilities larger than 1,500 Square feet require a fire sprinkler and Fire Alarm Systems per the requirements of the DFD Prevention Bureau, DEN insurance carrier, and NFPA.

2.8 Specific Building Requirements

2.8.1 Airport Terminal and Concourse Buildings

A. All areas of the Terminal Complex shall be sprinkled 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.

2.8.1.1 Public Areas of Terminal and Concourse Buildings

A. The Smoke Control System shall be activated by a single sprinkler zone in the same area.

2.8.2 Parking Garages

A. Existing parking garages, modules 1, 2, and 3 on the east and west sides 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-throughs shall have wet pipe systems with dry-style pendent heads.
C. On Levels 1, 2, and the part of Level 3 where there are no alternate baggage conveyors, the dry pipe systems extend 75 feet from the 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.

2.8.3 Baggage Handling Areas

Refer to the IBC Amendments, Appendix S, and this Design Standards Manual for fire protection requirements in baggage handling areas.

End of Chapter

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Chapter 3 - Fire Alarm and Detection System

3.0 General

Per International Codes, our buildings require a minimum amount of smoke detection. Along with these codes, the Denver Building Code Amendments, specifically Appendix S, details the level of detection required and how that detection is placed within the restrictions of NFPA 72.

3.1 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.

3.2 System Description

The Fire Alarm System installed in the DEN Terminal Complex is a Networked Fire Alarm System as supported by Johnson Controls. The system consists of a 50-Node Network connected via a Class A fiber optic backbone. Most nodes are 4100ES fire alarm control units with an integrated and supervised system of initiating and control devices and notification appliances. There are twelve (12) network head-end annunciation units, known as TSW, located throughout the facility in Fire Command Centers and DEN Operation Centers.

The Johnson Controls Fire Alarm System was progressively installed from 2010 through 2017. The system was integrated with the airport's IED paging/PA system in 2014-15 to form an integrated ECS.

Fire Alarm Systems in out-buildings and other DEN facilities outside the Terminal Complex may not require integration with the Johnson Controls Networked Fire Alarm System. For information regarding Fire Alarm Systems outside the Terminal Complex, Contact the DEN Life Safety Engineer.

3.3 Criteria

Fire Detection and Alarm Systems are required to meet CCD requirements. Fire Detection and Alarm Systems shall be provided in accordance with the latest editions of the standards and codes listed in this DSM, as well as the IBC and IFC as currently adopted and amended by the CCD. Note that in the current edition of the Denver Amendments to IBC, Appendix S has specific requirements for airports, which are in addition to all other referenced standards.

3.4 Drawing Requirements

Refer to 1.5.1 A/E Construction Drawings to 1.5.6 Drawing Format.

3.4.1 A/E 30% Drawings

The A/E 30% drawing should determine if any detection will be required, as well as the required Architectural drawings

3.4.2 A/E 60% Drawings

The A/E 60% drawings should contain the information in 3.4.1 A/E 30% Drawings and the following information:

A. Initial placements of the detection
B. Fire alarm notification
C. Emergency communication devices
D. If there are any other life safety systems, they need to be identified, as well as their future locations.
E. The preliminary sequence of operations
F. Identification of the Fire/Smoke Zone the equipment is part of.

3.4.3 A/E 90% Drawings

The A/E 90% drawings should contain the information in 3.4.1 A/E 30% Drawings, 3.4.2 A/E 60% Drawings, and the following information:

A. Final locations of all detection, fire alarm notification, and emergency communication devices. Fire Alarm Terminal Cabinets included.
B. Final tap settings of strobes.
C. If there are any other life safety systems, they shall indicate any monitoring or controlling of those devices.
D. The Sequence of Operation is the responsibility of the Engineer of Record.

3.4.4 Fire Alarm System Interim Drawings

Fire Alarm existing devices in the area of construction shall remain operational. The contractor shall install a Fire Alarm Terminal Cabinet (FATC) in the Concession/Tenant area, if one does not already exist, where all the Fire Alarm circuits terminate for the space and allow the rest of the connected circuits to remain operational. Interim fire alarm wire can be installed without conduit for this phase of construction. The existing devices shall be left in place and hung or supported in a Code approved manner after demolition. If fewer devices are requested, DEN requests the contractor, the DEN Life Safety Team, and the Engineer prior to submitting the Scope of Work letter signed by a NICET III or higher detailing the existing condition, proposed demolition work, and the interim condition. The conduit to the existing devices may be removed, and the wire for the existing circuit reused for the interim. No new devices need to be added, and as-built reference drawings shall be provided. The access to the FATC shall be no higher than 9' a.f.f. The intent is to have the demolition and interim condition as a single submittal that is a Fire walk-through E-permit.

3.5 Design Analysis Requirements

The Design Consultant shall provide a Fire Alarm System Basis of Design to substantiate the Fire Detection and Alarm System design. At a minimum, the Fire Alarm System Basis of Design shall include the following categories:

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

3.5.1 Applicable Code

The list of Codes that this system is required to follow for the shop drawings.

3.5.2 Design Responsibility

The Engineer of Record for the Shop Drawings. PE Seal applied to the drawings as required by DBCA. The entity creating the shop drawings shall be certified by the manufacturer for designing their system.

3.6 Initiating Devices

3.6.1 Heat Detectors

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

3.6.2 Smoke Detectors

Smoke detectors shall be provided as determined by the DAR. 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.

3.6.3 Carbon Monoxide Detectors

Detectors designed and listed for the detection of carbon monoxide, which is a product of incomplete combustion.

3.6.4 Duct Detectors

Smoke detectors are designed and listed for the detection of smoke within a duct of an Air Handling system. This device may include the ability to interface with the Air Handling Unit.

3.6.5 Pull Stations

Manual stations shall be provided as determined by the DAR. 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 the use of addressable stations, use non-addressable stations that are tied back to an I/O panel in a conditioned space where monitoring can take place.

3.6.6 Water Flow Switches

Provide monitor devices for non-addressable water flow indicators. Water flow indicators include paddle-type flow switches, pressure switches, and other types. Ensure the 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.).

3.6.7 Kitchen Hood

Provide monitoring devices for the non-addressable kitchen hood suppression system. A minimum of two points of monitoring are disabled/trouble and activation.

3.6.8 Clean Agent Alarm/Release

Provide monitoring devices for the monitoring of this panel and a minimum of three points. The minimum three points are Alarm, Trouble, and Supervisory. If the releasing panel listed for this use is allowed to be attached to the facility network as long as it does not conflict with the Adopted Codes at the time of submittal.

3.6.9 Dry System Pressure Switch

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

3.6.10 Other 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 a means to monitor individually each non-addressable alarm devices.

3.7 Monitoring

3.7.1 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.

3.7.2 Pressure Switches

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.

3.7.3 Clean Agent Supervision

The monitoring of the supervision and trouble contacts of the Clean Agent Control Panel. The designation shall be specific to the area in which this system is installed.

3.7.4 Generator Supervision

The monitoring of the Generator for the points as defined in NFPA 110.

3.7.5 Elevator Shunt Power Supervision

The monitoring of the power supporting the shunt trip capability of an elevator or elevator bank.

3.7.6 Fire Pump Supervision

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

3.7.7 Emergency Fuel Shut Off

The monitoring of the EFSO system for any changes in status other than fully operational. This includes but not limited to: EFSO button activated, EFSO system trouble. Refer to the Fueling Systems DSM and related EFSO documents.

3.8 Control

3.8.1 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 interfaces shall be achieved by addressable fire alarm relays.

3.8.2 Dry System Release

When approved by the DFD, the Fire Alarm System could be authorized to control a dry sprinkler system for a specific area. When authorized, the fire alarm system shall have the listing and capability to monitor and control the valve that releases water to a specific area.

3.8.3 Door Holder 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 relays.

3.8.4 HVAC Shutdown

A. Provide duct smoke detectors in accordance with applicable codes to shut down the associated HVAC unit.
B. The duct smoke detectors shall initiate a supervisory condition on the Fire Alarm System.
C. Where installed, combination fire/smoke dampers shall be individually controlled by the Fire Alarm System.
D. Access panels in ductwork for fire/smoke dampers shall be located no more than 12" from the penetration.
E. HVAC unit shutdown and damper control shall be achieved by addressable fire alarm relays.

3.8.5 Media Shunt

In Tenants with private audio/visual systems or other visual advertising, a media shunt shall be provided during emergency messaging activation. Media shunt shall be achieved by addressable fire alarm relays.

3.9 Notification Devices

3.9.1 Strobes

Strobes with ALERT shall be installed on walls or ceilings as indicated on the Fire Alarm System drawings. All new work shall be designed and installed to the prescriptive requirements of NFPA 72. Activation shall be per the approved Sequence of Operation for the building.

Activation of the strobes shall be per the approved Sequence of Operation.

Figure 3-1: Typical ALERT Strobes

In the AOB, CUP, Concourse A, AGTS Maintenance Facility, and in certain AGTS spaces between the AGTS tunnels, standard (non-addressable) visual notification appliances are utilized as manufactured by Eaton Cooper Notification (i.e., Wheelock). In the Terminal, Concourse B, Concourse C, and HTC, addressable visual notification appliances are utilized as manufactured by Johnson Controls.

3.9.1.1 Terminal Complex (Jeppesen Terminal, Concourses, HTC)

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

E. The DEN Life Safety Engineer shall determine if devices are to be conventional or addressable.
F. Strobes designed and installed in Passenger Loading Bridges shall be considered interior devices and are not required to be rated for exterior use.

3.9.1.2 Out-Buildings

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

3.9.2 Horns

3.9.2.1 Out-Buildings

A. Audible alarm devices shall be used in all areas as required by applicable codes.
B. The audible signal shall be significantly different from other signals and shall be per the requirements of NFPA 72.
C. Audible notification shall occur through fire alarm horn appliances unless otherwise required by the applicable code.

3.9.3 Speakers

3.9.3.1 Terminal Complex (Jeppesen Terminal, Concourses, AOB, CUP, and HTC)

A. Audible alarm devices shall be used in all areas as required by applicable codes.
B. The audible signal shall be significantly different from other signals and shall be per the requirements of the DEN ECS Operational Plan.
C. The audible notification shall occur through the ECS.
D. 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.

3.9.4 Combination Audio/Strobe

Combination Audio/Strobe appliances with ALERT shall be installed on walls or ceilings as indicated on the Fire Alarm System drawings. These appliances are installed in non-public areas like electrical and mechanical spaces that are not covered by ECS loudspeakers. The horns are programmed to deactivate (silence) at the same time as the strobes, although they shall be controllable and separate from the strobes. All future installations (e.g., Tenant finishes, concourse expansions, remodels, etc.) should have visual-only notification appliances (i.e., strobes) installed with ECS loudspeaker coverage provided. Horn/Strobe appliances should not be necessary for future installations without a specific reason to do so.

ALERT Audio/Strobes shall be activated anytime an emergency message requires an action to be taken by a building occupant. Currently, this includes only the emergency evacuation message and weather/tornado relocation messages. ALERT Audio/Strobes shall not be activated during any message that shall not require an action to be taken by a building occupant. This specifically includes an all-clear message or any other type of non-emergency message. Once activated, these appliances shall be deactivated when the emergency message is deactivated/stopped.

In the AOB, CUP, Concourse A, AGTS Maintenance Facility, and in certain AGTS spaces between the AGTS tunnels, standard (non-addressable) audible/visual notification appliances are utilized as manufactured by Eaton Cooper Notification (i.e., Wheelock). In the Terminal, Concourse B, Concourse C, and HTC, addressable audible/visual notification appliances are utilized as manufactured by Johnson Controls.

3.9.5 Textual Visual

An LED Text Messaging Appliance shall be Johnson Controls model 4907-9001 installed as indicated on the Fire Alarm System drawings. Refer to Table 4-2: NFPA 72 ADA Sign Requirement. These appliances are installed in Baggage Tunnel/Tug Ramp areas.

Figure 3-2: Typical LED Text Messaging Appliance

The LED Text Messaging Appliance can display up to 32 pre-programmed message selections in response to pre-defined emergency situations or linked to specific system point status conditions. This appliance has 10 factory default messages. However, custom messages have been provided to match the chosen DEN prerecorded audible messages. Once activated, these appliances shall be deactivated when the emergency message is deactivated/stopped.

3.9.5.1 Terminal Complex (Jeppesen Terminal, Concourses, HTC)

The Fire Alarm System is supplemented visually by FIDs, GIDs, BIDs, and advertising displays, which provide textual messaging. This concept is referred to as visible textual notification in NFPA 72.

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

3.9.5.2 Out-Buildings - Not applicable

3.9.6 Loudspeakers

In the Hotel portions of the HTC (i.e., Level 6 – 15), high-fidelity fire alarm loudspeakers have been provided. These loudspeakers are powered and controlled by the Johnson Controls Fire Alarm System.

3.9.7 Supervision

Circuit supervision shall be provided consistent with NFPA 72.

3.10 System Configuration

3.10.1 Power

All Fire Alarm Control Units and their remote panels shall be designed to operate from 120 volts, 60-hertz, single-phase power source. In buildings equipped with an emergency power source, connect FACPs to the emergency source. The FACPs shall be provided with a battery backup of sufficient capacity to allow system monitoring for a period of 24 hours of quiescent operation and 15 minutes of alarm. All graphic workstations shall have a backup to last at least 4 hours.

The PLB is considered a separate building from the Concourses. As a result, a surge suppressor shall be installed in all circuits that enter and leave the PLB. Reference is NFPA 72 10.6.2 and NFPA 70 fault circuits.

3.10.2 Network Communication

3.10.2.1 Terminal Complex (Jeppesen Terminal, Concourses, HTC)

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-N fiber-optic or copper wiring in accordance with NFPA 72.

ECS network utilizes strands in the Fire Alarm fiber-optic cables and conduit. Designer shall coordinate fiber-optic designs with the ECS designer.

DEN Fire Alarm System shall be monitored directly by DFD 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 Life Safety Engineer.

3.11 Survivability

3.11.1 Core System – Backbone

To provide a higher level of survivability from fire and physical damage, a level of protection consistent with Level 3 pathway survivability, as described in NFPA 72 12.3.8, shall be provided.

Because Fiber Optic cables are not UL-listed to maintain a 2-hour rating, the following shall apply:

A. All Fiber shall be installed in metallic conduit
B. The Horizontal separation shall be no less than 20'

3.11.2 Extended System

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 visual notification circuits to fire alarm visual appliances (strobes).

All circuits shall be Class B as defined by NFPA 72, and ‘T-taps’ are not allowed.

3.11.3 Signaling Line Circuits

Signaling line circuits (SLCs) shall follow the requirements as dictated in NFPA 72, Chapter 23.

All circuits shall be Class B as defined by NFPA 72, and ‘T-taps’ are not allowed.

3.11.4 Conduit and Wire

All wiring shall be continuous from device to device. No circuit splicing allowed.

All new conduit shall be red in color, existing conduit shall be tagged as fire alarm with red tape/identification tape.

3.12 Clean Agent System

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 CCD amendments to applicable codes.

3.13 Graphic Annunciation

3.13.1 Terminal Complex (Jeppesen Terminal, Concourses, HTC)

Graphic annunciation shall be provided at all the Fire Command Centers via the TSW 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.

3.13.2 Out-Buildings

Graphic annunciation panels shall be provided in accordance with currently adopted CCD fire code amendments. The panel shall be located in the main entrance at an AHJ-approved location.

3.14 System Layout

3.14.1 Terminal Complex (Jeppesen Terminal, Concourses, HTC)

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

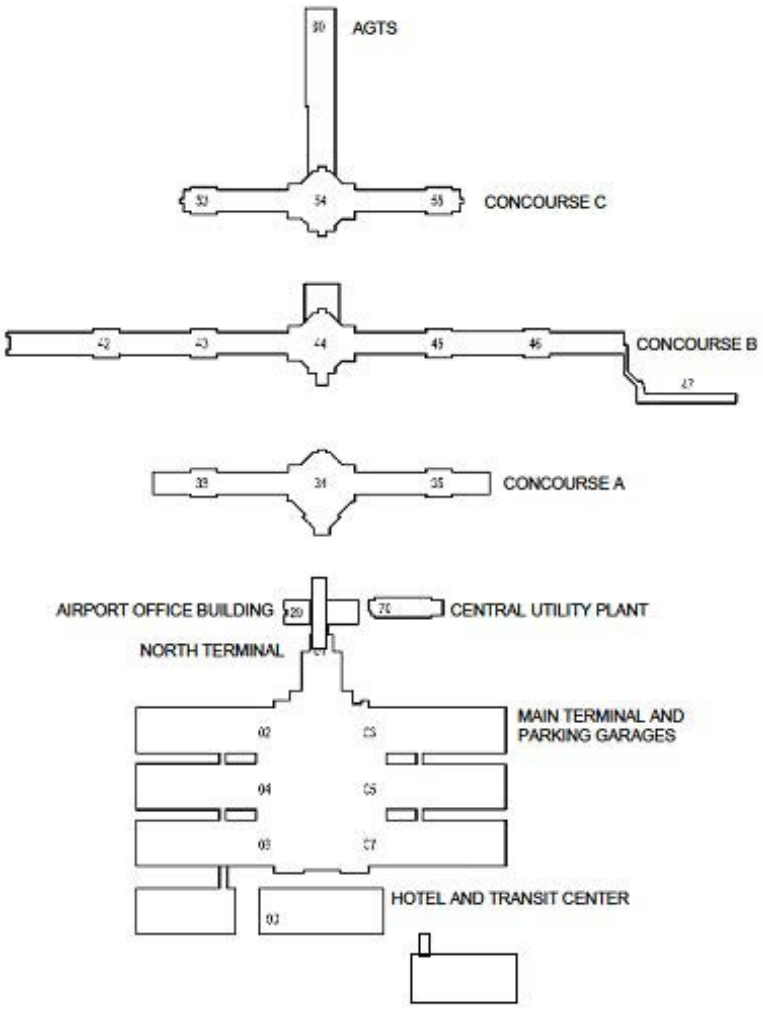

Figure 3-3: Terminal Complex

3.14.2 Out-Buildings

In general, all outbuildings are standalone Fire Alarm Systems with approved central station monitoring.

3.15 Fire Alarm System Maintenance

Maintenance shall be performed as described in NFPA 72, Chapter 14, with documentation similar to that described in NFPA 72, Chapter 7.

End of Chapter

Chapter 4 - Emergency Communication System

4.0 General

The Airport is equipped with an Emergency Voice Communication System (ECS), which acts as the facility's paging system. The zoning of the paging system shall correlate with the established Fire Zones as defined by the IFC and NFPA 72. Refer to Chapter 1- General.

4.1 Scope

This chapter provides design guidance to the Engineer in the area of the Emergency Communication System (ECS), which is utilized for both emergency communication and public address (PA) messaging at DEN. The ECS is designed, operated, and maintained as a life safety system at DEN. General criteria are set forth, as well as drawing and design analysis requirements.

4.2 System Description

A. The ECS audio system shall have the following required operational capabilities:
   a. The system is capable of automatic or manual audible testing of microphone inputs, IED headend audio outputs, equalizer outputs, amplifiers, and loudspeaker systems.
   b. In all Public Areas, the system has the capability of sensing ambient noise sound levels and adjusting loudspeaker zone signal levels up or down accordingly to maintain good speech intelligibility.
   c. All inputs and outputs shall be monitored for correct operation. Audio levels of each logical system parameter shall be monitored, including but not limited to Microphone Stations, DSP, Amplifiers, loudspeaker lines with impedance and ground faults, and ambient noise system. Other data information of equipment and power monitoring shall be included in monitoring when available. All detected faults shall be displayed on the ECS standard and remote CPUs.
   d. Critical faults shall generate a contact closure for detection by the Fire Alarm System monitor module in HTC, Terminal, AOB, Central Plant, and concourses.
   e. All network connections must be monitored by the DEN Network Operations Center. ECS network requirements must be coordinated with DEN Technologies.
   f. Electrical power shall be from the emergency panel, and the battery/UPS backup shall be calculated to sustain the system for 4 hours for quiescent and 15 minutes for alarm. Battery sizing shall comply with NFPA 72.

B. Manufacturer Limitation:
   a. Components provided under this Contract shall be compatible with and connected to the existing Innovative Electronic Designs, Inc. (IED, Inc.) IED IP108 vACS is located in the center core of each concourse, the Hotel and Transit Center, and Room TML_04_2E_010 in the Terminal.

C. Remote amplification rooms shall be configured to match existing rooms.

D. The Emergency Communications System (ECS) provides paging and background music to all public areas of the airport facilities. Voice paging must be provided to all non-public support areas and parking areas. The system is used for general announcements and emergency announcements throughout Concourses A, B, and C, Terminal, Hotel, Transit Center, AGTS Tunnel, Office Tower, and Central Utility Plant.

E. Fixed PLBs of length greater than 20' shall be equipped with ECS loudspeakers.

F. The emergency announcements functions of the system provide audio evacuation messaging and announcements for the airport.

G. The system provides ambient noise sensors and monitoring which allow automatic level control of individual loudspeaker zones located in public areas.

H. The monitor/test system is capable of monitoring and/or testing all audio or DC signal, loudspeaker level outputs, or system wiring to ensure the integrity and reliable operation. All 275114 inputs and outputs must be monitored for correct operation.

I. The ECS shall be integrated with and supplement the facility Fire Alarm System (FAS). The interface with the FAS will enable the use of the ECS power amplifiers and loudspeakers for audible notification. The FAS provides the messages via line-level audio signal and FAS contact closures that enable the ECS to broadcast incident-specific messages into pre-designated audio zones.

J. Terminal cabinets are/shall be used for a breakout of loudspeaker wiring home to the equipment racks.

K. The output of each amplifier must go through a terminal cabinet and Integrated Test Switch panel to match existing switches mounted in the amplifier rack. This network allows loudspeaker loads to be disconnected from the amplifier outputs for manual measurement of load impedances by maintenance personnel.

L. Most loudspeakers operate on a 70 Volt distributed system. Powered loudspeaker arrays are permitted. The loudspeakers shall be grouped in modular zones allowing maximum flexibility for paging area assignment. Loudspeaker types shall match DEN's current standards to the greatest extent possible. All Gate Podiums, Ticket Counters, Baggage Claim podiums and offices, Fire Command Centers, and Operations Communications Centers must be equipped with microphone stations manufactured by IED, Inc. Match existing configurations for operator continuity between areas.

M. All ambient noise sensors and loudspeakers shall be hardwired to the local P.A. Rooms.

N. Local P.A. Rooms within a building are interconnected via the ECS Ethernet Network to the building ECS Control Room. Spare copper and fiber-optic cable for new installations may not exist. Contractor to verify the existence of available cable and cable raceways/conduit. Verify cable requirements with the understanding that fiber optic cabling used for the system is a hardened, redundant cable infrastructure designated as the part of the fire alarm infrastructure.

O. ECS Network Designers shall coordinate with DEN Technologies network engineers to determine specific network equipment, architecture and attachment points that are specific to the Project. Network equipment and cabling shall be provided by DEN Technologies.

P. ECS Network

Q. Automated Flight and Baggage Announcement System shall be provided as required. System shall interface to Owner provided AIDX feed for data to populate the Flight Announcement System with information to automatically or manually announce flight messages at gate or baggage claim areas.

R. ECS shall be capable of relaying text messages to SITA Flight Information Displays and DEN Visual Paging displays.

4.2.1 Manufacturer Limitation

Components provided under this Contract shall be compatible with and connected to the existing Innovative Electronic Designs, Inc. (IED, Inc.) IED IP108 vACS is located in the center core of each concourse, the Hotel and Transit Center, and Room TML_04_2E_010 in the Terminal.

4.3 Survivability

4.3.1 Core System – Backbone

To provide a higher level of survivability from fire and physical damage, a level of protection consistent with Level 3 pathway survivability, as described in NFPA 72 12.3.8, shall be provided.

Because Fiber Optic cables are not UL-listed to maintain a 2-hour rating, the following shall apply:

A. All Fiber shall be installed in metallic conduit

B. The Horizontal separation shall be no less than 20'

4.3.2 Extended System

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 audio notification.

4.4 Drawing Requirements

Refer to 1.5.1 A/E Construction Drawings to 1.5.6 Drawing Format.

4.4.1 A/E 30% Drawings

The A/E 30% drawing should determine if any audio notifications will be required, as well as the required Architectural drawings.

4.4.2 A/E 60% Drawings

The A/E 60% drawings should contain the information in 3.4.1 A/E 30% Drawings and the following information:

A. Initial placements of the speakers
B. Preliminary sequence of operations
C. Identification of the associated notification Zone for each piece of equipment

4.4.3 A/E 90% Drawings

The A/E 90% drawings should contain the information in 3.4.1 A/E 30% Drawings, 3.4.2 A/E 60% Drawings, and the following information:

A. Final locations of all emergency communication devices. ECS Terminal Cabinets included.
B. Final tap settings of speakers
C. The Sequence of Operation is the responsibility of the Engineer of Record
D. Audio Model indicating the speaker layout meets the initial dB levels and Intelligibility of the spaces.
E. The detailed Acoustically Distinguishable Spaces as required by NFPA 72 7.3.3.5.

4.5 Conduit and Wire

4.5.1 Microphone and Line Level Cable

A. Microphone, line level, and ambient sensor cable, when installed in conduit, shall be NEC Type CM cable consisting of ASTM stranded tinned copper, 22 AWG, 100% aluminum polyester foil shielded twisted pair with tinned copper drain wire, and 75-degree Centigrade rated polypropylene insulation.
    a. The cable shall have a nominal O.D. of 0.135" with a green outer jacket nominal capacitance of 34 pF/ft. between conductors and nominal capacitance of 67 pF/ft. between one conductor and other conductors connected to the shield.
B. Where cable is installed in cable trays, it shall be NEC Type PLTC stranded tinned copper, 22 AWG, 100% aluminum polyester foil shielded twisted pair with tinned copper drain wire.
    a. The insulation shall be PVC with nylon and rated for 105 degrees Centigrade.
    b. The cable shall have a nominal O.D. of 0.201" with a green outer jacket and a nominal capacitance of 50 pF/ft. Conductor to conductor and a nominal capacitance of 90 pF/ft. between one conductor and the others connected to the shield.

4.5.2 Loudspeaker Cable

4.5.2.1 Homerun

A. Manufacturer: Southwire P70031-1 or Equal
B. Size: #12 AWG, stranded
C. Type: Unshielded twisted pair
D. Insulation Color: Red (positive), black (negative)
E. Jacket Color: Dark green

F. Cable shall be plenum rated
G. All cable shall be installed in conduit
H. Loudspeaker circuits shall not contain T-Tap or star configurations.

4.5.2.2 Circuit Loudspeaker Cable

A. Manufacturer: Belden 6100UE or Equal
B. Size: #14 AWG, stranded
C. Type: Unshielded twisted pair
D. Insulation Color: Red (positive), black (negative)
E. Jacket Color: Dark green
F. Cable shall be plenum rated
G. All cable shall be installed in conduit
H. Loudspeaker circuits shall not contain T-Tap or star configurations.

4.5.3 Whip to Speaker Cable

A. Manufacturer: Smartwire, #MC-007960-11BR-GB or Equal
B. Size: #14 AWG, stranded
C. Type: Unshielded twisted pair
D. Insulation Color: Red (positive), black (negative)
E. Metal Cladding Color: Dark green or White with Dark green stripe
F. Cable shall be plenum rated
G. Loudspeaker circuits shall not contain T-Tap or star configurations.
H. Whip not to exceed 6' in length.
I. Control cable shall be installed in conduit and shall be low capacitance 22 AWG stranded four twisted pair with 100% aluminum polyester overall shield and drain wire.
    a. The nominal O.D. shall be 0.325" with a green outer jacket nominal conductor D.C.R. shall be 24 ohm/1000 ft.; the nominal capacitance shall be 15.5 pF/ft. between conductors and the nominal capacitance shall be 27.5 pF/ft. between one conductor and other conductors connected to shield.
J. The installation may involve localized conditions in which metallic-conductor cable systems will transition from conduit to tray installation for limited lengths of run.
    a. If a cable is transitioning from a room via tray into a conduit for the remaining distance of the run, the wiring should be the type rated for use in the conduit.
    b. If the majority of the cable run is in conduit, use cable rated for such use.
    c. If the majority of the cable run is in a cable tray, use cable rated for use in a tray.

4.5.4 Conduit Color & Wire Integrity

All conduits shall be green in color with from the manufacturer or done in the field.

All wiring shall be continuous from device to device. No circuit splicing allowed.

4.6 Criteria

Emergency Communications Systems are required to meet CCD requirements. Emergency Communications Systems shall be provided in accordance with the latest editions of the standards and codes listed in the DSM, as well as the IBC and IFC as currently adopted and amended by the CCD. 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.

Intelligibility shall follow the guidance of NFPA 72 Annex D. Each non-public Acoustically Distinguishable Space (ADS) shall have a measured Speed Transmission Index (STI) not less than .45 and an average STI of not less than.50 STI. All Public area ADS shall have a measured STI not less than .50 and an average STI of not less than.60 STI.

4.7 ECS Interim Documents

Emergency Communications System (ECS) existing devices in the area of construction shall remain operational. The contractor shall install an ECS Terminal Cabinet (ECSTC) for the Concession/Tenant area, if one does not already exist, where all the ECS circuits terminate for the space and allow the rest of the connected circuits to remain operational. This ECSTC is to be located above the ceiling in the common area outside the space. Interim speaker wire can be installed without conduit for this phase of construction. The existing conduit may be removed with the wiring. The existing devices shall be left in place and hung or supported in a Code-approved manner for demolition. If fewer devices are requested, DEN requests the contractor consult the DEN Life Safety Team and Engineer prior to submitting the Scope of Work for Denver Fire Department approval. New ECS speaker wiring shall be terminated on approved terminal strips as provided in the specifications. The Denver fire alarm permit can be obtained via a Scope of Work letter signed by a NICET III or higher detailing the existing condition, proposed demolition work, and the interim condition. The conduit to the existing devices may be removed, and the wire for the existing circuit reused for the interim. No new devices need to be added, and as-built reference drawings shall be provided. The access to the ECSTC shall be no higher than 9' a.f.f. The intent is to have a demolition and interim condition as a single submittal that is a Fire walk-through E-permit.

4.8 Design Analysis Requirements

The Design Consultant shall provide an Emergency Alarm System Basis of Design to substantiate the Alarm System design. At a minimum, the Emergency Alarm System Basis of Design shall include the following categories:

A. Building/Tenant description
B. Emergency alarm system type
C. Fire alarm system type
D. Design methodology
E. Acoustical models
F. Testing and inspection
G. Equipment and tools
H. Requirements for submittals
I. End of job closeout

4.8.1 Applicable Codes

The list of Codes that this system is required to follow for the shop drawings.

4.8.2 Design Responsibility

The Engineer of Record for the Shop Drawings. PE Seal applied to the drawings as required by DBCA.

4.8.3 Ambient Noise Levels

Any areas with 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 SPL 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.

Table 4-1: Measured Average Ambient Noise Levels

Measured Average Ambient Noise Levels	
Application	**Sound Level**
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

4.9 Amplifiers

Amplifier system design shall be modular, made up of 2-channel, 600-watt plug-in, replaceable modules, or dual-channel line driver modules. The system shall be configured so that the loss of any one module card does not appreciably interrupt system performance. New amplifiers shall be of the same manufacturer as the existing system.

4.10 Microphone Stations

All Fire Command Centers are furnished with ECS microphone stations and graphical user interfaces to select paging zones. In addition, all microphone stations shall meet the following requirements:

A. All new microphone stations shall be IP-based, connected via Ethernet to the ECS network.
B. Microphone stations in the Fire Command Center and in Airport Operation Centers shall be capable of emergency-level live voice announcements throughout the Terminal Complex.

4.11 Loudspeakers

The Design Consultant shall ensure that:

A. Loudspeaker circuits shall be grouped in zones for the sterile area, restricted area, and public area. Each individual stairwell shall be a unique circuit.
B. Loudspeakers shall be grouped by building floors. No circuit shall feed speakers on more than one building level or stairwell circuits excepted.
C. To the extent possible, loudspeakers on the same circuit shall be installed within no more than one smoke zone.
D. The contract provides an elevation view showing loudspeaker mounting height, spacing, and the angle of dispersion; shows calculations to verify the power delivered to the loudspeakers; and provides catalog cuts of the typical manufacturers' data that shall be provided in the DAR.

E. The ECS design uses a distributed loudspeaker system or line array layout as determined by the acoustical design.
F. Designers are encouraged to creatively select speaker types, makes, models, and loudspeaker placement to optimize speech intelligibility in all airport building locations. The STI levels specified within this document are only the minimum requirements.
G. 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.
H. The ECS shall be designed to deliver PA announcements at 10 dBA above the design ambient noise level and emergency announcements at the level specified in NFPA 72.
I. PLBs containing fixed walkways in excess of 20 feet in length shall be provided with intelligible ECS loudspeaker coverage, in its own zone, throughout the entire fixed walkway.
J. DEN Approved Speaker List Matrix: Contact DEN's Life Safety Team for approved speaker information.

4.12 Fire Alarm System Interface

4.12.1 ECS

The ECS shall:

A. Provide the capability of prioritizing and broadcasting a 70-volt audio signal from the Fire Alarm System.
B. Provide the capability of sending the microphone-level audio signal to the Fire Alarm System.

NOTE: Emergency Live-Voice and Fire alarm announcements shall always take precedence over PA announcements.

4.12.2 Circuits Running to PLBs

The PLB is considered a separate building from the Concourses. As a result, a surge suppressor shall be installed in all circuits that enter and leave the PLB.

4.13 Central Controls

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

4.13.1 Central Controls

Central controls shall:

A. Provide microprocessor-based programmable controls to allow maximum flexibility for the ECS.
B. Allow any microphone station to be programmed so that it is capable of addressing any or all zones.
C. Queue access requests into each paging zone to allow access in turn.

4.13.2 Announcement Control Systems

The Announcement Control System (ACS) shall:

A. Manage announcements and messages using routed data on a standard Ethernet Network.
B. Manage dynamic requests for live and delayed announcements, prerecorded and assembled messages, actions, defined events, and two-way full duplex intercom connections.
C. Provide assignable priority levels to announcements so high-priority emergency announcements may interrupt lower-priority announcements.
D. Require two levels of password security to protect system programming assignments.

E. Provide programmed automatic daily testing of the entire PA system.

4.13.3 Fire Alarm Annunciation Systems

A. Systems used for Fire Alarm annunciation shall:

B. Provide automatic testing compatible with NFPA 72.

When implemented in public areas, provide automatic gain control to compensate for transient, ambient noise.

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 (FACP).

4.14 Visual Notification

The ECS system is supplemented visually by Flight Information Displays (FIDs), Gate Information Displays (GIDs), Baggage Information Displays (BIDs), and other displays, which provide textual messaging. This concept is referred to as visible textual notification in NFPA 72. Airport terminal and concourse buildings shall be provided with an emergency 14 voice/alarm communication system fully integrated into the complex-wide Emergency Communication System (ECS), incorporating audible, visual, and textual notification appliances. In areas accessible to the public, DEN-controlled flight, gate, baggage, and multi-use information display systems (FIDS, GIDS, BIDS, and MUFIDS, respectively) and DEN-controlled visual paging monitors shall display ECS messages. Non-DEN-controlled video displays, DEN CATV, and tenant audio systems in public areas shall be shunted upon activation of the emergency communication system.[1]

LED text messaging appliances are installed in the 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 distractions during emergency events. Consult the DFD fire code official to determine requirements.

4.15 ECS Operational Plan

4.15.1 Introduction

DEN has implemented a robust and comprehensive Emergency Communication System (ECS) throughout the major buildings on the DEN campus. This includes the HTC, Jeppesen Terminal (Main and North Terminal), AOB, CUP, Concourse A, Concourse B, Concourse C, and the AGTS Maintenance Facility. This system has been progressively implemented from 2011 – 2016 in conjunction with the airport's Public Safety Notification Upgrade (PSNU) and Fire Alarm Replacement Projects. Simultaneously, the HTC was built, and appropriate system interfaces were designed and implemented.

This plan provides a detailed review of system operation, infrastructure, interfaces, messages, and maintenance requirements. This document is based on previously issued documents, including the "Emergency Communication System Migration Plan" (Revision 1 dated March 14, 2012) and the "Emergency Communication System Implementation Plan" (Revision 6.4 dated September 13, 2013). The information contained herein is considered ancillary to the "Fire Alarm Replacement Project Design Analysis Report" (Revision 2.0, dated June 22, 2011, Final revision pending) and supplements the findings of the "Emergency Communication System Risk Analysis," Revision 1.0, dated September 21, 2011.

The operation of the DEN ECS has been implemented in close consultation with DFD. This includes the documentation and approval of PSNU Administrative Modifications #2 and #8 and multiple plan reviews and permit issuance and acceptance. The system has also been implemented in accordance with the 2010 Edition of

1. Exception: Non-DEN-controlled video displays exceeding 60" (25.4mm) measured diagonally shall display ECS messages when required by the fire code official.

NFPA 72©, National Fire Alarm and Signaling Code, which is the Code of Record per PSNU Administrative Modification #1.

This document supports the DEN Fire Alarm System Replacement Project, which provides fire alarm protection and emergency communication for the DEN Complex. The scope of the project was the complete replacement of the Fire Alarm System in the integrated DEN Complex, which includes the Main Terminal Building, three passenger Concourses (A, B, and C), AOB, CUP, and the AGTS Maintenance Facility. The replacement Fire Alarm System is the primary means of audible notification for both fire and non-fire emergencies and the only system that can initiate textual and visual messaging. The Johnson Controls TrueSite Workstations (TSWs) are used to initiate all emergency communication messages. The Johnson Controls Fire Alarm equipment interfaces directly with the Multi-User Flight Information Display (MUFID) Software (SITA System) to initiate textual and visual messaging on flight displays and appropriate electronic advertising video displays.

With the DEN ECS, when DFD or DEN Operations deem that in the interest of public safety, an announcement shall be made, trained personnel shall activate either a prerecorded message or conduct a live announcement via a microphone to one, several, or all areas within the Complex. In addition to broadcasting the message, primary visual notification (i.e., strobes) in the affected areas shall activate during emergency relocation announcements and remain activated until an all-clear announcement is made or the signal is canceled. The ECS is supplemented visually by FIDs, GIDs, BIDs, and other appropriate video displays, which provide textual and visual messaging.

4.15.2 Presignal Operation

DFD and DEN Operations has implemented 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, CUP, or the AGTS Maintenance Facility, as those facilities continue to operate with automatic notification actuation.

In accordance with presignal requirements, any automatic alarm shall be immediately transmitted to DFD for emergency response, even though building notification is not initiated.

4.16 Sequence of Operation

4.16.1 Building Definition

Based on building usage and population, the following sequence of operation is required:

4.16.1.1 AOB and CUP

These areas shall have automatic initiation of an evacuation message upon activation of a single alarm signal. Manual override and messaging shall be provided consistent with NFPA 72 requirements for an in-building Emergency Voice/Alarm Communication System (EVACS). These buildings do not utilize textual visual displays (i.e., FIDs/BIDs/GIDs and advertising displays) and thus do not require textual visual notification interface or activation.

4.16.1.2 AGTS Maintenance Facility

This area shall have automatic initiation of an evacuation tone upon activation of a single alarm signal. This facility has only limited ECS loudspeakers (in the train maintenance bay only), so the fire alarm is limited to horn and strobe notification for evacuation. This building does not utilize textual visual displays (i.e., FIDs/BIDs/GIDs and advertising displays) and thus do not require textual visual notification interface or activation.

4.16.1.3 Terminal and Concourses A, B, and C

The sequence of operation for these airport terminal buildings shall utilize the Presignal approach from NFPA 72 (i.e., manual operation).

4.16.1.4 HTC

The sequence of operations for this building is split into two operations. Levels 1 through 4 of the HTC represent the transit center, airport terminal extension, and public conference center and shall utilize the Presignal approach from NFPA 72 (i.e., manual operation). Levels 5 through 15 of the HTC represent the hotel, and these areas shall have automatic initiation of an evacuation message upon activation of a single alarm signal. Manual override and messaging shall be provided consistent with NFPA 72 requirements for an in-building EVACS for a high-rise building (i.e., the floor of alarm, the floor above, the floor below, and 6th Floor alarm activation). The hotel portion of the building does not utilize visual displays (i.e., FIDs/BIDs/GIDs and advertising displays) at this time and thus does not require textual visual notification interface or activation.

As approved in Administrative Modification 10, all audible and visual signals (except for the hotel floors of the HTC) shall deactivate upon signal silence, also called Alarm Silence. The Cancel Message button on the TSW shall have the same functionality as the Alarm Silence button on the FACP.

4.17 Operational Sequences

4.17.1 Fire Alarm Automatic Sequence – AOB, CUP, and AGTS Maintenance

Upon a fire alarm event, the building fire alarm shall be activated (strobes operating), and the ECS shall play the Emergency Evacuation message.

ECS loudspeakers in the stairwells of the AOB are for manual paging only and do not automatically activate during an evacuation message.

It should be noted that the primary method of notification in the CUP and AGTS Maintenance is through the fire alarm horns due to the limited number of PA/ECS loudspeakers provided in these facilities. In addition, as there are no ECS touch screens at the ECS Paging Panel, which is also called the A-Panel. Refer to Figure 4-9: IED Paging Panel (A Panel) and Digital Microphone Station for zone selection in the CUP or in AGTS Maintenance, the sequence of operations is slightly different in these facilities.

4.17.1.1 Live Voice Activation

For live voice announcements, the user shall utilize the ECS Paging Microphone Station.

4.17.1.2 Alarm Silence

A. Selecting the Cancel Message button on the TSW (AOB only) shall deactivate the playing of the prerecorded message. This shall deactivate all strobes and textual messages.
B. Alternatively, selecting the Alarm Silence button on the FACP or TSW shall deactivate the playing of the prerecorded message and all strobes and textual messages.

4.17.1.3 System Reset

Selecting the System Reset button on the FACP or TSW shall return the Fire Alarm System to normal and stop all messages that have automatically been activated (assuming all devices are no longer in an alarm condition and have returned to normal status).

4.17.2 Fire Alarm Automatic Sequence – HTC Levels 5-15

Upon a fire alarm event, the building fire alarm shall be activated (strobes operating), and the ECS shall be playing an Emergency Evacuation message. Notification activation shall be on the floor of the alarm, the floor above the alarm, the floor below the alarm, and the sixth floor (main lobby), typical of a high-rise voice Fire Alarm System.

Fire alarm loudspeakers in the stairwells and elevator cabs of the HTC are for manual paging only and do not automatically activate during an evacuation message. There are available selection switches located on the Johnson Controls FACP in the Level 1 Fire Command Center or the FACP in the Terminal Level 6 Southwest Fire Command Center.

It should be noted that the loudspeakers provided on Levels 1 – 5 of the HTC are controlled and powered by the IED Paging System. Loudspeakers on Levels 6 – 15 of the HTC are controlled and powered by the Johnson Controls Fire Alarm System. The system has been integrated so that an announcement made on one system can be heard with loudspeakers on the other system.

4.17.2.1 Live Voice Activation

For live voice announcements, the user shall utilize any of the ECS Paging Panels/A-Panel for zone selection and the IED Digital Microphone Station or the Johnson Controls Fire Alarm Microphone Station. Johnson Controls Fire Alarm microphone availability is limited to the Level 1 Fire Command Center and the Terminal Level 6 Southwest Fire Command Center.

4.17.2.2 Alarm Silence

Selecting the Cancel Message button on the TSW shall deactivate the playing of the prerecorded message. This shall also deactivate all strobes and textual messages.

Alternatively, selecting the Alarm Silence button on the FACP or TSW shall also deactivate the playing of the prerecorded message. At DFD's request, the strobes in the hotel portion of the HTC shall continue to operate after Alarm Silence has been activated.

4.17.2.3 System Reset

Selecting the System Reset button on the FACP or TSW shall return the Fire Alarm System to normal and stop all messages that have automatically been activated (assuming all devices are no longer in an alarm condition and have returned to normal status) and shall deactivate strobes in the hotel portion of the HTC.

4.17.3 Fire Alarm Automatic Sequence - Terminal, Concourses A, B, and C and HTC Levels 1 – 4

Upon a fire alarm event the fire department shall arrive with the building FA/ECS in a standby mode. The fire alarm event shall be annunciated on the FACP and TSW. The incident commander shall decide on whether and when to activate emergency notification.

4.17.3.1 Fire Alarm under Investigation Activation

If notification to building occupants regarding a fire is desired, but an evacuation is not determined to be necessary, the following shall be activated:

A. On the TSW, select the Fire under Investigation message. The message shall play building-wide and shall include textual notification. No strobes shall activate, and the message times out automatically after three rounds.

4.17.3.2 Emergency Evacuation Activation

If building evacuation is determined to be necessary, evacuation (i.e., Emergency Evacuation prerecorded message, all strobes building-wide, and Evacuation textual messages) can be initiated by any one of the following:

A. On the TSW, select the Emergency Evacuation button.
B. Blue manual evacuation station in FCC.

4.17.3.3 Live Voice Activation

For live voice announcements, the user shall utilize the ECS Paging Panel/A-Panel for zone selection and the IED Digital Microphone Station.

4.17.3.4 Alarm Silence

Selecting the Cancel Message button on the TSW shall deactivate the prerecorded message playing. This shall also deactivate all strobes and textual messages.

Alternatively, selecting the Alarm Silence button on the FACP or TSW shall deactivate the prerecorded message playing and all strobes and textual messages.

4.17.3.5 System Reset

Selecting the System Reset button on the FACP or TSW shall return the Fire Alarm System to normal. System Reset shall not alter non-FA/ ECS messages initiated on the TSW.

4.17.4 Emergency Evacuation Manual Sequence

Upon a non-fire emergency event, the building FA/ECS shall be in standby mode. The incident commander shall decide as to whether and when to activate emergency notification.

The sequence for an Emergency Evacuation is the same as the Fire Alarm Manual Sequence above, except that no fire alarm has occurred in the building. In addition, it would not be anticipated that the System Reset button on the FACP or TSW would be utilized in this sequence.

4.17.5 Media Shunt

The Fire Alarm System provides media shunt function in Tenant spaces throughout the complex, as well as select visual displays throughout the public space. When a Tenant has a private hard-wired audio and/or video system, the system shall be shunted (i.e., power removed) to allow the emergency audible message to be heard over the ECS loudspeakers and any significant visual distractions removed. The fire alarm control module that provides media shunt shall activate anytime an emergency message sequence is activated.

4.17.5.1 Audio Shunt

Tenant audio systems shall be capable of accepting a contact closure to mute their system. The mute input shall be wired to an audio sensing relay on the local ECS loudspeaker circuit that closes anytime an emergency message is active.

4.17.5.2 Visual Shunt

The Fire Alarm System provides a shunt of all public cable television (CATV) feeds at key CATV distribution points in the Terminal, Concourse A, Concourse B, Concourse C, and the Hotel. The fire alarm control module shall remove the CATV feed during an active emergency message sequence by removing power from the central distribution hub in the area.

Select advertising video displays and digital directory displays shall shunt anytime an emergency message is activated. This is accomplished using a fire alarm control module that removes power to the select device or devices.

4.18 Evacuation Activation

Once DEN Operations, DFD, or other authorities deem that in the interest of public safety, an evacuation is required, there are two ways to activate an evacuation:

A. On each TSW, there is an ECS control screen. This screen is easily accessed from the Home site plan screen. Once on the ECS control screen, there is an Emergency Evacuation activation button for each building. Once selected, the emergency evacuation sequence of operations is activated. If the button is selected a second time (toggled), the sequence is deactivated.

B. In each Fire Command Center (a total of eight in the complex), there is a single Manual Evacuation Station. When activated, this initiates the emergency evacuation sequence of operations for that specific building

only. Once activated, the blue evacuation station button is reset by turning the mushroom switch until it releases. However, to deactivate the emergency evacuation sequence, a System Reset shall be initiated via the local FACP or the TSW System Reset screen.

This functionality enables an evacuation to be initiated remotely, usually from the AOB 10th Floor Operations Center or locally from the Fire Command Center. The Manual Evacuation Station is provided for local operation in case the TSW is compromised or non-functional or if the evacuation needs to be initiated very quickly.

Once activated, the emergency evacuation sequence is initiated building-wide, as noted above.

4.19 Fire Alarm System Notification Appliances

The Johnson Controls Fire Alarm System shall control and power strobe appliances labeled ALERT, combination horn/strobe appliances labeled ALERT, and LED text messaging appliances.

4.19.1 ECS / Paging System Notification Appliances

The Fire Alarm System relies entirely on the IED Paging System for audible ECS notification in all but a select few locations.

The IED Paging System uses commercial-grade loudspeakers to provide adequate audibility and intelligibility throughout all spaces with paging system coverage. Paging loudspeakers and circuits are zoned for routine airport paging as well as emergency paging consistent with the ECS sequence of operation. Loudspeakers placed in Tenant finish areas and non-public areas are provided with a sticker on the front surface of the loudspeaker that states Fire Alarm Do Not Disconnect to prevent tampering. Refer to Figure 4-1: Typical Ceiling Loudspeaker with ECS Indicator.

Figure 4-1: Typical Ceiling Loudspeaker with ECS Indicator

Notification devices (i.e., loudspeakers) are in each of the main complex buildings in areas where intelligible audio reproduction can be accomplished. There are loudspeakers in some parking structures and passenger pickup/drop-off areas (i.e., curbside), AGTS tunnels, most mechanical and electrical rooms, as well as all office and public spaces. These devices range from small coaxial in-ceiling loudspeakers, industrial horn-type loudspeakers used in harsh environments, and large-format line array-type loudspeaker units used in the Terminal Great Hall and HTC RTD train platform to achieve intelligibility in difficult acoustic environments.

4.20 ECS Operation

4.20.1 System Description

The ECS system consists of the IED Globalcom Suite of hardware and software providing audible voice coverage throughout the DEN Complex. The system relies on a distributed data network of controllers, digital microphones, and amplifiers. The system uses industry-hardened network standards for audio transmission over TCP/IP networks utilizing both RTP (Real Time Protocol) and Cirrus Logic Cobranet audio transport. The integrity of the network is maintained by the DEN Technologies/Life Safety department. There is a dedicated backbone and distribution system of switches for the IED audio traffic separate from the typical users' network (enterprise). This data network is a redundant class A network. This network model allows greater control, monitoring, and notification both for fault notifications as well as emergency messaging. The system can reproduce a single audio input source to every loudspeaker in the network, approximately 15,000 loudspeakers simultaneously. There is some control of the zoning available to the user allowing the selection of a part of the building, most of the building, or all buildings for live voice announcements.

IED titan amplifier frames have eight (8) available amplifier card slots with a ninth automatic failover backup amplifier card. Each card is capable of two channels of 300W of 70.7V audio or Line Level audio. The redundant amplifier switches over automatically upon amplifier card failure providing a redundant backup.

The IED system receives via a dry contact closure signal from the Johnson Controls Fire Alarm System to capture all zones of loudspeakers and accepts audio from the Johnson Controls Fire Alarm System to play over all zones in the local building. This happens in five buildings during an emergency weather message, as each building has separate activation into the IED system. The IED system also provides a fault relay into the Johnson Controls Fire Alarm System to notify of any large system outages that substantially affect the operation of the paging system.

4.20.1.1 IED Globalcom System

The IED Globalcom system is also responsible for the normal voice reproduction functions for the airport, including courtesy announcements, regulated prerecorded messages for airport security, and Airline daily operations. The fire alarm audio feed and live voice announcements from the FCC microphone station take priority, interrupting any other audio playing through the system.

The microphone stations in Fire Command Centers and Operations Centers have special authority to allow emergency-level paging.

Globalcom provides an ambient sound analysis system that monitors the ambient level of the sound in a space, and if it is outside of the threshold, the system automatically increases or decreases the level of the loudspeakers in that zone accordingly. This system allows better intelligibility in space by providing accurate SPLs during normal activities as well as abnormal activities by actively attenuating the level. These sensors are provided in all public spaces in the Terminal Complex. The system has been equalized and set up to provide a minimum of 10dB over ambient levels. This system is limited in the amount of gain allowed to keep overall levels within acceptable ranges.

4.20.1.2 SITA Video System

The SITA video system is responsible for visual, textual messages during alarm conditions. This system consists of approximately 1,500 video displays in the MUFIDS system and approximately 100 advertising displays. These displays utilize the SITA distributed video content system that allows for server-controlled display content to be dynamically changed. During an alarm event, the typical Airlines content from most of these monitors is captured and switched to an emergency message pertinent to the alarm selected on the TSW. The screen capture system has multiple components required to make it work. There is a virtual server running as the director for the system responsible for command and control (C&C), sending signals out to network-connected computers to trigger the switch.

When the Johnson Controls Fire Alarm System triggers an alarm, SITA accepts one of eight relay contact closures in the black box via an analog-to-digital USB device, which notifies a PC in the local building. Refer to Figure 4-10: Fire Alarm/ECS Interface Cabinet. This computer reports to the C&C server to initiate an emergency message. The C&C

server then activates all the computers located behind each monitor via a network command with the correct message to display.

For non-MUFIDs screens (i.e., advertising displays), a network signal is sent to an RS-232 device (print server) to switch the display to an emergency message. The print server sends an RS-232 command to switch the input of the DVI switch located at the monitor. The second input of this DVI switch is connected to the emergency DDC computer by SITA. This DDC also receives a network signal to display the correct message on the screen.

4.21 System Interface

The operation of, and integration with, the Fire Alarm System and the PA/ECS (provided by IED) and MUFID Software (provided by SITA) systems forms the overall life safety system that allows fire detection, emergency response, and occupant notification. As such, the operation of these systems shall be intuitive and simple for all users during an emergency, and the interface between the systems shall be reliable and supervised.

To achieve this, the following system configuration is supported:

A. Fire Alarm/Emergency Communication (FA/ECS) shall be accomplished through the TSW as the primary emergency system user interface.

B. The Johnson Controls Fire Alarm System shall provide audio output of prerecorded emergency messages as outlined below to the IED System.

C. The paging zone interface between the Fire Alarm System and the PA/ECS and MUFID systems shall be limited to supervised dry contact connections.

D. The interface between MUFID and Airline-owned or commercial advertising displays entails four (4) unsupervised electronic devices and software. As such, the use of these interfaces is limited to areas where additional supplemental visual notification is required.

E. The Fire Alarm System shall activate visual notification devices (i.e., Fire Alarm System alert strobes) and textual visual notification devices (i.e., LED text message signs and visual textual notification via MUFIDs (FIDs, BIDs, and GIDs)). Text message signs have pre-determined messages, as noted later in this document.

F. Direct activation of the ECS Paging Panel/A-Panel for zone selection and the IED Digital Microphone Station shall be used for live voice paging.

G. The PA/ECS provides a trouble/fault contact to the Fire Alarm System (1 per interface, a total of five) upon any critical trouble/fault that renders a portion of the PA/ECS inoperable.

4.21.1 Live Voice Messages

The most effective method of audible notification is a live message from a recognized authority figure (e.g., Fire Chief, Chief of Police, head of security, etc.). Additionally, the message should provide concise information about the event and provide clear instructions for building occupants with frequent follow-up messages to update occupants.

Additionally, it was recommended that the message be announced on a building-wide basis to ensure that a consistent message is provided to all occupants. This is important, as most areas of the buildings are not separated, and the occupants are highly transient. By way of example, a family might split up, with some members remaining at the gate area while others walk to another part of the concourse to shop. (It should be noted, however, that the IED Paging System zoning still allows for notification of select locations within each building in an emergency, although such notification would not provide the entire breadth of emergency notification as provided by the ECS as described within this document.)

Only prerecorded messages shall be initiated through the TSW via a dedicated ECS Control Screen. TSWs are provided in each Fire Command Center and at Airport Operation Centers. The Fire Alarm System shall ensure that visual notifications (both strobes and textual appliances) are activated and deactivated, as appropriate for the event, when audible messages occur. The Fire Alarm System shall activate dry contacts, which shall be input into the ECS to activate the prerecorded building-wide emergency announcement overriding any current

announcements. Live voice announcements shall utilize the ECS Paging Panel/A-Panel for zone selection and the IED Digital Microphone Station to provide the concise information discussed above.

As a rule, a live voice announcement shall not activate a visual notification if it is not already activated, nor shall it deactivate a visual notification if it is already activated. Therefore, as noted in the sequence of operations below, when a recognized authority figure makes the decision to conduct an emergency live-voice announcement that requires action by a building occupant (e.g., evacuation or relocation), then it should be a standard operating procedure to initiate the most appropriate prerecorded emergency message first, thereby initiating the correct notification appliance activation, followed by initiating a live voice announcement.

A live voice announcement from the ECS Paging Panel/A-Panel for zone selection and the IED Digital Microphone Station shall always be a priority signal over any other prerecorded message of any type. A live voice announcement shall immediately interrupt any existing message being played for the duration of the announcement. DFD has determined that based on the multiple possible scenarios and the ability for the emergency responders to either cancel a message or restart a message on the TSW, it is not appropriate to modify the audio signal that is being sent from the Fire Alarm System to the ECS after microphone activation. As such, no connection (dry contact) is necessary between the ECS and the Johnson Controls Fire Alarm System for this purpose.

This live voice priority sequence is accomplished within the ECS with the use of priority levels. The ECS Paging Panel/A-Panel for zone selection and the IED Digital Microphone Station shall be the highest priority microphone (Priority 1) and shall immediately interrupt any existing message being played, including prerecorded messages being supplied by the Fire Alarm System. The Fire Alarm System's prerecorded message shall be the second-highest priority signal (Priority 2) and shall immediately interrupt any existing message being played except for a live voice announcement from an ECS Microphone. General paging (normal) messages from the PA system shall be a third-level signal (Priority 3) and shall operate and sequence as currently programmed. Fire alarm/ECS test messages shall be a Priority 2 signal so that they can be used to test (mimic) the emergency operation of the system.

4.21.1.1 Live Voice Messages at the HTC

As noted, in all areas of the complex, live voice messages are made using the ECS (IED) Paging Panel Microphone Station, and these messages are transmitted over the ECS (IED) loudspeakers. At the HTC, however, IED System loudspeakers are located on Levels 1 – 5, and Johnson Controls Fire Alarm System loudspeakers are located on Levels 6 – 15 and in stairwells and elevator cabs. The fire alarm and ECS system have been linked so that a live voice message made from either the IED System microphone or the Johnson Controls system microphone shall be played in select areas of the HTC.

A live voice message made using the ECS (IED) Paging Panel Microphone Station shall play over the Johnson Controls Fire Alarm System loudspeakers on Levels 6 – 15 of the hotel as a single paging zone. The IED System provides a line-level audio input to the Johnson Controls Fire Alarm System upon activation of a supervised dry contact that tells the Fire Alarm System to accept the message and override any existing prerecorded message that may be playing. The IED microphone station has seven selection switches for Levels 1, 2, 3, 4, 5, 1-5, and 1-15 All Building.

The Johnson Controls Fire Alarm Control Unit (FACP) in the HTC Fire Command Center (and the backup command center in the Terminal Level 6 Southwest) contains a Johnson Controls microphone with manual selection switches. The Johnson Controls microphone can make manual selective announcements to floors 5 – 15, stairs 1 – 7, and all elevator cabs. Activation of the All Loudspeakers Talk button provides activation of all Johnson Controls Fire Alarm System loudspeakers. To provide voice messages from Johnson Controls Fire Alarm System into the ECS (IED System), the Johnson Controls Fire Alarm System provides a 70 VRMS audio output into the IED System upon activation of a supervised dry contact, which tells the IED System to accept the message and override any existing prerecorded message that may be playing. Thus, there is a selection switch for Levels 1 – 4 (as a single group) and Level 5, which allows the Johnson Controls Fire Alarm System microphone to conduct manual voice announcements over the IED System loudspeakers located on Levels 1 -5, including the exterior loudspeakers located on Level 5. Finally, an All Call button is provided to allow the Johnson Controls Fire Alarm System

microphone to conduct a manual voice announcement over all IED and Johnson Controls Fire Alarm System loudspeakers located within the HTC.

4.21.2 Pre-recorded Messages

While live voice messages are the recommended method of occupant notification, it is recognized that the ability to initiate prerecorded messages on the system is desirable and even necessary from an emergency operational standpoint. All prerecorded messages shall have the ability to be initiated from any TSW located throughout the Complex, including in each Fire Command Center and airport operations centers.

It should be noted that in accordance with NFPA 72-2010 section 24.4.1.2, prerecorded evacuation messages play the voice message three to five times, followed by the 3-Pulse Temporal Code (Temporal 3) until the system is silenced or reset. A button is provided to allow the emergency evacuation prerecorded message to be re-initiated if desired by the authorized user. However, it should be noted that the Temporal 3 signal is not used at DEN because it too closely resembles the existing security breach tone that is utilized. As such, a slow-whoop tone is utilized to differentiate the evacuation tone from the security breach tone. Additionally, in the HTC, a steady, low-frequency tone shall be utilized to provide better waking ability for hotel occupants in line with more recent NFPA 72 requirements. This low-frequency tone is used in both sleeping and non-sleeping spaces for consistency of evacuation tone.

The prerecorded messages reside within the Johnson Controls Fire Alarm System audio controller. Tones and voice messages are digitally recorded and stored in the audio control modules message memory. Audio output shall be a 70.7 VRMS audio signal to the PA/ECS system. (The Johnson Controls 70.7 VRMS audio signal is converted to line-level audio before being converted to the digital audio format (Cobranet) that IED routes to the selected output.) A Fire Alarm System dry contact shall activate, notifying the PA/ECS system to accept the audio input signal from the Fire Alarm System at a Priority 2 level. The fire alarm prerecorded message shall then be played over the ECS loudspeakers.

Note: Exact message format and content has been coordinated with DEN and responding emergency personnel.

It is recommended that the number of prerecorded messages shall be limited for ease of use, quick response, and accuracy. The required ECS prerecorded messages are as follows:

4.21.2.1 Emergency Evacuation

Building evacuation due to fire or another emergency.

4.21.2.2 Emergency Under Investigation

Emergency situation (alarm) requiring further investigation by the fire department and not requiring occupant evacuation until such an investigation has occurred.

4.21.2.3 Emergency All Clear

Emergency situation requiring evacuation has passed and operations can return to normal.

4.21.2.4 Tornado Warning

National Weather Service has issued a Tornado Warning that includes DEN concourses and terminal and occupant relocation to identified tornado shelters is required.

4.21.2.5 Tornado Sighted

A tornado has been sighted or is imminent and occupant relocation to identified tornado shelters is required.

4.21.2.6 Tornado All Clear

Tornado situation requiring tornado shelter use has passed and operations can return to normal.

4.21.2.7 DEN Property Tornado Warning

National Weather Service has issued a Tornado Warning that includes the DEN property. This is an informational message only.

4.21.2.8 DEN Property Tornado All Clear

Tornado situation involving DEN property has cleared and operations can return to normal.

4.21.2.9 No Smoking Message

ECS System audio test message utilizing the No Smoking message.

4.21.2.10 ECS Test Message

ESC System complete test message, including audio, visual, and textual messaging.

4.21.3 Supplemental Textual Messages

The ECS system is supplemented visually by FIDs, GIDs, and BIDs and select advertising displays, which provide textual messaging. This concept is referred to as textual visual notification in NFPA 72. Refer to Figure 4-2: Typical FID Bank and Figure 4-3: Typical FID Bank.

Figure 4-2: Typical FID Bank

As with the prerecorded audible messages, a fundamental recommendation shall maintain simplicity in the textual message and its control. Textual messages should be disseminated automatically when a prerecorded audible message is selected on the TSW and do not require additional action by the initiator.

Figure 4-3: Typical FID Bank

It should be noted that primary visual notification for emergencies is achieved using the Fire Alarm Systems visual notification (i.e., ALERT strobes). Such primary visual notification shall be provided specifically to alert those who are deaf or hard of hearing. The use of FIDs, GIDs, BIDs, and select advertising displays are supplementary visual notifications. Refer to Figure 4-4: Concourse A, 2x5 Advertising Video Display and Figure 4-5: Concourse B, 2x5 Advertising Video Display for examples of emergency textual messaging on an advertising display. Such supplementary notification should not be subject to the same prescriptive requirements of primary visual notification, such as supervision, location, and wiring integrity. Since the use of these displays relies on commercial-grade video monitors, network switches, computers, and infrastructure (rather than listed fire alarm equipment), individual video displays may, at times, not capture reliability for a host of reasons. The small risk created by these deficiencies is more than outweighed by the benefit provided by many captured video displays. The use of supplemental textual visual notification provides content-rich messaging, which should provide an improved response from all occupants (i.e., both hearing and deaf) and can also assist with overcoming disabilities (e.g., hearing, speech recognition, etc.) or language barriers that cannot be easily addressed by audible notification.

Figure 4-4: Concourse A, 2x5 Advertising Video Display

Figure 4-5: Concourse B, 2x5 Advertising Video Display

4.21.3.1 Textual Message Distribution to FIDs/BIDs/GIDs

The fire alarm interface to MUFID Software (provided by SITA) utilizing a dry contact interface is the approach for distributing textual messages to the FIDs/GIDs/BIDs as well as other video displays, like those used for advertising, throughout the airport. With this approach, the message resides on the MUFID server, and the fire alarm dry contacts shall be used to notify the system as to what textual message should be sent to the MUFID Software. If displays are not interfaced with MUFID software, messages will not display.

4.21.3.2 Textual Message Distribution to Non-MUFIDs Displays

When interfacing with Airline-owned or commercial advertising displays, two network connections to a MUFID server and four unsupervised electronic devices (a SITA computer, a print server, a digital video interface switcher, and an Extended Display Identification Data (EDID) minder device) are required to capture the display with an emergency message. Additionally, SITA software must be installed on every non-DEN display to interface with the MUFID software and thus can receive the emergency message.

4.21.3.3 Textual Message Code Considerations

The textual messaging at DEN is utilized to improve notification for the hearing impaired and in support of the overall emergency communication approach, including pre-signal implementation.

Textual visual information should be of a size and visual quality that is easily read. Many factors influence the readability of textual visual appliances, including the following:

A. Size and color of the text or graphic
B. Distance from the point of observation
C. Observation time
D. Contrast
E. Background luminance
F. Lighting
G. Stray lighting (glare)
H. Shadows
I. Physiological factors

NFPA 72, 1020 edition provides guidance for font size based on viewing distance and mounting height of the display, as does the ADA. The information in the following tables is extracted from NFPA 72, which has been harmonized with the requirements of ADA.

Table 4-2: NFPA 72 ADA Sign Requirement

NFPA 72 Number	Guidance
24.4.2.21.10	Textual visible appliance messages shall be permitted to be static, flashing, or scrolling, depending on the message being delivered.
24.4.2.21.11	The message text shall be permitted to be any color, as long as it is clearly legible in the environment in which it is located.
24.4.2.21.12	Emergency textual messages shall override non-emergency textual messages.
24.4.2.21.14.1*	Characters shall contrast with the background using either light characters on a dark background or dark characters on a light background.
24.4.2.21.14.2	Characters shall be permitted to be uppercase or lowercase, or a combination of both.
24.4.2.21.14.3	Characters shall be conventional in form and not italic, oblique, script, highly decorative, or of other unusual form.

Table 24.4.2.21.14.5 Visual Character Height

Height to Finished Floor or Ground from Baseline of Character	Horizontal Viewing Distance	Minimum Character Height
>70 in. (1780 mm)–≤10 ft (3050 mm)	<15 ft (4570 mm)	2 in. (51 mm)
>70 in. (1780 mm)–≤10 ft (3050 mm)	≥15 ft (4570 mm)	2 in. (51 mm), + ⅛ in. (3.2 mm)/ 12 in. (305 mm) of viewing distance above 15 ft (4570 mm)
>10 ft (3050 mm)	<21 ft (6400 mm)	3 in. (77 mm)
>10 ft (3050 mm)	≥21 ft (6400 mm)	3 in. (77 mm), + ⅛ in. (3.2 mm)/ 12 in. (305 mm) of viewing distance above 21 ft (6400 mm)

Figure 4-6: NFPA Visual Character Height Resources

For purposes of utilizing FIDs/BIDs/GIDs, a 3-inch Sans Serif font is recommended. Smaller font sizes might be acceptable for displays where the viewing distance is less than 30 ft. In the case of larger video displays (e.g., Jumbotron™-type displays), the suggested visual message should be scaled larger as needed to provide legibility from greater distances. The following figure shows an example of emergency messaging on a large video display.

Figure 4-7: Great Hall Large Video Advertising Displays

4.21.4 Tornado Warning or Sighted Manual Sequence

DEN Operations staff shall determine whether and when to activate emergency weather/tornado notification. The National Weather Service shall determine if the tornado situation is on the DEN property or directly affects the DEN terminal and concourses. If the tornado situation involves the DEN property, then the Operations Staff shall activate the DEN Property Tornado Warning message, which is informational and shall not require occupant relocation into the identified tornado shelters. If the tornado situation directly involves the DEN terminal and concourses, the Operations Staff shall activate the Tornado Warning or Tornado Sighted messages, which requires occupant evacuation/relocation into the identified tornado shelters. It is anticipated that only Operations Center staff shall activate weather/tornado notifications, even though weather/tornado prerecorded messages shall be available on the TSW message selection screen available throughout the campus.

4.21.4.1 DEN Property Tornado Warning Activation

On the TSW, select the Site Wide DEN Property Tornado Warning button. The selected prerecorded message shall play on the ECS loudspeakers. Such notification shall activate complex-wide (all buildings, except HTC), and the message shall automatically time out. At the same time, the operator shall select the Hotel DEN Property Tornado Warning button to activate the notification within the HTC.

4.21.4.2 Tornado Evacuation Activation

On the TSW, select the Tornado Warning or Tornado Sighted button. The selected prerecorded message shall play on the ECS loudspeakers, the strobes connected to the Johnson Controls Fire Alarm System shall activate, and textual visual notification shall display the appropriate tornado textual message. Such notification shall activate complex-wide (all buildings, except HTC) and shall continue to operate until canceled or silenced. At the same time, the operator shall select the Hotel Tornado Warning or Tornado Sighted button to activate the notification within the HTC.

4.21.4.3 Live Voice Activation

For live voice announcements, the user shall utilize the ECS Paging Panel/A-Panel for zone selection and the IED Digital Microphone Station typical of the existing condition to provide the concise information discussed above.

4.21.4.4 Alarm Silence

Selecting the Cancel Message button on the TSW shall deactivate the playing of the prerecorded message. This shall also deactivate all strobes and textual messages.

4.21.4.5 System Reset and Fire Alarm Silence

System Reset and FACP Alarm Silence shall not alter non-FA/ECS messages initiated on the TSW.

4.21.5 Non-Emergency Manual Sequence

Select the appropriate non-emergency notification to activate. This would include an Emergency All Clear message, ECS Test message, or any other informational, non-emergency message.

4.21.5.1 Non-Emergency Activation

On the TSW, select the non-emergency message desired. The selected prerecorded message shall play on the ECS loudspeakers building-wide and the visual, and textual messaging shall display as indicated in 4.22.1 ECS Message Sequence of Operations of this document.

4.21.5.2 Live Voice Activation

For live voice announcements, the user shall utilize the ECS Paging Panel/A-Panel for zone selection and the IED Digital Microphone Station typical of the existing condition to provide the concise information discussed above.

4.21.5.3 Alarm Silence

A. Selecting the Cancel Message button on the TSW shall deactivate the playing of the prerecorded message. This shall also deactivate all strobes and textual messages if activated.
B. Activating the Cancel Message button on the TSW or the Alarm Silence button on the Johnson Controls FACP or TSW shall not be necessary or required, as all non-emergency messages shall time-out automatically (i.e., shall play either two or three times and then stop).

4.21.6 Live Voice Announcements Only

For live voice announcements, the user shall utilize the ECS Paging Panel/A-Panel for zone selection and the IED Digital Microphone Station typical of the existing condition to provide the concise information discussed above. Live announcements may be made using available zoning options, including all campus, individual buildings, or zoned sections of buildings as determined by the user.

If an emergency live voice announcement is made without first selecting an emergency sequence on the TSW, the live voice plays on the selected zones, but no other emergency ECS functions like strobe activation, video capture, and the like are initiated. Activating the proper emergency sequence via the TSW prior to making an emergency live voice announcement is the only method to activate the entire ECS sequence, as described further in 4.22.1 ECS Message Sequence of Operations of this document.

4.22 ECS Messages

A fundamental principle shall maintain simplicity in messaging. This should extend to both the messages themselves and to the flexibility and control of the system. Research has shown that message effectiveness depends on the following considerations:

A. Message shall explain the nature of the alarm and the resolution.

B. In an emergency, people's cognitive ability decreases, so messages should be simple and concise.

C. Messages should be approximately 27 words and last no more than 10 seconds. They should be repeated three times.

4.22.1 ECS Message Sequence of Operations

The following matrix sequence of operations, as shown in the following tables, shall apply to the ECS messages. The sequences are specific to the noted buildings due to the variations between buildings. The remainder of this section provides more details on this sequence of operations.

Table 4-3: AOB, CP, AGTS Maintenance ECS Sequence of Operations

AOB, CENTRAL PLANT, & AGTS MAINTENANCE	ACTIVATION	PRE-TONE	DURATION	POST-TONE	AUDIBLE ZONE	STROBES	TEXTUAL MESSAGE **	STOP MESSAGE	SIMPLEX MSG #
EMERGENCY EVACUATION	AUTOMATIC	SLOW WHOOP (3 TIMES)	5 TIMES	SLOW WHOOP CONTINUOUS [a]	BLDG WIDE*	YES	N/A	MANUAL	101
EMERGENCY UNDER INVESTIGATION	MANUAL	CHIME (3 TIMES)	3 TIMES	REPEAT CONTINUOUS	BLDG WIDE*	YES	N/A	MANUAL	102
EMERGENCY ALL CLEAR	MANUAL	CHIME (1 TIME)	4 TIMES	NONE	BLDG WIDE*	NO	N/A	TIMES OUT	103
DEN PROPERTY TORNADO WARNING	MANUAL	TONE 1 [8 BEATS] (3 TIMES)	1 TIMES; 3 Rounds 2.5 Minutes apart	NONE	BLDG WIDE	YES	N/A	TIMES OUT	121
DEN PROPERTY TORNADO ALL CLEAR	MANUAL	CHIME (2 TIMES)	2 TIMES; 3 Rounds 2.5 Minutes apart	NONE	BLDG WIDE	YES	N/A	TIMES OUT	120
TORNADO WARNING	MANUAL	STUTTER (WARBLE) TONE (3 TIMES)	3 TIMES	REPEAT CONTINUOUS 30 SECONDS APART	BLDG WIDE	NO	N/A	MANUAL	122
TORNADO SIGHTED	MANUAL	STUTTER (WARBLE) TONE (3 TIMES)	3 TIMES	REPEAT CONTINUOUS 40 SECONDS APART	BLDG WIDE	NO	N/A	MANUAL	123
TORNADO ALL CLEAR	MANUAL	CLEAR BELL TONE (3 TIME)	1 TIMES; 5 Rounds 2.5 Minutes apart	NONE	BLDG WIDE	NO	N/A	TIMES OUT	124
NO SMOKING MESSAGE (PA TEST)	MANUAL	NONE	2 TIMES	NONE	BLDG WIDE	NO	NONE	TIMES OUT	107
ECS TEST MESSAGE (PA & VISUAL)	MANUAL	NONE	8 TIMES	NONE	BLDG WIDE*	YES (90 SEC)	N/A	TIMES OUT	108
LIVE VOICE ANNOUNCEMENT	MANUAL	NA	NA	NA	SELECTABLE	NO	NONE	MANUAL	N/A
CANCEL MESSAGE	MANUAL	NA	NA	NA	NA	NO	NONE	NA	N/A

* EXCEPT STAIRWELLS IN AOB.

** THERE ARE NO TEXTUAL MESSAGE DEVICES (BIDs, FIDs, GIDs OR FIRE ALARM TEXT APPLIANCES) IN THESE BUILDINGS.

Table 4-4: Concourses and Terminal ECS Sequence of Operations

CONCOURSES AND TERMINAL	ACTIVATION	PRE-TONE	DURATION	POST-TONE	AUDIBLE ZONE	STROBES	TEXTUAL MESSAGE	STOP MESSAGE	SIMPLEX MSG #
EMERGENCY EVACUATION	MANUAL	SLOW WHOOP (3 TIMES)	5 TIMES	SLOW WHOOP CONTINUOUS [a]	BLDG WIDE	YES	EVAC	MANUAL	101
EMERGENCY UNDER INVESTIGATION	MANUAL	CHIME (3 TIMES)	3 TIMES	REPEAT CONTINUOUS	BLDG WIDE	YES	NOTICE (60 SEC)	MANUAL	TBD
EMERGENCY ALL CLEAR	MANUAL	CHIME (1 TIME)	4 TIMES	NONE	BLDG WIDE	NO	EMER CLEAR (40 SEC)	TIMES OUT	103
DEN PROPERTY TORNADO WARNING	MANUAL	TONE 1 [8 BEATS] (3 TIMES)	1 TIMES; 3 Rounds 2.5 Minutes apart	NONE	BLDG WIDE	NO	NONE	TIMES OUT	121
DEN PROPERTY TORNADO ALL CLEAR	MANUAL	CHIME (2 TIMES)	2 TIMES; 3 Rounds 2.5 Minutes apart	NONE	BLDG WIDE	NO	NONE	TIMES OUT	120
TORNADO WARNING	MANUAL	STUTTER (WARBLE) TONE (3 TIMES)	3 TIMES	REPEAT CONTINUOUS 30 SECONDS APART	BLDG WIDE	YES	WARNING	MANUAL	122
TORNADO SIGHTED	MANUAL	STUTTER (WARBLE) TONE (3 TIMES)	3 TIMES	REPEAT CONTINUOUS 40 SECONDS APART	BLDG WIDE	YES	SIGHTED	MANUAL	123
TORNADO ALL CLEAR	MANUAL	CLEAR BELL TONE (3 TIME)	1 TIMES; 5 Rounds 2.5 Minutes apart	NONE	BLDG WIDE	NO	NONE	TIMES OUT	124
NO SMOKING MESSAGE (PA TEST)	MANUAL	NONE	2 TIMES	NONE	BLDG WIDE	NO	NONE	TIMES OUT	107
ECS TEST MESSAGE (PA & VISUAL)	MANUAL	NONE	8 TIMES	NONE	BLDG WIDE	YES (90 SEC)	TEST (90 SEC)	TIMES OUT	108
LIVE VOICE ANNOUNCEMENT	MANUAL	NA	NA	NA	SELECTABLE	NO	NONE	MANUAL	N/A
CANCEL MESSAGE	MANUAL	NA	NA	NA	NA	NO	NONE	NA	N/A

[a] SEPARATE BUTTON ALLOWS VOICE SEQUENCE TO BE RE-STARTED.

Table 4-5: Westin Hotel and Transit Center ECS Sequence of Operation

WESTIN HOTEL & TRANSIT CENTER	ACTIVATION	PRE-TONE	DURATION	POST-TONE	AUDIBLE ZONE	STROBES	TEXTUAL MESSAGE [c]	STOP MESSAGE	SIMPLEX MSG #
EMERGENCY EVACUATION FLOOR 1 - 4	MANUAL	SLOW WHOOP (3 TIMES)	5 TIMES	SLOW WHOOP CONTINUOUS	FLOORS 1 - 4	YES, FLOORS 1 - 4	EVAC	MANUAL	101
EMERGENCY EVACUATION FLOOR 5 - 15	AUTOMATIC	STEADY LOW FREQUENCY (15 Seconds)	3 TIMES	REPEATS SEQUENCE CONTINUOUS	FLOOR OF ALARM, FLOOR ABOVE, FLOOR BELOW, & 6TH FLOOR [b]	YES, FOLLOWS AUDIBLE ZONE	NONE	MANUAL	126
EMERGENCY UNDER INVESTIGATION	MANUAL	CHIME (3 TIMES)	3 TIMES	REPEAT CONTINUOUS	BLDG WIDE	YES	NOTICE (60 SEC)	MANUAL	TBD
EMERGENCY ALL CLEAR	MANUAL	CHIME (1 TIME)	4 TIMES	NONE	FLOORS 1 - 4	NO	EMER CLEAR (40 SEC)	TIMES OUT	103
DEN PROPERTY TORNADO WARNING	MANUAL	TONE 1 (8 BEATS) (3 TIMES)	1 TIMES; 3 Rounds 2.5 Minutes apart	NONE	BLDG WIDE [b] (FLOORS 1 -15)	NO	NONE	TIMES OUT	121
DEN PROPERTY TORNADO ALL CLEAR	MANUAL	CHIME (2 TIMES)	2 TIMES; 3 Rounds 2.5 Minutes apart	NONE	BLDG WIDE [b] (FLOORS 1 -15)	NO	NONE	TIMES OUT	120
TORNADO WARNING	MANUAL	STUTTER (WARBLE) TONE (3 TIMES)	3 TIMES	REPEAT CONTINUOUS 30 SECONDS APART	BLDG WIDE [b] (FLOORS 1 -15)	YES	WARNING	MANUAL	122
TORNADO SIGHTED	MANUAL	STUTTER (WARBLE) TONE (3 TIMES)	3 TIMES	REPEAT CONTINUOUS 40 SECONDS APART	BLDG WIDE [b] (FLOORS 1 -15)	YES	SIGHTED	MANUAL	123
TORNADO ALL CLEAR	MANUAL	CLEAR BELL TONE (3 TIME)	1 TIMES; 5 Rounds 2.5 Minutes apart	NONE	BLDG WIDE [b] (FLOORS 1 -15)	NO	NONE	TIMES OUT	124
NO SMOKING MESSAGE (PA TEST)	MANUAL	NONE	2 TIMES	NONE	FLOORS 1 - 4	NO	NONE	TIMES OUT	107
ECS TEST MESSAGE (PA & VISUAL)	MANUAL	NONE	8 TIMES	NONE	FLOORS 1 - 4	YES (90 SEC)	TEST (90 SEC)	TIMES OUT	108
LIVE VOICE ANNOUNCEMENT	MANUAL	NA	NA	NA	SELECTABLE	NO	NONE	MANUAL	N/A
CANCEL MESSAGE	MANUAL	NA	NA	NA	NA	NO	NONE	NA	N/A

[b] EXCEPT STAIRWELLS IN HOTEL. SPEAKERS IN STAIRWELLS AND ELEVATOR CABS ARE MANUAL ACTIVATION ONLY.

[c] TEXTUAL MESSAGE DEVICES (BIDs, FIDs, GIDs OR FIRE ALARM TEXT APPLIANCES) ARE LIMITED TO LEVEL 1 IN THE HOTEL & TRANSIT CENTER AT THIS TIME.

If additional messages (e.g., security) are added to the ECS, the sequence of operations shall be updated so that appropriate control points can be added to provide the required functionality.

4.22.2 Pre-recorded ECS Messages

4.22.2.1 Emergency Evacuation

A. ECS plays three rounds of Slow Whoop tone followed by prerecorded message:

ATTENTION. THERE IS AN EMERGENCY IN THE BUILDING. ALL OCCUPANTS MUST LEAVE THE BUILDING IMMEDIATELY BY THE NEAREST EXIT.

B. Repeat message 5 times and then play the Slow Whoop tone until cancelled, silenced, or until the message sequence is restarted.

4.22.2.2 Emergency Under Investigation

A. ECS plays three rounds of Chime Tone followed by prerecorded message:

ATTENTION. AN EMERGENCY HAS BEEN REPORTED IN THE BUILDING AND IS CURRENTLY UNDER INVESTIGATION. PLEASE STAND BY FOR FURTHER INSTRUCTIONS.

B. Repeat message three times. Then the Pre-Tone and Message cycle continues until canceled or silenced.

4.22.2.3 Emergency All Clear

A. ECS plays one round of Chime Tone followed by:

ATTENTION. THE EMERGENCY HAS BEEN INVESTIGATED AND IS NO LONGER A THREAT. ALL OCCUPANTS CAN RESUME NORMAL ACTIVITY.

B. Repeat message 4 times.

4.22.2.4 DEN Property Tornado Warning

A. ECS plays three rounds of Tornado (Wail/Siren) Tone followed by:

ATTENTION PLEASE. THE NATIONAL WEATHER SERVICE HAS ISSUED A TORNADO WARNING THAT INCLUDES DENVER INTERNATIONAL AIRPORT. PLEASE REMAIN ALERT FOR ANY INSTRUCTIONS.

B. Repeat message three times, once every 2.5 minutes.

4.22.2.5 DEN Property Tornado All Clear

A. ECS plays three rounds of Clear Bell Tone followed by:

ATTENTION PLEASE. THE THREAT OF A TORNADO IS NO LONGER PRESENT. YOU MAY NOW RESUME NORMAL OPERATIONS. REMAIN ALERT FOR CHANGING WEATHER CONDITIONS.

B. Repeat message three times, once every 2.5 minutes.

4.22.2.6 Tornado Warning

A. ECS plays three rounds of Stutter (Warble) Tone followed by:

ATTENTION PLEASE. THE NATIONAL WEATHER SERVICE HAS ISSUED A TORNADO WARNING THAT INCLUDES DENVER INTERNATIONAL AIRPORT CONCOURSES AND TERMINAL. TAKE SHELTER IMMEDIATELY IN MARKED STAIRWELLS AND RESTROOMS. STAY AWAY FROM WINDOWS AND BE ALERT FOR FURTHER INSTRUCTIONS.

B. Repeat message three times. Approximately 30 second pause between sequences and repeats continuously until canceled or silenced.

4.22.2.7 Tornado Sighted

A. ECS plays three rounds of Stutter (Warble) Tone followed by:

ATTENTION PLEASE. A TORNADO HAS BEEN SIGHTED AT THE AIRPORT. TAKE SHELTER IMMEDIATELY IN MARKED STAIRWELLS AND RESTROOMS. STAY AWAY FROM WINDOWS AND BE ALERT FOR FURTHER INSTRUCTIONS.

B. Repeat message three times. Approximately 40 second pause between sequences and repeats continuously until canceled or silenced.

4.22.2.8 Tornado All Clear

A. ECS plays three rounds of Clear Bell tone followed by:

THE THREAT OF A TORNADO IS NO LONGER PRESENT. YOU MAY LEAVE YOUR SHELTER. REMAIN ALERT FOR CHANGING WEATHER CONDITIONS.

B. Repeat message five times, approximately once every 2.5 minutes.

4.22.2.9 No Smoking Message (PA Test)

A. ECS Plays:

ATTENTION. SMOKING IS PERMITTED IN DESIGNATED AREAS ONLY. THESE AREAS ARE CLEARLY MARKED FOR YOUR CONVENIENCE. ALL SMOKING MATERIALS MUST BE EXTINGUISHED IN PROPER RECEPTACLES BEFORE LEAVING SMOKING AREAS. THANK YOU.

B. Repeat two times.

4.22.2.10 ECS Test Message (PA and Visual Test)

A. ECS Plays:

ATTENTION. THIS IS A TEST OF THE EMERGENCY COMMUNICATION SYSTEM. THIS IS ONLY A TEST. THANK YOU.

B. Repeat 8 times.

4.22.2.11 Westin Hotel Emergency Evacuation

This message is specific to Levels 5 – 15 of the HTC. The evacuation message plays on Level 6, floor of alarm, floor above alarm, and floor below alarm only.

A. ECS plays 15 seconds of low frequency tone, followed by:

ATTENTION. ATTENTION. ATTENTION. AN EMERGENCY HAS BEEN REPORTED. YOU ARE TO LEAVE THE BUILDING BY THE NEAREST EXIT OR EXIT STAIRWAY. DO NOT USE THE ELEVATOR. YOU ARE TO LEAVE THE BUILDING BY THE NEAREST EXIT OR EXIT STAIRWAY.

B. Sequence repeats until silenced.

4.22.2.12 Westin Hotel DEN Property Tornado Warning

As of the date of this report, this message is not currently utilized, but should be used soon for the HTC facility.

A. ECS plays three rounds of Tornado (Wail/Siren) Tone followed by:

ATTENTION PLEASE. THE NATIONAL WEATHER SERVICE HAS ISSUED A TORNADO WARNING THAT INCLUDES DENVER INTERNATIONAL AIRPORT AND THE WESTIN HOTEL AND TRANSIT CENTER. PLEASE REMAIN ALERT FOR FURTHER INSTRUCTIONS.

B. Repeat message three times, once every 2.5 minutes.

4.22.2.13 Westin Hotel Tornado Warning

As of the date of this report, this message is not currently utilized, but should be used soon for the HTC facility.

A. ECS plays three rounds of Stutter (Warble) Tone followed by:

ATTENTION PLEASE. THE NATIONAL WEATHER SERVICE HAS ISSUED A TORNADO WARNING THAT INCLUDES DENVER INTERNATIONAL AIRPORT CONCOURSES, TERMINAL, AND THE WESTIN HOTEL AND TRANSIT CENTER. PLEASE MOVE AWAY FROM WINDOWS AND EXTERIOR WALLS. TAKE SHELTER IN YOUR GUEST BATHROOM WITH THE DOOR CLOSED. ALL GUESTS AND ASSOCIATES IN PUBLIC AREAS MUST PROCEED TO THE NEAREST INTERIOR MEETING ROOM OR STAIRWELL. STAY AWAY FROM WINDOWS AND BE ALERT FOR FURTHER INSTRUCTIONS.

B. Repeat message three times. Approximately 30 second pause between sequences and repeats continuously until canceled or silenced.

4.22.2.14 Westin Hotel Tornado Sighted

As of the date of this report, this message is not currently utilized, but should be used in the near future for the HTC facility.

A. ECS plays three rounds of Stutter (Warble) Tone followed by:

ATTENTION PLEASE. A TORNADO HAS BEEN SIGHTED AT THE AIRPORT. TAKE SHELTER IN YOUR GUEST BATHROOM WITH THE DOOR CLOSED. ALL GUESTS AND ASSOCIATES IN PUBLIC AREAS MUST PROCEED TO THE NEAREST INTERIOR MEETING ROOM OR STAIRWELL. STAY AWAY FROM WINDOWS AND BE ALERT FOR FURTHER INSTRUCTIONS.

B. Repeat message three times. Approximately 30 second pause between sequences and repeats continuously until canceled or silenced.

4.22.3 Video Textual Messages

4.22.3.1 Emergency Evacuation (Evac)

4.22.3.2 Emergency Under Investigation (Notice)

4.22.3.3 Emergency All Clear (All Clear)

4.22.3.4 Tornado Warning (Warning)

4.22.3.5 Tornado Sighted (Sighted)

4.22.3.6 Tornado All Clear (Tornado Clear)

4.22.3.7 ECS Test Message (Test)

4.22.4 Fire Alarm LED Text Messaging Appliances

The following are the messages for the Fire Alarm LED Text Messaging Appliances.

4.22.4.1 Emergency Evacuation (Evac)

A. Top Line (Fixed): EVACUATE
B. Bottom Line (Continuous Scroll):
C. ATTENTION. THERE IS AN EMERGENCY IN THE BUILDING. LEAVE THE BUILDING BY THE NEAREST EXIT.

4.22.4.2 Emergency Investigation (Notice)

A. Top Line (Fixed): ALERT
B. Bottom Line (Continuous Scroll): EMERGENCY UNDER INVESTIGATION. PLEASE STAND BY.

4.22.4.3 Emergency All Clear (All Clear)

A. Top Line (Fixed): ALL CLEAR
B. Bottom Line (Continuous Scroll): ATTENTION. THE EMERGENCY HAS BEEN INVESTIGATED AND IS NO LONGER A THREAT. ALL OCCUPANTS CAN RESUME NORMAL ACTIVITY.

4.22.4.4 Tornado Warning (Warning)

A. Top Line (Fixed): WEATHER ALERT
B. Bottom Line (Continuous Scroll): TORNADO WARNING. TAKE SHELTER IN MARKED STAIRS AND RESTROOMS. STAY AWAY FROM WINDOWS.

4.22.4.5 Tornado Sighted (Sighted)

A. Top Line (Fixed): WEATHER ALERT
B. Bottom Line (Continuous Scroll): ATTENTION. TORNADO SIGHTED. TAKE SHELTER IN MARKED STAIRS AND RESTROOMS. STAY AWAY FROM WINDOWS.

4.22.4.6 Tornado All Clear (Tornado Clear)

A. Top Line (Fixed): ALL CLEAR
B. Bottom Line (Continuous Scroll): TORNADO THREAT HAS PASSED. RESUME NORMAL ACTIVITY.

4.22.4.7 ECS Test Message (Test)

A. Top Line (Fixed): TEST
B. Bottom Line (Continuous Scroll): ATTENTION. THIS IS A TEST OF THE EMERGENCY COMMUNICATION SYSTEM.

4.23 ECS Screens

A fundamental recommendation should maintain simplicity in the interface screens. This simplicity should extend to both the number of possible screens and to the simplicity and ease of use of each screen. Control of the screen is recommended to be via touch screen, but mouse control is acceptable. TSWs shall utilize a dedicated ECS Control Screen.

4.23.1 TSW Prerecorded Message Screen

The TSW has a single ECS Control Screen, which contains selection buttons for all the various messages. Refer to Figure 4-8: TSW ECS Control Screen. The screen is separated into six main sections:

A. Master Control Buttons to enable and cancel/disable the screen.
B. Help / Legend section to explain colors and operation.
C. Play the Emergency Messages section to activate emergency messages for each of the buildings.
D. Play the Test Messages section to activate the test message for each of the buildings.
E. Play Tornado Messages to activate tornado-related messages site wide (not including the HTC).
F. Hotel and PTC section to activate tornado-related messages within the HTC.

G. Selection buttons are toggle-type buttons with a feedback color change indicating a change of state if the button has been selected. Travel/navigation, cancel/reset, and similar buttons shall not require a change of state indications but shall simply perform the intended operation.

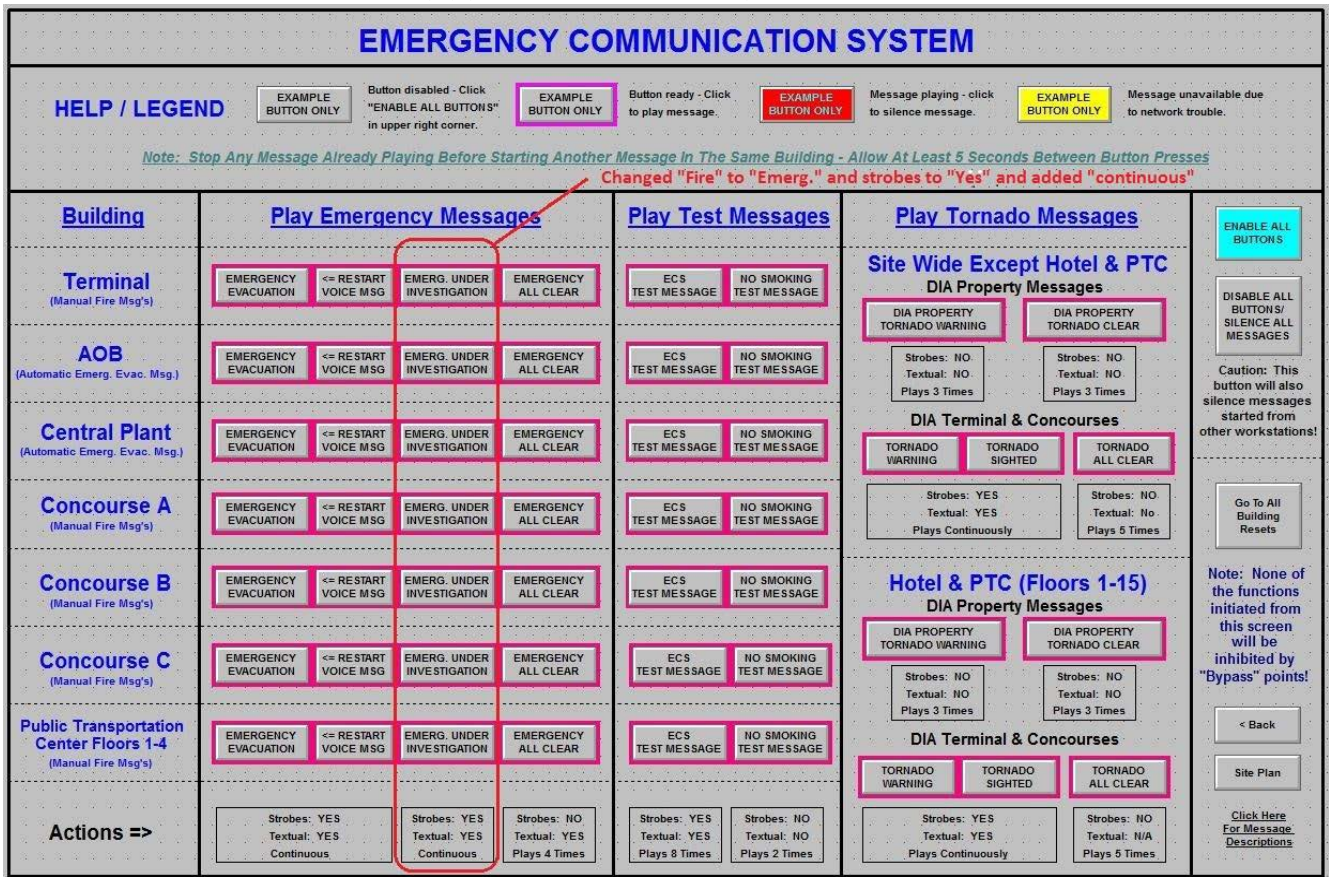

Figure 4-8: TSW ECS Control Screen

To activate the ECS Control Screen, an Enable Button shall act as a confirming prompt message (e.g., Are You Sure? message). This enable button shall provide a final reminder to the authorized user that they are about to initiate the selected message. Cancel message, clear all, and navigate screen buttons shall not include a confirmation pop-up message.

The Restart Voice Message button is provided to allow an authorized user to re-initiate the emergency evacuation prerecorded message. This button shall not be active unless/until the Emergency Evacuation button (or equivalent) has been previously activated, and the Evac message is still playing. This button shall immediately activate the Evac message to play five times, followed by a Slow Whoop signal until canceled or silenced. This button shall not include a confirming prompt message since the Evac signals are already active.

4.23.2 ECS System Live Voice Selection

Live voice announcements shall continue to be made from the IED Microphone Station and IED Touch Screen. This screen is also called the A-Panel. Refer to Figure 4-9: IED Paging Panel (A Panel) and Digital Microphone Station. The operator shall select the area (zone) and key the microphone to conduct an announcement.

As an operational recommendation, it is recommended that live voice messages be made on a building-wide basis due to the transient nature of the occupants. Selective zone paging should only be done when there is a specific reason to do so to avoid occupant confusion.

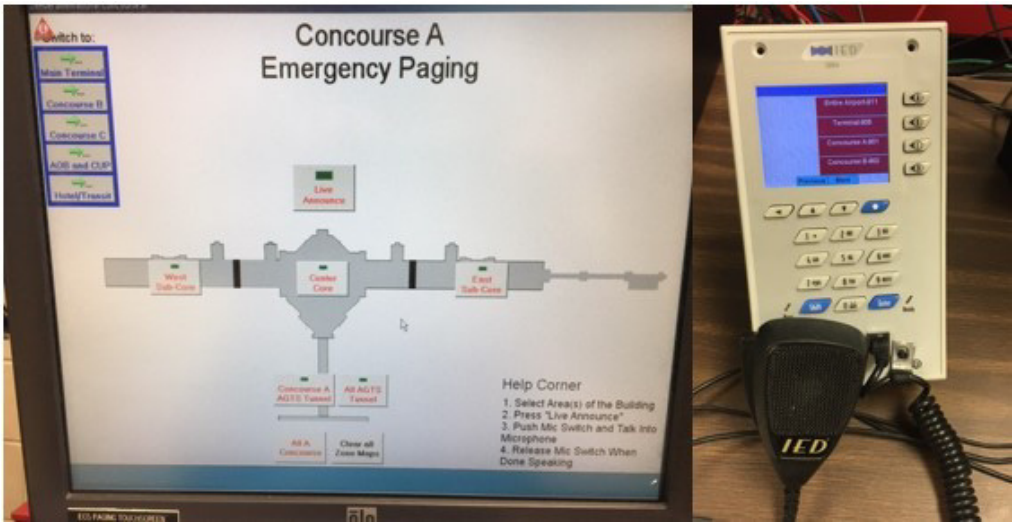

Figure 4-9: IED Paging Panel (A Panel) and Digital Microphone Station

4.23.2.1 ECS/Fire Alarm Interface

As a rule, the Johnson Controls Fire Alarm System shall provide the prerecorded messages as detailed in this operational plan and the IED System shall provide the live voice capability, except as noted herein. The Johnson Controls Fire Alarm System shall provide a dry contact to notify the ECS to accept the audio messages. The ECS shall accept the audio messages as well as providing live voice override.

For other required operations, the Johnson Controls Fire Alarm System and PA/ECS and MUFID systems shall be interconnected via dry contacts. This interface, for both audio and video capture, is housed in the ECS/Fire Alarm Interface Panel (FA/ECS) located in the PA Communications Room in the North Terminal, Concourse A, Concourse B, and Concourse C and in the MDF room of the HTC. Contacts shall be maintained (i.e., latching), unless otherwise noted, so that visual displays are directly controlled by the Fire Alarm System to the extent possible. The dry contact shall remain latched for the duration of the playing message as detailed in Table 4-3: AOB, CP, AGTS Maintenance ECS Sequence of Operations. An All Clear message shall deactivate its associated message latched contacts. ECS messages shall be allowed to override fire alarm messages. Johnson Controls Fire Alarm System custom control programming shall be used to activate and latch (or deactivate) dry contacts.

Figure 4-10: Fire Alarm/ECS Interface Cabinet

4.24 ECS Maintenance

As a critical life safety component of airport operations, it is critical that the ECS is properly monitored, inspected, and maintained. This can be done by proper adherence to applicable codes and standards.

4.24.1 System Addition or Alteration

All system alterations or additions shall be made with the knowledge and assistance of DEN Life Safety and through a properly permitted process. Per the 2016 Denver Amendments to the 2015 IFC, construction permits are required for any work on Fire Alarm and Detection Systems, Emergency Alarm Systems, ECS, Mass Notification Systems, Public Safety Radio Communication Systems (RES), and Two-Way Communication Systems. Permits are required prior to the installation or modification of the fire alarm and detection system and related equipment. Work performed to keep equipment operable or to make repairs is considered maintenance and, when performed in accordance with Denver Code and Fire Department policy, is not considered a modification and shall not require a construction permit.

The 2016 Denver Amendments contains Appendix S (Construction of Airport Buildings and Structures), which states the following as applicable to the ECS:

> **4.5.2.3** New Airport Terminal Building(s) shall be provided with an emergency voice/alarm communication system fully integrated into the complex-wide Emergency Communication System (ECS), incorporating audible, visual and textual notification appliances including; flight, gate, baggage and multi-use information displays (FID's, GID's and BID's, MUFID's), other large format displays and video displays exceeding 60" (25.4mm) measured diagonally. DIA CATV and tenant audio systems shall be shunted upon activation of the emergency communication system.

Therefore, modifications/alterations or additions to the existing implemented DEN ECS require adherence to the above requirement. Tenant finishes and additions shall account for the prescriptive design of primary visual notification (i.e., strobes) per NFPA 72, as well as the capture and/or shunt of noted video displays. Given the unsupervised nature of the interface to non-DEN owned displays and the expense of the interface, if prescriptive visual notification is provided, shunting of video displays is the preferred method of integration with video displays exceeding 60" in size.

The addition of advertising displays in public areas of the airport complex shall be subject to the above-stated Denver Amendments as well. Given the unsupervised nature of the interface to non-MUFID, non-DEN-owned advertising displays and the expense of the interface, shunting of video displays is the preferred method of integration with video displays exceeding 60" in size. The exception to this would be if there is a lack of prescriptive (i.e., strobes) and/or supplementary (i.e., MUFID displays) visual notification in the area, in which an engineering decision should be made on whether to capture the advertising display.

Should modifications or additions be required in utility or baggage tunnels, the following item from the 2016 Denver Amendments, Appendix S, shall apply:

> **Section 7.4 Life Safety System.** All life safety systems shall be provided with emergency power. Utility and baggage tunnels shall be provided with visible (strobes) and textual visible notification appliances for emergency alarm and ECS integration where applicable. Device locations shall be as approved by the fire code official.

System modifications and additions should be designed in accordance with the applicable code and the DEN DSMs. This includes detailed Design Documents that provide prescriptive visual notification coverage, audibility, the intelligibility of loudspeakers, and coordinated capture or shunting of video displays.

It is critical to maintain accurate records of as-built drawings of all system components. As the system is expanded and modified, documentation should be provided to back to DEN Life Safety. This includes the layout of individual loudspeakers, loudspeaker zoning, screen capture, screen shunt, and related items. As systems are altered, DEN

has implemented a NFPA 72 Record of Completion form that can be updated to reflect additions to the ECS and/or Fire Alarm System. This form should be utilized each time additional equipment is provided for the system.

4.24.2 Inspection and Maintenance

On-going system inspection and maintenance shall be performed by or under the direction of DEN Life Safety. The inspection, testing, and maintenance of the fire alarm and ECS shall be performed in accordance with NFPA 72 Chapter 14. In general, this requires a semi-annual visual inspection of the control equipment and an annual visual inspection of all other equipment. It also requires annual testing of all components of the fire alarm and ECS.

Failures of any primary component of said systems shall be documented and repaired in accordance with the applicable code. Failures of supplementary components of said systems, including the capture of individual video displays, should be documented and repaired in a timely manner. This is with the acknowledgment of the fact that an individual video display failure shall not adversely affect the overall performance of the ECS.

End of Chapter

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Chapter 5 - Smoke Control System

5.0 General

The Airport is equipped with a Smoke Control Systems, which provides a tenable space within the facility if smoke is developed because of a fire. The zoning of this system is zoned per the adopted codes and functions accordingly. Any new or alterations occurring to the facility shall follow the existing methodology and codes adopted at the time of construction.

5.1 Scope

This chapter outlines specific requirements to be included in the overall mechanical system designs and specifications for the 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, AOB, AGTS Tunnels, Baggage Tunnels, Passenger Bridge from the North Terminal to Concourse A, CUP, and the HTC. In general, the requirements of this chapter do not apply to outbuildings unless specifically required by the Denver Building Code or the DEN Project Manager.

5.2 System Description

The purpose of this system is to remove smoke from the facility in such a manner as to have a tenable space for the occupants as they exit the facility in an orderly manner.

5.3 Criteria

The Smoke Control System shall meet CCD requirements. The Smoke Control System shall be provided in accordance with the latest editions of the standards and codes listed in the DSM, as well as the IBC and IFC as currently adopted and amended by the CCD. Note that in the Denver Amendments to IBC, Appendix S has specific requirements for airports, which are in addition to all other referenced standards. In addition, the design shall comply with all applicable Contract Documents.

5.4 Tenant Spaces

Tenant spaces 5,000 square feet in gross area, or more are required to have their own smoke control zone.

5.5 Drawing Requirements

Refer to 1.5.1 A/E Construction Drawings to 1.5.6 Drawing Format.

5.5.1 A/E 60% Drawings

A preliminary sequence of operations. The identification of the Smoke Zone the equipment is part of.

5.5.2 A/E 90% Drawings

The A/E 90% drawings should contain the information in 5.5.1 A/E 60% Drawings. The final Sequence of Operation is the responsibility of the Engineer of Record.

5.5.3 Preparation

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.

5.6 Design Analysis Requirements

The Design Consultant shall provide a Fire Alarm System Basis of Design to substantiate the Smoke Control System Design. At a minimum, the Fire Alarm System Basis of Design shall include the following categories:

A. Building description
B. Fire Alarm system type
C. Design methodology
D. Testing and inspection
E. Equipment and tools
F. Requirements for submittals
G. End of job closeout
H. All items required by Appendix N of the DBCA

5.6.1 Applicable Codes

The list of Codes that this system is required to follow for the shop drawings.

5.6.2 Design Responsibility

Each discipline shall have their section with the appropriate PE Seal applied to the drawings as required by DBFCA.

5.7 Equipment

All new smoke control system designs shall provide dedicated smoke control equipment for providing pressurization or exhaust. 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 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. Other components and accessories (e.g., starters, drives, variable frequency drives (VFDs), actuators, etc.) shall be UL-listed for their intended purpose.

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 and Life Safety Engineers and the DEN Life Safety Team.

5.8 Equipment / Zone Identification

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

In general, new smoke control equipment is identified as follows:

Table 5-1: Smoke Control Equipment Identification

Smoke Control Equipment Identification Example: SEF 2 W5S	
SEF-	Equipment Type: SEF for Smoke Exhaust Fan, SPF for Smoke Pressurization Fan, FSD for Fire/Smoke Damper, and SD for Smoke Damper.
2-	Alpha/Numerical Identifier for Fan or Damper Number. (Obtain from DEN Mechanical Engineer)
W5S	Alpha/Numerical Identifier for Fan or Damper Location. (Obtain from DEN Mechanical Engineer)

The addition of smoke control equipment to an existing building shall follow the 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. The 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.

5.8.1 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.

5.8.2 Smoke Zone and Airflow Diagrams

Existing smoke control zone diagrams, operating sequences, and airflow diagrams are available upon request from the DEN Life Safety 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.

5.8.3 System Initiation

The sequence of operations provided on Fire Alarm Record Drawings includes all initiation and operational requirements, including whether one or two initiation devices 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 firefighters' 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 (TSW) provided throughout the Main Complex. Manual smoke control panels are provided for the AGTS smoke control system in both AGTS control centers.

5.9 Terminal Smoke Control Operation Overview

5.9.1 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.

5.9.2 Levels 5 and 6 Ticketing, Baggage Claim and Tenant Areas

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.

5.9.3 Level 4 Train Platform

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

5.9.4 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.

5.9.5 Level 1 Offices

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.

5.9.6 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 IBC Amendments, 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 IBC Amendments, Appendix S.

5.9.7 Water Flow Activation in Public Areas

In areas commonly occupied by the public, the Smoke Zone of that area shall activate upon activation of the Water Flow Alarm from the same zone.

5.10 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 air changes per hour or 20,000 cfm 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 are 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.

5.10.1 Levels 5 and 6 and 7 International, Domestic, and Customs Area

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 (AHUs) supplying the area. Isolation of exhaust and pressurization by the 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.

5.10.2 Level 4 Offices and Communications Area

The smoke control system serving Level 4 areas utilizes return fans located in the Mechanical Rooms on Level 4. The communications rooms located on the North end of Level 4 are provided with a 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.

5.10.3 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 four air changes per hour minimum.

5.11 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 the 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 four 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.

5.11.1 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.

5.11.2 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.

5.12 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 motorized smoke and a fire damper on each floor served by the systems.

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 the alarm is isolated via return/exhaust dampers located at the return airshafts on each floor. Levels 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. Variable Air Valve (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. Refer to Chapter 3- Fire Alarm and Detection System, 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.

5.13 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 air changes per hour or 20,000 cfm (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 in 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 Concourse A starts automatically with the activation of two initiating devices in public areas and a single initiating device in non-public areas.

5.13.1 Center-core and International Smoke Control Zones

This section does not pertain to the passenger bridge or the Level 3 International Walkway located between the Center-core and Sub-cores. Tenant areas less than 5,000 sf in area, located on the Concourse and Mezzanine Levels of the Center-core, are considered a part of the Center-core smoke zone (SZ-CC). Manual, dedicated smoke exhaust for these Tenants is provided and shall be maintained. Draft curtains or equivalents are provided between the Tenant areas and the Center-core. 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. Refer to Chapter 3- Fire Alarm and Detection System, for required return air grille specifications.

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

5.13.2 Sub-core, 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 Sub-core of the Concourse and Mezzanine Levels are not dedicated smoke control zone.

5.13.3 Basement Smoke Control Zones

Basement area smoke control pressurization and exhaust are provided through dedicated exhaust fans and supply air through Ventilation Fans (VF). The VF 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 VF fans in the affected smoke zone.

5.13.4 Tenant Space Smoke Control Zones

Tenant space smoke control zones shall comply with IBC Amendments, Appendix S.

5.13.5 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.

5.13.6 Water Flow Activation in Public Areas

In areas commonly occupied by the public, the Smoke Zone of that area shall activate upon activation of the Water Flow Alarm from the same zone.

5.14 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 air changes per hour or 20,000 cfm 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.

5.14.1 Center Core Smoke Control Zones

Tenant areas less than 5,000 sf located on the Concourse and Mezzanine Levels of the Center-core are considered a part of the Center-core 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 curtains or equivalents are provided between the Tenant areas and the Center-core. In general, Center-core smoke control systems utilize a ceiling plenum or return air plenum with 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 ensure adequate smoke removal from the Tenant space. The sizing of openings shall not exceed a face velocity of 200 fpm. If no ceiling is planned in a Tenant space or adjacent spaces, a 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. Refer to Chapter 3- Fire Alarm and Detection System, for required return air grille specifications.

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

5.14.2 Sub-core 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 Sub-core of the Concourse and Mezzanine Levels are not part of the smoke control zone.

5.14.3 Basement Smoke Control Zones

Basement area smoke control pressurization and exhaust are provided through 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 the respective VFDs and through the respective bypass cabinets for smoke control pressurization and exhaust. AGTS and baggage tunnel smoke control system details are discussed later in this chapter.

5.14.4 Ventilation/Smoke Control Fans (VSCFs)

VSCFs are a legacy system used exclusively in the basement of Concourse B. The VSCFs at DEN are being phased out, and new VSCFs shall not be installed. VSCFs work by using dampers to reverse the flow of air through ventilation ductwork, changing their function from providing ventilation to smoke exhaust.

No new VSCFs shall be installed at DEN. All fans used for smoke exhaust or smoke pressurization shall be used exclusively in these functions and shall be labeled as Smoke Exhaust Fans (SEFs) or Smoke Pressurization Fans (SPFs), respectively. Refer to Chapter 5- Smoke Control System for smoke control requirements.

5.14.5 Tenant Space Smoke Control Zones

Tenant space smoke control zones shall comply with IBC Amendments, Appendix S.

5.14.6 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.

5.14.7 Water Flow Activation in Public Areas

In areas commonly occupied by the public, the Smoke Zone of that area shall activate upon activation of the Water Flow Alarm from the same zone.

5.15 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 four air changes per hour or 20,000 cfm 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.

5.15.1 Center Core Smoke Control Zones

Tenant areas located on the Concourse and Mezzanine Levels of the Center-core are considered a part of the Center-core 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 Tenant areas and the Center-core. In general, Center-core smoke control systems utilize a ceiling plenum or return air plenum with 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 ensure adequate smoke removal from the Tenant space. If no ceiling is planned in a Tenant space or adjacent spaces, a 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. Refer to Chapter 3- Fire Alarm and Detection System, for required return air grille specifications.

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

5.15.2 Sub-core 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 Sub-core of the Concourse and Mezzanine Levels are not part of the smoke control zone.

5.15.3 Basement Smoke Control Zones

Basement area smoke control pressurization and exhaust are provided through dedicated exhaust fans and supply air through Ventilation Fans (VF). The VF 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 VF fans in the affected smoke zone.

5.15.4 Tenant Space Smoke Control Zones

Tenant space smoke control zones shall comply with IBC Amendments, Appendix S.

5.15.5 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.

5.15.6 Water Flow Activation in Public Areas

In areas commonly occupied by the public, the Smoke Zone of that area shall activate upon activation of the Water Flow Alarm from the same zone.

5.16 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 four 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 FSCPs 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 is used as directed by the incident commander to exhaust or pressurize zones as necessary to meet operational requirements.

5.16.1 CUP Smoke Control Operation Overview

The 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 FACP.

5.16.2 HTC Smoke Control Operation Overview

The following is a general description of the smoke control systems installed for specific areas in the HTC. Fire Alarm Record Drawings for the 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 motorized smoke and a fire damper on each floor of the building served by the systems. 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 the water column from the stairs to the fire floor. The 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 of 0.05 inches of water column greater than the surrounding spaces. Area exhaust is achieved through a dedicated ducted exhaust system.

5.17 Tenant Spaces

A. Tenant spaces less than 5,000 sq. ft. and open to the terminal or concourse shall be incorporated into the terminal and concourse smoke control exhaust operating sequence and shall be separated by an 18-inch draft curtain/draft stop with closely spaced sprinklers in accordance with Section 9.3.5 of NFPA 13 and smoke detectors in accordance with Section 4.5.2 in the tenant space.

B. Tenant Spaces and similar rooms adjoining the airport terminal and concourse buildings. All continuous tenant spaces adjoining the airport terminal and concourse buildings that exceed 5,000 sq. ft. shall be a separate smoke control zone per Section 4.6.1. Separate smoke zones must be separated by a smoke partition or an 18-inch draft curtain/draft stop with closely spaced sprinklers installed in accordance with Section 9.3.5 of NFPA 13 and smoke detectors in accordance with Section 4.5.2 in the tenant space.

5.18 Construction Documents

The Contract Documents for smoke control systems shall include, as a minimum:

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 operations describing how the 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 are required to adequately define the smoke control equipment products and installation.

F. Deferred smoke control shop drawing and Design Documentation submission in accordance with IFC Amendments, Appendix N and S. Only for submitting for the DFD Permit.

5.19 Smoke Control System Testing

Smoke Control System Testing is required whenever any of the following conditions occur:

A. Smoke Control Zone boundary is altered.
B. Smoke removal route path has been altered (interior walls removed or added, ceilings modified, etc.).
C. The smoke control equipment and\or devices has been altered, installed, or replaced.

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

5.20 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 zones affected, and the immediately adjacent zones are required to be tested and certified by the EoR upon completion of the work.

End of Chapter

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Chapter 6 - Emergency Alarm Systems

6.0 General

The Airport is equipped with various systems that are essential to the well-being of all personnel who occupy any of our facilities. The zoning of these systems is specific to the area in which they are utilized. They shall also report the Facility Fire Alarm System and specifically identified as to the area and the hazard which is being monitored.

6.1 Scope

This chapter provides design guidance to the Engineer in the area of Emergency Alarm Systems, which is utilized for all systems that require a notification of the Fire Department and Operations for the Safety of the occupants.

6.2 System Description

These include a variety of systems that are not part of the Fire Alarm System or any components of the Fire Alarm System. They are, however, required by Code to be monitored and relayed to the Fire Department and Operations for Emergency Response. These systems include but are not limited to:

A. Carbon Dioxide Detection
B. Refrigerant detection
C. Emergency fuel shut off
D. Inert gas monitoring

6.3 Criteria

These systems do not follow under any of the specific systems detailed in this DSM but are essential to the Health and Well-being of all persons working and traveling through our facilities. Each system, as identified in 6.2 System Description, has its own set of Code and Amendments requirements that must be followed.

These systems shall meet CCD requirements. Emergency Alarm Systems shall be provided in accordance with the latest editions of the standards and codes listed in the DSM, as well as the IBC and IFC as currently adopted and amended by the CCD. Note the Denver Amendments to IBC, Appendix S has specific requirements for airports, which are in addition to all other referenced standards.

6.4 Drawing Requirements

Refer to 1.5.1 A/E Construction Drawings to 1.5.6 Drawing Format.

6.4.1 A/E 30% drawings

On top of what is expected from the Architects, the drawings shall indicate if any system detection shall be required.

6.4.2 A/E 60% drawings

All of what is expected for the 30% and initial placements of the system detection and fire alarm monitoring points. A preliminary sequence of operations. The identification of the Fire/Smoke Zone the equipment is part of.

6.4.3 A/E 90% drawings

All of what is expected for the 60% and the final locations of all monitoring detection and fire alarm monitoring points. The final Sequence of Operation is the responsibility of the Engineer of Record.

6.5 Design Analysis Requirements

The Design Consultant shall provide a Fire Alarm System Basis of Design to substantiate the Fire Detection and Alarm System design. At a minimum, the Fire Alarm System Basis of Design shall include the following categories:

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

6.5.1 Applicable Codes

The list of Codes that this system is required to follow for the shop drawings.

6.5.2 Design Responsibility

The Engineer of Record for the Shop Drawings. PE Seal applied to the drawings as required by DBCA.

6.6 System Requirements

6.6.1 Inert Gas

Inert Gas systems with more than 100 pounds (45.4 kg) of inert gas or any system using any amount of an inert gas below grade used in a commercial, manufacturing, or industrial application, such as water treatment with pH balancing, food processing or laboratories shall comply with this Manual. Inert gases include but are not limited to argon, helium, nitrogen, and carbon dioxide.

Excessive storage amounts of inert gases shall be required to comply with this Manual. Excessive storage amounts shall be 6,000ft^3 of the inert gas or a combination of multiple inert gases stored together. The table below outlines the maximum storage amounts for common inert gases as a reference. However, it is up to the Design Engineer to correctly calculate the total storage amounts per scenario.

Table 6-1: Inert Gas Maximum Storage Amounts

Inert Gas	Maximum Storage Amount (lbs)
Argon	612
Carbon Dioxide	686
Helium	61
Nitrogen	429

Where inert gas storage tanks, cylinders, piping, and equipment are located indoors, rooms or areas containing inert gas storage tanks, cylinders, piping, and fittings and other areas where a leak of inert gas can collect shall be provided with either ventilation in accordance with 4.12 Fire Alarm System Interface or an emergency alarm system in accordance with 4.10 Microphone Stations or 4.11 Loudspeakers.

6.7 Beverage Dispensing Carbon Dioxide Emergency Alarm Systems

Continuous gas detection shall be provided to monitor areas where carbon dioxide may accumulate, including any areas where detection is required by code. Detection equipment shall be provided to indicate carbon dioxide levels at each point of use and in each storage area/room. For other code information see Denver Fire Code Amendments Section 916 & 5307.

6.7.1 Alarm Set Points

Alarm set points shall be set at:

A. 5,000 PPM (TWA) Time Weighted Average – Self Re-Setting (Non-Latching) Alarm
    a. Notification for employees only in approved locations with instructional signage.
B. 15,000 PPM (TWA) – Latching Alarm
    a. Notification for employees only in approved locations.
    b. Requires a service company or approved.
C. 30,000 PPM – Latching Alarm
    b. Initiate amber strobes and audible horns provided in the vicinity of each interior storage container, cylinder, or tank and at each point of use. Additional amber strobes and audible horns shall be placed at the entrances to below-grade locations, confined spaces, and walk-in coolers. The notification devices shall be rated a minimum of 80cd for a visible effect and 75 dBA for an audible effect and shall be mounted in accordance with NFPA 72 requirements.
    c. Activation of the automatic system shutoff valve.
    d. Evacuate the room/area and call 4211.
    e. Alarm Signal to the fire alarm system and transmitted as a “HAZMAT Alarm” through the AES.

6.8 Inert Gas Emergency Alarm Systems

6.8.1 Alarm Set Points

A. Alarm set points shall be set at:
    a. Oxygen levels below 19.5%- Self-re-setting (non-latching) Alarm
    b. Visual notification only in approved locations
B. Oxygen levels below 17%- Latching Alarm
    f. Visual and audible notifications in approved locations
    g. Activation of the automatic system shutoff valve
    h. Evacuate room/area and call 4211
    i. Alarm Signal on the fire alarm system and transmitted as a “HAZMAT Alarm” through the AES.

6.9 Mechanical Ventilation

Mechanical ventilation shall be in accordance with the International Mechanical Code and shall comply with all the following:

A. Mechanical ventilation in the room or area shall be at a rate of not less than 1 cubic foot per minute per square foot [0.00508 $m^3/(s \cdot m^2)$].
B. Exhaust shall be taken from a point within 12 inches (305 mm) of the floor.
C. The ventilation system shall be designed to operate at a negative pressure in relation to the surrounding area.
D. Ventilation shall run continuously or be activated by a sensor or detector to maintain an atmosphere of less than 5,000 PPM.
E. A mechanical permit is required in accordance with the Denver Building Code.

6.10 UPS Backup

Battery/UPS backup for the equipment shall be 24-hours quiescent operation and 15 minutes of alarm. Calculations shall mirror that of a Fire Alarm System.

End of Chapter

Chapter 7 - Radio Enhancement System

7.0 General

A radio distribution system Airport Wide for the continuous communication of Emergency Responders and Airline Communications. Which operate on different frequencies and do not interfere with each other.

7.1 Scope

This chapter provides design guidance to the Engineer for the Radio Enhancement Systems (Distributed Antenna System), which is utilized for all radio communications for Emergency Responders and authorized to also incorporate the radio communications for all the airlines while on Airport Grounds.

7.2 System Description

This system is utilized for both communication with the aircraft and for Emergency Responders. This system may be expanded to handle all forms of wireless communications. However, none of the subsystems shall interfere with each other during emergencies.

7.3 Criteria

Radio Enhancement Systems shall meet CCD requirements. Radio Enhancement Systems shall be provided in accordance with the latest editions of the codes and standards listed in the DSM, as well as the IBC and IFC as currently adopted and amended by the CCD. Note the Denver Amendments to IBC, Appendix S has specific requirements for airports, which are in addition to all other referenced standards.

7.4 Tenant Spaces

There are no specific requirements under this section as the radio performance is based upon the building as a whole.

7.5 Drawing Requirements

Refer to 1.5.1 A/E Construction Drawings to 1.5.6 Drawing Format.

7.6 Design Analysis Requirements

The Design Consultant shall provide a Fire Alarm System Basis of Design to substantiate the Fire Detection and Alarm System design. At a minimum, the Fire Alarm System Basis of Design shall include the following categories:

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

7.6.1 Applicable Codes

The list of Codes that this system is required to follow for the shop drawings.

7.6.2 Design Responsibility

The Engineer of Record for the Shop Drawings. PE Seal applied to the drawings as required by DBCA.

7.7 Electrical Power

The system shall be on Emergency Power, and the Battery/UPS backup for the equipment shall be 4 hours of quiescent operation. Provide calculations as part of the construction documents submittal documenting system power requirements in kilowatts (kW) and energy in use in kilowatt-hours (kWH), and confirming backup power source runtime meets requirements. DEN Engineering has calculation templates available upon request. Contact the DEN Project Manager to request templates.

End of Chapter

Chapter 8 - Two-Way Communication System

8.0 General

A two-way communication system Airport Wide for continuous communication for Emergency Responders and people who may be located in a safe location and awaiting assistance to exit the building. This system utilizes the existing phone IP system but is programmed to call specific locations within the DEN facility.

8.1 Scope

This chapter provides design guidance to the Engineer in the area of Two-Way Communications as required by the IBC, which is discussed in Chapter 10- Systems Testing and Commissioning and regulated by the Fire Department.

8.2 System Description

This system provides communications for ADA-defined people who are either located in an Area of Rescue or an Elevator Lobby that does not have direct access to an Exit outside.

8.3 Criteria

These call devices shall be installed in all elevator lobbies that do not have direct access to an exit from a building. The communication method, wiring, shall be placed upon the facility's communication system and programmed as required by code for who and where the calls shall be placed.

8.4 Tenant Spaces

There are no requirements for this system for tenants unless the tenant installs a personnel conveyance system (including elevators, escalators, and moving walkways).

8.5 Drawing Requirements

Refer to 1.5.1 A/E Construction Drawings to 1.5.6 Drawing Format.

8.6 Design Analysis Requirements

The Design Consultant shall provide a Fire Alarm System Basis of Design to substantiate the Fire Detection and Alarm System design. At a minimum, the Fire Alarm System Basis of Design shall include the following categories:

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

8.6.1 Applicable Codes

The list of Codes that this system is required to follow for the shop drawings.

8.6.2 Design Responsibility

The Engineer of Record for the Shop Drawings. PE Seal applied to the drawings as required by DBCA.

8.7 Associated Systems

This system is integrated into the Facility I/T system; however, it is regulated by the Fire Department for inspection, testing, and maintenance.

8.8 Electrical Power

This system shall be fed from the Emergency Panel, and the associated Battery/UPS backup for the equipment shall provide a minimum runtime of 4 hours of quiescent operation unless it utilizes the same UPS as the ECS system. Backup power sources shared between the ECS system and the Two-way communication system shall provide 4 hours of quiescent operation for both systems simultaneously, plus minutes of alarm. Provide calculations as part of the construction documents submittal documenting system power requirements in kilowatts (kW) and energy use in kilowatt hours (kWH), and confirming backup power source runtime meets requirements. DEN Engineering has calculation templates available upon request. Contact the DEN Project Manager to request templates.

All Two-Way communication wiring shall be installed in conduit.

End of Chapter

Chapter 9 - Area Specific Life Safety Systems

9.0 Scope

This section specifies unique situations based on the building and its unique features. Every attempt is made to follow the current code.

9.1 System Description

The requirements of this chapter are specific to the building feature noted.

9.2 Criteria

The design shall comply with the applicable Codes as adopted by the CCD.

9.3 Tenant Spaces

Tenant Spaces over 5,000 square feet are required to have their own Smoke Control Zone and Sprinkler Zone. These subsystems shall be monitored and controlled by the facility's Fire Alarm System.

9.4 Specific Building Features

9.4.1 Passenger Loading Bridges

In all cases, each PLB shall be its own fire and notification zone.

A. Sprinkler System shall be installed in all PLBs longer than 20 feet in length before the rotunda.
B. Where a sprinkler system is installed for a PLB, each gate PLB shall have its own dry system valve for the purpose of individual alarm and trouble identification.
C. Fire Alarm notification shall be installed in all PLBs longer than 20 feet in length before the rotunda.
D. ECS notification shall be installed in all PLBs longer than 20 feet in length before the rotunda.
E. Mechanical Requirements following NFPA 415 are found in the Mechanical DSM.

Quiet Rooms

A. See Architectural DSM Chapter 3 for Life Safety details.

End of Chapter

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Chapter 10 - Systems Testing and Commissioning

10.0 General

This chapter provides guidance on the Inspection and Testing of the previously mentioned systems and their associated sub-systems.

10.1 Scope

The testing of Life Safety Systems individually and as a full building system.

10.2 System Description

Each system has its unique testing criteria as dictated by the appropriate Codes that are adopted for that system. Since the Fire Alarm System is the focal point of all the information for the Fire Department and Operations, all related systems shall have their signals verified at the Fire Alarm System.

The following list shows the systems and their respective codes for Commissioning. Refer to the Sustainability DSM for information related to the DEN Commissioning Process.

A. Sprinkler Systems- NFPA 25, Chapter 5
B. Standpipe- NFPA 25 Chapter 6
C. Fire Pumps- NFPA 25, Chapter 8
D. Clean Agent- NFPA 2001 Chapter 7, NFPA 72 Chapter 14, NEC 760, 780
E. Fire Alarm and Detection Systems- NFPA 72 Chapter 14, NEC 760, 780
F. Emergency Communication System- NFPA 72 Chapter 14, NEC 760, 780
G. Emergency Alarm Systems- NFPA 72 Chapter 14, NEC 760, 780
H. Smoke Control- NFPA 72 Chapter 14, NEC 760, 780
I. Radio Enhancement System- IBC 510, DFCA 510 & 916, NEC 780
J. Two-way Communications- IBC 1009.8, DFCA 1009.8, NEC 760, 780
K. Kitchen Hoods- IFC 904, 906, NFPA 17A
L. Emergency Fuel Shut Off- NFPA 72 Chapter 14, NEC 760, 780

When an area is complete, testing of all the systems, integrated shall be performed to ensure that all Alarms are noted and recorded in the Fire Command Center as well as reported to the Airport Fire Department.

10.3 Criteria

As a large, complicated complex, it is advised to follow the dictation of NFPA 3 and 4 for commissioning of systems as they are installed, repaired, and replaced. This ranges from each individual system to its interaction with other Life Safety Systems.

10.4 Documentation

Documentation shall be from the system's corresponding NFPA Codes and written per NFPA 4, Chapter 7.

End of Chapter

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Chapter 11 - Other Life Safety Systems

11.0 Design Review

The following listed systems shall have their drawings created and submitted to DEN for review prior to submitting them for the permit with the Building/Fire Departments. Refer to the Standards and Criteria DSM for general submittal requirements.

A. Media cutoff
B. Security – Access control
C. Video security
D. Video advertisements
E. Carbon dioxide detection
F. Carbon monoxide detection
G. Hazardous gas detection
H. Refrigerant leak detection
I. AES transmitters
J. Generators, normal and emergency power
K. Fire pumps
L. Oxygen sensors
M. Temperature sensors
N. Low-frequency notification system

11.1 Code Requirements

The above systems are required to be logged and permitted by the City and County of Denver prior to any installation or testing.

The above systems may or may not interact with the site Fire Alarm System; each installation is unique and requires the Engineer of Record/Designer of Record to review the design conditions with the DEN Life Safety Engineer.

The International Codes (I-Codes), as adopted and amended by the City and County of Denver, contain the information required to create an acceptable set of shop drawings for permitting and construction.

11.2 Fire Pump

A. The following needs to be added to the specifications as a required means and methods.
    1. The tank fuel level settings, low and high shall be set prior to filling the tank with any fuel.
    2. The fire pump needs to be run and final tested before the insulation for the exhaust is installed.

End of Chapter

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Chapter 12 - Technical Specification Requirements

12.0 General

Designers are required to provide project specifications on all DEN projects in accordance with the Standards and Criteria DSM, Chapter 11. The project specifications should encompass all aspects of the project and be based on industry-standard construction methods and products, with content based on the DEN Standard Specifications (where available) or from an industry-standard guide specification.

12.0.1 How to Use This Chapter

12.0.1.1 DEN Standard Specifications

The DEN Standard Specifications listed in this chapter have been developed to ensure project consistency and compliance with DEN policy and procedure. For sections available as DEN Standard Specifications, the designer must obtain and use these sections for their project.

12.0.1.2 DEN Technical Requirements

This chapter, as well as similar chapters in other DSMs, provides DEN-specific requirements that must be included in nonstandard specifications for all DEN projects. An itemized list of DEN-specific technical specification requirements is provided, which may include general requirements, product requirements, and execution requirements. The designer shall incorporate these requirements into their project specification content as appropriate for the project scope. Requirements are provided in an outline format similar to construction specifications for ease of incorporation. Content may be copied directly from this chapter, with article/paragraph numbering and structure modifications as needed to ensure a cohesive document.

Note: This chapter is intended to be used as an aid to the development of a project specification and ***is not intended to represent a complete specification as presented***.

The designer is responsible for developing a complete specification, incorporating the requirements of this chapter, which encompasses all aspects of the project and complies with general specification requirements outlined in the Standards & Criteria DSM, Chapter 11. After incorporating the requirements listed herein, the project specification should be reviewed to ensure it is free of redundant and/or conflicting information.

12.0.1.3 Notes to the Designer

Notes to the designer are included throughout the chapter, shown in red highlighted text. These are provided for guidance and clarification of requirements and are intended for use only by the designer in development of their specification.

Notes to the designer shall not be incorporated into the final project specifications.

12.0.2 Specification Numbering

12.0.2.1 Numbering of Deliverables

Project deliverables should utilize Section names and numbers contained in the latest edition of *MasterFormat Numbers & Titles* at the time of project kickoff, which may vary from those in this chapter. It is the designer's responsibility to ensure that all applicable DEN requirements are reflected accurately in the appropriate sections of the project specifications.

12.0.2.2 Numbering Provided in This Chapter

Specification section names and numbers provided in this chapter are based on *MasterFormat Numbers & Titles*, 2014 edition.

12.0.3 Product and Manufacturer Listings

Where manufacturers and products are listed in this chapter, they represent approved manufacturers and/or products. Do not include additional manufacturers and/or products for that Article or paragraph without written permission from the DEN Project Manager.

For sections without manufacturer and/or products listed in this chapter, the designer shall select a basis of design based on current industry standards which comply with all applicable requirements in this and other DEN DSMs, the DEN Standard Specifications, and the Denver Building Code. Provide at least (2) acceptable alternatives to the basis of design for all products, for a total of (3) or more acceptable products, except where a sole-source selection has been approved in writing by the DEN Project Manager.

12.1 DEN Standard Life Safety Specifications

DEN does not currently maintain any standard specifications in Division 21.

12.2 DEN Technical Requirements – Division 21: Fire Suppression

Except where directed by designer notes, add the following requirements to all project specification sections. Where there are similar or matching specification section names, include all content below in addition to the content in the generic specifications. The content below may be omitted where related equipment, mechanical systems, and furnishments are not in the project scope.

Section 210400: Basic Fire-Suppression Requirements

PART 1 GENERAL

1.01 REGULATORY REQUIREMENTS

A. Comply with latest editions of all applicable Codes, Standards, Ordinances and Regulations in effect as of the date of the Contract Documents adopted by CCD, BD, and FD, including but not necessarily limited to the following:

1. National Electrical Code NFPA-70
2. NFPA
3. Underwriters Laboratories

1.02 PRODUCT OPTIONS AND SUBSTITUTIONS

A. Substitutions: Refer to Division 01, General Requirements.

1.03 OPERATING AND MAINTENANCE DATA

A. Division 21 Contractor shall submit electronic record, in accordance with Division 1 requirements, a single PDF file of the entire maintenance manual to the DEN Project Manager and General Contractor for their approval.

B. The manual shall have as a minimum the following:

1. Alphabetical list of all system components including the name, address, and 24-hour phone number of the company responsible for servicing each item during the first year's operation.
2. Operating instructions for complete system, including emergency procedures for fire or failure of major equipment and procedures for normal starting/operating/shutdown and long-term shutdown.
3. Maintenance instructions, including valves, valve tag, and other identified equipment lists, proper lubricants and lubricating instructions for each piece of equipment and necessary cleaning/replacing/adjusting schedules.

a. Manufacturer's data on each piece of equipment, including:

1. Installation instructions

2. Drawings, specifications, and approved shop drawings.
3. Complete parts lists.

4. Complete wiring and temperature control diagrams (approved shop drawings).
5. Each piece identified on any schedule shall be bookmarked in the electronic file by its scheduled tag ID.

C. In addition to the maintenance manual, and keyed to it, the equipment shall be identified and tagged as specified elsewhere. Insert a copy.

1. Identify all starters, disconnect switches, and manually operated controls, except integral equipment switches with permanently applied, legible markers corresponding to operating instructions in the “Maintenance Manual”.
2. Tag all manual operating valves with 1-1/2" diameter brass tags attached with chains. Tags are to be sequence numbered with legible metal stamps. Obtain latest tag identification schedule from the DEN Project Manager.
3. Provide a typed tag list or schedule mounted under glass in the room designated by DEN Project Manager stating number, location, and function of each tagged item. Insert a copy of tag list in each “Maintenance Manual”.

D. Division 21 Contractor shall be responsible for scheduling instructional meetings for maintenance personnel on the proper operation and maintenance of all fire suppression systems, using the maintenance manual as a guide. These meetings must be scheduled through the DEN Project Manager, and General Contractor far enough in advance so that all personnel can be notified.

E. Division 21 Contractor shall provide proof of performance certification of all fire suppression systems to demonstrate that all fire suppression systems are operating to the intent of the design.

1.04 FINAL OBSERVATION

A. Comply with the requirements of Division 01 and the following.

B. Prior to the request for final observation, all Work under the contract shall be completed, all systems shall be in proper working order and placed in operation (System Startup of 48 hours).

C. All equipment shall be cleaned, including but not limited to, plumbing fixtures. All debris and construction materials shall be removed from the DEN property to a suitable landfill off-airport.

D. The temperature control system shall be complete and in proper working order. All instruments shall be properly and accurately field calibrated.

E. At the request of the DEN Project Manager, a representative of the Contractor who is thoroughly familiar with the Project and operation of the various systems shall be present during the final observation to demonstrate proper operation of the equipment and controls. If requested by the DEN Project Manager, the Contractor shall have representatives from the Contractor's subcontractors present to assist during final observation.

1.05 PROJECT CONDITIONS

A. Accessibility

1. Division 21 Contractor shall be responsible for the sufficiency of the size of shafts and chases and the adequate clearance in double partitions and hung ceilings for proper installation of the Contractor's Work. The Contractor shall cooperate with Contractors of other Divisions of the Work whose work is in the same space and shall advise the General Contractor of the Contractor's requirements. Such spaces and clearances shall, however, be kept to the minimum size required.
2. Division 21 Contractor shall locate all equipment, which must be serviced, operated, or maintained in fully accessible positions. Such equipment shall include (but not be limited to) valves, shock absorbers, traps, cleanouts, motors, controllers, switchgear, and drain points. If

required for better accessibility, furnish access doors for this purpose, minor deviations from Drawings may be allowed to provide for better accessibility. Any changes shall be approved by the DEN Project Manager prior to making the change.

3. Division 21 Contractor shall provide the General Contractor with the exact locations of access doors for each concealed valve, shock absorber control, damper, or other device requiring service. Locations of these doors shall be submitted in sufficient time to be installed in the normal course of work.

4. Provide carpentry, masonry, concrete and metal work required for Work of this Division where not specifically called for under other Sections.

B. Freeze Protection:

1. Do not run lines in outside walls, or locations where freezing may occur. Piping next to outside walls shall be in furred spaces with insulation between the piping and the outside wall. Insulation of piping shall not be considered freeze protection.

1.06 START-UP PROCEDURES

A. Before start-up, each piece of equipment comprising a part of the system shall be checked for proper lubrication, drive rotation, belt tension, proper control sequence, and any other condition, which may cause damage to equipment or endanger personnel.

B. Ensure that all control systems are fully operational in automatic mode.

C. If systems are not to continue in use following the start-up procedures, steps should be taken to ensure against accidental operation or operation by unauthorized personnel.

D. Factory personnel shall be notified as appropriate to start systems requiring their services.

E. Notify the DEN Project Manager in writing a minimum of 72 hours prior to start-up of all major fire protection equipment and systems.

F. Should there be any equipment found which had not been properly started up, it will be the responsibility of this Contractor to arrange for the appropriate personnel to start up the equipment at the Contractor's expense and at a time as scheduled by the DEN Project Manager.

1.07 SCHEDULE OF TESTING

A. Notify the DEN Project Manager, DEN Commissioning Agent and Quality Assurance Inspector, and DEN Mechanical Engineer in writing a minimum of 72 hours prior to testing of any fire protection equipment and systems.

B. All testing must be performed in the presence of the DEN Project Manager and or the DEN Project Manager's designated representative; DEN Project Manager's signature for verification of the test must appear on the schedule.

C. All testing must be performed in accord with the procedures set forth in Division 21 and other Sections of the Specifications where referenced. At completion of testing, the schedule shall then be submitted in triplicate to the DEN Project Manager.

Section 210553: Identification for Fire-Suppression Piping and Equipment

PART 1 GENERAL

PART 2 PRODUCTS

2.01 SIGNAGE AND LABELING- GENERAL

A. Signage shall be per the requirements of NFPA- 13, FM Global, and any applicable Insurance underwriter.

B. Signs shall be pre-manufactured metal, approximately 2" x 6", located at all valves, main drains, auxiliary drains, air, alarm, and similar devices.

Section 211100: Facility Fire-Suppression Water-Service Piping

PART 1 GENERAL

Ensure project specification meets all applicable code. Where existing systems are being modified, ensure specifications reflect appropriate product and execution requirements.

Section 211313: Wet Pipe Sprinkler Systems

PART 1 GENERAL

PART 2 PRODUCTS

2.01 SPRINKLER PIPING GENERAL REQUIREMENTS

A. Mechanical grooved joints: Allowed for 2.5" and greater

B. Mechanical grooved joints not allowed for 2" and smaller

End of Chapter

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