

REAL PEOPLE
MAKE UP LIFE SAFETY

SMOKE CONTROL

**CODE REQUIREMENTS AND
APPLICATIONS**



BEN LOMBARDO
VICE PRESIDENT
H.R. KIRKLAND COMPANY

What is a Smoke Control System?

2018 International Building Code, Section 909.1 defines a smoke control system as:

- A system designed to provide a tenable environment for the evacuation or relocation of occupants.
- 909.16.1 - Fans within the building shall be shown on the FSCS panel. A clear indication of the direction of airflow and the relationship of components shall be graphically displayed
- It is not intended for the preservation of contents, the timely restoration of operations or for assistance in fire suppression or overhaul activities.

Codes and Standards Governing Smoke Control Systems

- 2018 IBC Section 909 Smoke Control Systems
- NFPA-92, Standard on Smoke Control Systems
- NFPA-92A, Standard for Smoke Control Systems- Utilizing Barriers and Pressure Differences.
- Underwriters laboratories, UUKL, Fire Fighters' Smoke Control Station- Includes requirements of ANSI/UL 864 Control Units for Fire-Protective Signaling Systems.

Smoke Control System Required

Covered mall buildings with an atrium connecting 3 or more stories (IBC, Section 402.7.2)



Smoke Control System Required

High-rise buildings 75 feet and higher (IBC, Section 403.4.7)



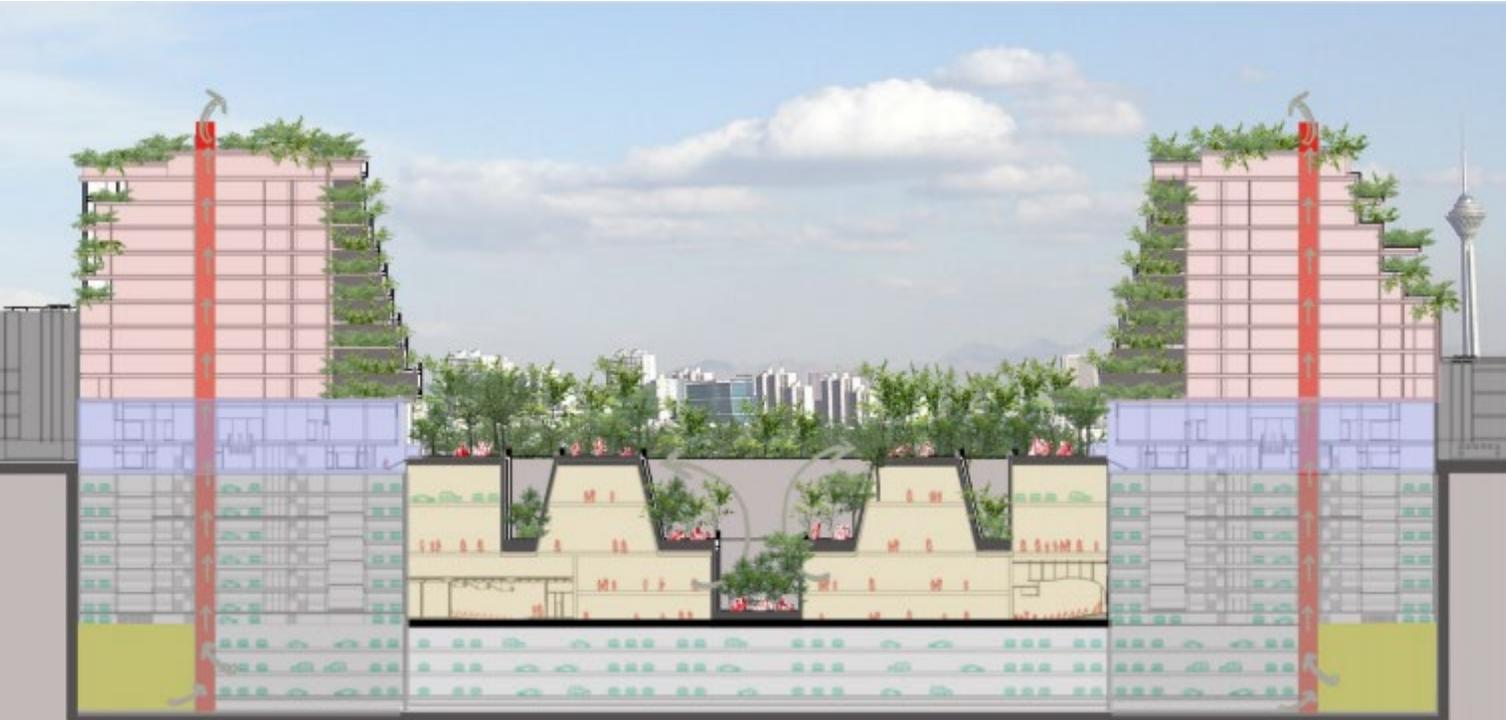
Smoke Control System Required

Atriums (IBC, Section 404.5)



Smoke Control System Required

Underground buildings having a floor level more than 30 feet below ground (IBC, Section 405.5)



Smoke Control System Required

Group I-3 buildings - Detention Facilities (IBC, Section 408.9)



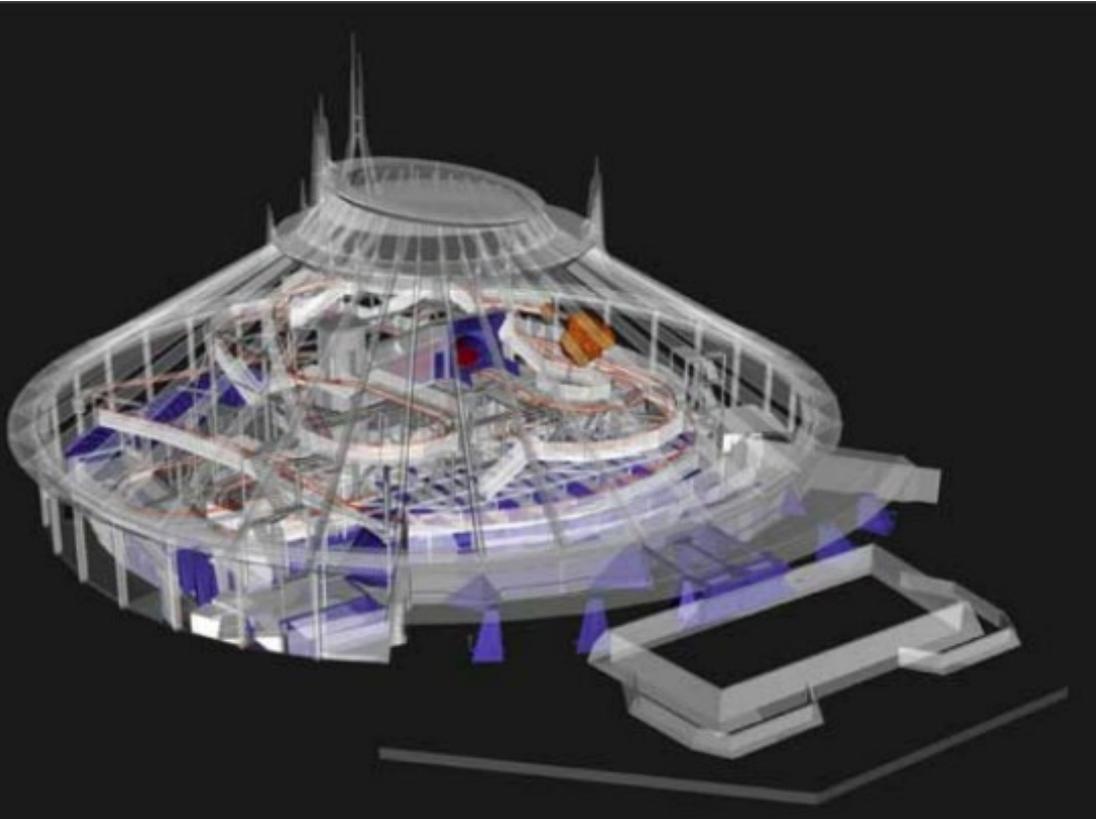
Smoke Control System Required

Stages larger than 1,000 square feet or greater than 50 feet high (IBC, Section 410.2.7.2)



Smoke Control System Required

Special amusement buildings with an occupant load of 50 or more (IBC, Section 411.1)



Smoke Control System Design

Rational Analysis (IBC, Section 909.4.1 through 909.4.7)

- Smoke control system design starts with the rational analysis
 - Types of systems to be employed
 - Methods of Operation
 - Supporting Systems
 - Method of Construction
- Prepared by a Fire Protection Engineer
- Design considerations include:
 - Stack effect
 - Temperature effect of fire
 - Wind effect
 - HVAC systems
 - Climate
 - Duration of operation
 - Smoke control system interaction

Dedicated or Non -Dedicated Smoke Control

Dedicated System

A smoke control system designed for the sole purpose of controlling smoke within a building

- In this case, equipment is not linked to building HVAC controls.
- This is accomplished by forming a system of air movement that is separate and distinct from the building's HVAC system and only operates to control smoke.

Non-Dedicated System

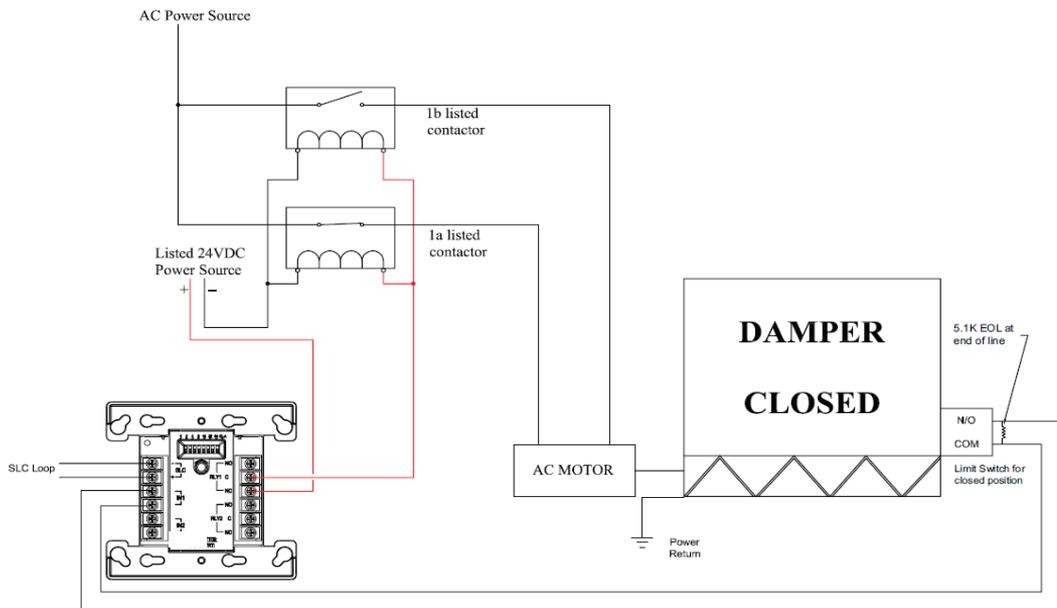
A smoke control system that shares components with other air moving equipment. When the smoke control mode is activated, the operating of the building's air moving equipment changes to accomplish the objectives of the smoke control design.

Smoke Control System Design

Dedicated

Dedicated Systems

Figure 5. Damper Control

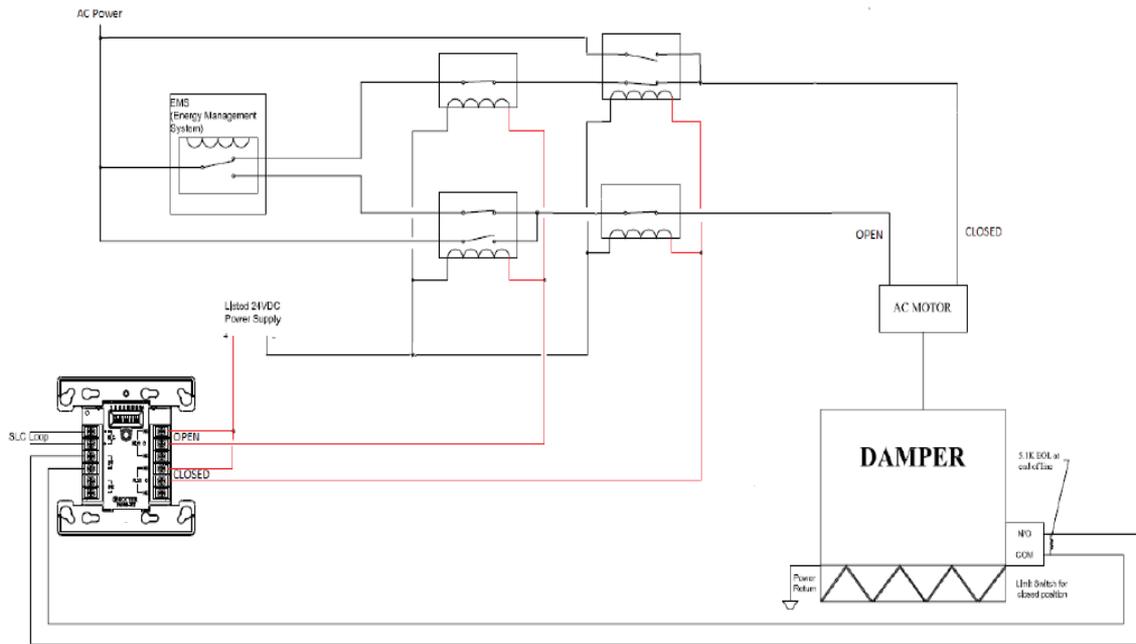


- Fans and dampers used exclusively for smoke control
- Equipment is only activated automatically when there is a fire or manually from firefighter smoke control panel.
- Automatic weekly test required to assure equipment is operable.

Smoke Control System Design

Non-Dedicated

Figure 8. Damper Control



- Fans, air handling units, and dampers used on a daily basis for temperature control of building.
- A failure of this equipment will likely be reported.
- No Automatic Weekly Test Required.

Methods of Operation – Passive

IBC, Section 909.5 - Walls and Floors Constructed as Smoke Barrier

Openings required to be protected with automatic closing devices, such as fire dampers and doors:

Fire Doors



Smoke and Fire Dampers



Methods of Operation – Mechanical

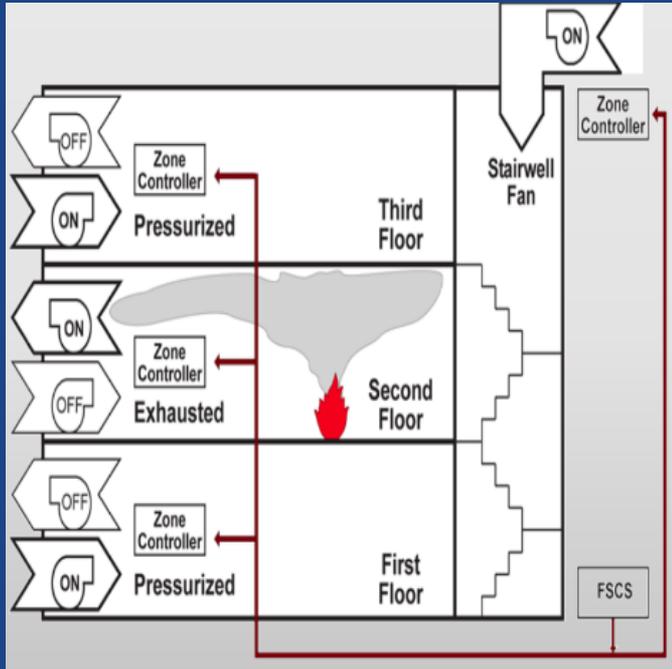
Smoke Control Definitions

- Pressurization (IBC, Section 909.6)
 - Stairwell and Shaft Pressurization
- Airflow (IBC, Section 909.7)
 - Zoned Smoke Control Systems
- Exhaust (IBC, Section 909.8)
 - Smoke Purge / Exhaust / Evacuation

Methods of Operation

IBC, Section 909.6 - Pressurization IBC

– Mechanical



- Primary mechanical means of controlling smoke across smoke barriers.
- Minimum pressure difference across smoke barriers = 0.05 inch water gage
- Maximum fire door opening force = 30 pounds to start, 15 pounds to open
- Has to meet NFPA 92 requirements

Smoke Control System Design

Shaft or Floor Protection

Shaft Protection

- Provides for smoke movement in stair towers and elevator hoist ways in either a dedicated or non-dedicated system environment.
- Most common is dedicated fans and dampers
- Common in high-rise applications (ex. Stair Pressurization– SPF-xx)

Floor Protection

- Floor protection systems limit the flow of smoke through shafts and cracks in floors or partitions in either a dedicated or non-dedicated system environment.
- Can be an entire floor or multiple zones on each floor

Smoke Control System Definitions

Pressurization

Pressurization is employed by creating pressure differences across partitions that separate the smoke zone from other areas. This can be accomplished by making pressure in the area surrounding the smoke zone higher than pressure in the smoke zone itself (refer to Figure 1.2.1.1).

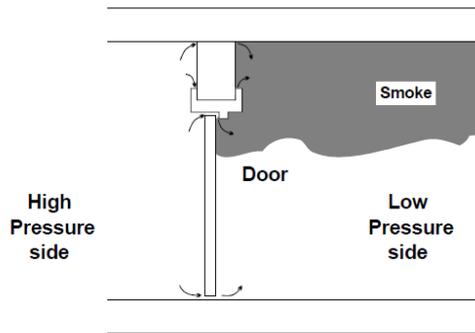
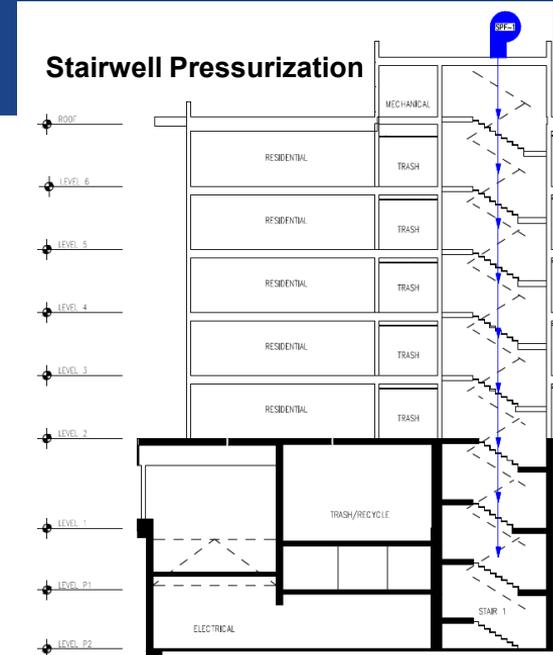


Figure 1.2.1.1 Elevator Piston Effect

Airflow through construction and door cracks prevents the movement of smoke to the high-pressure side. The pressure difference must be enough to contain the smoke in the smoke zone and at the same time allow doors leading to exit routes to be opened.

Fan Pressurizes Stairwell to prevent smoke from entering the space. >>



Smoke Control System Definitions

Examples of Shaft Protection

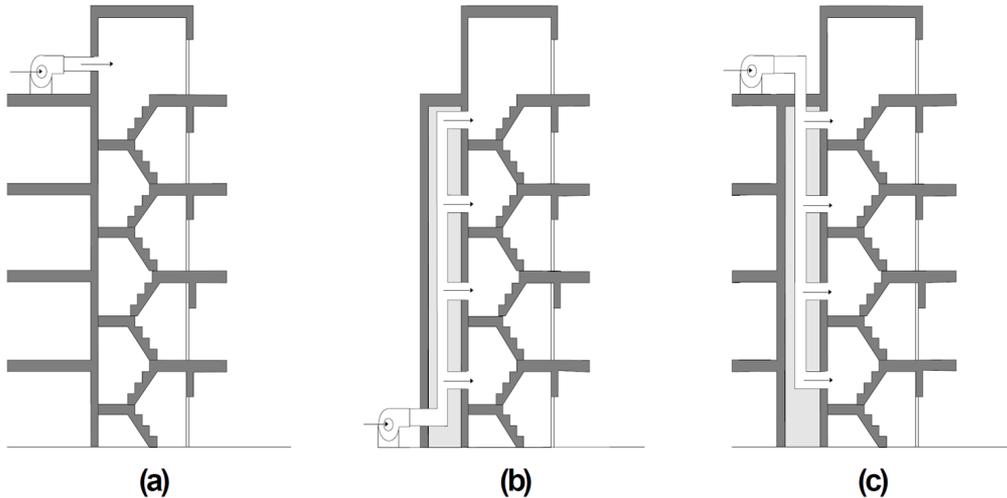


Figure 1.4.2.1 Single and Multiple Injection Stairtower Pressurization Systems

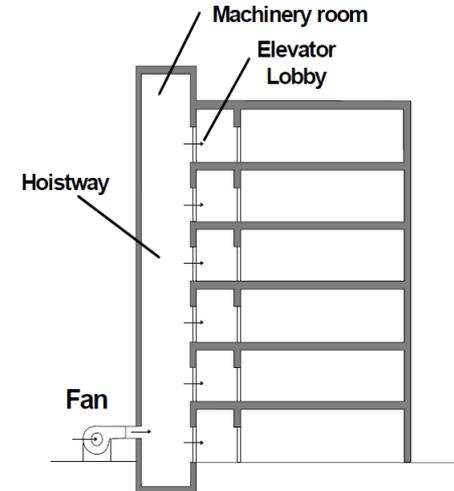
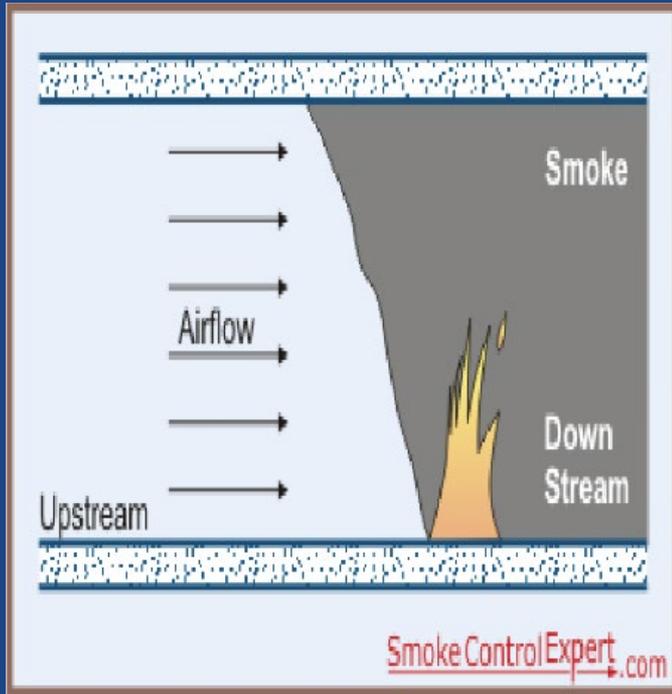


Figure 1.4.2.3 Elevator Smoke Control Using Shaft Protection

Methods of Operation – Mechanical

IBC, Section 909.7 - Airflow Method

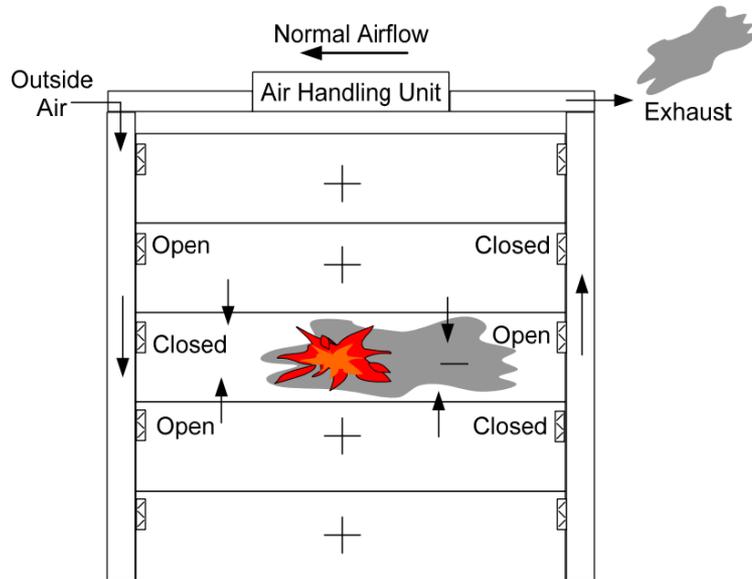


Zoned Smoke Control Systems

- Buildings can usually be divided into several smoke control zones where each zone can be separated from the smoke zone to prevent the movement of smoke.
- The smoke control zone boundaries are usually partitions, floors, and doors that can be closed. Often each floor of a building is chosen as a smoke control zone boundary.
- However, a smoke control zone can consist of more than one floor, or a floor can contain more than one zone. Also, all non-smoke zones can be pressurized, or just those surrounding the smoke zone.

Smoke Control System Definitions

Zoned Smoke Control Systems



- Smoke is exhausted from the fire floor.
- The floor above and below the fire floor are pressurized to prevent migration of smoke to those areas.

Smoke Control System Definitions

Examples

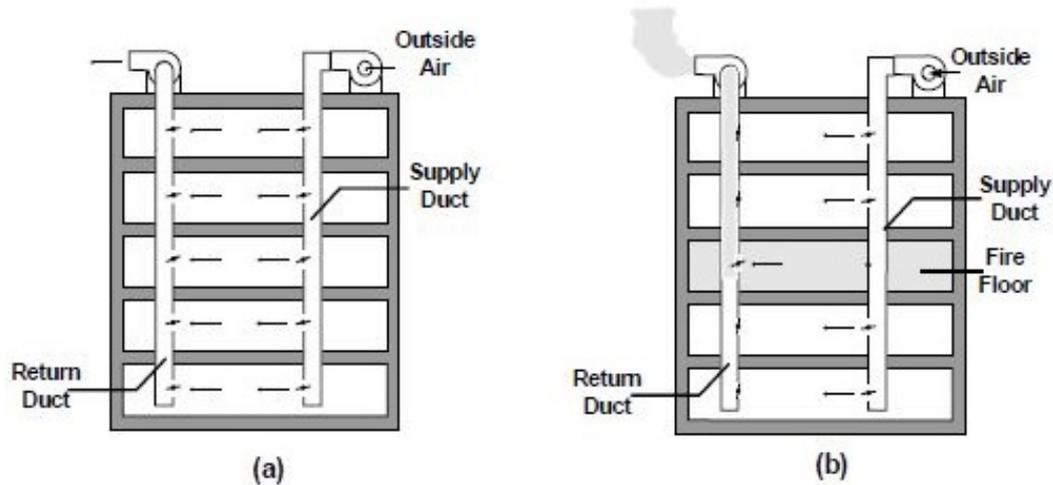
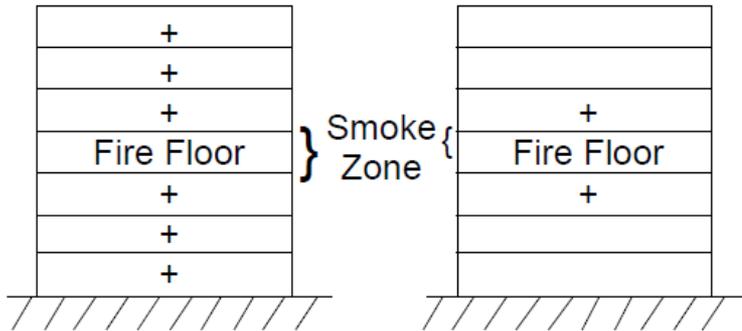


Figure 1.4.4.2 Zoned Smoke Control using the HVAC System Normal Operation (a) and Smoke Control Operation (b)

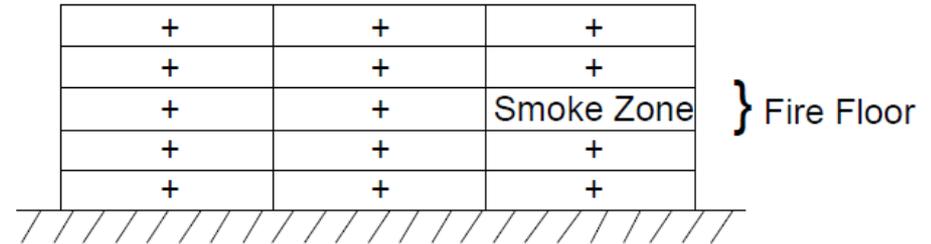
Smoke Control System Definitions

Examples

Smoke Control Zone Every Floor



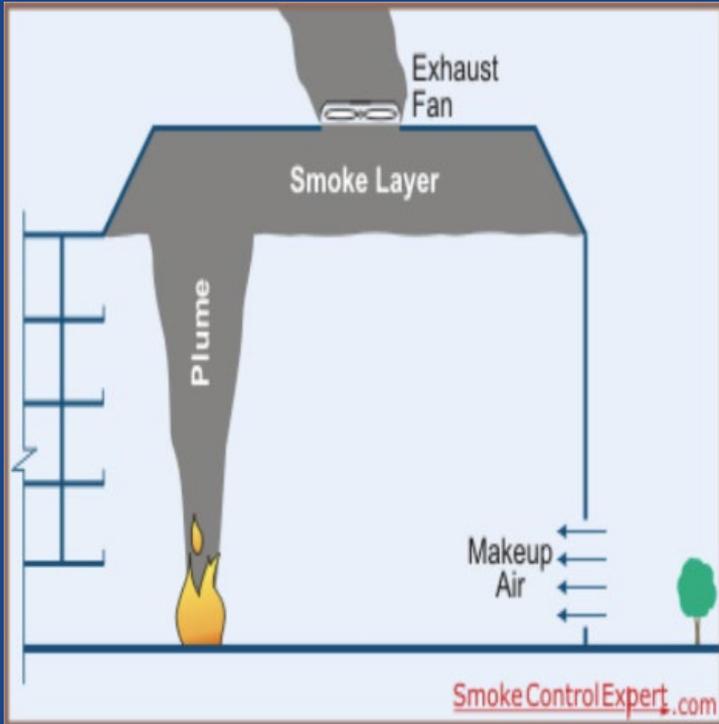
Three Smoke Control Zones Per Floor



Methods of Operation

IBC, Section 909.8 - Exhaust Method

– Mechanical



- Used to exhaust smoke from large enclosed volumes, such as atriums or malls
- Smoke level must be at least 6 feet above a walking surface used for egress
- Must be approved by the fire code official
- Has to meet NFPA 92 requirements

Detection and Control Systems

IBC, Section 909.12

Fire detection systems providing control input or output signals to mechanical smoke control systems shall:

- Comply with IBC Section 907
- Be ANSI/UL 864 listed
- Be listed as smoke control equipment (UUKL)
- Includes:
 - Types of systems to be employed
 - Passive (Isolates the smoke zone)
 - Mechanical (Moves air around)
 - Methods of operation
 - Supporting systems
 - Methods of construction

Smoke Control System Verification

IBC, Section 909.12.1 - Verification

- Applies to mechanical smoke control systems
- Requires positive confirmation of:
 - Actuation
 - Testing
 - Manual override
 - Presence of power downstream of all disconnects

Smoke Control System Verification

IBC, Section 909.12.1 - Weekly Self Test

- A preprogrammed weekly test sequence of all devices, equipment and components used for smoke control is required.
- Must indicate abnormal conditions audibly, visually and by printed report.
- Not required when verification of individual components will interfere with normal building operations

Smoke Control System Verification

Smoke control fans and dampers are equipped with status switches

- Validation/ positive feedback for fans required in 60 seconds.
- Validation/positive feedback for dampers required in 75 seconds
- Status switches monitored by contact input module

Damper Status- Limit/Position Switch

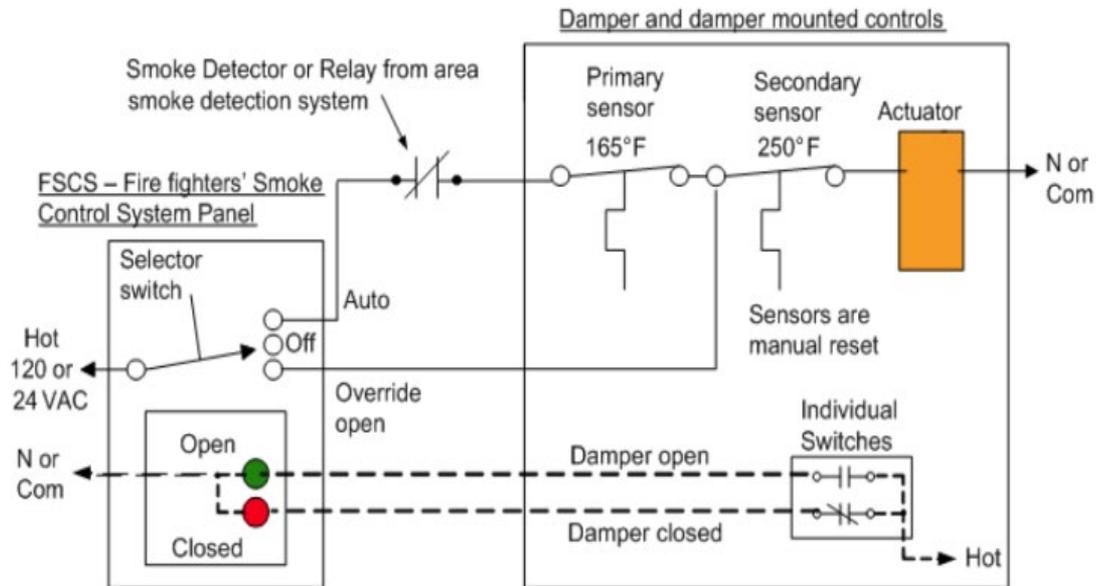


Fan Status - Differential Pressure Switch



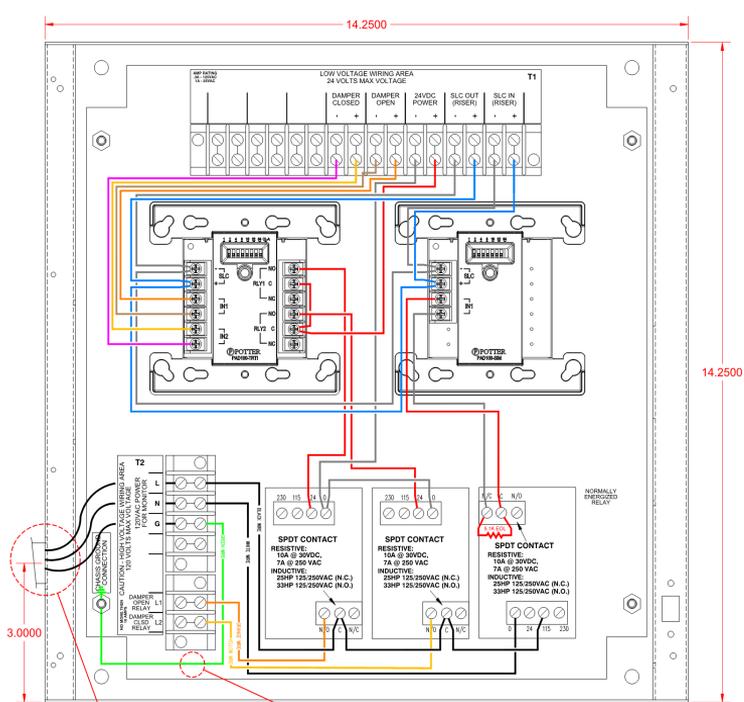
Managed Equipment Control

Damper



Smoke Control System Design - Managed

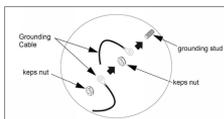
DAMPER CONTROL MODEL #: BBTC-DC100-PSC



GROUND WIRES - TERMINATED TO BACKPLANE MOUNTING SCREW (SEE DETAIL "A")

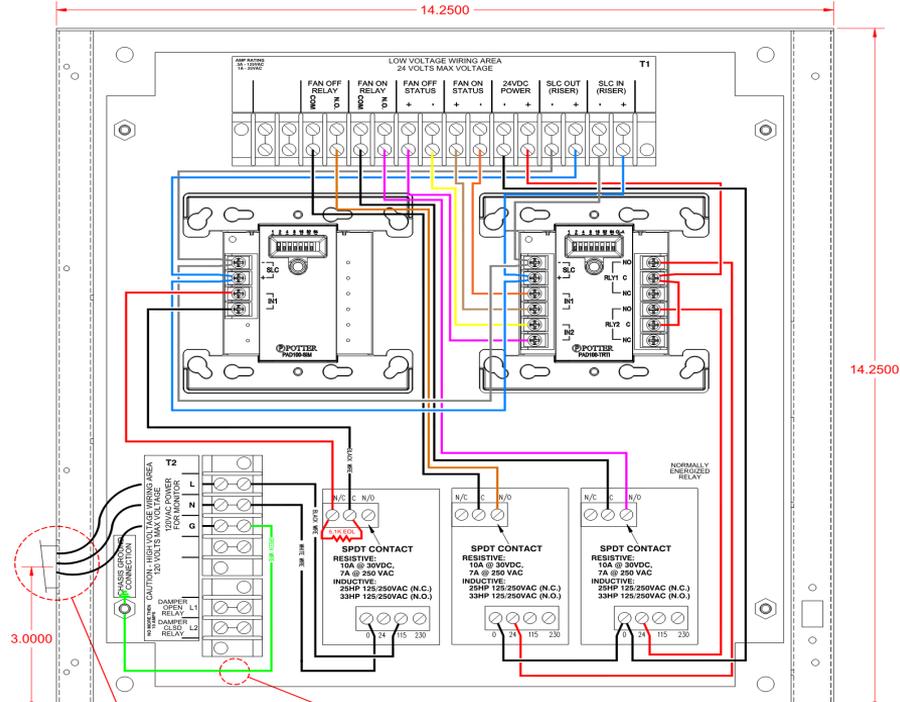
AC MAINS - THIS CONDUIT ONLY!
MUST BE SEPARATED FROM ALL OTHER CIRCUITS

ALL HIGH VOLTAGE WIRES WILL BE 14 GAUGE. (COLORS MAY VARY)
ALL LOW VOLTAGE WIRES WILL BE 16 GAUGE. (COLORS MAY VARY)



DETAIL "A"

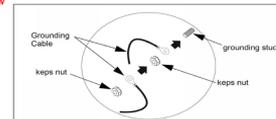
FAN CONTROL MODEL #: BBTC-FC100-PSC



GROUND WIRES - TERMINATED TO BACKPLANE MOUNTING SCREW (SEE DETAIL "A")

AC MAINS - THIS CONDUIT ONLY!
MUST BE SEPARATED FROM ALL OTHER CIRCUITS

ALL HIGH VOLTAGE WIRES WILL BE 14 GAUGE. (COLORS MAY VARY)
ALL LOW VOLTAGE WIRES WILL BE 16 GAUGE. (COLORS MAY VARY)



DETAIL "A"

Firefighter's Smoke Control Panel

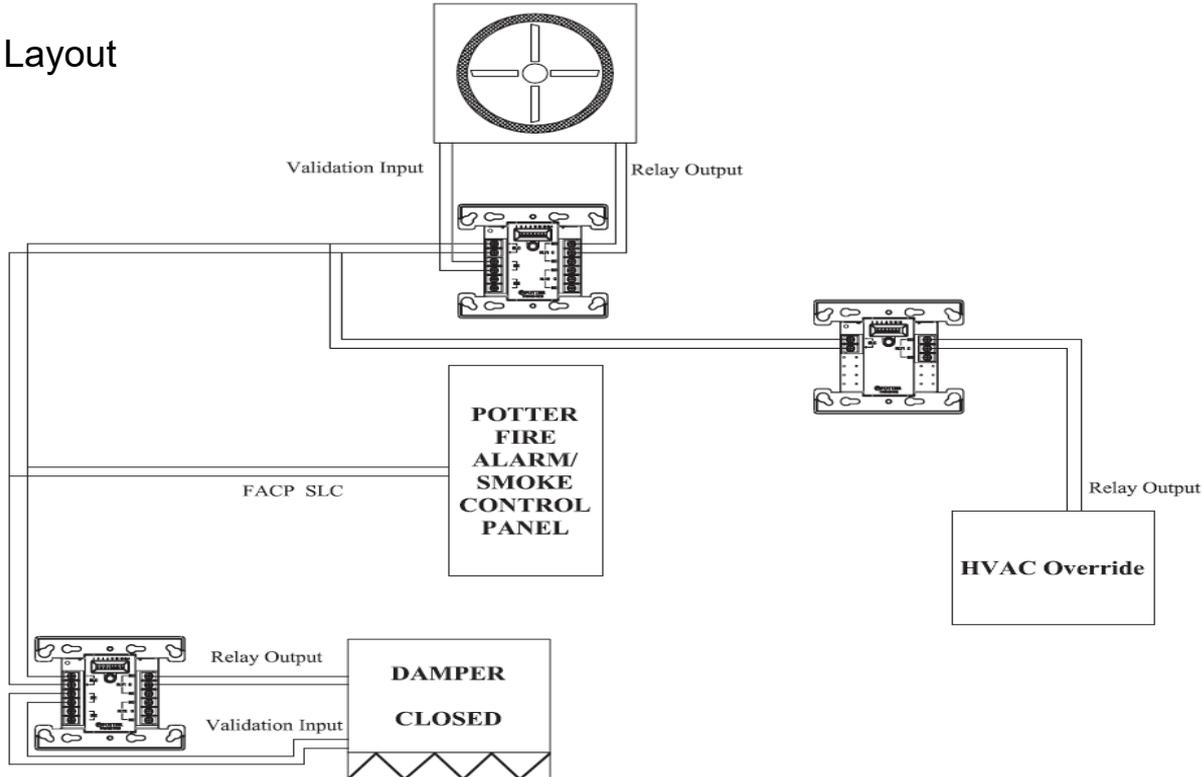
FSCP or FSCS

- Required by IBC, Section 909.16
- Fire department emergency use only
- Must have manual control or override of automatic control for mechanical smoke control systems.
- Located in the fire command center or approved location next to the fire alarm control panel.
- Requirements vary widely between jurisdictions

FSCS - Control Functions

The FSCS must provide control over each individual piece of equipment that can also be controlled from other sources within the building:

Basic System Layout



Smoke Control Panel UUKL

UUKL Listing

Category Name	Link to File
Control Unit Accessories, System	<u>UOXX.S3616</u>
Smoke Control System Equipment	<u>UUKL.S3616</u>

- Must be a UUKL Listed FSCS
- Locations to install the FSCS
 - Fire Command Center (FCC)
 - AHJ Approved location (Lobby)
 - Next to the FACP

Smoke Control Panel UUKL

UUKL Listing ID Card

UUKL.S3616 Smoke Control System Equipment

[Page Bottom](#)

Smoke Control System Equipment

[See General Information for Smoke Control System Equipment](#)

H R KIRKLAND CO INC
UNIT 13
4935 ALLISON ST
ARVADA, CO 80002 USA

S3616

Investigated to UL 864 (10th edition)

Firefighter's Smoke-Control Station Model(s) BGRA (a), BGRA-D-X, BGRB (a), BGRB-D-X, CEF (a), RSA (a), RSB (a), RSC (a), RSC-D-X, RSD (a), RSE (a), RSF (a), RSG (a), RSH (a), RSX-GR (a)

(a) - Requires graphic styles GP4 or GP6. May contain WP suffix identifying suitable for outdoor use.

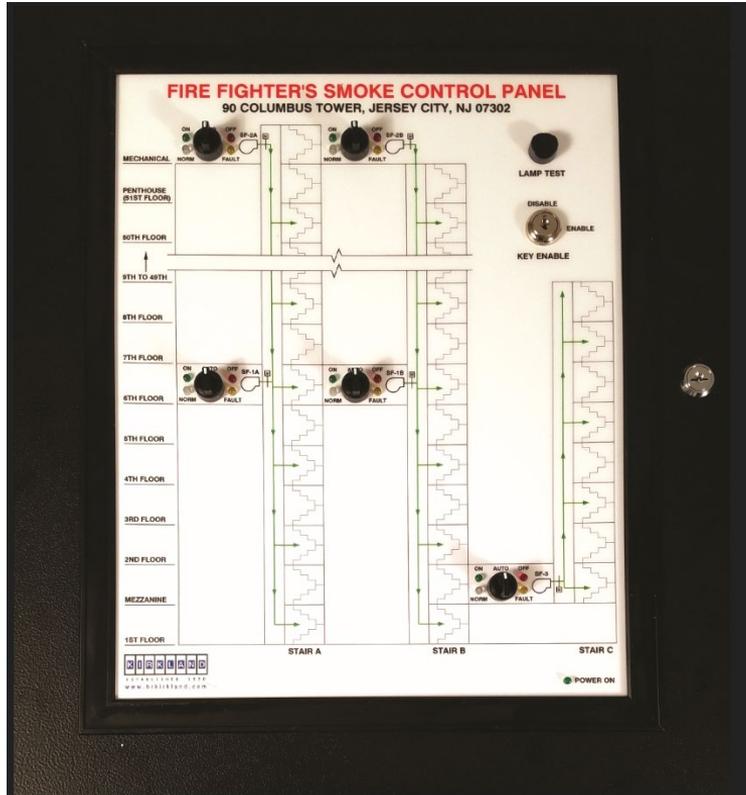
X - length

[Last Updated](#) on 2016-10-16



Firefighter's Smoke Control Station

Includes:



- Graphic representation of the Smoke Control System, direction of airflow and relationship of components in Riser format.
- Provide LED status indicators for all managed smoke control equipment (fans, dampers, and other equipment)
 - **White:** Normal status
 - **Red:** Off/Closed
 - **Green:** On/Open
 - **Amber:** Fault status
- 3 position switches for manual control of fans/dampers
- Manual control enable key switch (when applicable)
- Lamp Test
- Power On LED

Firefighter's Smoke Control Station

Includes:



- LEDs indicate the status of the fan or damper
 - **White: Normal status** : fan or damper in Auto position and ready for automatic activation.
 - **Red: Off/Closed**: Fan is turned Off or Damper is set to Close.
 - **Green: On/Open**: Fan is On or Damper is Open. Green LED lights only when positive feedback of activation is received.
 - **Amber: Fault status**: No positive feedback turned On or damper Opened.
- LEDs are controlled with the LED driver module
- 3 position switches provide manual control of fans/dampers
 - Auto – Switch in Auto position fire alarm controls fan or damper activation
 - On / Open – Manually turns fan On or Opens damper.
 - Off / Closed – Manually turns fan Off or Closes damper
- The ON/Open and OFF/Closed position of each switch is monitored with contact input modules. When switch is not ON or OFF panel assumes it is in the Auto position.

Firefighter's Smoke Control Station

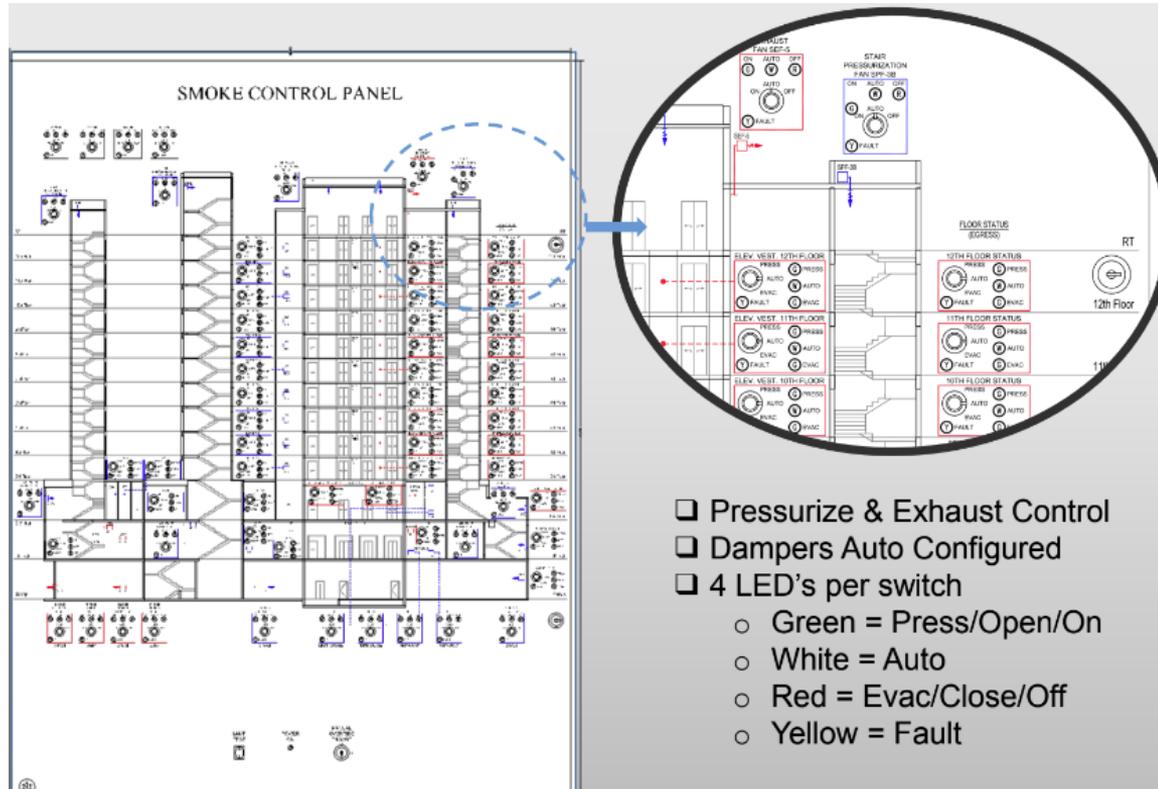
Control Functions

The FSCS must provide control over each individual piece of equipment that can also be controlled from other sources within the building:

- On-Auto-Off
 - Stairway pressurization fans
 - Smoke exhaust fans
 - Air handling system supply, return, and exhaust fans
 - Elevator shaft fans
- Open-Auto-Close
 - Dampers directly related to smoke control
 - Dampers that are also controlled from other sources within the building.
- On-Off or Open-Close
 - Other critical equipment that can only be controlled from the FSCS (smoke/fire dampers, lobby doors, etc.)
- Complex systems can be combined so that all elements of a smoke zone can be controlled and status indicated as a unit

Smoke Control Panel

Example



Smoke Control Panel

Control Priorities

SCP

Highest
Priority

Smoke Control Panel

FAS

2nd Priority

Fire Alarm System

BMS

Lowest
Priority

Building Automation System

Smoke Control Panel

Control Priorities

- SCP Control Actions have priority over all other control points
- Control actions shall not require the smoke control system to assume more than one configuration at any one time (IBC Section 909.16.3.1)
- Auto position of SCP control switches shall allow automatic or manual control action from other control points in the building.
- When in the auto position, actual status of equipment is displayed (on, off, open, closed) by status indicators (IBC Section 909.16.3.2)z

System Response Time

- Governed by IBC Section 909.17
- Smoke control system activation initiated immediately after receipt of automatic or manual command
- Equipment to be activated in sequence to prevent damage to components
- Response times vary.
 - Required to be set to allow for full operational mode to be achieved before conditions in the space exceed the design smoke condition
 - Response times shall be detailed in the rational analysis

Acceptance Testing

- Requirements listed in IBC, Section 909.18
- Shall include verification of the correct operation of all components of the smoke control system, including:
 - Smoke detectors
 - Airflow in Ducts
 - Dampers
 - Fans
 - Smoke barriers
 - Controls
- Must be performed by a special inspector (IBC, Sections 909.3 and 1705.18) and the authority having jurisdiction
 - Special inspections must be performed by an independent agency
 - Specific requirements vary by jurisdiction

Maintenance

- Components must be maintained in accordance with manufacturer's instructions
- Written schedule is required and records must be kept
- Semiannual Testing is required for:
 - Dedicated smoke control systems (stairway pressurization, atrium exhaust, etc.)
 - Systems or components bypassed by a preprogrammed weekly test
- Annually
 - Non-dedicated smoke control systems (air handling units, economizer dampers, etc.)
 - Smoke control systems must be tested under standby power conditions

Question

False or False? A smoke system is designed to preserve contents and building occupants.

Question

Which is **not** possible for a designing
the P&ID discipline engineer

Question

A smoke control system will be required when the construction is _____ feet or more below grade

Question

True or False: Control zones can press into zones on an adjacent floor, or a floor can contain more than one zone

Question

Smart Rational Analysis design starts with the:

- A. Rational Analysis
- B. Fire Alarm Riser
- C. Mechanical Riser

Question

False ~~A~~ dedicated smoke system designed for the equipment with concealing smoke equipment installing with dedicated air moving equipment

Question

~~A. Mechanical~~ Method of Operation includes which of the following?

- A. Pressurization- Stairwell and Shaft
- B. Fire Alarm Riser- Zoned Smoke Control Systems
- C. Exhaust- Smoke Purge / Exhaust / Evacuation
- D. All of the above

Question

The fire fighters Smoke Control Station (FSCS) must meet which listing requirement?

- A. UOXX
- B. UUKL
- C. All of the above

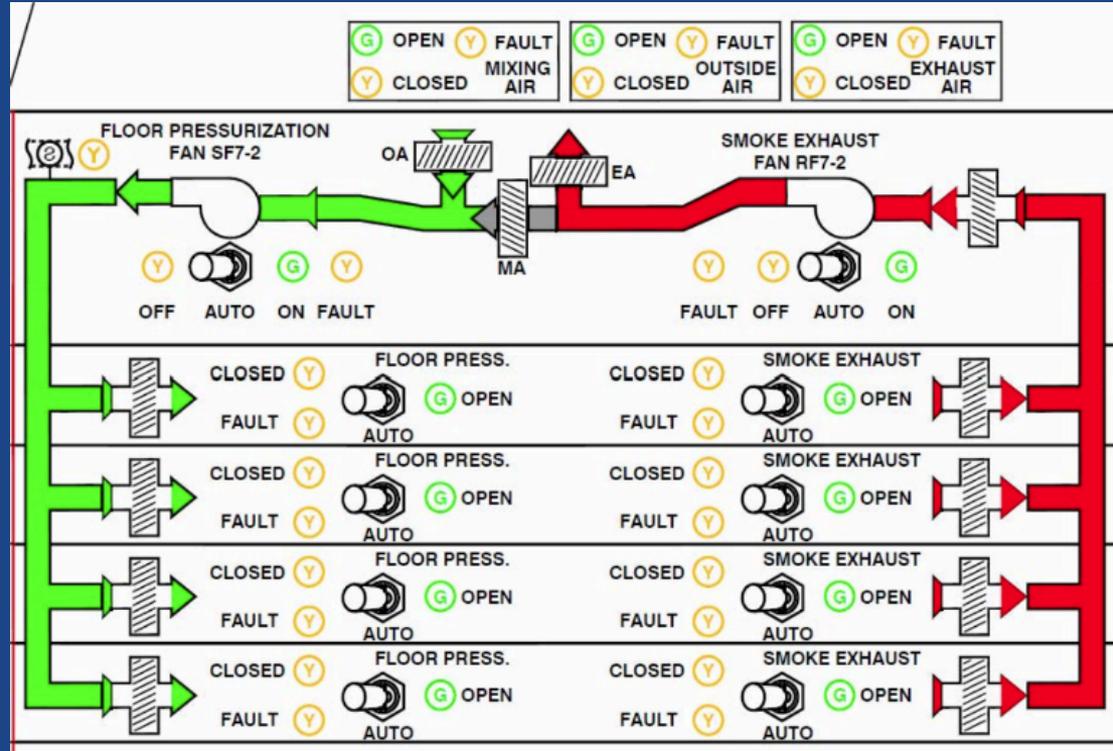
Question

Which device has the highest priority in a smoke control design:

- A. Fire Alarm Control Panel (FACP)
- B. Firefighter's Smoke Control Station (FSCS)
- C. Building Automation System (BAS)

Question

Find the discrepancy >



Additional Questions?

Feel free to email ben@hrkirkland.com

Thank you for joining today.



Ben Lombardo, LEED AP

H.R. Kirkland

ben@hrkirkland.com

303-598-0885