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Local Expert

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Mission Critical Fire Protection: Smoke Control

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Antinomy Consulting Engineers

- Headquartered in Lake Mary, Florida
- Specialize in smoke control, building/fire code, fire alarm design, themed entertainment and high-rise buildings
- Founded 2017 as Caliber Code & Fire Engineering

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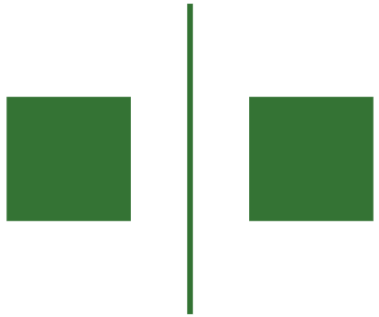

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Topics

- Introduction to Smoke Control
- Types of systems
- Mission criticality
- System components and control
- Code requirements, Florida amendments
- Reliability and common problems
- Integration with other fire protection systems

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What is Smoke Control?

- **NFPA definition**
  - NFPA 92: 3.3.23.5 Smoke Control System. An engineered system that includes all methods that can be used singly or in combination to **modify smoke movement.**
- **Florida/International Building Code**
  - FBC 909.1: Mechanical or passive… systems that are intended to **provide a tenable environment for the evacuation or relocation of occupants.** These provisions are not intended for the preservation of contents, the timely restoration of operations or for assistance in fire suppression or overhaul activities.
    - ✓ FBC 909.6: Maintenance of a tenable environment is not required in the smoke control zone of fire origin [for pressurization method systems].

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Major Categories of Smoke Control

- **Active**
  - Uses operating equipment
    - ✓ Dedicated
    - ✓ Non-dedicated: Shared with HVAC system
- **Passive**
  - Uses static construction and opening protectives
- **Natural**
  - Smoke & heat venting

System Components

- **Static boundaries**
  - Partitions, shaft walls
  - Draft curtains
- **Dynamic boundaries**
  - Elevator smoke seal appliances
  - Drop-down smoke curtains
  - Powered doors
- **Active components**
  - Air handlers
  - Fans
  - Dampers
  - Fire alarm control
  - Firefighter's smoke control station
- **Other**
  - Smoke & heat vents

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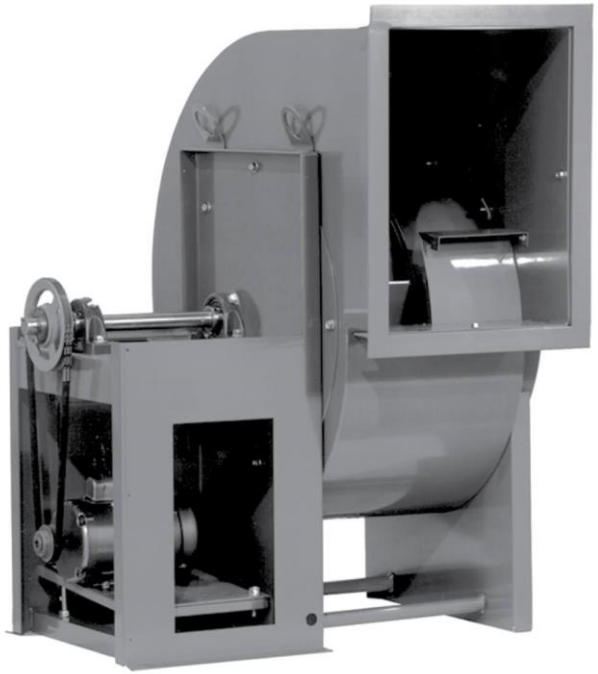
Fans



Photos by Loren Cook Co.

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Dampers

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Smoke/Heat Vents

Photo by Babcock Davis

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Elevator Smoke Seal

Photo by Smoke Guard

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Perimeter Smoke Seal

Photo by Smoke Guard

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Rollup Opening Protectives

Photo by Smoke Guard

Door Operators

Photo by Stanley Access Technologies

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Firefighter's Smoke Control Station

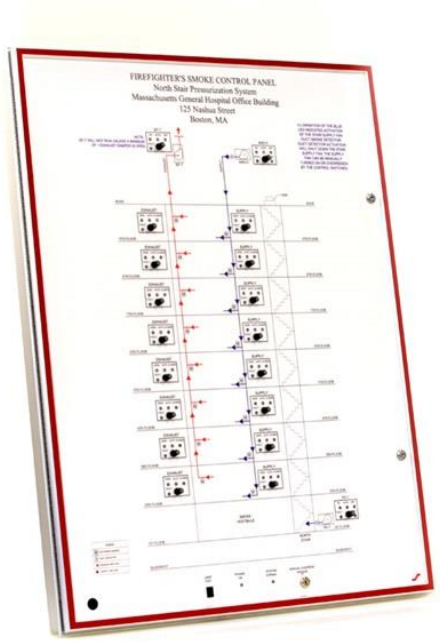

Photo by Space Age Electronics

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Where is active smoke control used?

Common in Florida:

- Atria
- High rise buildings
- Indoor theme park rides
- Jails/prisons
- Theaters
- Shopping Malls

Uncommon in Florida:

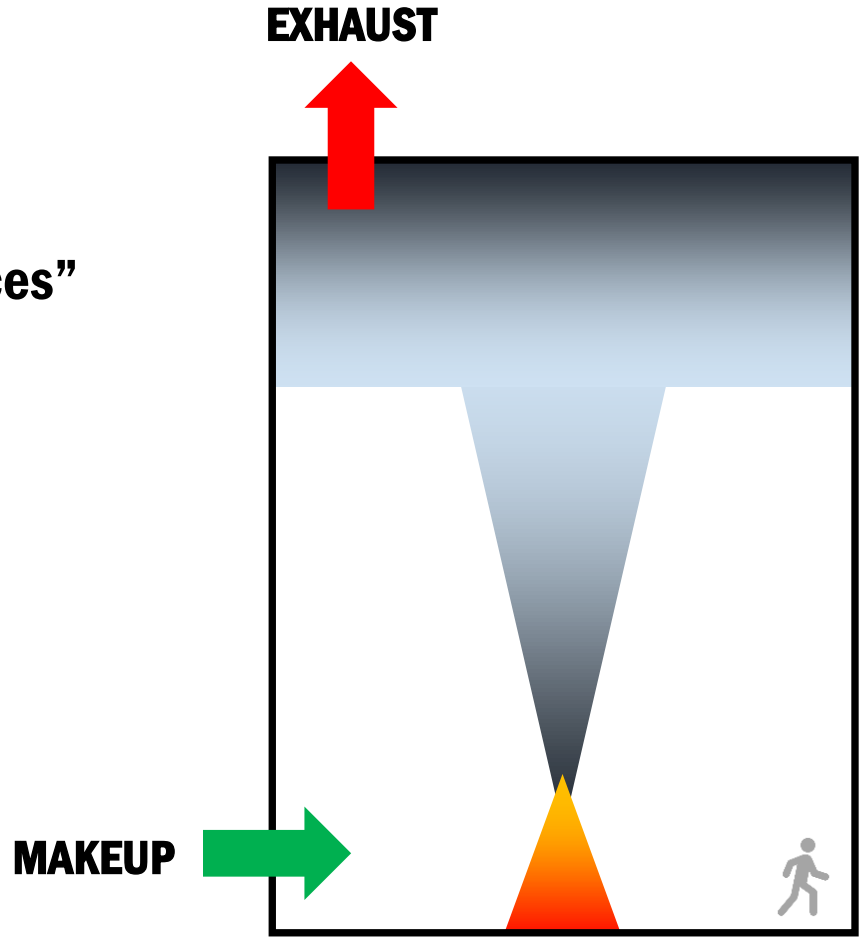
- Hospital floors
- Underground buildings
- Occupant evacuation elevators
- Road/train tunnels (NFPA 502)
- Alternatives to smoke & heat vents

Common Conditions

- **Occupants exposed to smoke from remote fires**
- **Rescue hampered by building height (or depth)**
- **Egress impractical**
  - Hospitals
  - Jails/prisons
- **High fuel & occupant loads**
  - Theaters with stages

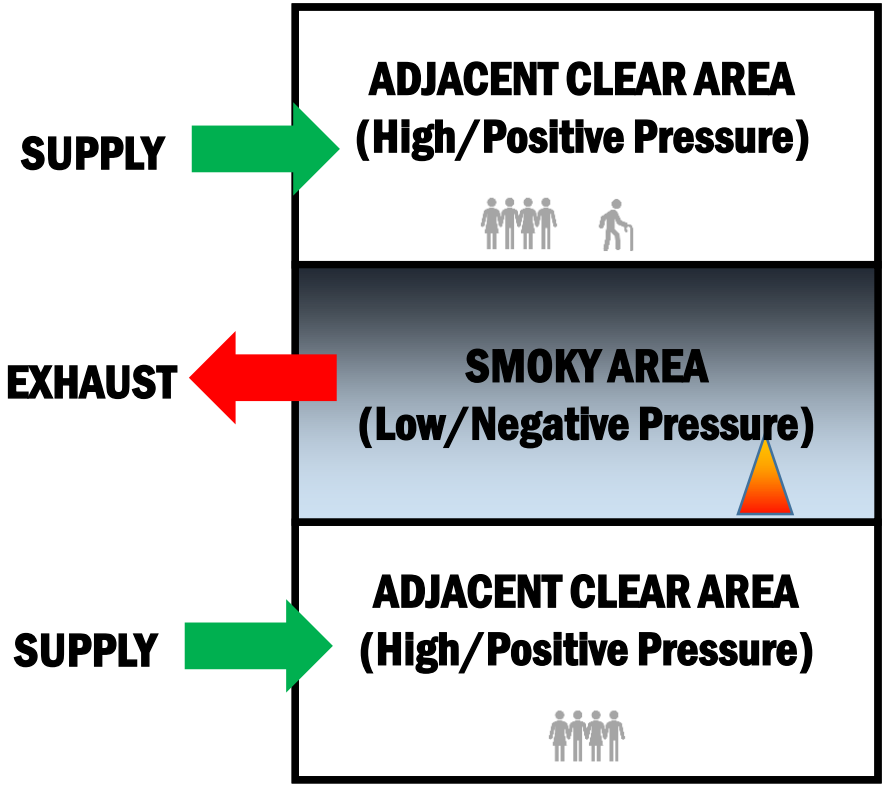
Exhaust Method

- **Classic "*smoke evac*" system**
- **Often seen on "Large Volume Spaces"**
  - Theme park rides
  - Atria
  - Shopping malls
- **Similar approach with "natural" method with vents on top**



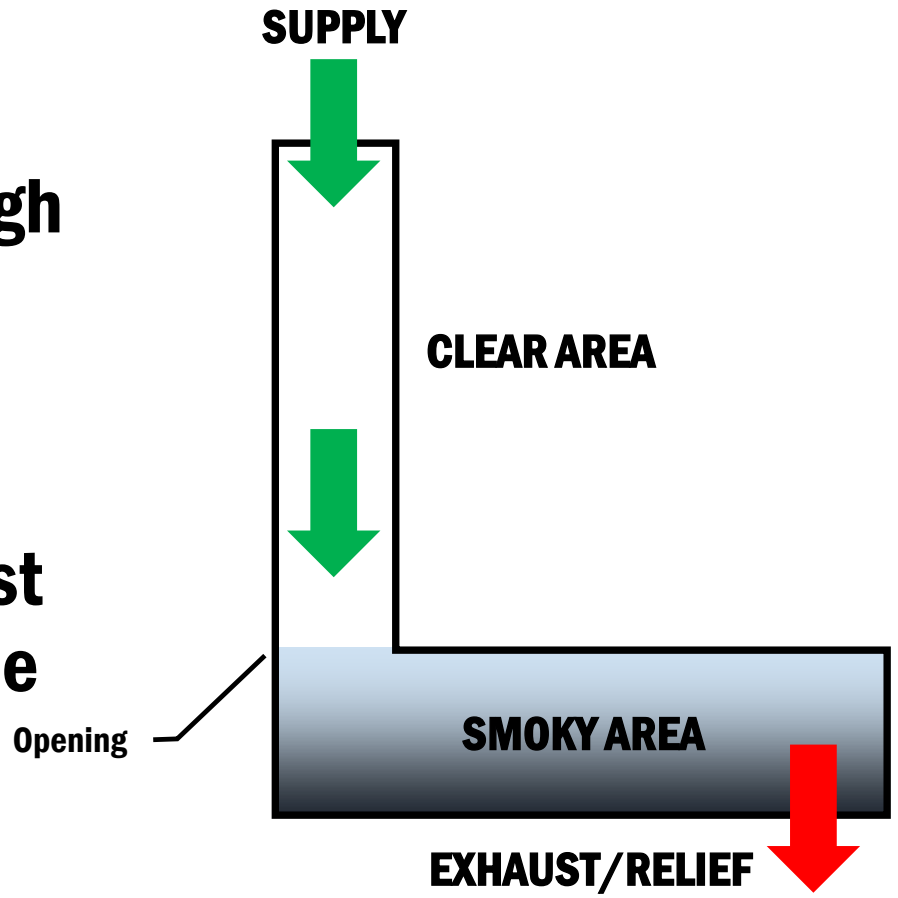
Pressurization Method

- **Method 1: Use positive pressure to keep smoke out**
  - Stair pressurization
  - Elevator pressurization
- **Method 2: Use negative air pressure to confine smoke to zone of origin**
- **Often seen on high rise residential and office buildings**
- **Different exhaust/supply schemes possible**



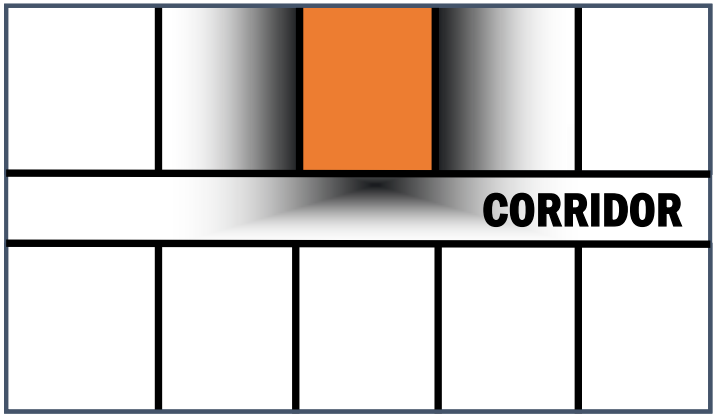
Airflow Method

- Use current of air through an opening to confine smoke
- Sometimes used in conjunction with Exhaust method for Large Volume Spaces



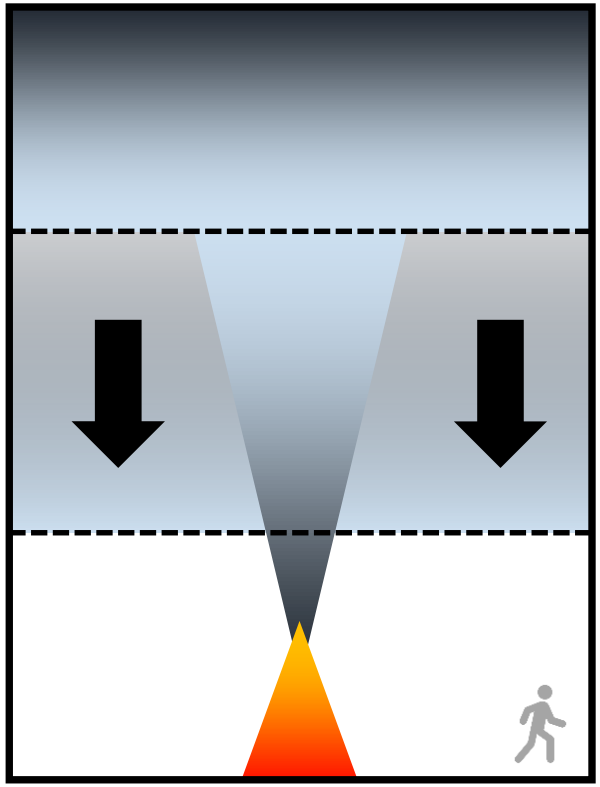
Passive Method 1

- Use “smoke barriers” to confine or limit spread of smoke
- Fundamental form of fire protection
- Static/fixed walls
- Opening protection (doors, shutters)
  - Self- or automatic closing
  - Dampers
- May be fire-resistance rated
  - “Fire rated” ≠ “Smoke rated”
- Present in active methods



Passive Method 2

- **Sequestration: Sufficient volume overhead to store smoke until egress completes**
- **For very large buildings**



Mission Critical

- **Code-required fire protection system (NFPA 1 §13.1.2)**
  - Similar stature to fire alarm, fire sprinkler, fire standpipe, fire pump
  - Fire smoke control system?
- **Critical component of life safety strategy**
  - Extends available egress time
  - Limits extent of smoke spread

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Effectiveness

- **Life safety system, not property protection**
- **Protection against interior fire**

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Business Interruption

- **Inactive system will disallow usage of the building**
- **Assembly spaces**
  - Theme park ride closed
  - Theater production stopped, show canceled
  - Unhappy patrons
  - Refund of ticket sales?

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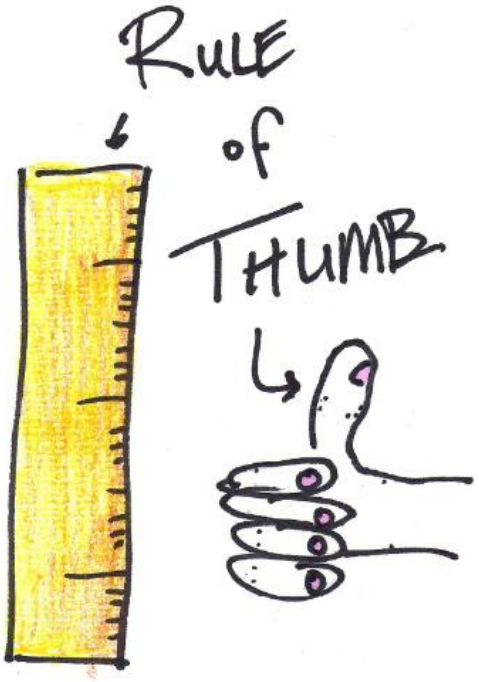
Property Damage

- **Large Volume/Exhaust Systems:**
  - May reduce smoke damage to lower floors of atrium
  - May reduce damage to stock stored on shelves in warehouse
  - May have superior performance to FBC §910 smoke & heat vents
- **Pressurization Systems:**
  - Confine smoke damage to one floor or zone
  - Restore rest of building to operation quickly

Applicable Codes

- Florida Building Code
- Florida Fire Prevention Code
- Epcot Building Code
- City of Orlando Code of Ordinances
- Florida Statutes
- NFPA 92
- NFPA 204
- NFPA 502

Design Basis: Historical



- **Based on 4 to 6 air changes per hour for large volume (Exhaust)**
  - Did not consider key variables about space and fire
- **Highrise smokeproof enclosures for firefighter use, not egress**
  - Ventilated vestibule
- **Corridor positive pressurization**

Design Basis: Current

- **Several codes, several names**
  - "Rational Analysis"
    - ✓ FBC §909.4
    - ✓ EBC §720.4
  - "Engineering Analysis"
    - ✓ LSC §8.6.4(5)
  - "Detailed Design Report"
    - ✓ NFPA 92 §7.1(1)
- **Emphasis on *defined performance***
- **Requires more analysis than volumetric air change or purge systems**

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Local Requirements: High Rises

- **Emergency smoke control requirements not enhanced for FBC 6th/2017**
- **"Engineered Life Safety System" for existing unsprinklered residential high rises (LSC §31.3.5.12)**
  - Compliance by December 31, 2019
- **Alternative to fire service access elevator lobby (FS 553.79(19))**
  - Pressurized hoistway with….
  - Wider corridor (6 ft)…
  - Minimum corridor floor area… and
  - Floor-to-floor smoke control
  - For buildings over 120 ft in height
  - Maximum 420 ft for R-1, above which FSAEL required.

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Local Requirements: Themed Entertainment

- **City of Orlando (5/2017)**
- NFPA 1 Section 11.8 Addition:
- (1) Smoke Removal System in Special Amusement. All new special amusement occupancies greater than 25,000 sq. ft. shall be equipped with an engineered smoke control system acceptable to the AHJ.
- (2) Testing of Smoke Control Systems. The owner, operator, or person in charge of the premises shall perform maintenance test of all mechanical smoke control systems in accordance with NFPA 92A and shall submit annual reports to the AHJ demonstrating compliance.

- **Epcot Building Code (4/2016)**
- 5-12.401.4 Smoke Control. A smoke control system shall be designed to control the migration of products of combustion in the show space [of amusement buildings/attractions]. Upon detection of a fire, the system shall shut down the air supply to the fire floor and the return air from all non-fire floors.
- (a) Show spaces shall have a smoke exhaust system located at the ceiling. Such system shall be designed in accordance with Section 720 and shall not be less than exhaust 40,000 cubic feet per minute per smoke zone. Supply inlets shall be provided at the lowest level of the show area. These inlets shall be sized to provide 75 percent of the exhaust air.
- (b) When the heights of the show area exceeds three stories, an exhaust system shall be provided as required in Paragraph(a), however, supply air shall be introduced mechanically from the floor of the show area. The capacity of the supply shall be 75 to 85 percent of the exhaust.

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Reliability

- **Prevent failures**
  - During emergency
  - During normal operation
- **Initial commissioning**
  - FBC 909.18
  - NFPA 92
  - NFPA 3 – New to FL
- **Regular testing & maintenance**
- **Weekly self test**
- **FA supervision**
- **Best practices**

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Common Problems: Design & Construction

- **S/C as Capstone event**
- **Design & Construction**
  - Poor design/complexity
  - Misunderstanding of concept
  - Rushed testing at completion
  - Missing components
  - Hidden override switches
  - Unmonitored disconnect switches
  - Motors tripping overloads
  - Shared systems
- **Continued**
  - Interfering fire dampers
  - Inadequate temperature rating
  - 3-phase fans spinning backwards
  - Modulation with inappropriate time constants
  - Premature test & balance
  - Missing smoke detectors at stairs
  - Transition to generator power

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Common Problems: Operation

- Lack of maintenance
- Disabling smoke control on system upgrades
- Disabling life safety systems on troubleshooting
- Water intrusion
- Unanticipated fuel loads
- Loss of settings in VFDs
- New unsealed wall openings/penetrations
- Deteriorated pneumatic controls
- Building expansion ignoring smoke control
- End-of-life fire alarm or solid state controls
- Power-operated doors that do not unlock & unlatch
- Missing gaskets

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System Integration

- **Extensive integration with fire alarm and suppression systems**
- **Typically fire alarm controls and supervises smoke control systems**
  - BAS/BMS less common now
- **Increased smoke detection requirements**
  - Often larger areas and inaccessible heights
- **Fire alarm system required to be listed as *smoke control system control equipment* (UUKL)**
  - Impacts component selection
- **Sprinkler/suppression zoning important**
  - Selection of sprinklers vs. smoke control

Thank you!

Questions

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NFPA 1

NFPA 1: 13.1.2 The property owner shall be responsible for the proper testing and maintenance of the [fire protection] equipment and systems.

NFPA 1: 11.8 Smoke Control.

11.8.1 Newly installed smoke-control systems shall be inspected by the AHJ and tested in accordance with the criteria established in the approved design documents, NFPA 204 and NFPA 92.

11.8.2 Smoke-control systems shall have an approved maintenance and testing program to ensure operational integrity in accordance with this section. Components of such systems shall be operated, maintained, and tested in accordance with their operation and maintenance manuals.

11.8.2.1 Testing. Operational testing of the smoke-control system shall be in accordance with NFPA 92, and shall include all equipment related to the system including, but not limited to, initiating devices, fans, dampers, controls, doors, and windows.

11.8.2.1.1 An approved written schedule for such operational tests shall be established.

11.8.2.2 Test records shall be maintained on the premises and must indicate the date of such testing, the qualified service personnel, and any corrective measures needed or taken.

11.8.3 All smoke-control systems and devices shall be maintained in a reliable operating condition and shall be replaced or repaired where defective.

11.8.4 The AHJ shall be notified when any smoke-control system is out of service for more than 4 hours in a 24-hour period and again upon restoration of service of such systems.

11.8.5 The AHJ shall be permitted to require the building to be evacuated or an approved fire watch to be provided for all portions left unprotected by the fire protection system shutdown until the fire protection system has been returned to service.