Concord Department of Fire and Life Safety

FIRE MARSHAL'S OFFICE

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Fire Suppression Operations in Building Equipped with Smoke Management Systems.

Introduction

With current construction trends in warehousing and large mercantile, companies are building larger buildings to store, sell and distribute merchandise. Buildings of this type are sometimes referred to as "Big Box" stores. So named by their large open sales floor areas with little or no secondary storage areas, offices or separated rooms. Occupants frequenting these types of buildings are faced with long exit access travel distances, confusing or alternating aisles to a means of egress and increased life hazards due to high occupant loads and commodities stored and/or sold by these types of occupancies.

Hazards faced by firefighters when fighting fire in these structures include intense fire and heat conditions due to burning characteristics of stored materials, exposure or injury from hazardous materials, debris falling from high separated piles or palletized materials stored in rack storage systems, collapse hazards of high-piled/rack storage systems and limited or no visibility to conduct suppression operations.

Current building Codes require these buildings to install either fire detection or fire suppression systems and in certain instances, both types of systems are required. Installation requirements vary depending upon the types of commodities stored or size of the storage area.

To combat these hazards, modern Fire and Building Codes require the installation of Smoke Management Systems to limit fire spread, remove smoke

and heat, as well as provide a safe means of escape for building occupants and aid fire suppression efforts by fire sprinklers and firefighters.

Design Strategies and Operation

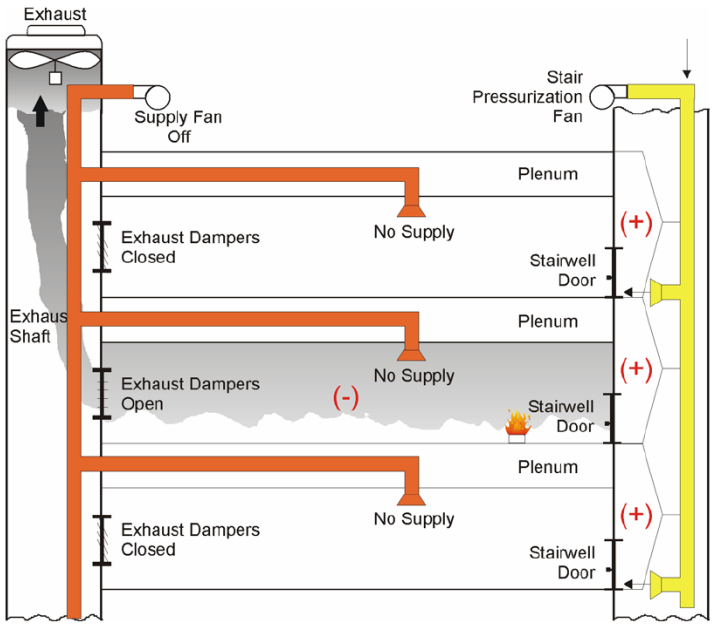
NFPA 92B, Standard for Smoke Management Systems in Malls [1], Atria [2], and Large Spaces (2005 Edition) gives the following purpose for smoke management systems:

> 1.2.1* The purpose of this standard is to provide requirements for implementing smoke management systems to accomplish one or both of the following:
>
> (1) Maintain a tenable environment in the means of egress from large-volume building spaces during the time required for evacuation
> (2) Control and reduce the migration of smoke between the fire area and adjacent spaces

Four design strategies are utilized in the design and installation of smoke management systems: Passive, Pressurization, Exhaust and Opposed Airflow. Each method uses a different approach to the removal of smoke.

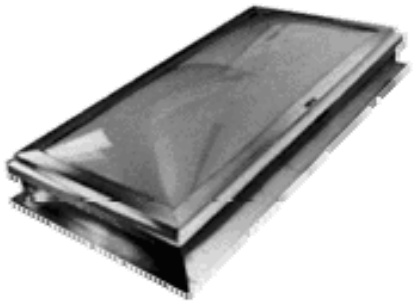
The **passive method** utilizes areas of a building separated by walls that extend from floor to the bottom of the roof deck. These “compartments” use self closing doors, fire dampers and other self closing devices to “trap” smoke and create a smoke reservoir.

The **pressurization method** is the primary method used and often employed in high-rise construction to pressurize stair enclosures and provide zoned smoke control. The pressurization of a stairwell creates a “Positive Pressure” in the stairwell; this pressure is a higher pressure than the floor areas that empty into the stairwell. This higher pressure pushes smoke back into the floor space and does not allow smoke to enter the stairwell area. Zoned smoke control utilizes “Negative Pressure” to pull smoke out of the area of fire origin to a vent located in another area of the building. Negative horizontal ventilation by firefighters using an electric fan hung in a doorway is a similar example to this form of smoke control.



Negative Pressurization (Source: NIST)

The **exhaust method** is associated with smoke control for malls and buildings with atriums. This method uses the principle of exhausting smoke through an opening or exhaust fan located at high points of a building while “make-up” air is introduced through a manual or automatic vent lower than the exhaust point (Make-up air is fresh air being introduced at a CFM rate similar to the rate of air being exhausted). This may be accomplished through several different designs with a combination of electric or non-electric automatic venting mechanisms including power ventilator fans, fusible element automatic smoke vents, electric or non-electric automatic louver vents or shrink-out (melt-out) vents installed on a roof. This method should not be confused with the negative pressurization method. The negative pressurization method uses an “exhaust” point but no means of “make-up” air is introduced.



Shrink-Out Smoke Vent

The last method employed is **opposed airflow method**. This method is not a primary method of smoke control. It is often used in conjunction with the pressurization or exhaust methods. It primarily is a system used to limit the spread of smoke by using building openings such as doorways or architectural features to limit the travel of smoke. Low pressure air currents are used to prevent smoke travel to parts of a building. These systems encourage smoke to travel to desired “points” of a building in order for the primary system to begin to control the removal of the smoke.

Roof Smoke Vent

The sizes and types of venting devices and mechanisms installed depend upon the systems design specifications. Large square foot storage areas may require numerous vents spread out over equal areas of the roof. The Codes require the vents to have a minimum size of 16 square feet with no side dimensions less of than 4 feet.

Another venting method used is mechanical smoke exhaust. These devices are electrically powered exhaust fans. The Code limits these devices to a maximum airflow of 30,000 cfm’s per fan. For large buildings multiple fans are installed on the roof over the entire storage area. Fans must be uniformly spaced on the roof and have a maximum of 100 feet of space between fans.

Mechanical Smoke Exhaust Fan

Fire Alarm Control Panel

Smoke control system startup is required to be automatic. This activation is accomplished through various means of automatic devices. A fire alarm and/or detection system is normally used to activate the system. In buildings not equipped with alarms, smoke detectors are used as well as spring loaded smoke and heat vents equipped with fusible elements that open upon the fusible element melting.

Occasionally, the building's HVAC system is used as a component of smoke control systems. Upon smoke control system activation, HVAC system operations including; shut-down and start-up of air handling equipment, opening and closing of dampers, and opening and closing of natural ventilation devices are automatically controlled. HVAC systems may also be used to provide make-up air, compartment/room pressurization or serve as an exhaust system for products of combustion.

Emergency Operations

Fire suppression tactics used in buildings with these systems installed are similar to those used in structures that have been positively pressurized by PPV fans. Air pressurization and exhaust points must be controlled in order for the systems to effectively control smoke. Poor fire suppression tactics that produce multiple exhaust openings or the disabling of make-up air devices will render these systems ineffective.

It is also important to remember, these systems control smoke movement and do not control fires. These systems rely on fire suppression systems or building construction methods to effectively control or extinguish fires. Fires, in buildings not equipped with fire suppression systems, will be intensified by the entrainment of fresh air. Upon entry into these buildings, engine company officers will be faced with relatively clear smoke conditions with little or no indications of fire development. Officers should not let their perception of smoke conditions lull them into a false sense of security. Standpipe hose connections should be made and personnel should quickly locate the fire's location and begin suppression operations. Firefighters should expect rapidly evolving fire situations and adjust tactics and safety measures accordingly.

Truck company operations should include sending companies to the roof to assess the operation of ventilation devices. After the seat of the fire is located truck company officers *may* assist fusible-element venting devices with opening. Note: this should only be performed after the fire seat has been located and officers should only open only the devices necessary for the smoke removal system to properly operate. Any fans found to be operating should not be

disabled or de-energized during rooftop operations. Disruption of these fans may be detrimental to the smoke control systems operation and effectiveness.

Safety officers should rapidly assess which part of the fire building contains smoke control systems and identify if those systems are in operation. Once identified, interior crews should be made aware of systems in operation and advised of the smoke color and intensity of smoke being exhausted from venting mechanisms. Interior crews should also be advised if any fire is also being exhausted by the system. The latter information will give suppression line officers a definitive mental picture of what to expect once they locate the seat of the fire.

Fire Investigators need to realize the operation of these systems influences the travel of heat, fire and smoke through a building. The introduction of fresh air and a method of exhaust ventilation into a fire area will have a definite effect on the burning characteristics of fuels and the fire's relative intensity. These factors also impact burn patterns throughout the area of fire origin. Burn patterns created as a result of system operation need to be identified and separated from those occurring at the time of the fire inception. A thorough understanding of the design and method of system operation should be known prior to making a fire origin and cause determination. A failure to incorporate these factors with all other accepted investigative methods and techniques may lead an investigator to an inaccurate determination.

Fire departments must be aware of structures that contain these systems and personnel trained to employ strategies and tactics that utilize these systems to their fullest advantage. Pre-incident planning must also take place to identify buildings with smoke control systems and the design strategy for the operation of the system. Critical system control device locations including switches, vent/fan locations must be located and personnel must also be trained in how to manipulate system controls in order to properly operate these systems during fire conditions. The specific occupancies that utilize smoke control systems have inherent hazards. These should be recognized and incident plans should be developed that emphasize firefighter safety and survival during fire suppression operations.

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Definition of Terms:

1. ATRIA (ATRIUM)
   An opening through two or more floor levels other than enclosed stairways, elevators, hoist-ways, escalators, plumbing, electrical, air-conditioning or other equipment, which is closed at the top and not defined as a mall.

2. MALL
   A roofed or covered common pedestrian area within a covered mall building that serves as access for two or more tenants and not to exceed three levels that are open to each other.