Smoke-Control
Application Guide

Fike®

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TABLE OF CONTENTS

LIST OF EXHIBITS

DOCUMENT HISTORY

Document Title: Smoke-Control Application Guide

Document Reorder Number: 06-470

Revision	Section	Date	Reason for Change
0	All Sections	10/08	Initial Release

ABOUT THIS GUIDE

This document provides sales representatives, system designers, and system installers with a general overview of smoke-control systems and how Fike's equipment and components are integrated into the system. Several design examples are provided for reference purposes. When properly applied, the Fike smoke-control system complies with Underwriters Laboratories standard 864 UUKL Ninth Edition Smoke-control Listing. This document is not intended to be a complete design reference for smoke-control systems. For specific information regarding the design of a smoke-control system, you must read and become familiar with the following documents, codes, and standards, as applicable:

- NFPA 92A, Standard for Smoke-Control Systems Utilizing Barriers and Pressure Differences
- American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) publication entitled "Design of Smoke-control Systems for Buildings"
- NFPA 70, National Electrical Code
- NFPA 72, National Fire Alarm Code
- NFPA 101 Life Safety Code
- NFPA 90A, Standard for the Installation of Air-Conditioning and Ventilating Systems
- NFPA 92B, Standard for Smoke Management Systems in Malls, Atria, and Large Areas
- UL 864 Ninth Edition, Standard for Control Units and Accessories for Fire Alarm Systems
- International Fire Code (IFC)
- Additional codes and standards adopted by the local Authority Having Jurisdiction (AHJ)

PRODUCT SUPPORT

If you have a question or encounter a problem not covered in this manual, you should first try to contact the distributor who installed the Fike system. Fike has a worldwide distribution network. Each distributor sells, installs, and services Fike equipment. Look on the back of the cabinet door, there should be a sticker with an indication of the distributor who installed the system. If you can not locate the distributor, please call Fike Customer Service for locating your nearest distributor, or go to our web-site at www.fike.com. If you are unable to contact your installing distributor or you simply do not know who installed the system, you can contact Fike Technical Support at (888) 628-FIKE (3453), Option 2, Monday through Friday, 8:00 am to 4:30 pm CST.

SAFETY INFORMATION

Important safety admonishments are used throughout this manual to warn of possible hazards to persons or equipment.

STOP WARNING
Warnings are used to indicate the presence of a hazard which will or may cause personal injury or death, or loss of service if safety instructions are not followed or if the hazard is not avoided.

⚠ Caution
Cautions are used to indicate the presence of a hazard which will or may cause damage to the equipment if safety instructions are not followed or if the hazard is not avoided.

Note: Provides information on installation, operation, maintenance, performance or general tips that are important but not hazardous to anything or anyone.

TERMS USED IN THIS GUIDE

Acknowledge - To confirm that a message or signal has been received, such as by the pressing of a button or the selection of a software command.

Authority Having Jurisdiction - The organization, office, or individual responsible for approving equipment, materials, an installation, or a procedure.

Configure - The control board is 'set-up' to properly recognize and supervise a device as the design requires.

Dedicated Smoke-Control System – Smoke-control systems and components that are installed for the sole purpose of providing smoke-control, and upon activation these systems operate specifically to perform the smoke-control function.

End-to-End Verification – A self-testing method that provides positive confirmation that the desired result (e.g., airflow or damper position) has been achieved when a controlled device has been activated, such as during smoke-control, testing, or manual override operations.

Fire Alarm Control Unit (Panel) - A system component that receives inputs from automatic and manual fire alarm devices and might supply power to detection devices and to a transponder(s) or off-premises transmitter(s). The control unit might also operate releasing circuits or solenoids, provide transfer of power to the notification appliances, or transfer of condition to relays or devices connected to the control unit. The fire alarm control unit can be a local fire alarm control unit or a master control unit.

Fire Alarm Signal - A signal from a fire alarm-initiating device such as a manual fire alarm box, automatic fire detector, waterflow switch, or other device in which activation is indicative of the presence of a fire or fire signature.

Fire Alarm System - Components and circuits arranged to monitor and annunciate the status of fire alarm or supervisory signal-initiating devices and to initiate the appropriate response to those signals.

Fire Fighters' Smoke-control Station (FSCS) – A system that provides graphical monitoring and manual overriding capability over smoke-control systems and equipment at designated location(s) within the building for the use of the fire department.

Nondedicated Smoke-Control System - Smoke-Control systems and components that share components with some other system(s), such as the building HVAC system, and upon activation cause the HVAC system to change its mode of operation in order to achieve the smoke-control objectives.

Nonpower-Limited - The amount of current flowing through the circuit is unlimited vs. being limited, or power-limited. A designation given for wiring purposes.

Power-Limited - The amount of current flowing through the circuit is limited vs. being unlimited, or non-power limited. A designation given for wiring purposes.

Reset - A control function that attempts to return a system or device to its normal, non-alarm state.

RS232 - A data communication standard produced by the Electronics Industry Association (EIA). This was developed to provide a standard for interface between data terminal equipment and data circuit – terminating equipment employing Serial Binary Data Interchange.

RS485 - A data communication standard produced by the Electronics Industry Association (EIA). This standard was developed to insure compatibility between units provided by different manufacturers, and to allow for reasonable success in transferring data over specified distances and/or data rates.

Smoke Barrier – A continuous membrane, either vertical or horizontal, such as a wall, floor, or ceiling assembly that is designed and constructed to restrict the movement of smoke.

Smoke-control Mode – A predefined operational configuration of a system or device for the purpose of smoke-control.

Smoke-Control System – An engineered system that uses mechanical fans to produce pressure differences across smoke barriers to inhibit smoke movement.

Smoke-Control Zone – A space within a building enclosed by smoke barriers, including the top and bottom that is part of a zoned smoke-control system.

Smoke Refuge Area – A space within a building enclosed by smoke barriers, including the top and bottom, that is part of a zoned smoke-control system.

Zone - A defined area within a protected premises. A zone can define an area from which a signal can be received, an area to which a signal can be sent, an area in which a form of control can be executed, a particular area being protected. This term is used to create the relationship between activation inputs to notification outputs and peripherals.

Zoned Smoke-Control System – A smoke-control system that includes smoke exhaust for the smoke zone and pressurization for all contiguous smoke-control zones.

1.0 INTRODUCTION

In a fire situation, the smoke and gases produced by the fire contains dangerous products of combustion that can have critical influences on life safety, property protection, and fire suppression practices in the building. Smoke often flows to locations remote from the fire, resulting in the death of building occupants because they are unable to reach a place of safety before being overcome by the spread of smoke. A substantial majority of fire fatalities can be attributed to the inhalation of smoke and toxic gases, not the fire itself.

To truly protect the building occupants, building furnishings, equipment, and the building structure from being damaged by the affects of smoke, a *Smoke-control* system may be required.

2.0 WHAT IS A SMOKE-CONTROL SYSTEM?

Smoke-control includes the use of active or passive means to minimize and control smoke movement within a building in the event of a fire. Active smoke-control generally involves the use of ventilation systems to control the movement of smoke. Passive smoke-control generally involves the use of smoke barriers to provide compartmentalization within a building to minimize smoke spread. The National Fire Protection Association (NFPA) currently has two standards that cover the application and design of a smoke-control system and they are as follows:

NFPA 92A, "Standard for Smoke-control Systems Utilizing Barriers and Pressure Differences" covers systems that utilize the passive building barriers (walls, floors, doors, etc.) in conjunction with airflows and pressure differences generated by mechanical fans to inhibit and/or control smoke movement.

NFPA 92B, "Standard for Smoke Management Systems in Malls, Atria, and Large Spaces" covers systems designed for the management of smoke in large volume spaces where a fire exists or between spaces not separated by smoke barriers.

Depending upon the scope of your project, one or both of these systems may be used to provide smoke-control in the event of a fire.

3.0 SMOKE-CONTROL SYSTEM OBJECTIVES

The objectives of a smoke-control system can vary depending upon local code requirements and the requirements of the AHJ (Authority Having Jurisdiction); however, the primary objective of a smoke-control system may include one or more of the following:

- Maintain safe egress routes
- Reduce the spread of smoke to adjacent areas
- Maintain safe refuge areas
- Reduce property loss
- Assist Firefighting Personnel

4.0 SMOKE-CONTROL APPROACHES

Smoke movement can be managed by the use of one or more of the following design approaches: compartmentation, smoke filling, buoyancy, or pressurization. A brief description of each approach is discussed in the following sections.

4.1 COMPARTMENTATION

Compartmentation is a passive form of smoke-control that minimizes smoke spread by using smoke barriers between defined areas of the building, typically referred to as smoke zones. The effectiveness of either a smoke-control system depends greatly upon these smoke barriers and their ability to restrict the movement of smoke. Each smoke zone must be separated from one another by a smoke barrier that is designed to prevent smoke from passing through it. Smoke barriers may be a wall, door, floor, or a ceiling. Any openings in the smoke barrier must be sealed with a smoke-proof fitting to prevent smoke from penetrating the barrier. For example: doors located in smoke barriers shall be self-closing or shall be designed to close automatically upon activation of the smoke-control system; all duct work going through a smoke barrier must have a smoke damper in it.

ⓘ**Note:** Compartmentation is normally used in conjunction with other smoke-control approaches to assist in achieving the smoke-control objective or to simply increase their effectiveness at controlling smoke movement.

4.2 SMOKE FILLING

Smoke filling controls smoke by allowing it to fill an unoccupied volume or smoke reservoir while the building occupants evacuate the space or building. This approach is commonly used in large spaces, such as atria, malls and sports arenas. This system relies greatly upon the buoyancy of the fire gases to convey the smoke to the ceiling level.

4.3 MECHANICAL SMOKE EXHAUST

This is an active smoke-control approach that uses mechanical fans along with the buoyancy of the smoke to maintain the smoke layer at a predetermined height in the space for an indefinite period of time; or slow the smoke layer descent to provide time for building occupants to safely exit the building. Smoke exhaust, as shown in Exhibit 1, is commonly used in large volume spaces, such as atriums, malls, etc.

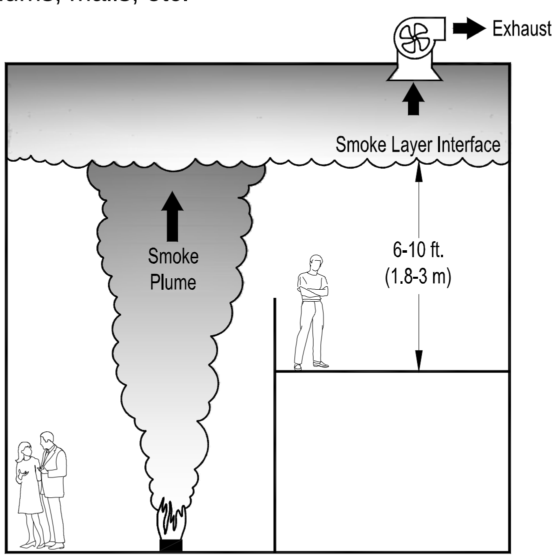

Exhibit 1: Mechanical Smoke Exhaust Approach

This approach is not intended for use in low-ceiling spaces, as a smoke reservoir is needed to maintain the smoke above the level of building occupants.

4.4 GRAVITY SMOKE VENTING

Gravity smoke venting, as shown in Exhibit 2, is a passive form of smoke-control that involves the installation of smoke vents at the roof level to allow the accumulating smoke to be naturally exhausted to the outside. This approach relies solely upon the buoyancy of the smoke in order to convey it to the ceiling level where it can be vented to the outside.

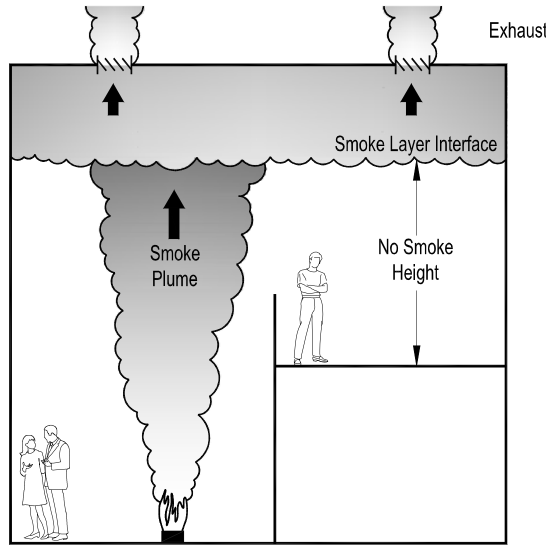

Exhibit 2: Gravity Smoke Venting Approach

4.5 PRESSURIZATION

Pressurization involves the use of mechanical fans to induce airflows and pressure differences across a smoke barrier between the zone of fire origin and adjacent spaces, in order to contain the smoke to the zone of fire origin. Pressurization is well suited for use in compartmented buildings with predominately low-ceiling spaces, such as high-rise office buildings. Exhibit 3 shows how pressure can be used to inhibit smoke movement.

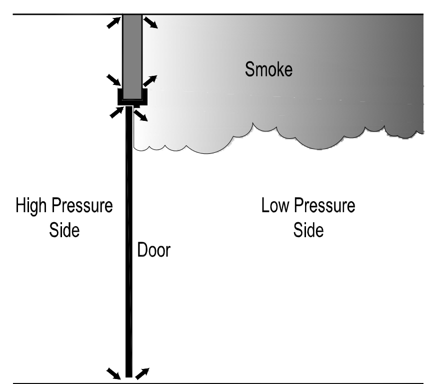

Exhibit 3: Air Pressure Containing Smoke

There are two general types of pressurization smoke-control systems: positive pressure systems, and negative pressure systems. A brief description of each system is described in the following sections.

4.5.1 POSITIVE PRESSURE SYSTEMS

Positive pressure systems supply air to the zones adjacent to the zone of fire origin to create a positive pressure in the adjacent zones as shown in Exhibit 4. Positive pressurization results in airflows of high velocity in the small gaps around closed doors and in construction cracks, thereby preventing smoke from back-flowing through these openings. The positive pressurization systems most commonly used are pressurized stairwells, vestibules, smoke refuge areas and zoned smoke-control. Elevator smoke-control is less common.

There are several drawbacks to using positive pressure systems. First, excessive overpressures or imbalanced positive pressures may force smoke from the zone of origin into other areas of the building. Second, overpressurization between smoke zones can make it very difficult (if not impossible) to open the door(s) during a fire situation, which can impede the safe egress from the building. Third, positive pressure systems do not result in the removal of smoke from the building.

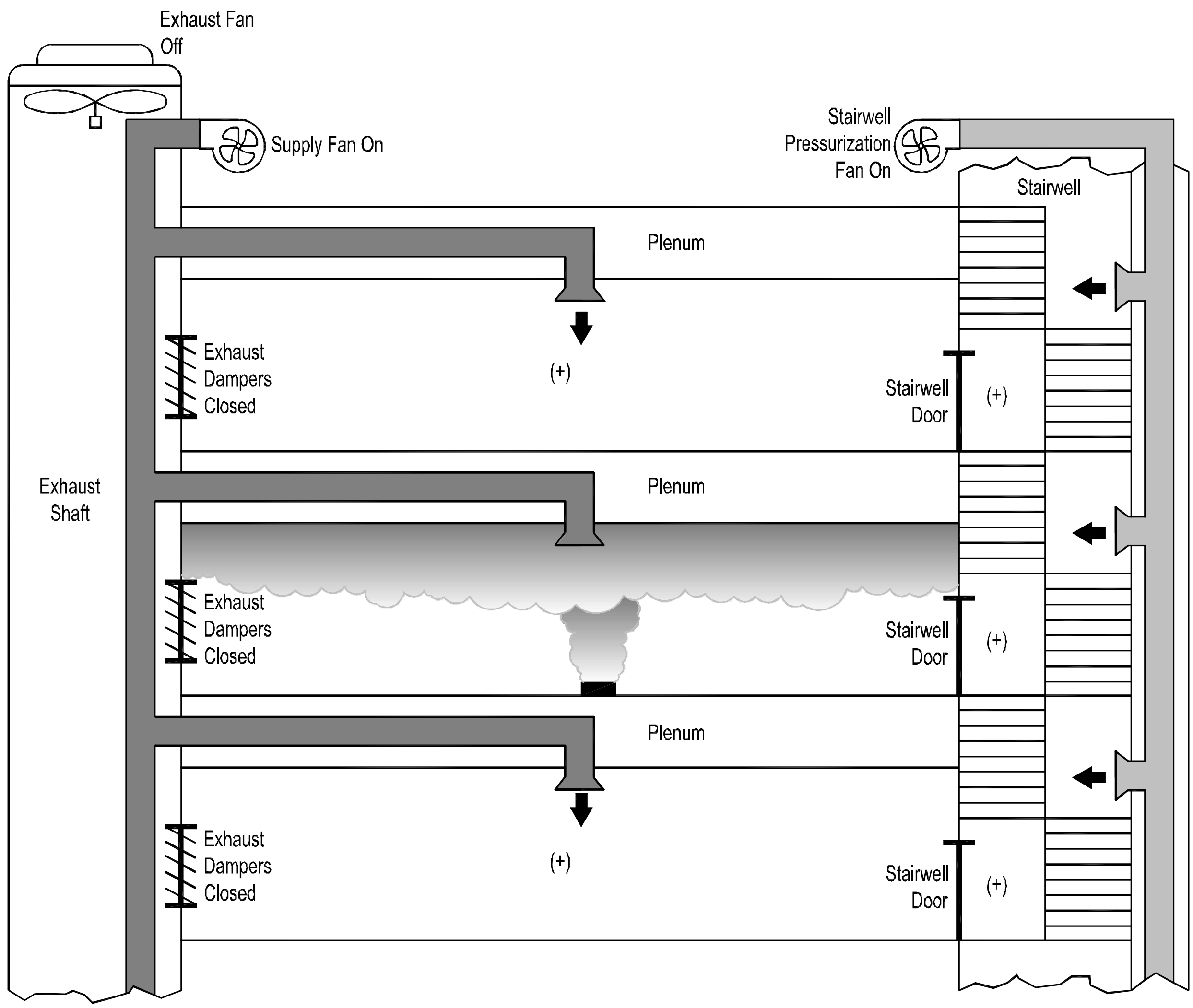

Exhibit 4: Positive Pressure System

4.5.2 NEGATIVE PRESSURE SYSTEMS

Negative pressurization systems typically exhaust the zone of fire origin, either alone or in combination with supply in adjacent zones, to achieve the desired pressure differential as shown in Exhibit 5. This is typically accomplished by shutting down ventilation in adjacent zones and exhausting the zone of fire origin. This type of system is beneficial in that it removes the smoke directly from the building, improving conditions within the fire zone and within the building as a whole.

Negative pressure systems are sometimes referred to as smoke purging, smoke exhaust, smoke removal, or smoke extraction. When used during a fire event, this approach is often referred to as dilution. Since pressurization smoke-control systems use air pressure created by fan(s) to control smoke movement, they can be designed to overcome most of the problems associated with traditional smoke-control methods as discussed in Section 5.0.

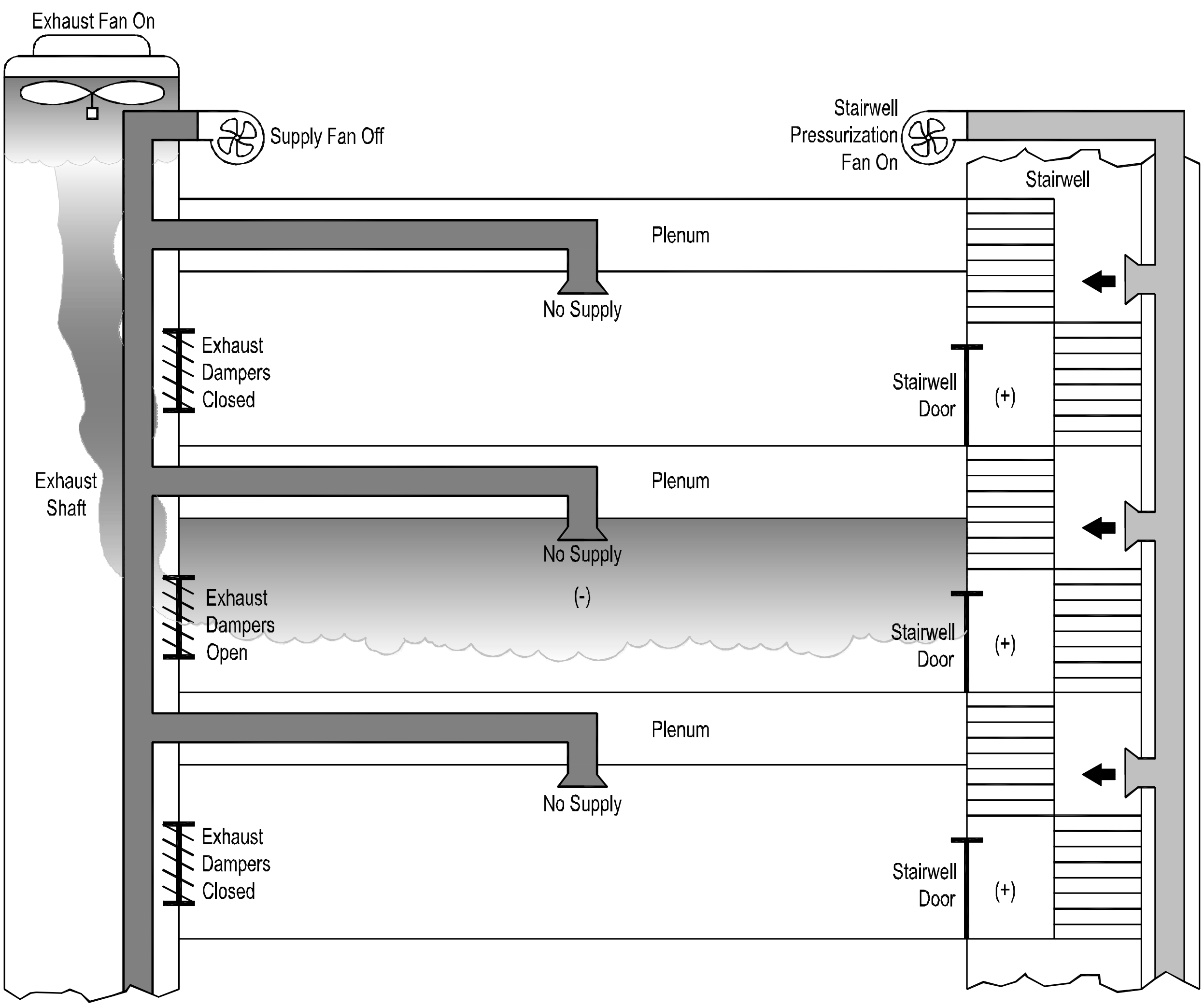

Exhibit 5: Negative Pressure System

5.0 FACTORS AFFECTING SMOKE MOVEMENT

The performance of a smoke-control system can be impacted by a number of factors including: stack effect, wind effect, air movement caused by the building's HVAC systems, temperatures associated with the fire itself (buoyancy), and climate effects. Generally, in a fire situation, movement of smoke will be caused by a combination of these forces. These factors are briefly described as follows.

5.1 STACK EFFECT

When it is cold outside, there is often an upward movement of air within building shafts such as stairwells, elevator shafts, dumbwaiter shafts, mechanical shafts, or mail chutes. This is referred to as normal stack effect. When the outside air is warmer than the building air, a downward movement of air frequently exists in the shafts. The magnitude of the stack effect induced airflow is directly dependent on the magnitude of the temperature differential between the building and the outside as well as the height of the building.

5.2 WIND EFFECT

The effect of wind on a building is influenced by wind speed and direction, building shape, building height, and other nearby buildings. Buildings that are exposed to the wind, without significant obstructions, experience a positive wind pressure on the wall facing the wind and a negative wind pressure on the other three faces. Wind generally acts to promote horizontal, rather than vertical air movement through a building, resulting in smoke spread from the windward side to the leeward side of the building.

5.3 HVAC SYSTEMS

HVAC systems that are not shut down during a fire will transport smoke to every area that it serves, thus endangering life in all those areas. The HVAC system also supplies fresh air to the fire space, which aids combustion. HVAC ductwork systems are often equipped with duct detectors that shut down the associated fans in an effort to limit smoke spread via the fan. However, the ductwork system may provide another avenue for smoke to spread from floor-to-floor, particularly if the ductwork contains fire dampers rather than smoke dampers. Smoke temperatures may not be sufficient enough to cause closure of the dampers, resulting in the movement of smoke past the open fire damper and through the HVAC duct system.

5.4 BOUYANCY (TEMPERATURE EFFECTS)

For an unsprinklered building, buoyancy of hot fire gases can be a significant contributor to smoke movement through a building. Smoke will form a layer in the upper part of the fire compartment and adjacent spaces, and spread vertically via openings to adjacent areas and floors above. For a sprinklered fire, the water spray will cool the hot gases upon activation reducing these buoyant forces. The momentum of the water spray will also stir the smoke layer, resulting in a more uniform smoke concentration within the room.

5.5 CLIMATE EFFECTS

Fans for a smoke-control system shall be provided with outside air for pressurization purposes. In some climates, the outside air can be so cold that drawing it directly inside the building can damage the building's interior (i.e., freeze pipes or damage temperature sensitive equipment). In this case, a preheater may need to be installed on the air inlet. The smoke-control system does not have to control the heater as closely as one in an HVAC system, since maintaining comfort levels is not an issue. It simply has to make sure that the air being sent into the area is not going to damage the building's interior.

6.0 EQUIPMENT USED FOR SMOKE-CONTROL

All equipment (i.e., fans, ducts, dampers, etc.) that is to be used for the purpose of smoke-control shall be suitable for their intended use and the temperatures that they are likely to experience. Equipment shall be designed or modified to provide the required smoke-control operation and shall have the highest priority over all other control modes associated with the equipment.

6.1 DEDICATED AND NON-DEDICATED EQUIPMENT

The equipment used for smoke-control shall be designated as either dedicated or non-dedicated. Dedicated equipment is used for the sole purpose of providing smoke-control, and upon activation, the equipment operates only to perform the smoke-control function. Non-dedicated equipment shares equipment with other system(s), such as building HVAC system, and upon activation causes the HVAC system to change its mode of operation in order to achieve the smoke-control objective. In most cases, a building will have both dedicated and non-dedicated equipment.

Dedicated equipment is less likely to be modified over the life of the building. Operation and control of dedicated equipment is relatively simple because they serve only one purpose and do not rely on or impact other building systems. However, dedicated equipment typically requires additional space, and problems may go undiscovered between the required weekly self-tests or maintenance activities. Examples of dedicated equipment are stair pressurization fans and atrium smoke exhaust fans.

Non-dedicated equipment is more likely to be maintained, and they require less space because the equipment serves multiple purposes. However, the system controls may become quite elaborate, and any modifications made to the shared HVAC equipment can affect the smoke-control functionality. An example of non-dedicated equipment is an air handler supply fan used to positively pressurize a smoke-control zone.

6.2 SELECTING FANS AND DUCTWORK

The fans and ductwork used in the smoke-control system must be capable of providing the amount of air pressure required for each smoke-control zone. In a nondedicated system, this may mean that you need to install fans that have a higher capacity than the HVAC system calls for. The ducts must be capable of handling the pressurization (or the depressurization for the fire zone's return duct) that the smoke-control system will exert. Both the fans and ducts should meet the requirements stated in NFPA 90A, Standard for the Installation of Air Conditioning and Ventilating Systems.

System fans must be able to reach their desired state or operational mode in 60 seconds from when the component receives the signal. Each fan must be equipped with a contact to provide feedback to the smoke-control system to indicate that the fan is operating correctly.

6.3 SELECTING DAMPERS

The smoke dampers installed to protect openings in smoke barriers or used as safety-related dampers in engineered smoke-control systems shall meet the requirements of UL 555S, Standard for Smoke Dampers. The dampers listed in this standard are designed to block the movement of smoke when they are fully closed. Where a combination fire/smoke damper is used, it must meet the requirements of both UL 555S and UL 555 Standard for Fire Dampers.

Dampers for a smoke-control system must be able to completely close in 75 seconds from when the component receives the signal. Each damper must be equipped with two contacts to provide feedback to the smoke-control system to indicate the open/closed position of the damper.

7.0 SYSTEM CONTROLS

Fike's CyberCat control panel serves as the single control point for the smoke-control system. It shall coordinate the smoke-control system functions of the fire alarm system and the Firefighter's Smoke Control Station (FSCS), with the operation of the building HVAC systems and dedicated smoke-control equipment. HVAC system controls shall be designed or modified to give the smoke-control mode the highest priority over all other control modes.

7.1 AUTOMATIC ACTIVATION

Automatic activation of the smoke-control system shall be initiated in response to signals received from a single smoke detector, heat detector, waterflow switch, or a combination of these devices. For large spaces where stratification may occur (e.g., malls, atria, etc.), beam type smoke detectors shall be used. Automatic activation shall have the highest priority over all other sources of automatic control within the building.

7.2 MANUAL ACTIVATION

Manual activation and deactivation of the smoke-control system is accomplished via smoke-control override switches. The override switches shall give the responding fire fighting personnel total control capabilities over the operation of the smoke-control system(s). Override switches can be incorporated either into the CyberCat control panel or into the associated Fire Fighters' Smoke-control Station (FSCS) and shall be clearly marked to indicate the zone and/or function served.

Manual activation and deactivation via an override switch shall have the highest priority over all other sources of automatic or manual control(s) within the building. The override switch must be able to override:

- Hand/off/auto switches
- Local start/stop switches on fan motor
- Freeze detection devices
- Duct smoke detectors

The override switch must not override any safety controls associated with the smoke-control equipment, such as:

- Electrical overload protection
- Maintenance personnel's electrical disconnects
- High limit pressure switches
- Any fire/smoke damper control as required by UL33, Standard for heat responsive links for fire protection service, or UL555S, Standard for leakage rated damper for use in smoke-control systems.

In non-dedicated systems, local motor controller's hand/off/auto (HOA) switch can remain in-circuit with the smoke-control initiating component, provided that the HOA switch is located in a locked room accessible only to authorized personnel. Activation of the HOA switch must sound an alarm at the building's main control center.

7.2.1 FIREFIGHTERS' SMOKE CONTROL STATION (FSCS)

A firefighters' smoke-control station (FSCS) shall be provided for all smoke-control systems. The FSCS can be any of the following:

- The local fire alarm control panel
- The building's main control center
- A separate annunciator - Refer to Fike document 06-447 "FSCS Graphic Panel Product Manual" for more details.
- The equivalent

7.3 MANUAL FIRE ALARM PULL STATIONS

Manual fire alarm pull stations shall NOT be used to activate smoke-control systems. This is due to the potential for the alarm signal to be initiated from outside the fire zone, which could cause the wrong smoke-control strategy to be initiated. The exception to this rule is where the response of the smoke-control system is identical for all zones, such as stairwell or elevator hoistway pressurization systems. Manual fire alarm pull stations can be used to cause doors in smoke barrier walls to close.

7.4 STAIRWELL PRESSURIZATION SYSTEM CONTROLS

In most cases, all stairwell pressurization systems will start upon activation of any zone of the building fire alarm system. The only exception is where an engineering analysis determines that activation of all stairwell pressurization systems is not required.

In order to prevent smoke from being introduced into the stairwell from the outside of the building during a fire situation, a smoke detector shall be installed in the air supply to the pressurized stairwell. Upon detector activation, the air supply fan will stop. Special consideration must be given to the location of the supply fan to prevent smoke from being pulled into the stairwell from the exterior of the building, through the fan intake.

A manual override switch shall be provided either in the CyberCat control panel or the FSCS that will allow activation and deactivation of the stairwell pressurization system. This switch can be used to restart the stairwell pressurization system fan(s) even after they have been shutdown by the air intake smoke detector.

7.5 ZONED SMOKE-CONTROL SYSTEM CONTROLS

Zoned smoke-control systems shall be automatically activated from devices connected to the fire alarm system that respond to products of combustion (i.e., smoke detectors, waterflow switches, or heat detectors). The zoning of the fire alarm devices shall coincide with the smoke-control zones. This requirement reduces the possibility that a smoke-control system(s) may be activated by a device located in a separate smoke-control zone.

A manual override switch shall be provided either in the CyberCat control panel or the FSCS that will allow activation of the zone's smoke-control system. Key-operated manual override switches located within the associated smoke zone can also be used to activate the zone's smoke-control system. All manual override switches used for smoke-control shall be clearly marked to identify the zone and switch function.

8.0 DESIGN CONSIDERATIONS

An extensive amount of information must be considered when designing a smoke-control system. A complete engineering evaluation of the building spaces, HVAC equipment, fire alarm, and suppression systems that are being used in the building must be performed since each of these components is critical to the effectiveness of the system. In most cases; the operation of these systems must be coordinated with other construction trades (i.e., Architect, HVAC engineer, etc.) during the design phase of the project in order to provide an effective smoke-control system for the building.

For these reasons, it is strongly recommended that a Fire Protection Engineer (FPE) be part of the design team at the start of the project. It will be the responsibility of the FPE to work with the building owner and AHJ to determine the design objective(s) and acceptance criteria for the smoke-control system up front. Once the design objective has been determined, the FPE will prepare a *Smoke-control Strategy* for the project.

In addition, the FPE must oversee the implementation of the smoke-control design with other trades during the course of the project to assure its proper implementation and overall effectiveness.

8.1 SMOKE-CONTROL STRATEGY

The smoke-control strategy may be in the form of a document often called a rational analysis. In English, it tells how the smoke-control system is supposed to work. It will include at least three key items.

One is the sequence of operation. It defines step by step how the fans and dampers should operate: Shut off fan A, close damper 32, turn on fan F. This may include a sequence of operation specifying how the system is restored to normal operation after a fire event has ended.

The second key item is a detail as to the action caused by the various fire alarm initiating devices. For instance, manual stations very often will start purge or pressurization sequences in stairwells, atria, etc. Smoke detectors may initiate a floor-by-floor sequence designed to contain the smoke at the floor of incidence.

The third key to the rational analysis has to do with positive feedback of the smoke-control operations. The strategy usually will provide some level of detail as to how quickly fans and dampers should operate. For instance, it may be necessary to delay starting a fan until its associated damper is partially or fully open in order to prevent damage to equipment. This will be specified in terms of actual operation and/or feedback at the Firefighters' Smoke-control Station (FSCS).

8.2 COORDINATING WITH OTHER SYSTEMS

The engineer must also keep in mind the effects that the smoke-control system can have on other systems installed within the building. For instance, activation of a smoke-control system in a zone that has a gaseous suppression system should not be vented (depressurized). Doing so, would reduce the systems ability to suppress the fire. Other specialized areas, such as hospitals or animal labs, may not be able to be pressurized due to the risk of contaminating surrounding areas. In addition, where multiple smoke-control systems operate simultaneously within a building, each system must be designed to meet its individual design objectives.

8.3 DEFINING SMOKE-CONTROL ZONES

When a zoned smoke-control approach is used, the smoke-control zones, in most cases, coincide with the fire control zones. Laying out the smoke-control zones in this manner will help to ensure the ability of the smoke-control barriers to inhibit smoke movement. Should the division of smoke zones differ from the fire control zones, a floor or several floors of the building can be a single smoke-control zone, or one floor can be broken into several smoke-control zones. In general, the overall size of the smoke zones shall be kept small so as to allow timely evacuation from the zones and to reduce the quantity of air required to pressurize the adjacent spaces.

Exhibit 6 shows several different possibilities for defining smoke-control zones. The smoke zone is indicated by a minus (-) sign and pressurized spaces are indicated by a plus (+) sign. Each floor can be a smoke-control zone (A, B) or a smoke zone can consist of more than one floor (C, D). All of the non smoke zones in a building may be pressurized as in (A) and (C), or only non smoke zones adjacent to the smoke zone (B) and (D). A smoke zone can be limited to a part of a floor (E).

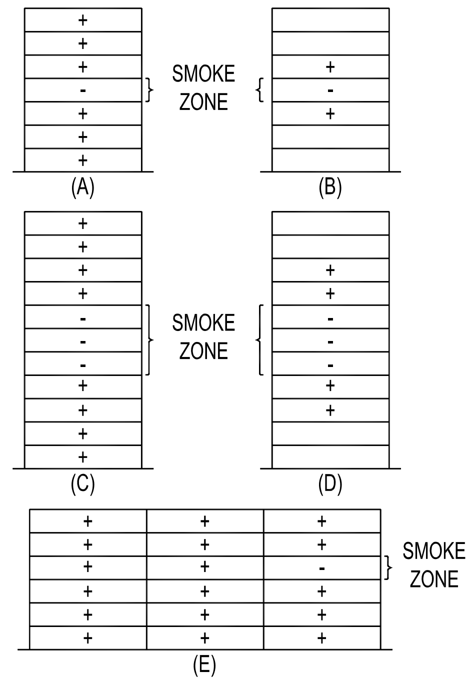

Exhibit 6: Smoke-control Zone Arrangements

If the smoke-control system is non-dedicated, the layout of the HVAC system(s) shall be taken into consideration when defining the smoke-control zones. Areas served by a common HVAC system should be included in the same smoke-control zone to make coordinating the two systems simpler. In a fire situation, all HVAC fans serving the affected smoke-control zone(s) shall be shut down and all smoke dampers installed in the associated duct work shall close to maintain the smoke-control barrier.

ⓘ **Note:** When a zoned smoke-control design approach is used, each stairwell, smoke refuge area, elevator hoistway, and elevator lobby shall be considered as a separate zone.

9.0 SYSTEM RESPONSE TIMES

Upon activation of a smoke-control input, either automatic from a detector or manual from an override switch, the CyberCat control panel shall initiate the smoke-control functions within 10 seconds. If multiple input signals are received from more than one smoke zone to initiate the smoke-control strategy, the CyberCat system shall continue operation in the mode determined by the first input received. Exhibits 7 through 9 show the typical system response times for automatic activation, manual activation, and the weekly self-test.

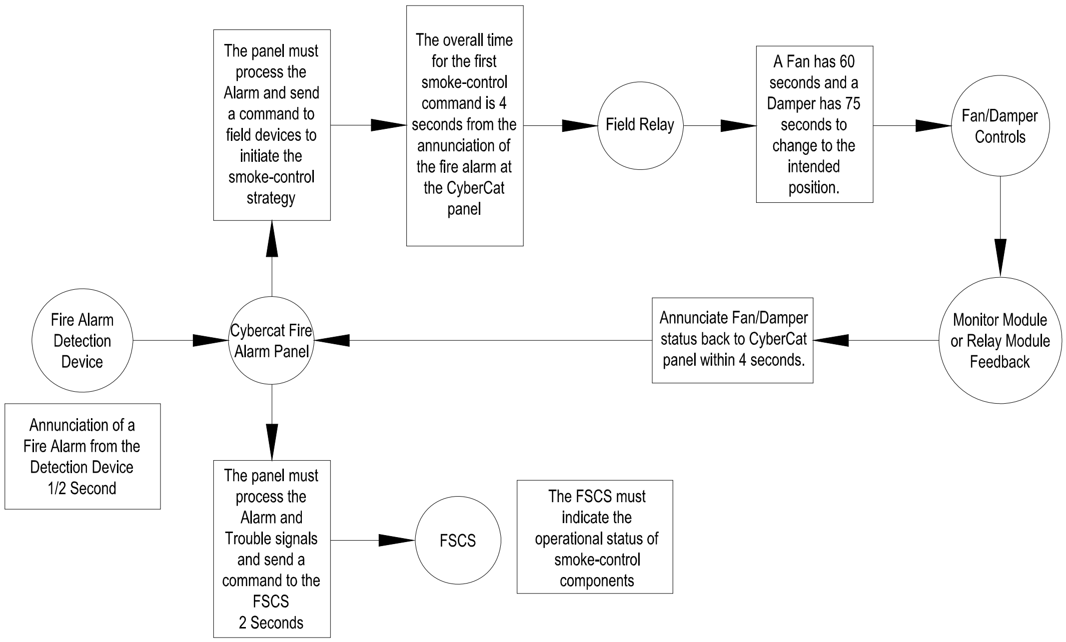

Exhibit 7: Automatic Smoke-Control Command Timing

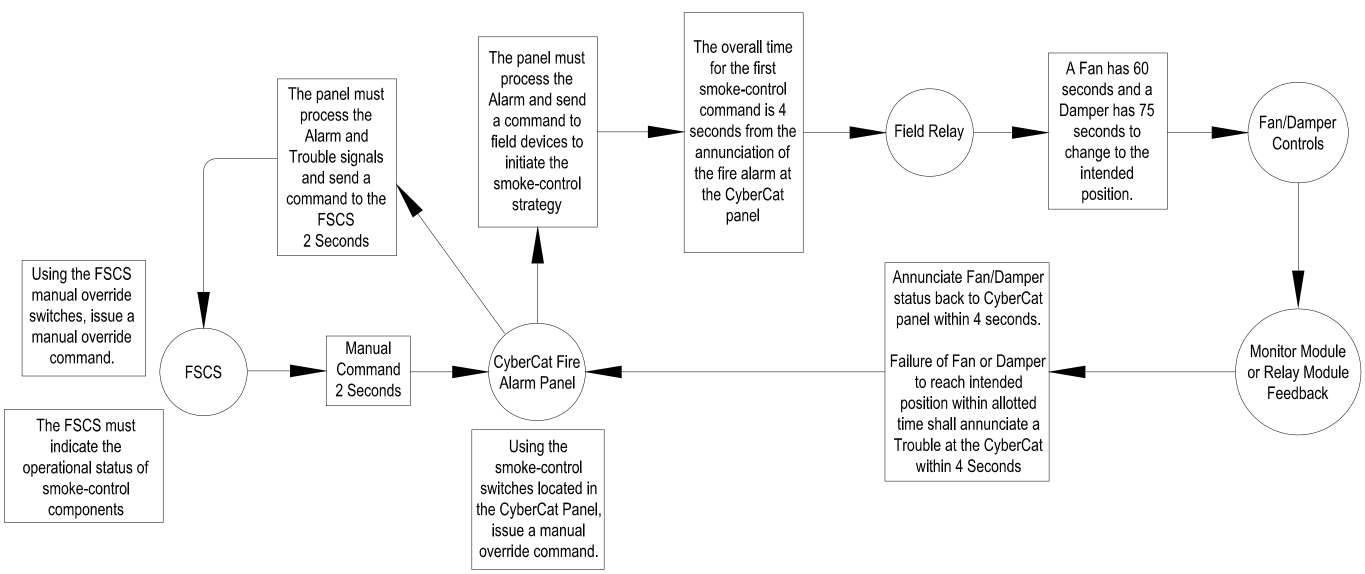

Exhibit 8: Manual Smoke-Control Command Timing

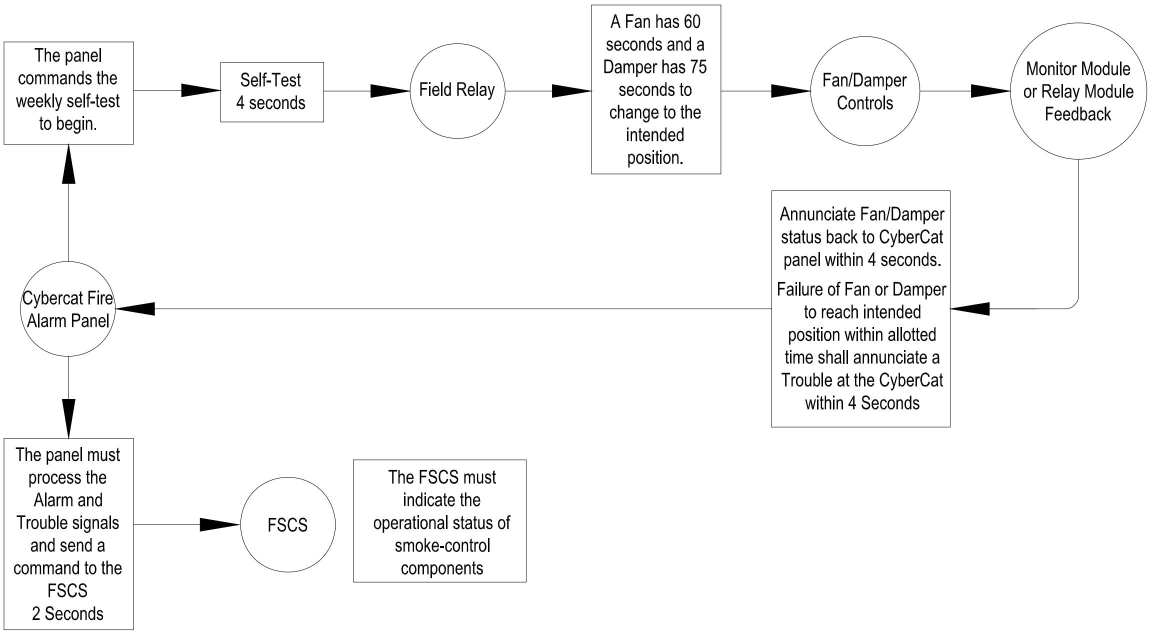

Exhibit 9: Weekly Dedicated Self-Test Command Timing

10.0 SYSTEM RESPONSE SEQUENCE

The CyberCat panel shall activate individual smoke-control components (based on programming) in a sequence necessary to prevent physical damage to the fans, dampers, and other equipment. The time necessary for individual smoke-control components to achieve their desired state or operational mode when the component is activated shall not exceed 60 seconds for fan operation and 75 seconds for completion of damper travel.

Example: If a damper is required to open before a fan starts, the total response time could be up to 135 seconds for operation (i.e., 75 seconds for the damper to open, plus 60 seconds for the fan to start). Time to annunciate the device activation (10 seconds per device) is added to this time.

STOP WARNING

If dampers in the ductwork are not opened before the associated fan is started, the resulting pressure build-up could cause the ductwork to explode.

11.0 END-TO-END VERIFICATION

Each smoke-control system component shall be equipped with a means of verifying correct operation when activated, such as during smoke control, testing, or manual override operations. Positive confirmation of fan operation should be by means of duct pressure, airflow, or equivalent sensors. Damper operation should be confirmed by contact, proximity, or equivalent sensors.

If the smoke-control system fails to operate as intended upon activation, a fault condition shall be indicated at the control panel and at the FSCS panel within 200 seconds. Positive confirmation must be received from each device associated with the smoke-control system.

12.0 WEEKLY SELF-TEST

Operational capability of dedicated smoke-control equipment shall be verified by the CyberCat control panel weekly using the panel's integral self-test feature. If the system fails to operate as intended upon activation, a fault condition shall be indicated at the control panel and at the FSCS within 200 seconds. Positive confirmation must be received from each device associated with the smoke-control system. The self-test function is not required for non-dedicated systems.

13.0 OPERATIONAL/ACCEPTANCE TESTING

The smoke-control system shall be tested against the smoke-control strategy developed for your specific project during the design stage. A testing plan and acceptance criteria should be established and agreed upon by all parties associated with the implementation and operation of the smoke-control system. Prior to testing, the operation and completeness of all systems and components associated with the smoke-control system shall be verified. This may include one or more of the following subsystems:

1. Fire Alarm System
2. Energy Management System
3. Building Management System
4. HVAC Equipment
5. Electrical Equipment
6. Temperature Control Systems
7. Normal Power
8. Standby Power
9. Automatic Suppression Systems
10. Automatic operating doors and closers
11. Dedicated smoke-control systems
12. Nondedicated smoke-control systems
13. Emergency elevator operation

14.0 MODIFICATIONS

Reacceptance testing is required after any change, addition or deletion of system component; after any modification, repair or adjustment to system hardware or wiring; or after any change to smoke-control zone boundaries since the last test. All components, circuits, system operations, or software functions known to be affected by a change must be 100% tested. In addition, to ensure that other operations are not inadvertently affected, at least 10% of initiating devices that are not directly affected by the change, up to a maximum of 50 devices, must also be tested and proper system operation verified.

15.0 FIKE'S SMOKE-CONTROL SYSTEM COMPONENTS

This section provides an overview of the Fike smoke-control system and describes the features of each component and how it is used as part of the smoke-control system. The following components are described:

- 10-066, CyberCat 254 Fire Alarm Control Panel
- 10-064, CyberCat 1016 Fire Alarm Control Panel
- 10-2658, Six-Zone Smoke-control Module
- 10-2659, Input/Output Control Module
- 10-1XX, FSCS (Firefighter's Smoke-control Station)
- 55-043, Relay Module
- 55-045, Mini Monitor Module
- 55-041, Monitor Module (4 inch)

Exhibit 10 shows the components that are used in the smoke-control system and how they are connected together.

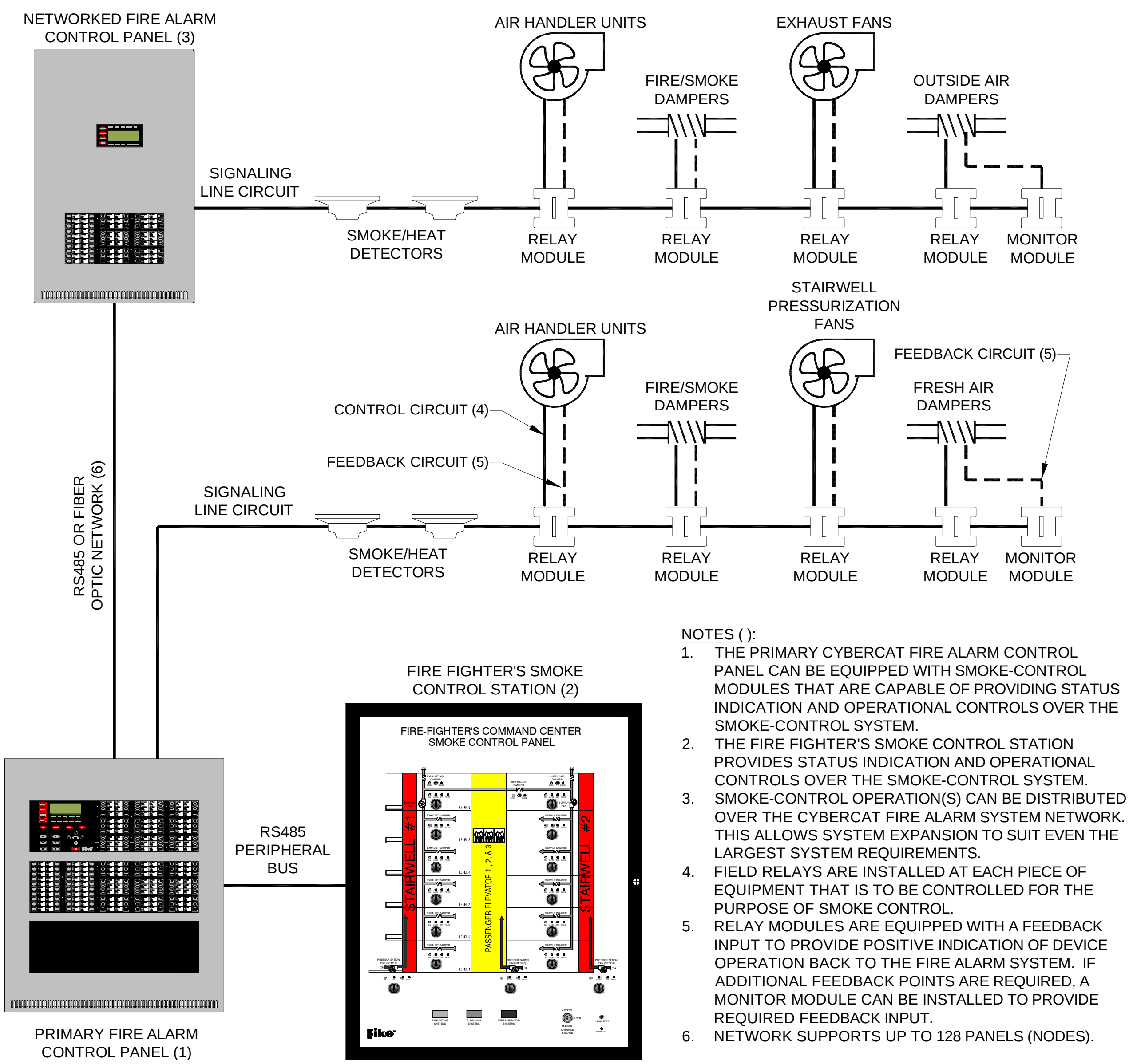

Exhibit 10: Smoke-control Application Overview

15.1 CYBERCAT FIRE ALARM CONTROL PANEL (254 & 1016)

The CyberCat fire alarm control panel (Exhibit 11) provides a single control point for all smoke-control system functions. The panel shall coordinate both the automatic and manual smoke-control functions provided by the fire alarm system, Firefighters' Smoke-control Station (FSCS), and any other related systems associated with the operation of the smoke-control equipment (both dedicated and non-dedicated).

The CyberCat can be used in dedicated or non-dedicated smoke-control applications. The panel provides options for mounting smoke-control switch cards inside panel enclosure. These modules provide manual control capability over the smoke-control system equipment. Refer to Fike document 06-326 "CyberCat Product Manual" for more details.

When the CyberCat panel is used for smoke-control, it performs the following functions:

- Receives fire alarms from the system input devices and initiates the automatic smoke-control strategy.
- Receives manual override switch inputs from the FSCS and integrated smoke-control switches and initiates the smoke-control override.
- Performs weekly self-tests on all dedicated components in the smoke-control system.
- Monitors field components used in the smoke-control system and signals the FSCS when there is a communication fault or output override.

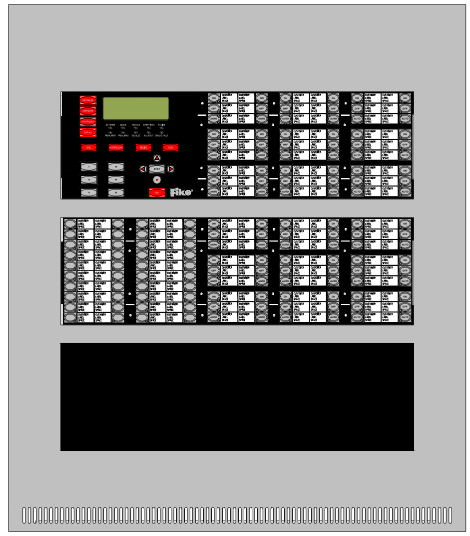

Exhibit 11: CyberCat 1016 Control Panel

Features

- Communicates with other CyberCat panels over an RS485 or fiber optic network data circuit (128 panels max.).
- 253 user defined zones
- 80 character, backlit liquid crystal display (LCD)
- 3200 event history buffer
- CyberCat 254 (P/N 10-066) provides one addressable loop capable of supporting 254 devices.
- CyberCat 1016 (P/N 10-064) provides two addressable loops (expandable to four) capable of supporting 254 devices each.
- True peer-to-peer digital protocol communications
- Communicates with up to 31 peripheral devices (including Firefighter's Smoke-control Station) over an RS485 bus.
- Digital Alarm Communicator Transmitter (DACT) option
- 24VDC power output to field devices
- 120/240V AC power input

15.2 SIX ZONE SMOKE-CONTROL MODULE

The 10-2658, six zone smoke-control module (Exhibit 12) mounts inside the CyberCat enclosure and provides ON-OFF-AUTO control capability over the smoke-control system components, such as; stairway pressurization fans; smoke exhaust fans; supply fans; return fans; exhaust fans; elevator shaft fans; and other equipment used or intended for smoke-control purposes. Refer to Fike document 06-444 “Six Zone Smoke-control Module Product Manual” for more details.

Features

- Tabular based display that incorporates 6 green “ON”, 6 red “OFF”, 6 white “NORMAL”, 6 yellow “FAULT” LEDs for smoke-control equipment status indication.
- Incorporates 18 momentary touch-pad switches, each capable of initiating manual override over the smoke-control equipment. When pressed, each switch is capabe of overriding up to 25 addressable relays used for smoke-control functions.
- “AUTO” switch returns the addressabe relays back to configured mode of operation as outlined/driven by automatic (panel) functions.
- Space for inserting custom label to identify switch function.
- Communicates on the associated control panel’s RS485 peripheral bus.
- 24vdc power input from associated control panel or battery backed 24VDC, regulated, power-limited, power supply listed for Fire Protective Signaling System use.

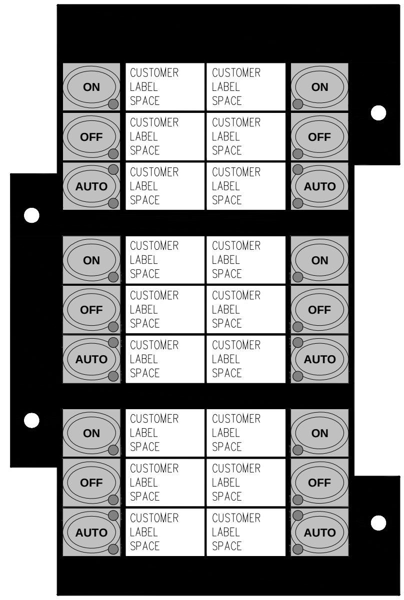

Exhibit 12: Six Zone Smoke-control Module

15.3 INPUT/OUTPUT CONTROL MODULE

The 10-2659, Input/Output Control Module (Exhibit 13) mounts inside the CyberCat enclosure and provides ON-OFF or OPEN-CLOSE control capability over smoke-control system components, such as; stairwell pressurization fans; elevator shaft pressurization fans; dampers; and other equipment used or intended for smoke-control purposes. Refer to Fike document 06-446 "Input/Output Control Module Product Manual" for more details.

Features

- Tabular based display that incorporates 20 red/yellow bi-color LEDs for smoke-control equipment status indication or other user configurable switch functions (i.e., silence, reset, disable, etc.).
- Incorporates 20 momentary touch-pad switches, each capable of initiating manual override over the smoke-control equipment. When pressed, each switch is capabe of overriding up to 25 addressable relays used for smoke-control functions.
- Space for inserting custom label to identify switch function.
- Communicates on the associated control panel's RS485 peripheral bus.
- 24vdc power input from associated control panel or battery backed 24VDC, regulated, power-limited, power supply listed for Fire Protective Signaling System use.

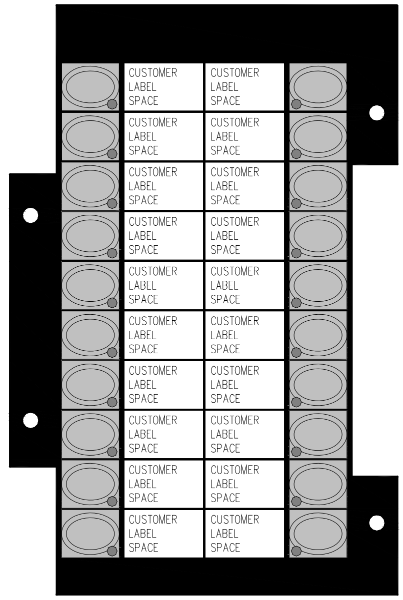

Exhibit 13: Input/Output Control Module

15.4 FIREFIGHTER'S SMOKE-CONTROL STATION (FSCS)

The FSCS graphic panel (Exhibit 14) provides a user-friendly interface to the smoke-control system for responding firefighters' to use to manually control the operation of smoke-control systems (dedicated and nondedicatd).

Each FSCS is custom made to suit the needs of the customer and the project scope. It consists of a lexan viewing window with silk-screened artwork that is designed to graphically depict the physical building arrangement, smoke-control systems and equipment, and the areas of the building served by the equipment. If the graphic layout is too large to fit on a single panel, multiple panels may be used.

LED indicators are used to indicate operational status (i.e., ON-AUTO-OFF, ON-OFF, OPEN-AUTO-CLOSE, OPEN-CLOSE, etc.) of smoke-control equipment. Distinct background colors can be used to highlight critical smoke-control areas like stairways, elevator shafts, main fresh air ducts, and main exhaust ducts.

Switches for manual override control of smoke-control components can be installed in the FSCS or within the associated fire alarm panel to provide a means for responding fire-department personnel to override automatic control of smoke-control equipment.

Refer to Fike document 06-447 "FSCS Graphic Panel Product Manual" for more details.

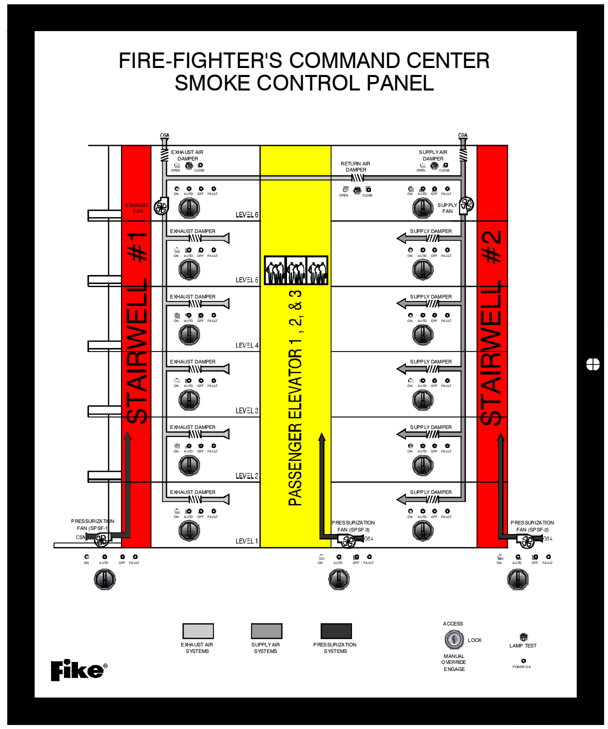

Exhibit 14: FSCS Graphic Panel

Features

- Communicates on the associated control panel's RS485 peripheral bus.
- Local piezo sounds for annunciation of system status changes.
- Access key switch for lock-out of smoke-control switches.
- Immediate visual status of smoke-control components in compact area.
- Bi-directional communication with associated control panel.
- Integrated LED test switch function.
- 24vdc power input from associated control panel or battery backed 24VDC, regulated, power-limited, power supply listed for Fire Protective Signaling System use.

15.5 RELAY MODULE

The 55-043, Relay Module (Exhibit 15) is used to control equipment associated with the smoke-control system (i.e. fans, dampers, AHUs, etc.) when used in conjunction with the CyberCat Fire Alarm Control panel. The module is equipped with an unsupervised dry contact input that can be used to provide positive feedback to the control panel that the system or component has operated correctly (e.g., verification of damper closing). Refer to Fike document 06-326 “CyberCat Product Manual” for more details.

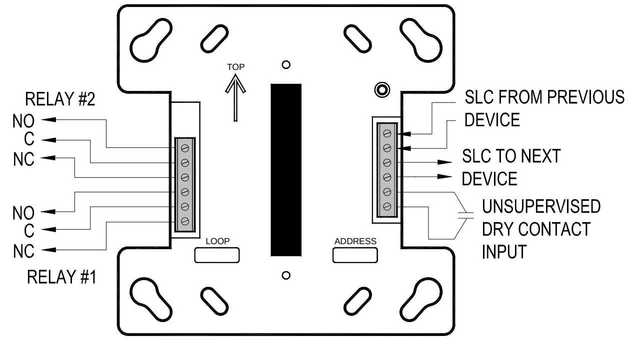

Exhibit 15: Relay Module

Features

- Communicates on the associated control panel’s signaling line circuit (SLC).
- Two sets of form-C contacts that switch together (DPDT)
- Normally open or closed dry contact input for smoke-control feed-back (unsupervised).
- Relays can be configured to turn ON or OFF to suit the smoke strategy.

15.6 MONITOR MODULES

The 55-041 (4-inch) and 55-045 (Mini) Monitor Modules shown in Exhibits 16 and 17 are used to provide positive feedback to the control panel that the equipment associated with the smoke-control system (i.e. fans, dampers, AHUs, etc.) has operated correctly. Refer to Fike document 06-326 “CyberCat Product Manual” for more details.

Features

- Communicates on the associated control panel’s signaling line circuit (SLC).
- Monitors normally open or closed dry contact inputs for smoke-control feed-back.

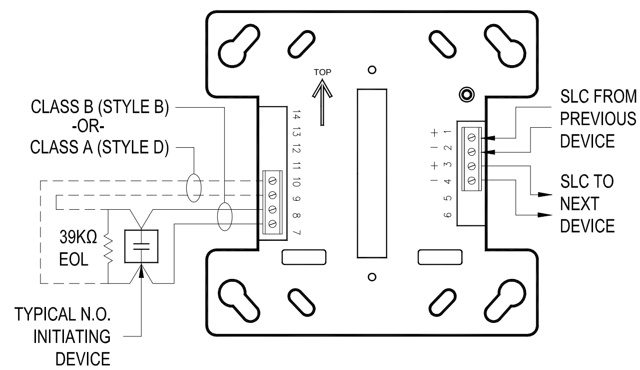

Exhibit 16: Monitor Module

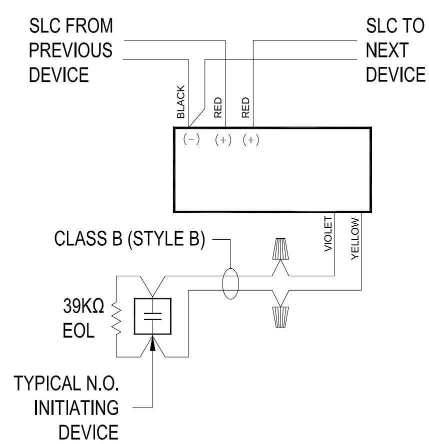

Exhibit 17: Mini Monitor Module

16.0 APPLICATION EXAMPLES

To help you better understand how to apply the equipment used in a Fike Smoke-control System, this section shows three approved smoke-control examples: High-Rise building; Warehouse; and a Single Story Shopping Mall. Keep in mind that these are only examples. The number and arrangement of components in your system may differ. You must make sure that your smoke-control system complies with all UL 864 UUKL Ninth Edition requirements and restrictions.

16.1 SMOKE-CONTROL APPLICATION OVERVIEW

The CyberCat control panel shall provide the automatic detection and control for Fike's smoke-control system. Addressable detection devices (i.e., detectors, waterflow switches, etc.) connected to the CyberCat's SLC circuits shall be installed in each smoke-control zone. Upon device activation, the smoke-control strategy for the building and/or zone is initiated.

Addressable field relays must be installed at each piece of equipment (i.e., fans, dampers, etc.) to initiate the required smoke-control function(s). NFPA 72, National Fire Alarm Code requires that the relay be located within 3 ft. (1 m) of the controlled circuit or device. For example: if a fan is being controlled by a motor controller located remotely from the fan, the relay field relay should be located within 3 ft. (1 m) of the motor controller, not the fan itself.

Monitor modules must be installed at each piece of equipment to provide positive feedback of proper equipment operation back to the CyberCat control panel and FSCS panels. For example: damper position indicators (i.e., OPEN or CLOSED) are monitored to indicate the true position of the damper during smoke-control operation.

An FSCS (Firefighter's Smoke-control Station) must be provided for every smoke-control application. It provides a user-friendly interface to the smoke-control system for responding firefighters' to use to manually control the operation of smoke-control systems (dedicated and nondedicatd). LEDs are provided on the FSCS to indicate the operational status of each piece of equipment (e.g., on, off, open, close, etc.) and/or an individual smoke-control zone. Manual override switches are provided for each piece of equipment to allow firefighters to manually override the automatic operation of the equipment used for smoke-control or a single manual override switch can be provided for each smoke-control zone.

16.2 HIGH-RISE BUILDING EXAMPLE

In this application example, zoned smoke-control systems are being employed to manage smoke in a six story high-rise building. Each floor of the building serves as its own smoke-control zone. Both the elevator and stairwell are equipped with pressurization fans and are designated as their own zones. Exhibit 18 only shows three floors of the building to allow better visibility of the system components.

The FSCS layout, shown below, provides manual override switches for each smoke-control zone rather than by individual equipment. This approach will aid firefighters in understanding the activation of the smoke-control system and will prevent activation of the equipment in the wrong sequence.

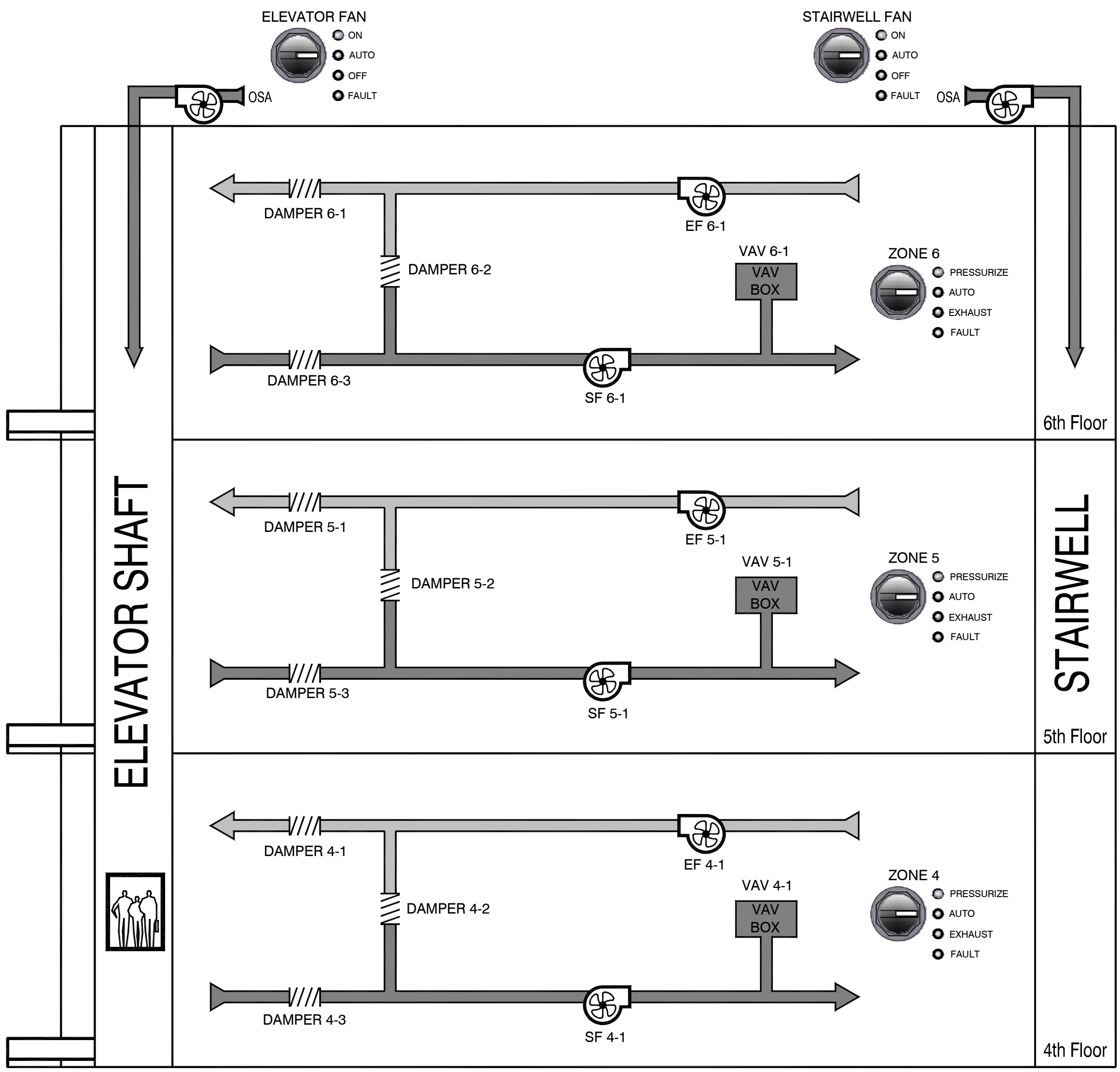

Exhibit 18: High-Rise Building FSCS Layout (Zone Control)

Where control over individual pieces of equipment is deemed necessary, manual override switches shall be provided for each piece of smoke-control equipment as shown in Exhibit 19.

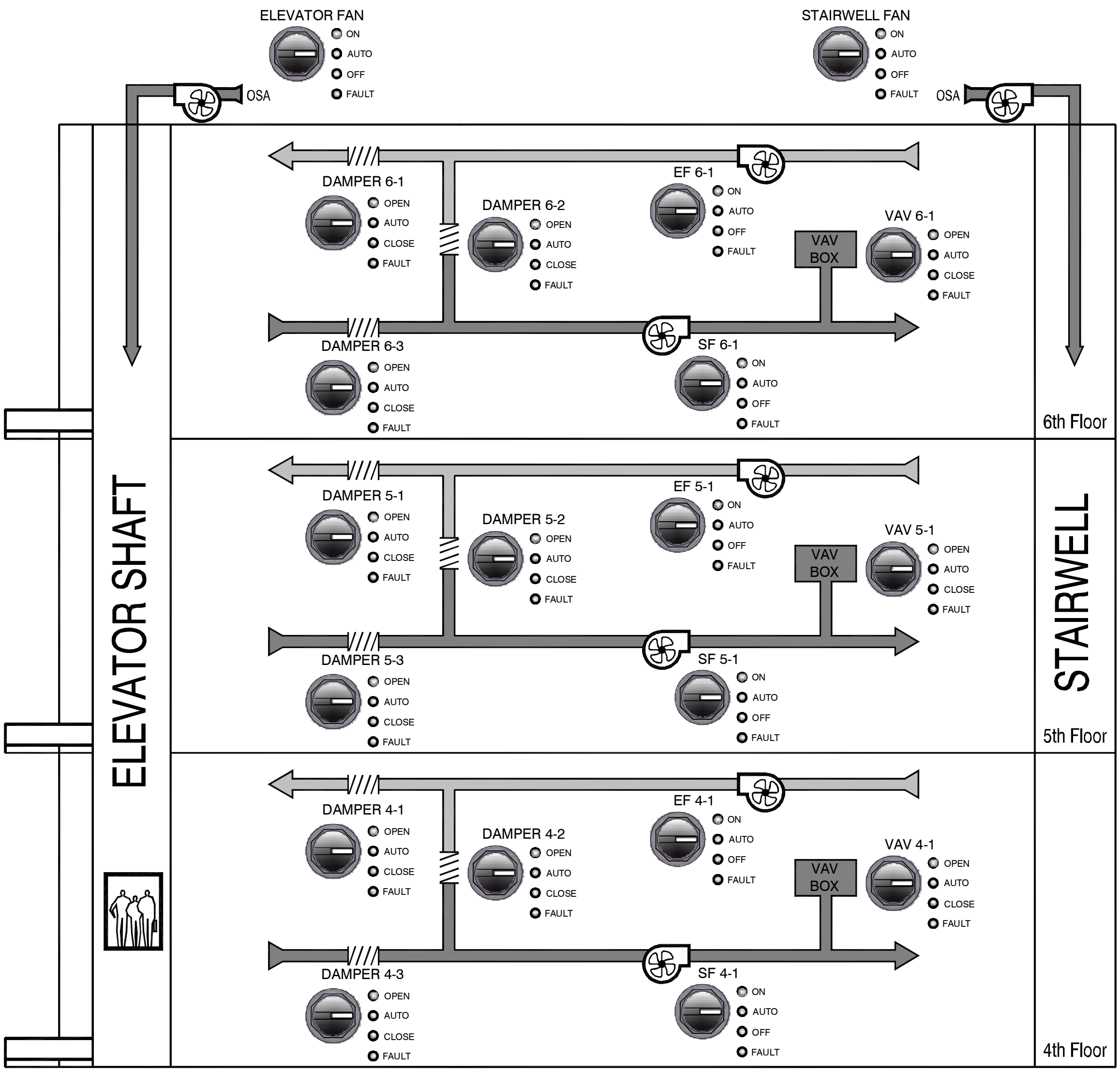

Exhibit 19: High-Rise Building FSCS Layout (Individual Control)

16.2.1 HIGH-RISE BUILDING FIELD DEVICE CONNECTIONS

Exhibit 20 shows the CyberCat control panel and SLC field device connections required for this smoke-control application.

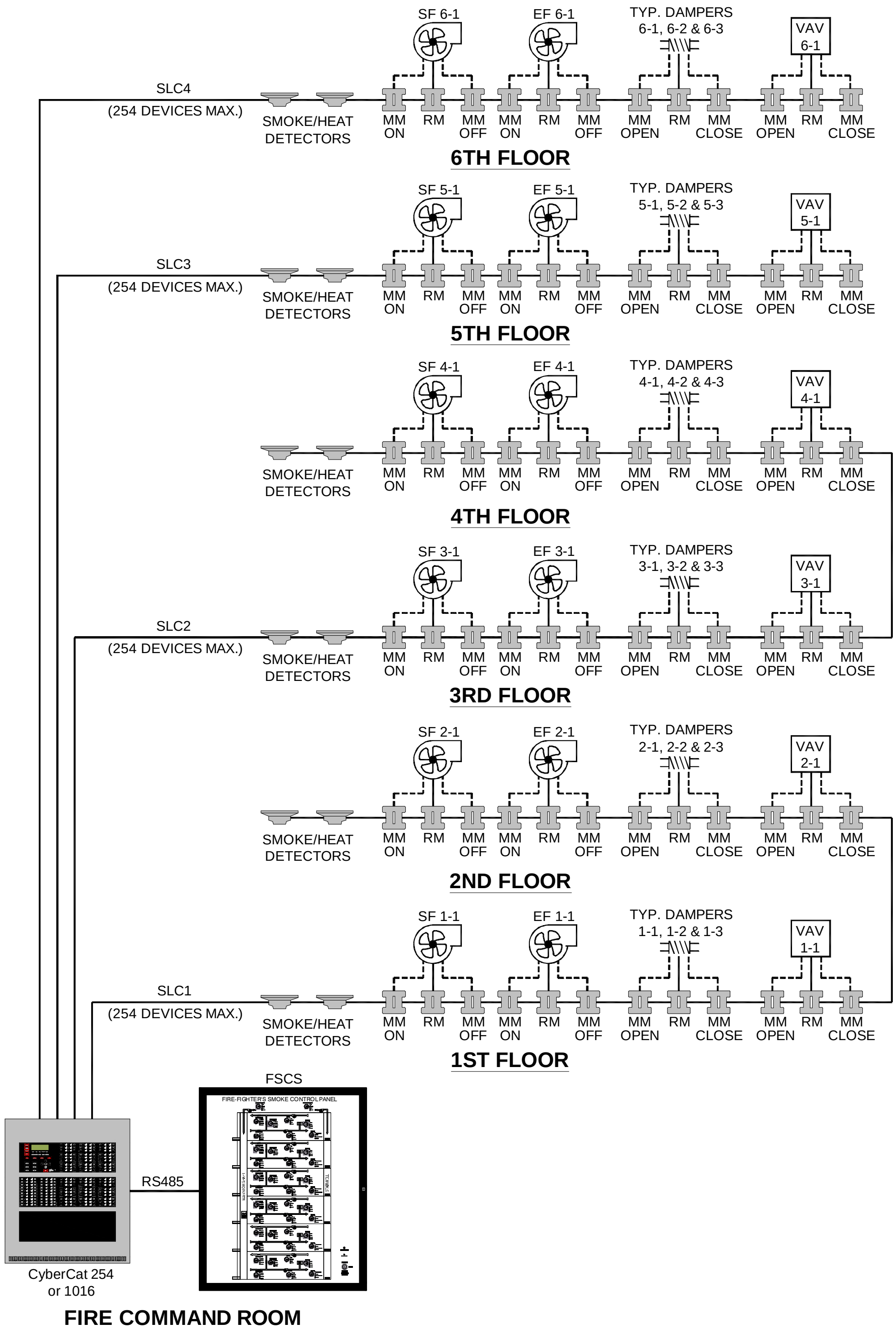

Exhibit 20: High-Rise Building Field Device Connections

16.2.2 HIGH-RISE BUILDING SYSTEM ACTIVATION

Exhibit 21 shows the smoke-control system in the activate state due to the detection of smoke on the 5th floor. The smoke-control strategy requires the fire floor (5th) to depressurize and the two adjacent floors (4th and 6th) to pressurize. The elevator and stairwell pressurization fans both turn on to prevent smoke from entering.

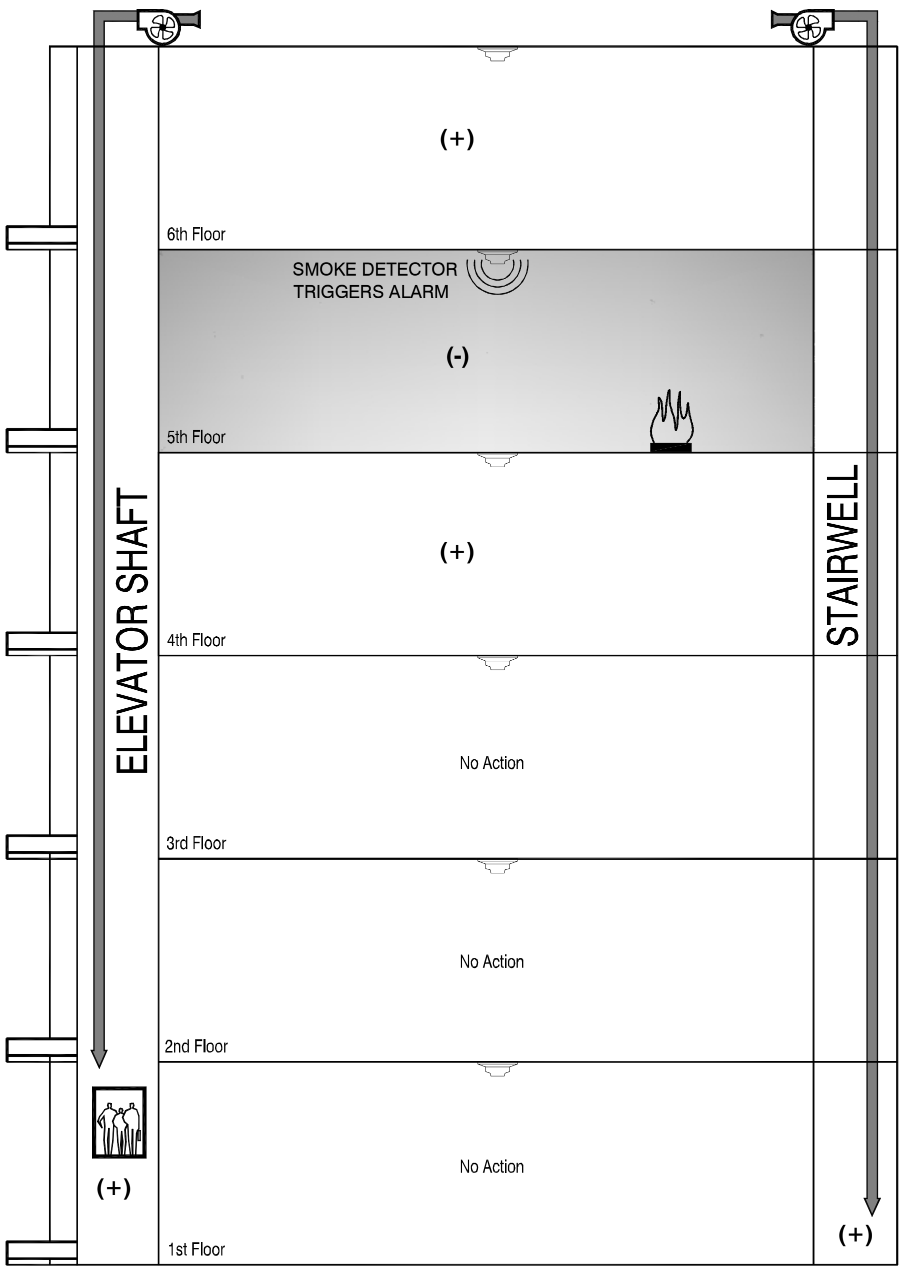

Exhibit 21: High-Rise Floor Above/Floor Below Pressurization (+)

16.3 WAREHOUSE BUILDING EXAMPLE

In this application example, a large warehouse is divided into two separate smoke-control zones, with each having its own smoke detector, roof top unit and exhaust fan (Ehibit 22).

The FSCS layout, shown below, provides individual control switches for each piece of smoke-control equipment. An alternative would be to provide a single control switch per zone.

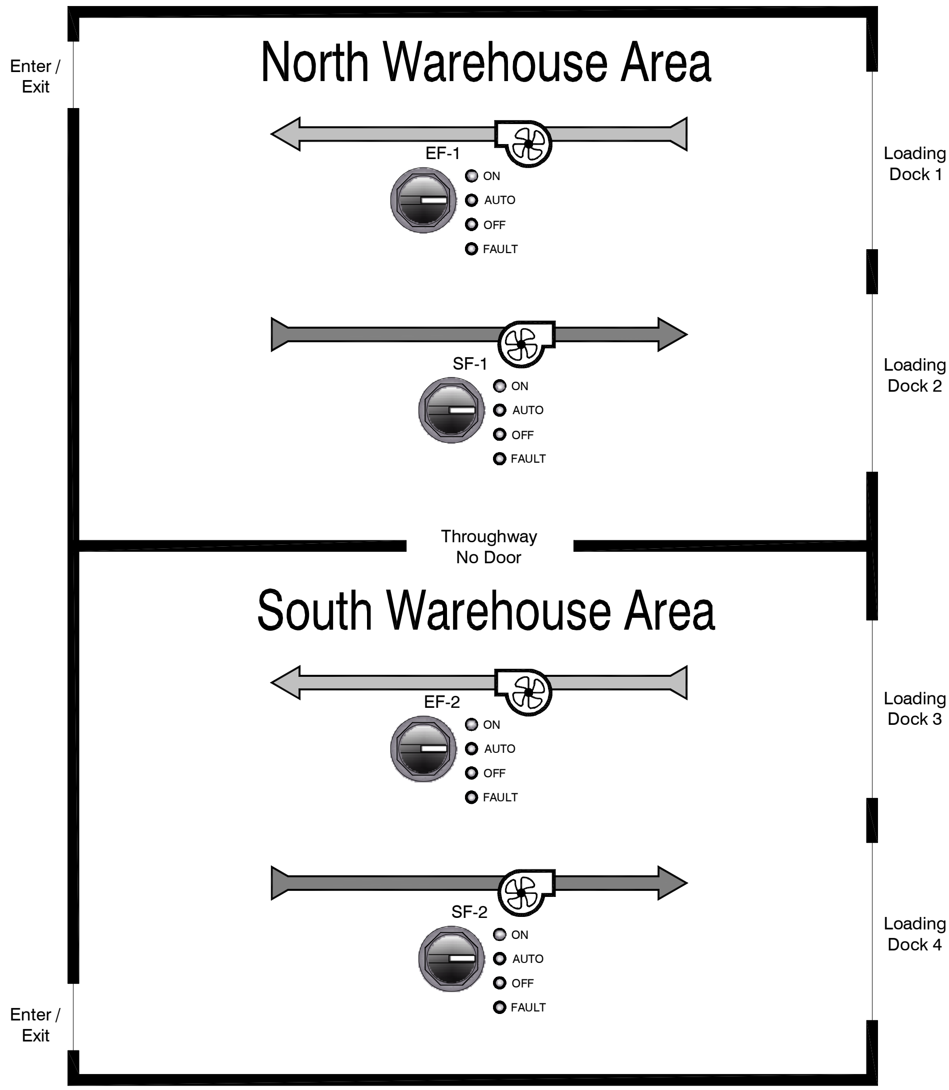

Exhibit 22: Warehouse Building FSCS Layout

16.3.1 WAREHOUSE BUILDING FIELD DEVICE CONNECTIONS

Exhibit 23 shows the CyberCat control panel and SLC field device connections required for this smoke-control application.

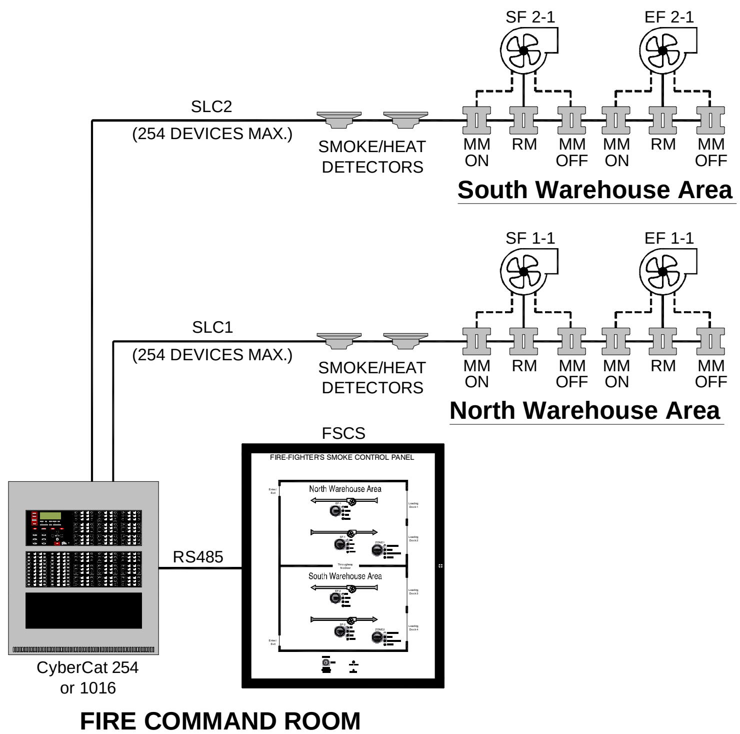

Exhibit 23: Warehouse Building Field Device Connections

16.3.2 WAREHOUSE BUILDING SYSTEM ACTIVATION

Exhibit 24 shows the smoke-control system in the activate state due to the detection of smoke in the South Warehouse Area. The smoke-control strategy requires both areas to depressurize. The warehouse North and South supply fans turn off and the exhaust fans turn on. This creates a negative pressure in the warehouse.

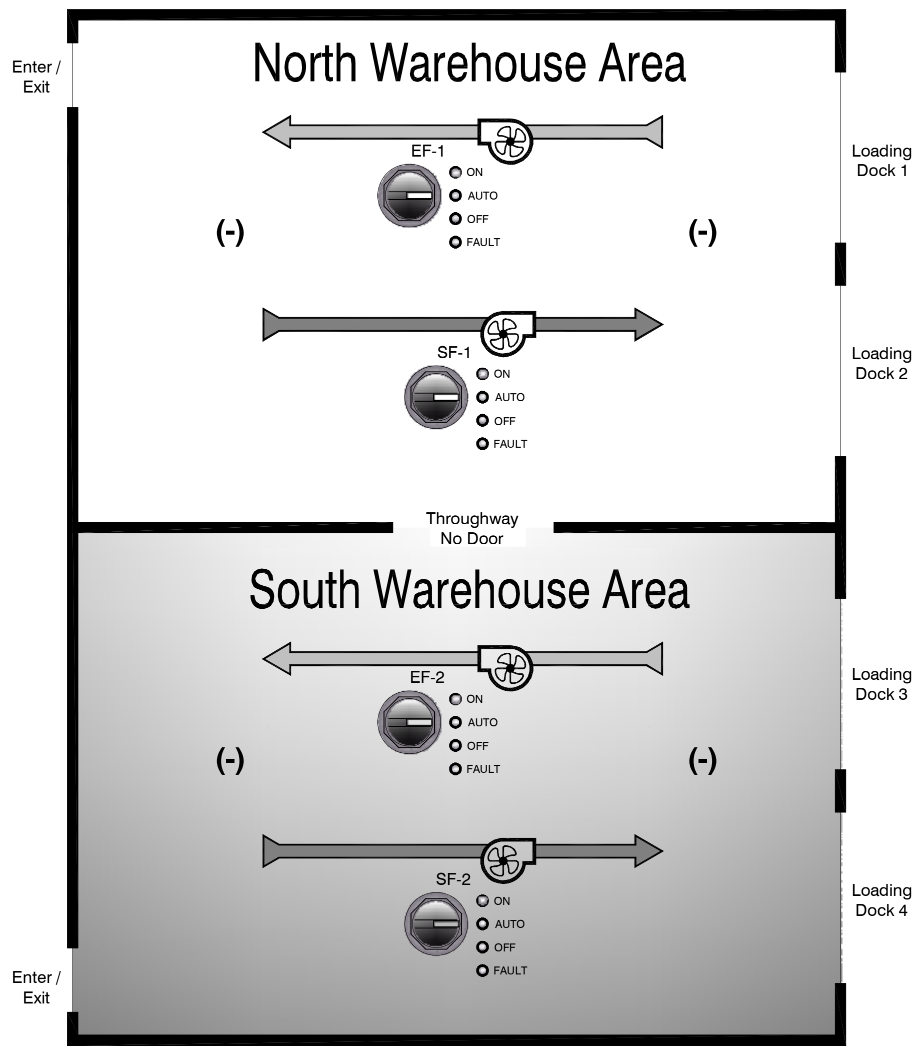

Exhibit 24: Warehouse Building Depressurization (-)

16.4 SHOPPING MALL EXAMPLE

In this application example, a single story shopping mall has large common area and six retail shops (Exhibit 25). Each retail shop is treated as a single smoke-control zone, with each having its own smoke detector, roof top unit, and exhaust fan. The common area is divided into two zones, with each having its own smoke detector, supply fan and exhaust fan.

The FSCS layout, shown below, provides manual override switches for each smoke-control zone rather than by individual equipment. This approach will aid firefighters in understanding the activation of the smoke-control system and will prevent activation of the equipment in the wrong sequence. Where control over individual pieces of equipment is deemed necessary, manual override switches shall be provided for each piece of smoke-control equipment.

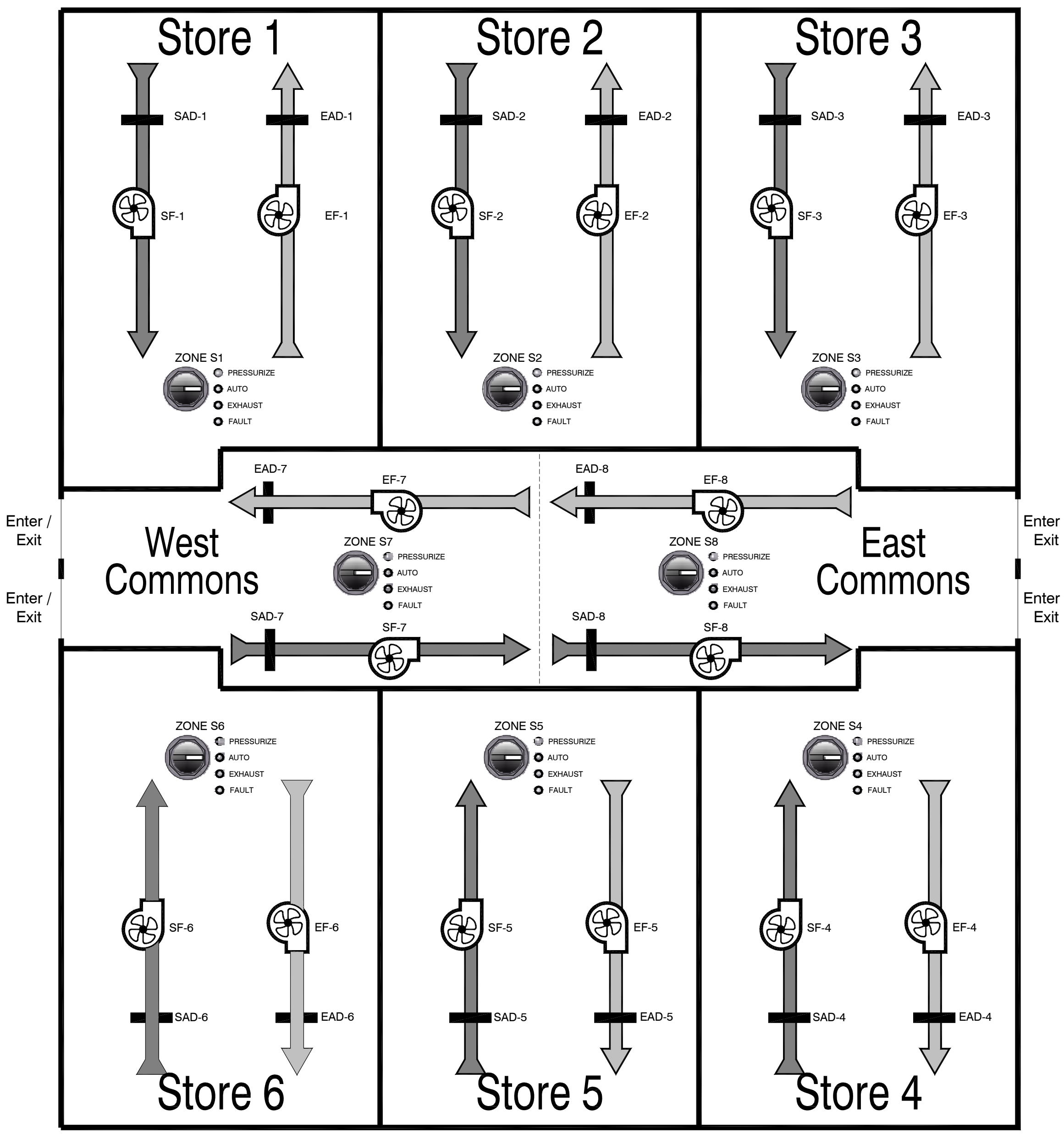

Exhibit 25: Single Story Shopping Mall FSCS Layout

16.4.1 SHOPPING MALL FIELD DEVICE CONNECTIONS

Exhibit 26 shows the CyberCat control panel and SLC field device connections required for this smoke-control application.

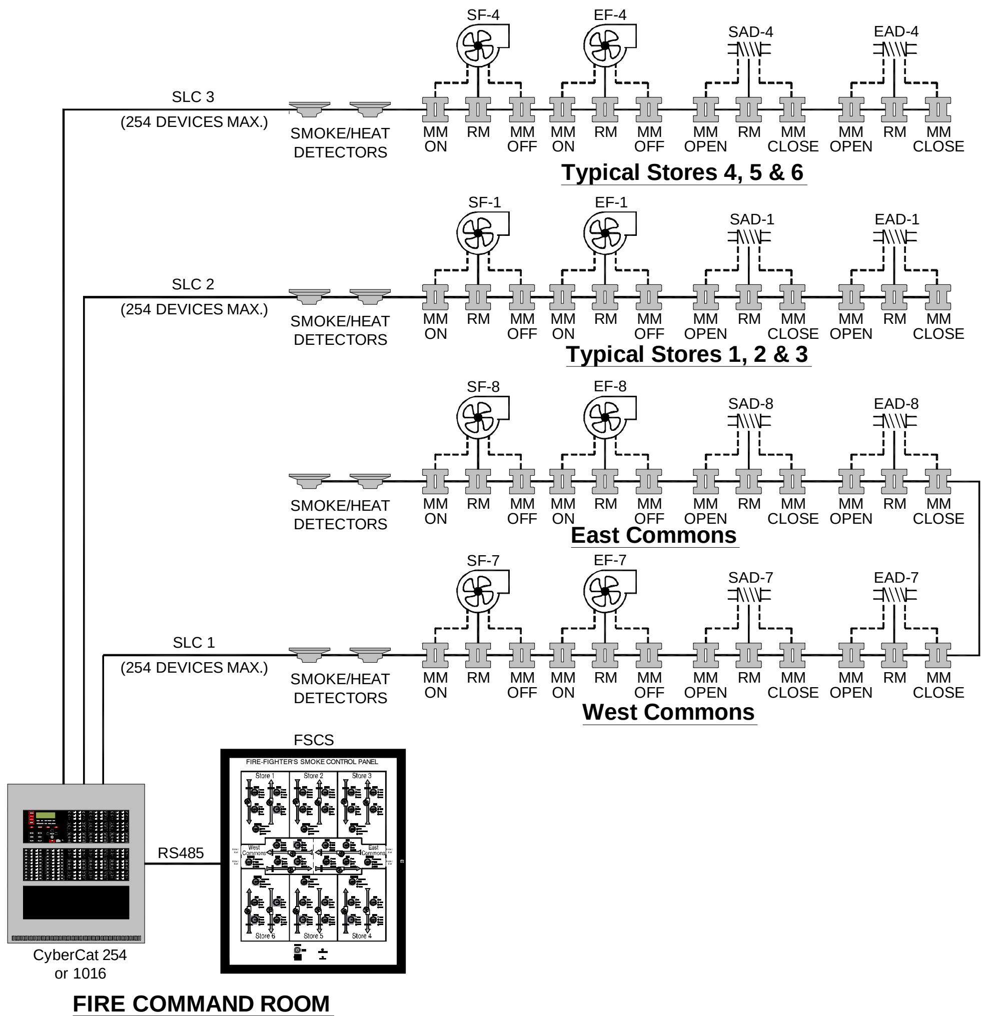

Exhibit 26: Shopping Mall Field Device Connections

16.4.2 SHOPPING MALL SYSTEM ACTIVATION (OPEN MALL AREA)

Exhibit 27 shows the smoke-control system in the activate state due to the detection of smoke in the East Commons Area. The smoke-control strategy requires both of the Commons areas to depressurize, while the adjoining shops are pressurized.

The East and West Common exhaust fans turn on and the supply fans turn off. This creates a negative pressure in the Common areas. At the same time, all stores surrounding the Common area are pressurized.

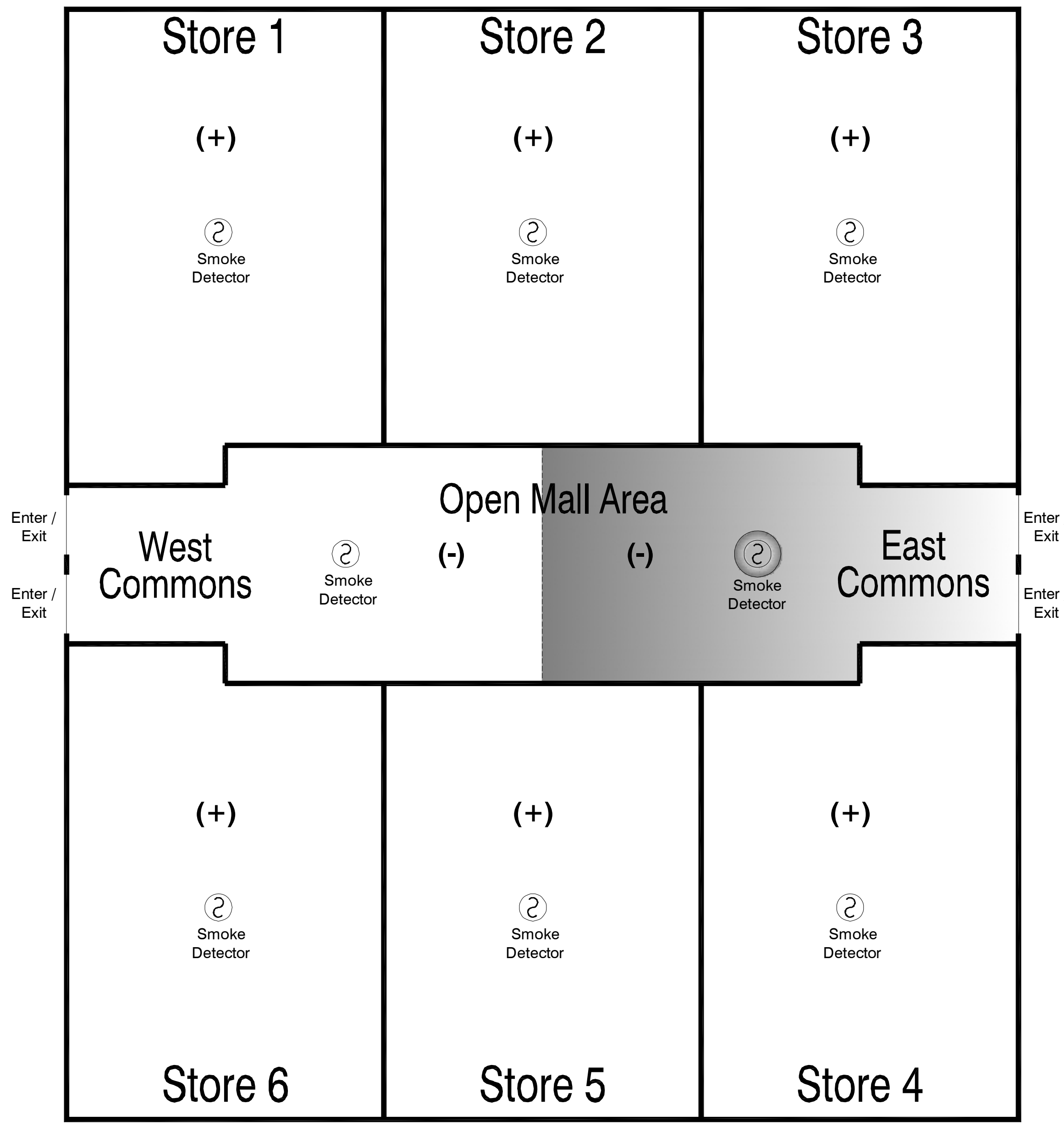

Exhibit 27: Shopping Mall – East Commons Area Alarm

16.4.2.1 SHOPPING MALL SYSTEM ACTIVATION (INDIVIDUAL STORE)

Exhibit 28 shows the smoke-control system in the activate state due to the detection of smoke in Store 4. The smoke-control strategy requires both of the Commons areas and the adjoining shops to pressurize, while Store 4 depressurizes. The East and West Common and Store 5 supply fans turn on and the exhaust fans turn off. This creates a positive pressure in these areas. At the same time, the Store 4 supply fan turns off and the exhaust fan turns on to depressurize the space. The remaining HVAC systems in the non-affected stores remain in their normal automatic state.

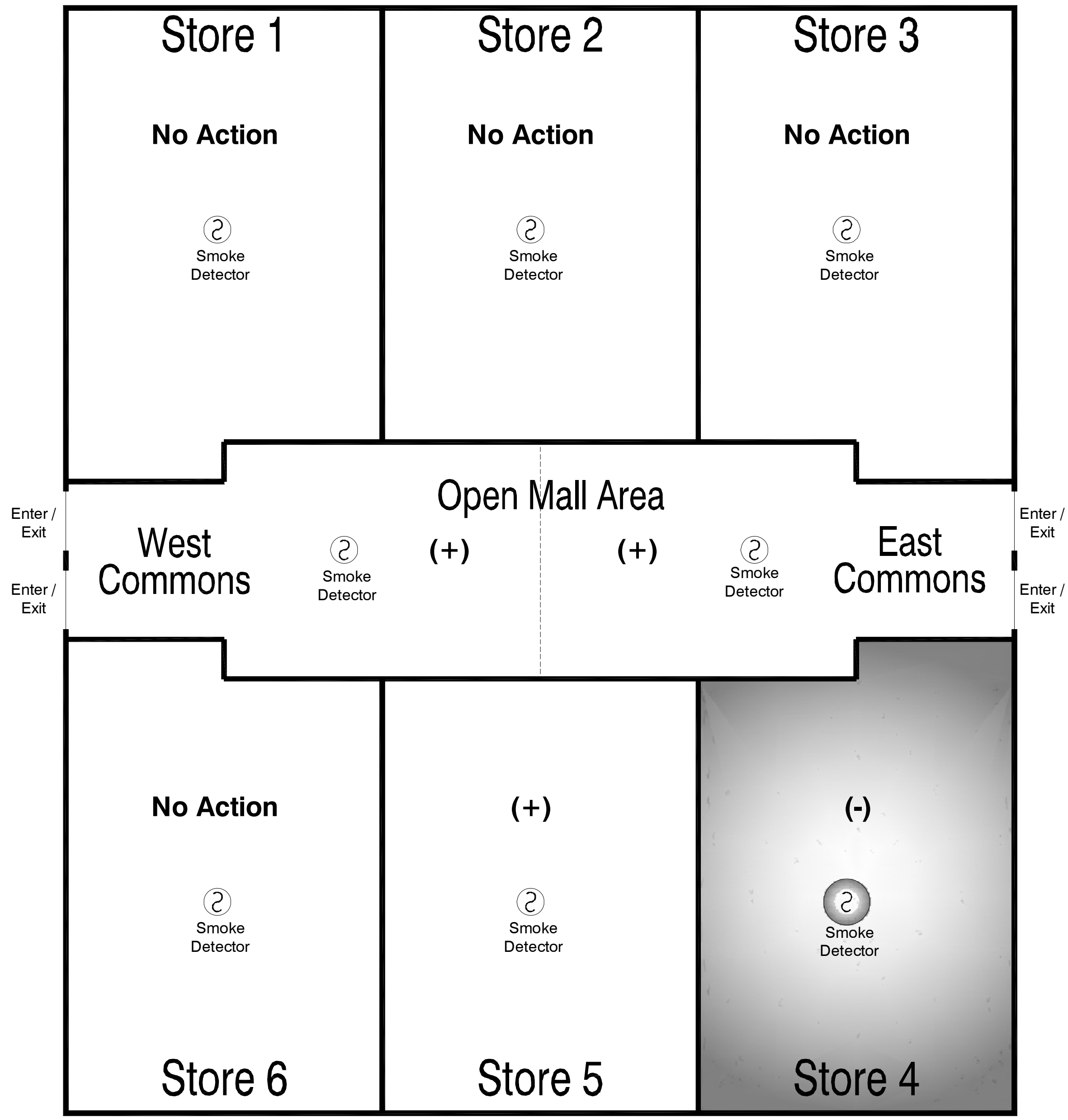

Exhibit 28: Shopping Mall – Store 4 Alarm

Reserved for future use.

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