Smoke Control for Fire-Protection Systems

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Workers in this nuclear power plant control room are served by a non-dedicated HVAC system that is captured by the facility's smoke-control system in the event of a fire.

Smoke-control systems are designed to control smoke during a fire incident in order to contain danger and allow the building to be safely evacuated. Until recently, smoke control has been managed by the building automation system (BAS). But the trend over the last few years has been to shift that control to the fire-protection system. That shift has created new fire-alarm functions and performance requirements, of which facility managers are often unaware.

Requirements and categories

NFPA Standards 92A and 92B cover all requirements for all types of smoke-control applications. BAS manufacturers also produce resources that explain the various applications. Smoke-control systems are broken into two major categories: Dedicated and Non-Dedicated Systems.

Dedicated systems are those that don't perform any other functions. The fans and dampers are not used for everyday ventilation, only for smoke-control events. These are often found in stairwells and elevator shafts. Typically these areas are pressurized to prevent the spread of smoke through exit passageways in the

building. In atria, these are typically used for smoke exhaust in order to control the smoke layer.

Non-dedicated systems provide HVAC in the building every day, but are captured by the smoke-control system in the event of a fire. There are numerous types of non-dedicated systems, based upon the HVAC design. For example, a building designed with single exhaust and pressurization fans to cover multiple floors or areas is a different type than one with fans for each floor. But the basic principles are the same: The smoke-control system captures the fans and dampers in the event of a fire, in order to control smoke.

The front-end of every smoke-control system is the Firefighters' Smoke Control Station. This includes annunciation of every fan, damper and other component of the system, typically through labeled LEDs. It also provides manual overrides for every fan and damper to be used by the fire department. It must be in an accessible location.

The two major authorities on smoke control - Underwriters Laboratory (UL) and the Uniform Building Code - require that this station include a graphic representation of the building. This typically includes the LEDs for annunciating device status placed over an elevation view of the building. Inputs to the system come from the basic fire initiating devices: smoke detectors and/or manual stations that initiate a smoke-control sequence. These devices are connected to the fire-alarm system.

At the other end of the system are the fans and dampers to be controlled. These are typically connected to some portion of the BAS. The challenge is to take the information from the initiating devices to the fans and dampers, and process the incoming information, either in the fire or HVAC system, to meet the specified control methodology of turning the correct fans and dampers on and off at the right times.

The next step is the interface that exchanges information between the fire and BAS. There is always a requirement for positive feedback at the smoke-control station, indicating that the specific fan or damper has reached the intended state.

The BAS provider or the fire-protection-system provider must assume a lead role in making the smoke-control operation work properly. Both provide hardware for the operation; either can provide the Firefighter's Smoke Control Station and process the logic necessary to control devices. Usually the same company provides the station and processes the logic.

There are two ways to get information from the fire system to the BAS system. The first is for the fire system to monitor all inputs, process the smoke-control logic, then operate fans and dampers through relays that capture the device controllers. This means that the fire system is in control. The other is for the fire system to communicate fire events and conditions to the BAS. That system will then process the logic that operates the proper fans and dampers.

Smoke-control strategy

At the time of new construction, the engineer for the project will develop a smoke-control strategy for the building. This will be in the form of a document often called a rational analysis. It will include at least three key items:

Sequence of operation - A step-by-step definition of how the fans and dampers should operate. Typical sequences of events for different applications can usually be found in the manufacturers' smoke-control application guides. The engineer may also specify a sequence of operation restoring the entire system to its normal operations after a fire event has ended.

Detail - An explanation of the action caused by the various fire-alarm initiating devices. For instance, manual stations will very often 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.

Feedback - The process of providing detail about how quickly fans and dampers should operate during a fire. This will be specified in terms of actual operation and/or feedback at the Firefighters' Smoke Control Station. The Uniform Building Code also includes specific time limits for both operation and feedback. The engineer should specify what the system should do if feedback is not received in the allotted time.

Be aware that the system response-time element can place a large burden on the operation of the controlling system and is often the most difficult criteria to meet. Typically, fire-alarm systems process alarms as a priority while smoke-control operations are treated as status events. The process of turning on an LED to annunciate the completion of a device's change in status is usually at the lowest priority level in the system.

If the fire system is managing too many other functions, smoke-control operations may not occur within the required time. Consult the system manufacturer for recommendations on how to best configure a system to meet the response requirements in your facility.