Attachment #2
DS 2015-015

605.3 Airflow over the filter. Ducts shall be constructed to allow an even distribution of air over the entire filter.

❖ Air ducts must be constructed to allow an even distribution of air over the entire face of a filter. This will extend the life of the filter because of the increase in its capacity to trap and retain particulates over more of its surface area. Also, maximizing the useable surface area of the filter minimizes the pressure drop across it. Equipment manufacturers' instructions and duct design handbooks provide information on proper filter placement and location in duct systems. For example, filters are ideally located where there is little or no airflow turbulence and filter enclosures are commonly enlarged or the filters are placed at angles other than perpendicular to the airflow to expose more filter surface area to the airstream.

SECTION 606
SMOKE DETECTION SYSTEMS CONTROL

606.1 Controls required. Air distribution systems shall be equipped with smoke detectors *listed* and *labeled* for installation in air distribution systems, as required by this section. Duct smoke detectors shall comply with UL 268A. Other smoke detectors shall comply with UL 268.

❖ Section 606 contains requirements for protection against the spread of smoke throughout a building through an air distribution system. Generally, smoke spreads through the air distribution system when the return air system conducts smoke from a fire in a room or space back to the air-handling equipment where the smoke is fed into the supply distribution system. The smoke may be diluted by mixing it with return air from other parts of the building and by the introduction of outdoor air; however, smoke will still be routed through the supply air distribution system to other parts of the building that may not be involved with the fire.

The intent of these provisions is to prevent ducted air distribution systems from distributing smoke from the area of origin to other areas or spaces in a building. An air distribution system can distribute smoke throughout a building much faster than the smoke would have traveled naturally and, of course, ducts can carry smoke across boundaries that otherwise would have stopped the natural migration of smoke. For these reasons, duct system smoke detectors are used to shut down a ducted air distribution system before it can threaten the building occupants by spreading smoke.

This section applies to ducted air distribution systems (see the definition of "Air distribution system") and, therefore, does not apply to installations of air handlers and HVAC equipment that do not involve ductwork and extensive plenums. For example, rooftop HVAC units, suspended unit heaters, suspended horizontal furnaces and blower/coil combination units are commonly installed without distribution ductwork. In these examples, the extent of what might be considered as ductwork is typically limited to short supply and return box plenums (drops) extending from the roof unit, or simple supply and return plenum extensions of the suspended equipment cabinets that are used only to accommodate return grilles, filter racks, flow splitters and similar directional discharge fittings and devices. Because no distribution ductwork extends to areas and spaces beyond the immediate location of the HVAC equipment, the HVAC equipment cannot contribute significantly to the spread of smoke in the building; therefore, a duct-mounted smoke detector would be of little value.

Also, it is not the intent of Section 606 to require duct smoke detectors in systems that function only as exhaust systems or only as makeup air supply systems. A makeup air supply system that discharges 100-percent outdoor air into a building does not withdraw air from the building and, therefore, cannot contribute to the movement of smoke. Likewise, an exhaust-only system discharges all air to the outdoors and, therefore, in most circumstances will not contribute to the movement of smoke into other areas of the building. In fact, the operation of an exhaust system in the area of fire origin could be considered beneficial because it provides some smoke removal capacity. Note that exhaust fans can create negative pressures within a building, thereby causing smoke migration.

It is more important to keep in mind the intended application of Section 606, which is to address the potential hazard caused by ducted air distribution systems that link together rooms and spaces within a building, thereby providing the pathway to distribute smoke to the linked rooms and spaces. Air-handling systems of any type that cannot transport smoke beyond the area of fire origin are exempt from the provisions of this section.

Smoke detectors installed in air distribution systems must be labeled for that application. Because the moving-air environment within the duct differs from a still-air environment, a duct smoke detector must be specially designed and tested to sense smoke within the air ducts at the design airflow rates. UL 268A is used to evaluate duct smoke detectors. The UL *Fire Protection Equipment Directory* contains listings of smoke detectors that have been evaluated for use in air duct systems. Some smoke detectors are mounted within the duct and sense smoke in the airstream; other designs incorporate air-sampling tubes that supply an air sample to smoke detectors mounted in a chamber attached to the exterior of the duct. It is important to observe the airstream velocity limitations in the detector's installation instructions to maintain acceptable detector sensitivity. For detectors that use air-sampling tubes, a maximum pressure differential between tubes will also be given.

606.2 Where required. Smoke detectors shall be installed where indicated in Sections 606.2.1 through 606.2.3.

Exception: Smoke detectors shall not be required where air distribution systems are incapable of spreading smoke

beyond the enclosing walls, floors and ceilings of the room or space in which the smoke is generated.

❖ Sections 606.2.1 through 606.2.3 state where and under what conditions duct smoke detectors are required in air distribution systems.

The design capacity of an air-handling system consisting of two or more air handlers paralleled to function as a unit would be the sum of the capacities of the individual air handlers. On the other hand, a building may have multiple air handlers, with each air handler serving entirely independent duct systems. In this case, the capacities of the individual independent air handlers would not be summed. Each system would be evaluated separately. If multiple air-handling units share any ductwork or plenum space, which occurs in a multiple-zone variable air volume system having individual zone air handler units that draw air from a common return air plenum, the capacities of all of the zone air handlers would be summed because the common return air plenum creates a single air distribution system. In such a system, the main air handler serving the return plenum would be evaluated as another distinct air distribution system (see commentary, Section 606.2.2).

The exception clarifies the intent of this section to prevent air distribution systems from distributing smoke to other rooms and spaces where the occupants might not be aware of the fire. Air distribution systems that serve only a single room or space would not require smoke detectors. The typical warehouse-type retail store served by roof top units that serve a single open space would be an example. In such spaces, the occupants would be aware of a fire anywhere in the space and could determine the safest egress path. Commentary Figure 606.2(1) shows an air distribution system that is greater than 2,000 cfm (0.9 m³/s) but is not capable of moving smoke beyond the walls, floors or ceilings of the space. In this installation a smoke detector would not be required in the return air duct or plenum. Commentary Figure 606.2(2) shows the same air distribution system that is greater than 2,000 cfm (0.9 m³/s) and is serving two separate spaces. In this installation smoke that might be generated in one space could be circulated through the air distribution system to another space. This system would require a smoke detector in the return air plenum.

606.2.1 Return air systems. Smoke detectors shall be installed in return air systems with a design capacity greater than 2,000 cfm (0.9 m³/s), in the return air duct or *plenum* upstream of any filters, *exhaust air* connections, outdoor air connections, or decontamination *equipment* and appliances.

Exception: Smoke detectors are not required in the return air system where all portions of the building served by the air distribution system are protected by area smoke detectors connected to a fire alarm system in accordance with the *International Fire Code*. The area smoke detection system shall comply with Section 606.4.

❖ Smoke detectors must be installed in return air systems having design capacities exceeding 2,000 cubic feet per minute (0.9 m³/s) (see Commentary Figure 606.2.1). Return air systems with design capacities equal to or less than 2,000 cfm (0.9 m³/s) are exempt from this requirement because their small size limits their capacity for spreading smoke to parts of the building not already involved with fire. The area that could be served by a 2,000 cfm (0.9 m³/s) system (approximately 5 tons of cooling capacity) is compar-

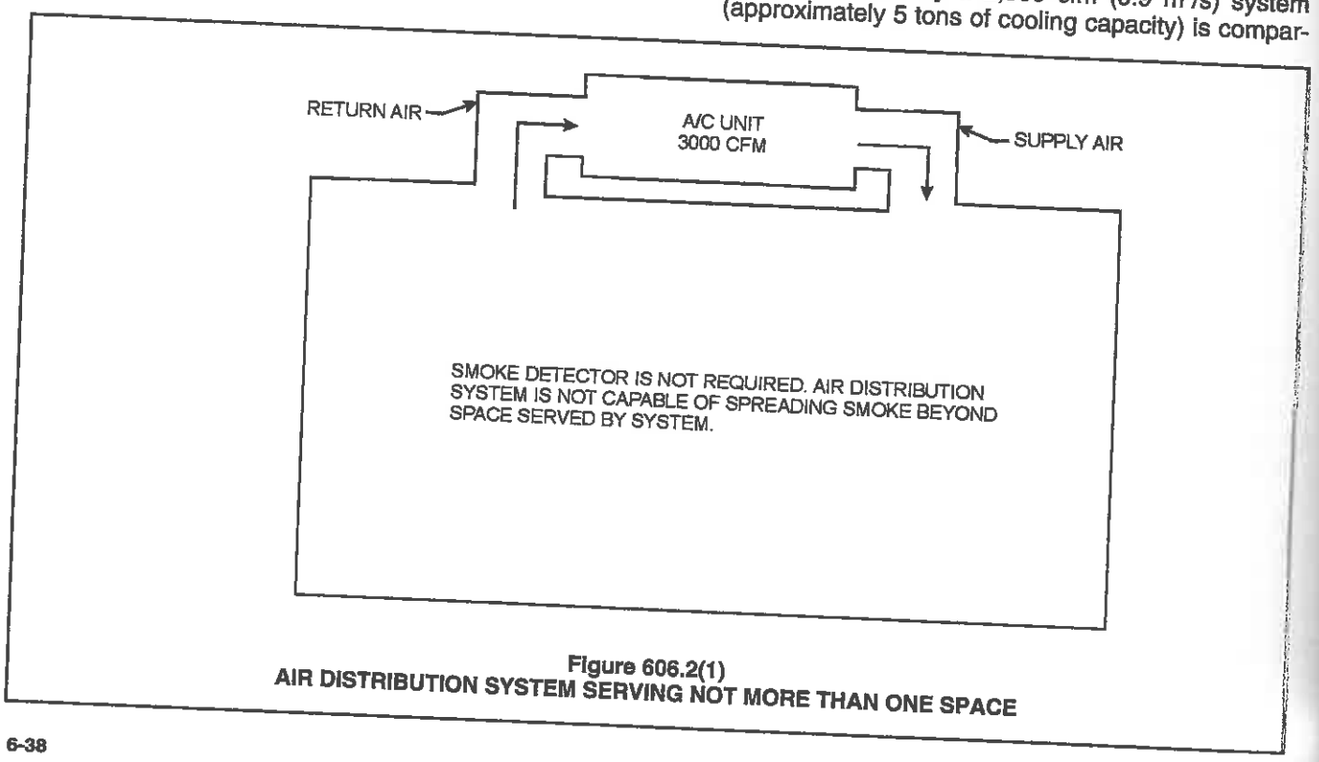


Figure 606.2(1)
AIR DISTRIBUTION SYSTEM SERVING NOT MORE THAN ONE SPACE

atively small. Therefore, the distribution of smoke in a system of that size would be minimal.

To maximize the effectiveness of smoke detectors in the return air duct, the detectors must be installed in the area of the highest concentration of smoke in the system. Therefore, the detectors must be installed in the path of airflow upstream of any filters, exhaust air connections, outdoor air connections or decontamination equipment in the system.

Filters and decontamination (air cleaning) equipment can remove some of the smoke from the air stream, and exhaust air and outdoor air connections can bleed off or dilute smoke in the air stream, all of which can delay the response time of the detector. Where a single detector would be unable to sample the total airflow at all times, detectors would be required for both the return and the exhaust ducts or plenums. If a return air system has a takeoff for exhausting a portion of the return air, and the takeoff is located upstream of the duct smoke detector, smoke detectors should be installed in both the return air and the exhaust air ducts or plenums. In this configuration, the detector is sampling only a fraction of the total airflow, because some of the total return air is exhausted before passing by the smoke detector (see commentary, Section 606.3). It is not uncommon for the exhaust (relief) duct to be independent of the return air system. In this case, airflow through the exhaust duct would not be sampled by the detector. This limited sampling by a smoke detector would delay the detector's response because of the reduced concentration of smoke.

An exception to the requirements of this section occurs where a system of area smoke detectors is

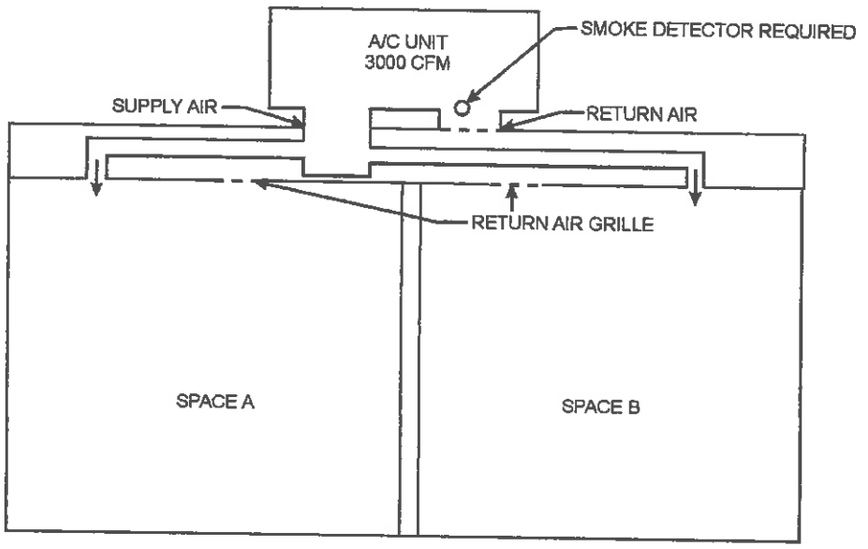


Figure 606.2(2)
AIR DISTRIBUTION SYSTEM SERVING MORE THAN ONE SPACE

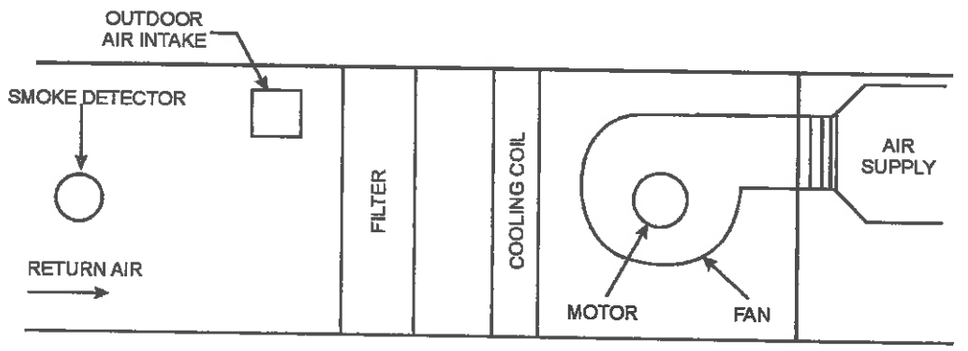


Figure 606.2.1
SMOKE DETECTOR REQUIRED IN RETURN AIR SYSTEMS WITH FLOW GREATER THAN 2000 CFM

used to protect all spaces served by the air distribution system. The smoke detectors must be installed as required by the *International Fire Code*® (IFC®). The logic of the exception is that a fire in the space served by the air distribution system will be detected by the area smoke detectors and the alarm will be processed as required by the IFC, thereby eliminating the need for smoke detectors in the return air system.

It is also important to note that installing duct smoke detectors does not waive any other requirements for smoke detectors within a room or space because duct smoke detectors are effective only if the air distribution system is operating. Additionally, duct detectors cannot respond until the concentration of smoke in a duct is detectable, whereas an area detector can respond before smoke even reaches the air distribution system. This exception still requires the air handler to shut down when smoke is detected (see commentary, Section 606.4).

606.2.2 Common supply and return air systems. Where multiple air-handling systems share common supply or return air ducts or plenums with a combined design capacity greater than 2,000 cfm (0.9 m^3/s), the return air system shall be provided with smoke detectors in accordance with Section 606.2.1.

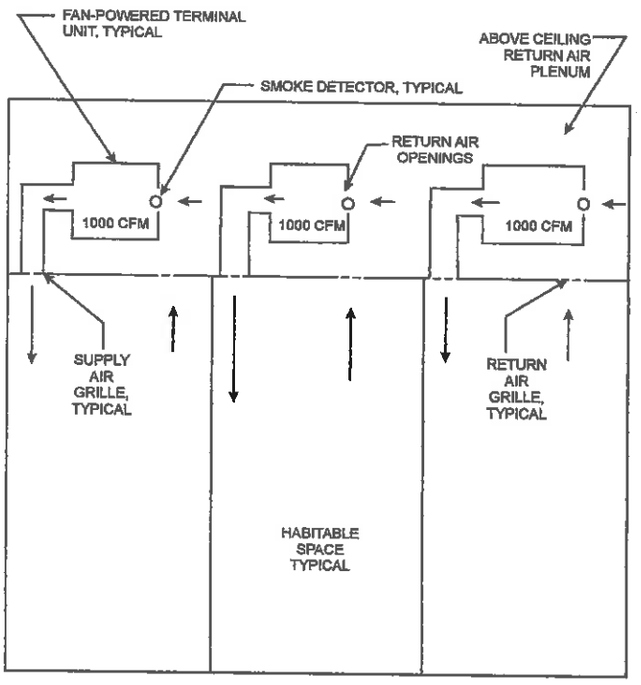
Exception: Individual smoke detectors shall not be required for each fan-powered terminal unit, provided that such units do not have an individual design capacity greater than 2,000 cfm (0.9 m^3/s) and will be shut down by activation of one of the following:

1. Smoke detectors required by Sections 606.2.1 and 606.2.3.
2. An *approved* area smoke detector system located in the return air *plenum* serving such units.
3. An area smoke detector system as prescribed in the exception to Section 606.2.1.

In all cases, the smoke detectors shall comply with Sections 606.4 and 606.4.1.

❖ It is not uncommon to have multiple air-handling systems of less than 2,000 cfm (0.9 m^3/s) each share a common return or supply air duct or plenum. When the combined capacity of all air-handling systems sharing a common duct or plenum is greater than 2,000 cfm (0.9 m^3/s), a smoke detector must be installed as required by Section 606.2.1 (see commentary, Section 606.2.1). Because multiple air-handling units are involved, a smoke detector installed in accordance with Section 606.2.1 at each air-handling unit may be required. For instance, if multiple air-handling units are located in different parts of a building, a single detector located at some point in a common return air duct might not be able to sample all of the airflow. A detector at each unit could be required. In this case, upon activation the smoke detector would shut down only the air-handling unit it serves [see Commentary Figure 606.2.2(1)].

NOTE EXCEPTION TO SECTION 606.2.2



For SI: 1 cubic foot per minute = 0.0004719 m^3/s.

Figure 606.2.2(1)
LOCATION OF SMOKE DETECTORS IN COMMON RETURN AIR PLENUM

If multiple air-handling units are located in a common area and are served by a common return air duct that allows a single detector to sample all the airflow, multiple smoke detectors at each unit would not be required. In this case, upon activation, the smoke detector must shut down all the air-handling units served by the detector (see commentary, Section 606.2). Where multiple air-handling systems serve a common space but do not share common ducts or plenums, the systems are treated as independent (stand-alone) systems, even though the combined capacity might exceed 2,000 cfm (0.9 m^3/s).

The exception states that individual smoke detectors are not required for fan-powered terminal units that are part of a larger air distribution system that has a method of smoke shutdown installed. The individual capacity of these units cannot exceed 2,000 cfm (0.9 m^3/s) and they must be shut down by one of the three means listed in the exception. In all cases, the fan-powered terminal units must be shut down, but not necessarily by their own dedicated smoke detectors. If the terminal unit design capacity exceeds 2,000 cfm (0.9 m^3/s), the unit is treated as an independent system and an individual smoke detector would be required. The air distribution system shown in Commentary Figure 606.2.2(2) has a supply air fan and return air fan along with two fan-powered terminal units. The return air fan is 3,000 cfm (1.42 m^3/s) and has a smoke detector ahead of the fan and filter. The two fan-powered terminal units are 500 cfm (0.24 m^3/s) each. The smoke detector in this system would have to be connected to the two fan-powered terminal units or the fan-powered terminal units would have to be shut down by a smoke detector that complies with one of the three items in the exception to Section 606.2.2. Commentary Figure 606.2.2(3) shows a typical fan-powered terminal unit.

606.2.3 Return air risers. Where return air risers serve two or more stories and serve any portion of a return air system having a design capacity greater than 15,000 cfm (7.1 m^3/s), smoke detectors shall be installed at each story. Such smoke detectors shall be located upstream of the connection between the return air riser and any air ducts or plenums.

❖ Where a return air system with a design capacity greater than 15,000 cfm (7.1 m^3/s) serves more than one story, the return air from each story must be monitored before intermixing the return in the common riser. This results in early smoke detection and is a means for determining on which story a fire has occurred.

Determining the story of fire origin provides valuable information to fire-fighting personnel and to smoke control systems. For example, if a smoke control system is installed in a building, detection of smoke in a particular story may cause the HVAC system to switch to a smoke control mode that could supply 100-percent exhaust in that story while the adjacent stories are supplied with 100-percent outdoor air and no return or exhaust, thereby creating a positive pressure on those stories.

To monitor each story accurately and to prevent detection delays, the duct smoke detectors must be installed within the return air duct or plenum of the

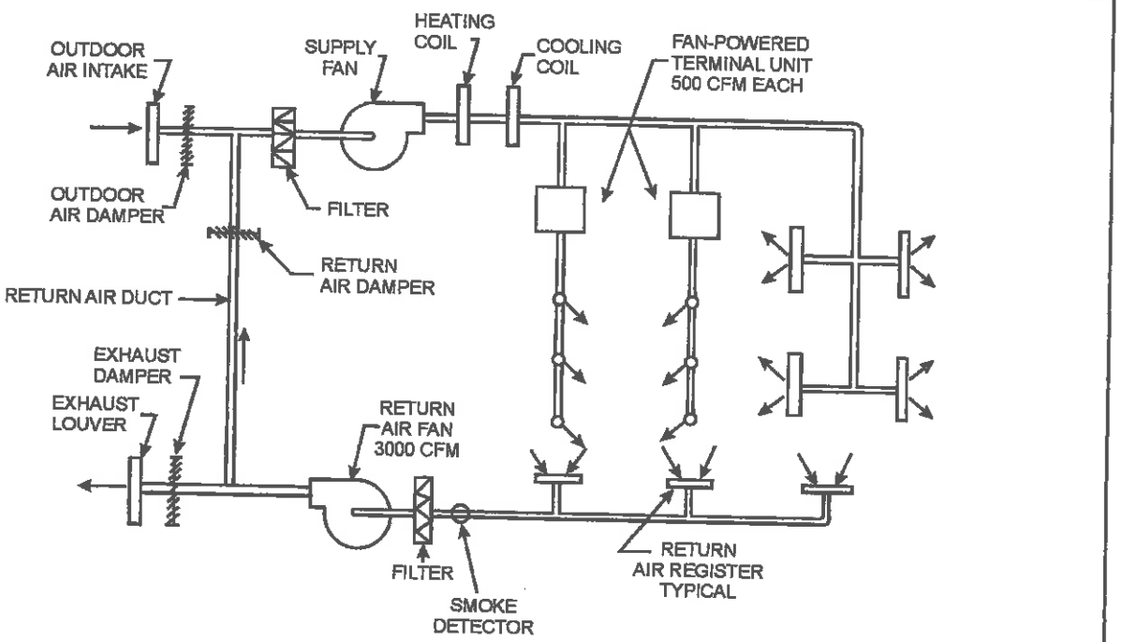


Figure 606.2.2(2)
LOCATION OF SMOKE DETECTOR, EXCEPTION ITEM 1