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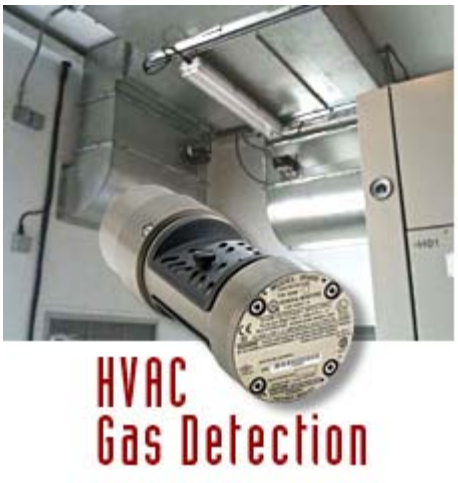
# The Monitor

GENERAL MONITORS

Your total solution provider for gas and flame detection

# Detecting Combustible and Toxic Gases in HVAC Ducts




**Air handling systems are used throughout industry to provide comfort and health in manned areas.** From systems that deliver fresh air in confined spaces, to HVAC systems in living quarters, exhaust / ventilation systems form part of the essential safety services of chemical process and petroleum facilities. Nevertheless, if unprotected, facility ventilation systems can transport combustible and toxic gases from a source area to other parts of the building, bringing the dangerous substances into non-hazardous areas, like control rooms, living quarters, electrical switch rooms, and equipment rooms.

Because of the potential for the inadvertent transport of dangerous substances, government agencies, industry groups and many leading companies have established procedures for exhaust/ventilation system safety. One important element in the protection of these systems is gas detection. Gas detectors reduce the risks from releases through early detection, indicating a supervisory signal to a constantly attended location and initiating an appropriate automatic protective response. Activation of a sensor, for example, can cause an alarm signal and lead to HVAC shutdown and activation of damper controls to prevent the ingress of toxic gas clouds into work spaces.

Three key challenges regulate the design of gas detectors for duct applications: Air velocity, dilution, and stratification. Since air flows turbulently through ducts at 2,000 - 6,000 ft/min (23 - 68 mph), sensors must be designed to withstand high ventilation rates. Electrochemical sensors, which rely on the generation of current in an electrolytic solution to measure gas concentration, must be well sealed to prevent evaporation, particularly when exposed to dry air. Other sensors like catalytic and solid state devices must be able to control optimum reaction temperatures in the presence of strong air currents or have protective covers (splash guards, screens, or sinters) to prevent air from impinging directly on sensor elements.

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## Industry news

### ASHRAE wants to know what's your building EQ?

Engineers across the country under the leadership of the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) have begun assessing the energy use of selected buildings as part of a pilot program designed to encourage the building industry to cut energy use and costs.

The Building Energy Quotient program, which is known as Building EQ, includes both As Designed (asset) and In Operation (as operational) ratings for all building types except residential. It also provides a detailed certificate with data on actual energy use, energy demand profiles, indoor air quality and other information that will enable building owners to evaluate and reduce their building's energy use.

For complete information, visit www.buildingeq.com. Seventeen provisional assessors have been named by ASHRAE to assess energy use, which is then provided in an easily understood scale to convey a building's energy use in comparison to similar buildings, occupancy types and climate zone. Building owners also are given building-specific information that can be used to improve building energy performance.

Under the pilot program, which launched in December 2009, new buildings are eligible to receive an As Designed, or asset, rating, which provides an assessment of the

A second challenge for gas sensing in exhaust/ventilation systems is dilution. As air enters the duct network, it typically mixes with circulated air, which dilutes gas concentration several times. As a result, gas sensors tailored for duct applications must be highly sensitive. Low detection limits enable operators to set warning and alarm set points at a few parts per million, as low concentrations of detected gas may be indicative of much higher concentrations in the air stream.

Last, stratification presents a severe risk for gas detection. Because duct networks contain bends, expansions, contractions, and other features, uniform air flow in the cross section area is hardly ever the norm. Sudden contractions and expansions can create eddies where gases can accumulate, leading to the improper sampling of air. Gas stratification appears to have been at the source of an incident on the Brae Alpha platform in the North Sea and the subject of an investigation into the placement of flammable gas detection systems in offshore installations. To prevent the risk of failures to detect gas as a result of uneven mixing, detection systems are designed with extended sampling lengths or distributed across the duct width to ensure optimal area coverage.

To mitigate the adverse effects of air velocity, gas dilution, and uneven mixing, plant safety professionals suggest detectors be installed in the main supply duct on the downstream side of the filters to automatically shut off the supply fans. In some instances, a second set of sensors can be installed on the downstream side of the return in order to increase area coverage within the HVAC system. In general, the detectors should be installed between 6 and 10 duct diameters of straight, uninterrupted run and downstream from any duct openings, deflection plates, sharp bends, and connections, as these may produce an uneven distribution of contaminants in the air flowing through the duct.

To illustrate detector placement in a duct application, consider the sketch below. As shown, detectors are installed after the fans, filters, chillers, heaters and humidifiers. In this arrangement, if a gas detector senses gas, the fan system will be turned off and the dampers closed, preventing the mixture from being distributed through the air handling system to unaffected areas of the facility. Alternatively, the detectors may be placed in the outdoor air supply to sense if the gas is being ingested into the HVAC inlet. In such case, the detectors would prompt the safety system to close the outdoor air damper, permitting the rest of the exhaust/ventilation system to operate without interruption.

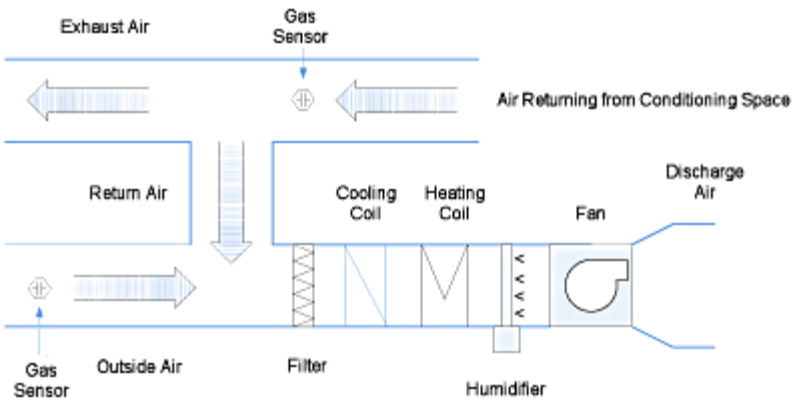


*Diagram Illustrating Placement of Sensors in Typical Air Handling System*

Maintenance and accessibility are important factors in the design of online gas detection systems. Dust, dirt and other debris can gather in the sensor's protective screen or splash guard and reduce access to the sensor

building based on the components specified in the design and is based on the results of building energy modeling and simulation. An In Operation rating is available once the building has at least one year of data on the actual energy use and is based on a combination of the structure of the building and how it is operated. Existing buildings would be eligible to receive both an As Designed and In Operation rating.


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element, particularly with sensors mounted inside ducts. As a result, gas monitors should be tested and maintained at regular intervals. Maintenance should include inspection of the device to ensure it samples the air stream, calibration and test at low detection limits; the latter one as a provision against the possibility the gas is distributed unevenly across the air stream.

With the growing acceptance of ISA 84, a large number of facilities have chosen to increase the safety integrity level (SIL) of safety instrumented functions by increasing redundancy or decreasing sensors' functional test intervals. For this reason, plant safety personnel have dedicated greater resources to establishing methods that are fast and convenient, employing, for example, set-ups that allow easy access to the instruments or permit remote testing and calibration.

Exhaust/ventilation systems are often exposed to the ingress of smoke, combustible and toxic gases from hazardous areas. To reduce their vulnerability, these systems are often equipped with gas sensors, which are installed in a manner that anticipates the adverse effects of ventilation rate, dilution and stratification in order to detect gas accumulations in the low parts per million. As shown in the diagram above, sensors can be installed downstream from the filters as air comes in from the outside and downstream of the air return. Sensors should be mounted along the duct cross section in order to ensure optimal area coverage and static mixers are introduced to prevent gas stratification. Where mixing elements cannot be installed, sensors should be located immediately outside the HVAC duct.

## Links of interest

- IR400 Infrared (IR) Gas Detector
- S4000CH Combustible Gas Detector
- S4000TH H2S Gas Detector
- TS4000H Toxic Gas Detector