

This publication is intended as a service to building owners, architects and facilities managers by presenting topics of general interest to the industry. For more information please contact Bob Thomas at 713-237-9800. The information originates from established industry publications and other informed sources.

Defensive HVAC Systems

Introduction

Since 9-11, building security has been a topic of heightened awareness and concern. Most people spend at least a third of their time in the work place, which is almost always served by an HVAC system that draws air from the outside for ventilation. In the event of an airborne chemical or biological attack, what can be done to protect the building occupants?

Background

Potential biological weapons include anthrax, botulism, plague, small pox, tularemia, viral hemorrhagic fever viruses and tuberculosis. Bacteria range in size from .3 to 35 microns in diameter, while viruses usually range from .01 to .3 microns in diameter. For a feel for how small this is, the period at the end of a sentence is about 300 microns in diameter.

Another form of a biological weapon is toxins, which are produced by an animal, plant or microbe. Unlike bacteria and viruses, toxins do not reproduce. Toxins as a whole, are generally hard to create with today's technology and during aerosolization are usually not very stable or continuous. This makes them less likely to be used during an attack, but it also makes them difficult to detect and monitor with current technology.

Chemical weapons and agents that can be a threat include nerve agents, blood agents, blister agents, choking agents, tear gas agents, incapacitates, psychochemicals and general industrial chemicals. In general, chemical agents and aerosols are in the range of 1 to 10 microns.

HVAC Considerations to minimize the effect of an attack

Filtering of all air intakes is an important step. Filters can be selected to capture many of the particles and agents that are of concern. HEPA (high-efficiency particulate air) filters are capable of providing 99.97% effectiveness or better for particles larger than .3 microns. These filters are best for filtering most of the dangerous particles discussed above.

Some viruses are too small to capture in a filter but other filters of less efficiency can be useful and still provide a high level of filtering at a lower cost. There is little room for error however, when dealing with contaminants noted above.

Location and protection of all air intakes should also be considered. Outside air intakes are best located at the top of the building to avoid access by terrorists. If outside air intakes are located at ground level, it is advisable to shield them from access with solid fences or walls and to provide a security camera in the area for monitoring. In addition to filters, emergency dampers and controls can allow an occupant to shutdown the air stream (and usually the HVAC equipment) in case of emergency.

Air-balance of the building and proper pressurization is also vital. Buildings tend to leak regardless of how well the building was designed or constructed. Pressurizing a building can help protect the building from outside agents. Just as stairwells are often pressurized, other public spaces can be protected by pressurization techniques using dedicated HVAC systems, controls and filtering.

Currently a new product called a Bio Blower™ is being produced to kill airborne particles by compressing the mechanical air stream, which causes the air to be heated up to a high temperature. This technology is still being tested.

Implementing Changes to the HVAC System

Having a design approach to provide protection is necessary, but the system components also need to be funded and properly installed. Other considerations are proper installation and proper maintenance. If filters are to be installed, then leakage around the filters becomes a cause for concern. Proper tight construction as well as careful replacement of filters must be provided to eliminate filter by-pass. Building maintenance personnel must be well trained in the operation and maintenance of the entire system during both common usage and emergency situations.

Once a design engineer and others have been consulted and a preliminary plan has been determined many issues need to be considered before moving forward with the design of a new system or the renovation of an existing system. The main concern should be the proper pressurization of the building as a whole and the provision of HEPA filters at all outside air intake locations.

As always, cost must be considered. HEPA filters are expensive in comparison to other filters (often 10 to 20 times for equivalent sizes). The front end cost is higher and lifetime maintenance and replacement costs will also be relevant. Filters only need to be provided at points where air enters the building. The use of HEPA filters will cause a significant increase in static pressure for the outside air intake system, which will lead to an increase in fan size (horsepower) and therefore electrical power consumption. In addition, the provision of separate (additional) HVAC systems, specialized zoning, dampers, and specialized controls will create a related first cost. Each project will have its own parameters that will need to be addressed by the professional engineer.

Summary

The means and technology exist for protecting building HVAC systems and building occupants from certain agents. The process must be well thought out and planned and will not come without a price. Building owners and designers should consider taking a step past conventional design to provide this level of protection for a building and its occupants. Although the cost may be high and the process difficult, the thought of safer buildings is very comforting.

Key References

1. CDC - Guidance for Filtration and Air-Cleaning Systems to Protect Building Environments, April 2003.
2. ASHRAE Journal, December 2002, "Defensive Filtration", James D. Miller, P.E.