HOMELAND SECURITY ISSUES FOR FACILITIES

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ABSTRACT

The events of September 11, 2001, along with the Oklahoma City bombing and Washington, DC area sniper attacks have forever changed America's sense of security. Federal, state, and local governments, businesses, and individual homeowners have become more aware of safety, security, and protecting property and people should similar incidents occur in the future.

The initial steps in facility protection are identifying potential threats and evaluating the condition of existing building infrastructure and systems. After assessments are complete, the results should be compared with guidelines and recommendations produced by government agencies or professional organizations. Areas to address to enhance security and safety include ventilation, control systems, air filtration, alarm systems, building access, and surveillance.

This paper will look at the objectives of task forces, sources of information, and measures owners can take in schools and other facilities. Although actions involving increased awareness, structural reinforcement, and emergency water supplies are important, this discussion will focus on mechanical and security systems and related items. The authors' experiences in assisting Texas school districts will also be shared.

UNITED STATES INCIDENTS

On September 11, 2001, radical Muslim terrorists attacked the Unites States. In April 1998 domestic dissidents blew up the Murrah Federal Building in Oklahoma City. More recently, in October 2002, snipers randomly picked targets, frightening citizens in the Washington, DC area and capturing the attention of the entire country. Headlines like the ones illustrated filled newspapers.

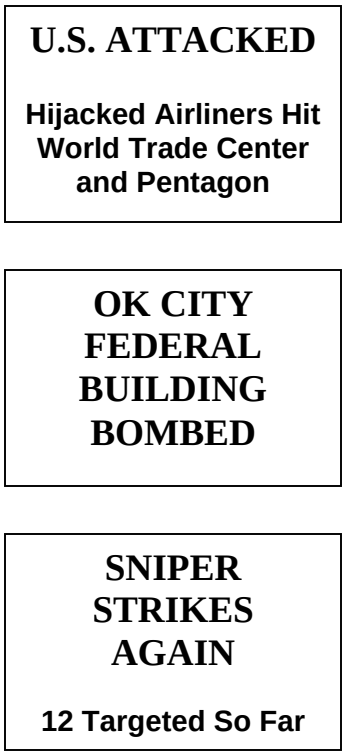

Figure 1. Sample Newspaper Headlines

All these events have changed the way our children and grandchildren will live. Their environment as well as ours has changed. Topics of conversation today in 2004 still relate to what people were doing, where they were, and if they had family in New York, Washington, DC, or Oklahoma City. All these acts have served to personalize the war on terrorism, both domestic and foreign, for most U.S. citizens. They caused many of us to reflect on past crises, for instance:

- How many U.S. citizens remember when President Kennedy was assassinated? Where were you?

Presented at the Fourteenth Symposium on Improving Building Systems in Hot and Humid Climates – May 17-18, 2004
Sponsored by Texas A&M University, Texas State Energy Conservation Office, Estes, McClure & Assoc., Inc., and others.

I remember being at work and observing massive numbers of military aircraft taking off. I remember going home and just holding my children and feeling a horrible knot in my stomach. After some time things got somewhat normal again for most U.S. citizens, but certainly not for the former President's family and friends.

- How many U.S. citizens remember the 9-11 attack on the U.S.?

We all certainly remember 9-11-01 and where we were. The difference between this incident and the Kennedy assassination and the Cuban Missile Crisis is that after 9-11-01 life is not just going back to the way we had it before. We still do most things, but we do some major things differently. The events themselves and the resulting fear and feelings will continue to impact lives.

Each event altered the way we perceive security and led to changes in security procedures. After the Oklahoma City bombing, security was tightened at almost every government building. Surveillance cameras, concrete barriers, additional armed guards, and metal detectors became commonplace. During and after the Washington, DC sniper incident, parents and school officials were hesitant to let children walk to school or play outside. Undoubtedly, we are all aware of the extensive unprecedented security measures implemented after 9-11.

GOVERNOR'S TASK FORCE ON HOMELAND SECURITY

Texas Governor Perry initiated immediate responses to 9-11-01, among them putting in place the Governor's Task Force on Homeland Security (GTFHS) to think through the event and have a planned response to terrorism, not a quick knee-jerk reaction. Governor Perry wanted to assess Texas' vulnerability and improve its readiness and response. Lt. Governor David Dewhurst was named chairman of the GTFHS. The mission of this task force includes the following:

- Assuring Texans of state and local preparedness to respond to threats;
- Facilitating coordination among federal, state and local agencies;
- Improving Texas' ability to detect, deter, and coordinate response to any terrorist events;
- Assessing the ability of state and local government agencies to respond to threats and to effectively provide victims assistance; and
- Coordinating Texas activities with those of the federal agencies including the Office of Homeland Security, Texas' neighboring states, and Mexico.

"We need not only to prepare our current state resources for the threat of terrorism, but also to plan better so that future generations are able to build our state's infrastructure in such a way that targets are minimized and security is strengthened." – David Dewhurst, Chair, November 8, 2001.

TEXAS ENGINEERING TASK FORCE

Lt. Governor David Dewhurst, GTFHS chairman, solicited and received the assistance of the Texas Society of Professional Engineers (TSPE). The TSPE subsequently formed the Texas Engineers Task Force on Homeland Security (ETF) to aid in gathering and interpreting technical information useful in preventing and responding to terrorist attacks in Texas. The mission of the ETF is to provide technical assistance to the task force organized by Gov. Perry and to create an organization that can sustain such assistance for the long term.

The ETF is a group of volunteer engineers organized to provide assistance to the GTFHS by assembling individuals with expertise, identifying potential threats and targets, assessing potential impacts, developing pre-emptive solutions, improving state readiness, and educating the public. To accomplish these tasks, five response teams were formed. Each team was given the responsibility of developing policies supporting the stated mission for inclusion into a statewide response. The five teams are: Threat Identification and Risk Assessment, Structural Damage Prevention and Assessment, Infrastructure Damage Prevention and Assessment, Industrial Damage Prevention and Assessment, and Citizen Education and Public Awareness.

The state was divided into five areas, based on the TSPE's five regions, for purposes of the ETF. Each region was to have engineers or other specialists on each of the five teams. This concept lent itself to decentralized data gathering followed by a centralized planning process. The plan could then be disseminated back to each region for execution.

On a region-by-region basis, the Threat Identification and Risk Assessment Team assessed the risk of a successful threat against people and resources. The Structural Damage Prevention and Assessment Team identified specific threats by region and ranked potential targets. This team is also

developing measures to protect publicly or privately owned infrastructures (i.e. building systems). Their initial focus was coming up with solutions to prevent damage that could be easily implemented and incorporated into building codes. Subsequent activities were to include developing mechanisms for mobilizing resources to conduct damage response in case of attack. The jobs of the Infrastructure Damage Prevention and Assessment and Industrial Damage Prevention and Assessment Teams were identical to that of the Structural Team, except focusing on infrastructures such as transportation, utilities, and communication; and industrial facilities, respectively. The Citizen Education and Public Awareness Team was to educate the public, making them aware of the nature of risks, the work of the ETF, and possible precautions to take.

THREATS

While the threat of terrorist activity is probably higher in Washington, DC and other large cities, attacks could occur almost anywhere. A headline reading "Van Oil Field on Alert" in the June 29, 2003, issue of the *Van Zandt News*, published in Canton, Texas, highlights this fact. The related article notes that oil fields near the small town of Van, Texas, have been on alert at times since September 11, 2001. Certain facilities such as refineries, government offices, skyscrapers, and power plants may be likely targets.

The likelihood of any particular building becoming a terrorist target is very difficult to predict. Because almost any area is at some risk, building owners and managers should consider the possibility and review the security and preparedness of their facilities. The primary goals of building protection and security are limiting infrastructure damage and notifying and protecting occupants.

The main threats from attacks include infrastructure damage from explosives and contamination from airborne chemical, biological, and radiological (CBR) agents. To prepare for such events, building owners and managers should focus on infrastructure, security, surveillance, ventilation and filtration, and maintenance and training. The remainder of this discussion will focus primarily on occupant protection through HVAC system readiness and additional security measures.

The aftermath of natural disasters and other unexpected occurrences such as chemical releases and spills can be similar to terrorist type incidents. Therefore, many of the measures noted here may be appropriate in preparation or response to these emergencies as well.

BUILDING ASSESSMENT

The first step in preparing for a possible incident is to assess existing facilities. Get to know your building. This exercise will be a good starting point to determine readiness for an incident. Understanding how your building is designed and how systems operate will also help in identifying areas of concern and any needed corrections or modifications. Conduct a walk-through, considering these primarily HVAC (heating, ventilation, and air conditioning) related items:

- Equipment
  - Condition
  - Proper connection of all components
  - Functionality
- Air filtration
  - Types of filters in use
  - Filter efficiencies
  - Locations of filters
  - Condition of filters
- Controls
  - Types of controls
  - Energy management system in use, if any
  - Response times
- Operation
  - Locations of air handlers
  - Building zoning for HVAC
  - Airflow patterns through the building,
  - Airflow through utility chases, elevator shafts, etc.
  - Locations of ducts and plenums
- Security
  - Locations of outside air intakes
  - Accessibility of outside air and return air louvers
  - Accessibility of mechanical rooms and equipment

Have a set of plans available during the building survey if possible. Any discrepancies between what is shown on the drawings and what is in place should be noted. This will document what actually exists, will be useful if any work needs to be done, and may help answer questions later on. Consider getting the services of a qualified professional to assist with the building survey and assessment.

Owners should carefully review the results of any building assessment. Taking actions without understanding how they will affect the operation of building systems should be avoided. For example, sealing outside air intakes might at first sound like a

good idea. However, doing this is a violation of building code outside air requirements and may affect the pressures inside the building. Indoor air quality may also be adversely affected.

HVAC SYSTEMS

HVAC systems can be an entry point and means of distribution for all types of contaminants, including CBR agents. The locations, condition, and operation of HVAC equipment and filtration systems can affect the ease with which these substances are capable of spreading.

Filtration

Filtration removes unwanted substances from the air. Different types of filters and levels of efficiency offer varying degrees of protection against everyday pollutants and CBR contaminants. Properly chosen, installed, and maintained air filters can offer increased protection from biological and radiological agents.

There are basically four approaches to air filtration. These methods and their primary targets are:

Dilution – viruses, bacteria, spores, chemicals
Removal – bacteria, spores, dust
Ultraviolet germicidal irradiation (UVGI) – viruses, bacteria
Gas phase filtration – chemicals

Particulate air filters are typically fibrous media designed to remove unwanted particles, including pollen, dust, molds, spores, smoke, bacteria, and viruses, from the air. They may be constructed from cotton, fiberglass, polyester, polypropylene, or other materials. These type filters are commonly rated according to their efficiency, pressure drop, and particulate-holding capacity. Efficiency measures a filter's ability to trap particles of a given size. Higher efficiency filters are able to capture smaller particles, such as smoke, bacteria, and viruses. Pressure drop describes the filter's resistance to airflow, and particulate-holding capacity quantifies the total amount of dust it is capable of capturing.

To capture gases and vapors, sorbent type filters must be used, as the particles are too small to be trapped by particulate filters. Sorbent filters are made from a wide range of very porous materials from clays and carbons to complex engineered polymers. Sorbent filters capture gaseous contaminants by adsorption, the binding of molecules or particles to a surface (as opposed to absorption, the filling of pores in a solid).

One technology, photocatalytic oxidation, actually destroys viruses, bacteria, molds, and fungi. This method is often combined with a high efficiency pleated particulate filter to first capture large particles. A chemical reaction involving ultraviolet (UV) light in the presence of a titanium dioxide catalyst then purifies the air. Studies suggest these filters may also improve building occupants' attendance and work environment.

The results of a Canadian study regarding the use of UV lights (UVGI) to kill microbes in HVAC equipment was published in the November 29, 2003, issue of *The Lancet*, an international medical journal. The use of UV lamps reportedly caused a 99 percent reduction in the quantity of germs left on irradiated surfaces (e.g. coils and drip pans) and yielded a 20 to 40 percent decrease in workers' respiratory symptoms.

The maximum filter efficiency that is compatible with a building's HVAC systems must be considered. Higher efficiency filters typically cause greater static pressure drop. Replacing air handling units to accept higher efficiency filters can be a major undertaking and expense. Besides offering some protection from biological and radiological agents, efficient filters improve overall indoor air quality and contribute to building cleanliness. High efficiency filters may also reduce instances of allergies, respiratory infections, and asthma among building occupants.

Life cycle costs typically are taken into account when considering upgraded filtration. However, in today's environment, occupant protection from terrorist events may override economics, especially for high threat assessment applications. High efficiency particulate and sorbent filters are more expensive than the filters generally used in commercial applications. Also, air handling units may have to be changed out or modified to handle the increased pressure drop caused by upgraded, more efficient filters.

Before selecting filter media, building owners should assess existing HVAC systems as described above. Afterward, they must attempt to determine what types of filters should be installed. Asking several questions, such as the following, may help in this selection process: What types of airborne contaminants are of concern? Are particulate or sorbent filters needed to provide the best protection against these agents? How clean does the air need to be as a general rule? What are the costs and benefits of various levels of filtration? What are the HVAC systems' capabilities? What types of filters are

compatible with the systems? Will the filters improve the working environment and/or reduce absenteeism? Who will maintain the systems and what is their level of expertise?

Filter bypass is a common problem in many HVAC systems. This occurs when air goes around a filter instead of passing through it. Bypass is often caused by incorrectly fitting filters, poor sealing of filters in their frames, missing filter panels, and openings in air handlers between blowers and filters. Addressing filtration efficiency without correcting bypass problems is of little benefit.

Selecting filters that are incompatible with a building's HVAC systems should be avoided. Their use can cause improper operation and decreased occupant comfort. The authors have observed numerous instances where maintenance personnel have substituted cheaper, inappropriate, or improperly sized filters. Therefore, consult a professional before installing new filtration systems.

Ducts and Equipment

Loose ducts or leaky plenums permit contaminants to bypass filters and enter spaces directly. Ducts that are improperly connected (or not connected at all) and plenums that are not sealed should be repaired as soon as possible.

Dampers control the flow of air entering a building as well as circulating within it. Inoperative dampers can reduce the HVAC system's ability to function properly and protect occupants as it should. Therefore, operation of all dampers should be checked. Malfunctioning dampers that do not close correctly may allow unwanted contaminants to enter ducts and spread through a building. Also, the speed at which dampers close can be important. For greater protection, dampers that respond quickly are preferred. Finally, consider low leakage dampers to slow or stop the entrance and movement of contaminants when dampers are closed.

Control Systems

Sophisticated energy management control systems are available to monitor and operate HVAC systems. These controls can also be used to operate the HVAC systems from a central location in the event of an incident. Units can be turned on or off and dampers opened or closed to regulate airflows and pressures within an affected building as needed. For example, stairwells or exit passageways can be kept pressurized to reduce contaminant infiltration during an evacuation. When necessary, affected areas can be isolated.

Building Pressures and Isolation

A separate, dedicated HVAC system should be provided for mailrooms. Also, air pressures throughout the rest of the building should be positive relative to mailrooms. This design helps keep any contaminants released in mailrooms from spreading to other parts of the building. Similar designs should be used in public lobby areas, also to slow the spread of any toxic agents discharged there. Control systems should permit operation of mailroom and lobby air systems independently from those in the remainder of the building.

Buildings as whole should typically be at a positive pressure relative to the outdoors. This strategy helps keep unwanted contaminants from entering through open doors, cracks, and other openings in the building envelope.

BUILDING ENVELOPE

The building envelope can be a source of unintended contaminant infiltration. Leaky exterior walls may allow significant quantities of unfiltered air containing everything from dust and pollen to CBR agents to enter a building. Improperly fitting doors and gaps around windows also serve as entrances for pollutants. Once inside, these substances can spread via HVAC systems potentially causing occupants discomfort or harm. Envelope tightness must be considered in conjunction with upgraded filtration.

SECURITY

Security includes any methods that enhance protection of occupants, infrastructure, or HVAC systems and controls whether directly or indirectly. Possible measures include limiting and monitoring facility access, protecting air intakes and equipment, and limiting the distribution of building drawings and information.

Publicly accessible outside air intakes offer would-be terrorists an opportunity to introduce CBR agents into a building. Pranksters and troublemakers can also toss stink bombs or other irritants into these openings. Commonly used chemicals such as landscape fertilizers and pesticides can also enter by this means. Therefore, access to outside air intakes should be limited, preferably by locating them as high as practicable above the ground. Existing intakes should be raised, if possible. If this option is not viable, consider establishing a secure zone around the intakes by installing physical barriers. Also look at fencing off outdoor equipment and blocking roof access.

Limit access to mechanical rooms. At a minimum install locks on the doors and distribute keys to as few people as possible. Even better, install keyless entry systems at these locations. Outdoors install fences or other barriers around equipment. Securely lock gates and distribute keys only as necessary.

Surveillance cameras can also be used to enhance security by allowing observance of activities both indoors and outside. Cameras locations should include entrances as well as sensitive areas such as mechanical rooms, air intakes, and outdoor equipment locations. Images can be recorded for review later on should it be necessary.

Access control systems can be installed at entrances and within facilities to regulate access to the building and within secured areas. Employees and visitors as well are issued cards that are scanned by card readers. These systems maintain consistent supervision and can detect, deter, and respond to unauthorized entry. They are capable of easily voiding or validating any individual's card and maintaining a trail of all cards granted access. Surveillance cameras can be integrated with access systems so that snapshots or streaming video can be associated with every access event.

BACKUP/EMERGENCY POWER

Some terrorist acts may result in the loss of utility power. In these cases a source of backup power will allow occupants to remain in the building if necessary and retain some functionality. The most common source of emergency power is an engine-generator fueled by diesel or natural gas. These generators can power lighting, HVAC, computers, communications, fire pumps, and many other functions for extended periods of time.

PLANNING

Today it is more important than ever to be prepared for possible emergencies. All building owners should have a formal crisis management plan. The plan should deal with unexpected situations that may arise, ranging from fires to inclement weather to building damage that interrupts normal operations.

The following is an outline of the Crisis Management Plan that the authors prepared for their company:

Prevention	Recovery Teams
Employee notification	Evacuation
Training	Data backup
Fire	Power interruption
Alternate facilities	Loss of workspace
Hazardous weather	Crime and violence
Medical emergencies	Missing employee
Technology disruption	

In addition to a plan, some facilities have emergency supplies or "kits" on hand. Items to consider including are first aid supplies, flashlights, water, and food. In especially high-risk areas, a safe room with sealed doors and windows may be appropriate. If a permanent room is not feasible, look at keeping materials such as durable plastic and tape on hand to quickly construct one. The safe room may be stocked with bottled water, non-perishable food items, and special communication equipment.

TRAINING

Maintenance staffs should be adequately trained to keep HVAC systems and equipment operating properly. Training should include familiarization with emergency procedures, HVAC diagrams, preventative maintenance schedules and requirements, and information on system performance.

CONSTRUCTION AND RENOVATIONS

During the design phase for new construction and renovation projects, homeland security issues need to be taken into account. Some design considerations include:

- Structural
  - Standoff distances between parking and buildings
  - Strength of equipment enclosures
  - Limiting access to rooftops and crawl spaces
  - Overall building structural strength
  - Entrance/lobby layout – minimize unauthorized access
  - Hallway arrangement – locate to protect occupied spaces
  - Glazing – types, locations, and amounts
- HVAC
  - Use of low-leakage and modulating dampers for ventilation
  - Mailroom HVAC and ventilation – separate from remainder of building
  - Locations of air intakes – away from accessible areas
  - High performance filtration
- Emergency response
  - Air distribution shutoff capability
  - Speedy notification of threat or hazard
  - Protection of building occupants from chemical, biological, and radiological agents

- Other
  - Emergency backup power
  - General routing of utilities – minimize in exterior walls
  - Enhanced equipment bracing
  - Recognition that schools and other public facilities could be used for shelters, locations of mass inoculations, etc.
  - Notification of threat to occupants

OTHER BENEFITS

Making the corrections and enhancements discussed will not only improve preparation for an incident, but may also generally increase occupant security and comfort. Some added benefits include better overall indoor air quality from enhanced filtration, improved temperature control due to proper airflow, and energy savings resulting from repairing or replacing equipment or installing more sophisticated controls. Security systems can decrease or eliminate access by all unauthorized persons. Surveillance systems may be helpful in monitoring all types of activities. Emergency generators for backup power may prove useful during power outages caused by tornadoes, winter storms, failures, and accidents. Finally, a well-trained maintenance staff will be better able to keep HVAC systems functioning at peak performance.

PHOTOCATALYTIC OXIDATION CASE STUDY

Tests to evaluate the effectiveness of high performance air filters combined with photocatalytic oxidation (PCO) are currently underway in the Lewisville (Texas) Independent School District. The first installation was completed there in the summer of 2002. Since that time this type air filtration system has been installed in two more schools and selected classrooms in two others.

The air filtration system involves a two-stage process. Pleated air filters first capture large particles and bioaerosols. Ultraviolet (UV) light is then used to activate titanium dioxide on the filter grid. Activation of the titanium dioxide with UV light creates hydroxyl radicals that sterilize bacteria, viruses, fungi, and molds.

Test results, although incomplete, suggest a significant reduction in mold concentration in schools (when compared to concentrations in outside air) with high performance filters plus PCO technology. Data is being compiled determine a possible reduction in absenteeism rates in these schools. However, more analysis, which is currently underway, will be needed to confirm these preliminary findings. Testing at the Lewisville ISD schools is ongoing.

ASHRAE EAST TEXAS CHAPTER HOMELAND SECURITY PRESENTATION

In April 2003, the East Texas Chapter of the American Society of Heating, Cooling, and Refrigeration Engineers (ASHRAE) held a meeting featuring a discussion, led by James McClure, P.E., on homeland security. During that dialogue, attendees participated in a brainstorming session regarding what can be done to protect schools. Many of these items can also apply to other types of facilities as well. Among the ideas generated:

Early warning
Backup electrical power
Remote control of HVAC
Hazard detection
"Safe rooms"
Limited access to building and HVAC equipment
Emergency response teams
Training for occupants and maintenance staff
Effective communication equipment and procedures

WHAT SCHOOLS ARE DOING

In the experience of the authors, schools are specifying and installing a variety of equipment that could assist with prevention of and/or or response to terrorist incidents. Systems that might potentially aid prevention include intrusion detection, controls, building access, and video surveillance. Fire alarms, intercoms, and telephones might help with occupant notification. Finally, fire suppression, emergency lighting, and HVAC control systems are useful in the response phase. Fire suppression (sprinkler) systems extinguish fires, emergency lighting can assist in occupant escape and rescue efforts, and HVAC controls can turn units on and off and open and close dampers to minimize infiltration of unwanted agents as well as to maintain desired building pressures and isolate systems to prevent the spread of chemical or germ agents once inside.

As noted above, some schools are installing generators to supply power in emergency situations. Lewisville ISD schools recently began specifying backup generators for their new schools. While not expressly due to the risk of terrorism, the generators could provide power in the event electric service was interrupted by such an incident. Schools in Loudoun County, Virginia, are also routinely equipped with emergency generators. While the driving force behind the installations is providing power during

outages from winter ice storms, again, the devices could prove essential after a terrorist incident.

Additionally, most school districts have implemented safety and security plans. Some have incorporated these as a part of their facility management and review programs. One north Texas district has combined their energy monitoring, hazardous materials abatement, and indoor air quality with their facilities administration, since all these issues can be interrelated.

SUMMARY

The attack of September 11, 2001, as well as other incidents such as the Oklahoma City bombing and Washington, DC sniper shootings, have left indelible marks on the United States and its citizens. As a result unprecedented concerns about homeland security are now commonplace. Two of the greatest threats to the United States today include extremist groups and complacency. Preventing and responding to terrorism is a long-term effort and we must not become comfortable and let down our guard.

In addition to all of the other measures discussed, work closely with local emergency management officials. They may be able to offer further information and suggestions regarding disaster preparedness. Despite one's best efforts to adequately reinforce structures and upgrade building systems (e.g. HVAC, electrical, security), in the event of an incident, public safety personnel (fire, police, etc.) are the ones who can save lives, limit damage, and apprehend the perpetrators.

To ensure the protection of property, and more importantly occupants, building owners and managers should evaluate their facilities. Among important areas for assessment are infrastructure, HVAC systems, and security. Helpful hints for evaluation as well as remediation have been presented. These are not all-inclusive, but are intended to be informative and create awareness. Obviously, every situation and circumstance cannot be anticipated. As buildings differ in their design, use, and operation, each should be considered on an individual basis. Also, as the threat of a terrorist attack varies depending upon type of facility and location, all measures described may not be appropriate in all cases.

FURTHER INFORMATION

More information on homeland security issues related to building preparedness and response is readily available. Sources include federal and state governments, professional organizations, and task forces. A few of the many resources are the Department of Defense, Department of Homeland Security, National Institute for Occupational Safety and Health, National Society of Professional Engineers, Texas Society of Professional Engineers, The Infrastructure Security Partnership, and The American Society of Heating Refrigeration and Air Conditioning Engineers (ASHRAE). Many resources are available both in printed form and on the Internet.

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