Report of Presidential Ad Hoc Committee for Building Health and Safety under Extraordinary Incidents

On

Risk Management Guidance for Health, Safety and Environmental Security under Extraordinary Incidents

Approved by Board of Directors

26 January 2003

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EXECUTIVE SUMMARY

Extraordinary incidents, whether caused by war, terrorism, accident or natural disaster, can impact immediate human needs including survival and safety, and also such longer-term needs as air, water, food, and shelter. ASHRAE's expertise in heating, ventilation, air-conditioning and refrigeration (HVAC&R), and its knowledge of building envelope performance, intake and exhaust air control, air and water treatment, and food preservation is critical in addressing life-safety, and environmental security. Recognizing this increased responsibility for providing guidance for enhanced building performance, the President of ASHRAE appointed a Study Group in October 2001 to provide initial guidance on actions that should be taken to reduce the health and safety risks of occupants in buildings that might be subjected to extraordinary incidents. After the presentation of the Study Group's Report on 14 January 2002, an ASHRAE Presidential Ad Hoc Committee was appointed to continue the work, and to provide a more comprehensive report to the ASHRAE Board of Directors by January 2003.

The *objective* of this report is to provide guidance for new and existing buildings regarding protection of air, water, and food systems within buildings. The *scope* of this report pertains to public use and assembly buildings; commercial, institutional, and educational facilities; and other areas of public assembly such as stadiums, coliseums, and vehicle tunnels and subways. This scope also pertains to those areas of industrial and manufacturing facilities that affect occupancy.

Framework

This Report is based on the framework presented in Figure 1 (see Chapter 1). In this framework, the first step is to evaluate the *risk* to a facility of an extraordinary incident. As used in this Report, risk is defined as the "possibility of suffering harm or loss."[1] Based on the level of risk, along with other considerations, the *vulnerability* of a given building to an extraordinary incident is assessed. As used in this document, vulnerability is defined as "susceptibility to physical injury or attack"[2]. For example, a building located next to railroad tracks is more vulnerable to a hazardous chemical leak resulting from a train derailment. While all buildings are vulnerable, the degree of *acceptable vulnerability* for a given building is determined, as noted in Fig. 1, based on those threats (i.e., "indication of impending danger"[3]) to be addressed, and those that will be accepted based on a low level of likelihood, or on the impracticality or high cost of protection. Next, the infrastructure constraints and vulnerabilities, which are the factors that determine the need for, and practicality of, different protective measures are considered in Chapter 3. These factors include the infrastructure supporting the facility, e.g. utility reliability, cost, currently available technology and existing building characteristics. Finally, protective measures, i.e., *options*, are considered for new or renovated buildings in Chapter 4, and for existing buildings in Chapter 5. These options are implemented based on the level of "acceptable" vulnerability and the constraints, which, as noted in Fig. 1, in a re-iterative

[1] Webster's II New College Dictionary 1995 edition
[2] Webster's II New College Dictionary 1995 edition
[3] Webster's II New College Dictionary 1995 edition

decision-making process that compares the various options and their constraints before making a decision on which options to implement.

Findings and Conclusions

Chapter 2

1. Some characteristics and attributes of buildings can make them more or less of a potential target. To put some of these characteristics in perspective, a summary of commercial building demographic data is provided in Chapter 2 and in Appendix B. This information may be helpful when determining the levels of risk and vulnerability faced by any particular building. However, current statistics are not readily available on the quantity, types, sizes, and systems serving underground spaces. These spaces include vehicle tunnels, subways, garages, and storage facilities.

2. Historical data exist on the occurrence and severity of extraordinary incidents associated with fire, wind, flood, storms, and some criminal activities. However, data on intentional incidents are far more limited and do not enable one to predict the nature, likelihood or severity of future events. Therefore, the guidance presented in this report and the decisions made by building owners, designers and operators are necessarily based on current experience.

- *These limitations in our knowledge base are not a justification for the abrogation of one's responsibility to deal with the potential risks in a building, but rather an acknowledgement that we are not yet able to base these critical decisions on a well-established body of knowledge*.

- *Section 2.3 suggests that, despite an increase in the relative percentages of time that extraordinary incidents occur as a result of terrorist activities, the amount of time that buildings function under normal conditions far exceeds the amount of time under extraordinary incidents.*

- *These data also lead to the conclusion that the HVAC&R systems must provide a control sequence continuum from normal operations to effective responsiveness during the occurrence of an extraordinary incident.*

3. Risk management, introduced in Section 2.4, is an expanded approach to building design and management. Integrating a comprehensive risk management program with safety, environmental, energy management, and productivity issues is done using standard evaluative methods such as Life Cycle Costing, Benefit-to-Cost ratio, Return On Investment, or simple payback.

Chapter 3

4. Building occupants have come to expect 100% reliability from the infrastructure that serves them. Most are not aware of how vulnerable and interdependent these systems are. Chapter 3 addresses many of the infrastructure systems that may be vulnerable to terrorists. Some outages can prevent building occupancy for days, weeks, or months until they are restored. Also included in this

Chapter are suggested measures and plans that could reduce the risks of disruptions to the infrastructure systems. Similar provisions apply to many types of natural occurrences and occasional outages, although the frequency, duration, and severity of those can be more predictable, based on prior experiences.

5. Onsite infrastructure failures happen regularly, but usually on a manageable scale. Most buildings make provisions for these failures or disruptions as a part of regular maintenance or periodic renovation. However, it may be necessary to perform specific risk and vulnerability assessments of buildings to determine the extent to which the function of any particular building can be compromised by extraordinary events.

- *If this is the case, detailed planning by the owner and licensed professionals may be needed that utilizes "what if" scenarios to examine the consequences of unusual and/or multiple situations.*

6. Many of the infrastructure issues discussed above are interdependent, and therefore, failure, disruption, or reduction in any one service can impact some of the others. For example, many communication systems rely on electric power for operation. Thus, an electric outage can also mean that communications are not available. As contingency plans are considered to deal with these issues, these interdependencies must be kept in mind.

7. Experience has been gained for dealing with most of these issues to at least some extent by ordinary utility outages, strikes, natural occurrences, or other expected unreliability. While the relative risk of their being impacted by terrorist attacks may be low in an individual building, this possibility and the potential impacts on infrastructure should not be overlooked. Most buildings incorporate some features to back up infrastructure, and can include simple items such as battery backup power supplies for computers and communications equipment, as well as more complex and expensive safeguards, such as emergency generators, redundant electricity, communications, and water service, or combustion driven heating and cooling.

- *If the risk of terrorist attack is judged to be sufficiently high, a greater number of redundant or backup features may be desirable and justifiable.*

Chapter 4

8. The health, comfort and productivity of building occupants should not be compromised in the name of the reducing building vulnerability to extraordinary incidents.

- *Methods for reducing vulnerability from extraordinary incidents should be identified based on a realistic evaluation of the actual risk.*

- *Many of these measures can also be justified based on the health, productivity and comfort of the building occupants during normal operations.*

- *Other features, such as high-performance air filtering techniques, can have a significant impact on first cost and operating cost.*

9. In the design of new buildings, care should be exercised in the details of construction and the contractual methods of installation, to assure that the systems will operate in the manner intended.

- *When subjected to a life threatening incident, the system becomes a component of a life safety system, therefore, the "performance as intended" takes on a much more important role. To this end, commissioning the "system" is highly recommended.*

- *The Owner of the building has the ultimate responsibility in determining the level of risk, which must be provided for in the design, as well as the vulnerability of the occupants under various scenarios of incidents.*

- *Once the required performance parameters have been determined, the system, controls, and machinery should be designed, constructed and operated to achieve the desired level of protection. While design professionals can assist building owners in reducing vulnerability to extraordinary incidents, it is not possible to eliminate all risk.*

- *The building owner, then, following the successful commissioning performance verification assumes the responsibility for the ongoing operations*

The following findings and conclusions in Chapters 4 and 5 are intended to establish not what steps in system design must be taken, but rather how the design decisions can best be implemented once decided upon.

10. Outdoor air intakes should be located so that they are protected from external sources of contamination, and away from publicly accessible areas in order to minimize obstructions near the intakes that might conceal a device. The use of surveillance cameras and/or intrusion alarm sensors to monitor the intake areas should be considered. These precautions should also provide the added benefit of minimizing the contamination of indoor air from ground applied fertilizers or pesticides, vehicle traffic and similar sources during normal building operation.

11. Entry of visitors, employees, tenants, delivery persons and other special persons should be carefully considered. In addition to providing increased building physical security, it will help minimize the opportunity for a deliberate internal release of an agent.

12. The building envelope should be designed to minimize liquid transfer, as well as air and water vapor infiltration. In addition, the pressurization zones within the building should be maintained at the appropriate values for the functions within them.

- *These efforts should reduce both building vulnerability and energy use while providing a healthy and comfortable environment for the increased productivity of the occupants.*

- *In areas with high humidity, the risk of mold and mildew formation and growth should also be reduced.*

13. Life safety issues under many extraordinary conditions require alerting occupants to the situation and providing proper instruction.

14. As biological and radiological particles are in the range of 0.1 to 10 microns (μm), filters should be selected with a highest MERV rating that is physically feasible and economically justified. Significant improvements in protection can be achieved at MERV ratings of 14 through 20 (based on risk assessment and economic analysis). Also, consideration should be given to the need and effectiveness of gas and vapor removal technology to reduce the building vulnerability to chemical agents. As filter and air cleaner efficiencies increase, so do the pressure drops across them, thus, likely requiring larger fans and motors and increased energy cost associated with operating the system.

- *The total cost of the filters and air cleaners, including first cost, maintenance cost and operating and energy cost should be evaluated and compared to risk assessment and reduction of vulnerability, as described in Chapter 2.*

15. *Integrating the control sequences of HVAC systems for normal and extraordinary periods of operation is a critical design issue.* Fundamentally, the issue is one of priority control. Given the variations in extraordinary conditions that can occur, a priority scheme must be determined to change from normal control sequences in order to respond to fire, smoke, floods, seismic, wind, and/or accidental and intentional releases of contaminants.

- *The priority of control should be decided by the design professional, together with the building owner, based on the relative risk assessments at the particular facility.*

16. Plans and drills for responses to extraordinary incidents are essential to the health and safety of the occupants and the first responders.

- *Plans to implement these actions should be addressed and refined during the design phases of the building project*.

- *Full-scale response drills should be held periodically to ensure that the building occupants, tenants/employees, and first responders understand and practice their duties and responsibilities.* These drills should include the operation of the appropriate protective features and the building evacuation, movement of occupants to designated areas within the building, or remaining in the building as appropriate for the emergency or threat being simulated.

17. Commissioning, as described in ASHRAE Guideline 1-1996[4], and as anticipated to be described in Guideline 0-P[5] for commissioning and recommissioning, should be an integral part

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[4] ASHRAE. 1996. Guideline 1-1996 *HVAC Commissioning Process*. American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc. Atlanta.

of the design process for any new or renovation project. However, the ASHRAE Guidelines do not provide specific performance criteria with which to ascertain intended performance during normal or extraordinary conditions. Therefore, the commissioning processes should be augmented by procedures[6] that define specific performance criteria and measures to demonstrate that the building and its systems are: 1) performing as intended under normal conditions; and 2) prepared to respond to extraordinary incidents in accordance with the accepted level of vulnerability, as determined in the risk assessment, Chapter 2.

Chapter 5

The objective of this Chapter is to consider some methods that can be effectively employed for existing buildings to meet the risk management strategy established by methods in Chapter 2.

18. As discussed in Appendix B, approximately 4.7 million buildings currently exist in the U.S. that are within the scope of the issues addressed in this Report. Not all of these buildings will reveal sufficiently high risk of intentional attack to justify expenditures for vulnerability reductions. However, some of the buildings do have elevated risk to chemical, biological & radiological (CBR) attacks and have known problems of performance during normal conditions that would affect the ability of the building to respond to the attack, and should be corrected.

- *Risk assessments of properties should be conducted, using procedures such as those described in Section 2.4.1. And, based on the results of the risk assessments, risk treatment procedures, similar to those in Section 2.4.2, should be initiated with concentration on changes to maintenance and operational procedures that can be implemented to reduce the vulnerabilities.*

19. Essentially all of the options considered for new building design are also applicable to building renovation and retrofit based on the risk, and on the acceptable level of building vulnerability.

- *Each of these options should be considered and implemented as appropriate and applicable in retrofit projects. However, with existing buildings some of the options may need to be revised and alternatives selected that will provide a similar reduction in vulnerability while meeting the economic and building features associated with renovations.*

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[5] ASHRAE. 2002. Guideline 0-P: *The Commissioning Process*. (Unpublished Public Review Document, April 2002). American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc. Atlanta.

[6] Woods, J.E. 2001. *What is Productivity and How is it Measured?* In: Productivity and the Workplace. GSA Office of Governmentwide Policy. December 2001, pp. 33-40.