1.1 PURPOSE AND OVERVIEW

The purpose of this primer is to introduce concepts that can help building designers, owners, and state and local governments mitigate the threat of hazards resulting from terrorist attacks on new buildings. This primer specifically addresses four high-population, private-sector building types: commercial office, retail, multi-family residential, and light industrial. However, many of the concepts presented here are applicable to other building types and/or existing buildings. The focus is on explosive attack, but the text also addresses design strategies to mitigate the effects of chemical, biological, and radiological attacks.

Designing security into a building requires a complex series of trade-offs. Security concerns need to be balanced with many other design constraints such as accessibility, initial and life-cycle costs, natural hazard mitigation, fire protection, energy efficiency, and aesthetics. Because the probability of attack is very small, security measures should not interfere with daily operations of the building. On the other hand, because the effects of attack can be catastrophic, it is prudent to incorporate measures that may save lives and minimize business interruption in the unlikely event of an attack. The measures should be as unobtrusive as possible to provide an inviting, efficient environment that does not attract undue attention of potential attackers. Security design needs to be part of an overall multi-hazard approach to ensure that it does not worsen the behavior of the building in the event of a fire, earthquake, or hurricane, which are far more prevalent hazards than are terrorist attacks.

Because of the severity of the types of hazards discussed, the goals of security-oriented design are by necessity modest. With regard to explosive attacks, the focus is on a damage-limiting or damage-mitigating approach rather than a blast-resistant approach. The goal is to incorporate some reasonable measures that will enhance the life safety of the persons within the building and facilitate rescue efforts in the unlikely event of attack.

It is clear that owners are becoming interested in considering man-made hazards for a variety of reasons including the desire to:

- attract more tenants or a particular type of tenant,
- lower insurance premiums or obtain high-risk insurance,

- reduce life-cycle costs for operational security measures, and
- limit losses and business interruption.

Protection against terrorist attack is not an all-or-nothing proposition. Incremental measures taken early in design may be more fully developed at a later date. With a little forethought regarding, for instance, the space requirements needed to accommodate additional measures, the protection level can be enhanced as the need arises or the budget permits after construction is complete.

This primer strives to provide a holistic multi-disciplinary approach to security design by considering the various building systems including site, architecture, structure, mechanical and electrical systems and providing general recommendations for the design professional with little or no background in this area.

This is one of a series of five FEMA primers that address security issues in high-population, private-sector buildings. It is the intent of FEMA that these reports will assist designers, owners, and local/state government officials in gaining a solid understanding of man-made hazards. These reports will also discuss current state-of-the-art methods to enhance protection of the building by incorporating low-cost measures into new buildings at the earliest stages of site selection and design.

Best practices recommended in this primer are listed below.

- ✔ Place building as far from any secured perimeter as practical.
- ✔ Secure the perimeter against vehicular intrusion using landscaping or barrier methods.
- ✔ Use lightweight nonstructural elements on the building exterior and interior.
- ✔ Place unsecured areas exterior to the main structure or in the exterior bay.
- ✔ Incorporate measures to resist progressive collapse.
- ✔ Design exterior window systems and cladding so that the framing, connections, and supporting structure have a lateral-load-resistance that is equal to or higher than the transparency or panel.
- ✔ Place air intakes as far above the ground level as practical.
- ✔ Physically isolate vulnerable areas such as the entries and delivery areas from the rest of the structure by using floor-to-floor walls in these areas.
- ✔ Use redundant, separated mechanical/electrical control systems.

1.2 CONTENTS AND ORGANIZATION OF THE REPORT

This report provides basic qualitative and descriptive information characterizing potential terrorist threats: the effects of terrorist-caused explosions or releases of chemical, biological, and radiological (CBR) agents; and measures that can be taken to limit and mitigate their impacts on buildings and their occupants.

Because explosive attacks are expected to remain the dominant terrorist threat, most of the guidance in the document relates to explosions and limiting their effects. In addition to descriptive information and guidance, each chapter identifies references for further reading. Chapter 2 focuses principally on bomb (explosion) threats, likely targets, and likelihood of occurrence. Weapons effects are described in Chapter 3, which discusses blast pressure waves, initial blast forces, and the decay of these forces with time and distance. Chapter 4 focuses on damage caused by explosions, including damage mechanisms for various building elements and systems, including both structural and nonstructural components. Topics include (1) progressive collapse, (2) comparisons with forces imposed by other extreme loads, such as earthquakes and wind storms, and (3) the potential extent and distribution of deaths and injuries resulting from various damage mechanisms. Design approaches to limit or mitigate damage caused by bomb attacks are described in Chapter 5. Goals include preventing collapse (at least until the building can be fully evacuated) and reducing the effects of flying debris. Security measures described include: (1) preventing an attack, (2) delaying an attack, and (3) mitigating the effects of these attacks.

The heart of the document is Chapter 6, which contains extensive qualitative design guidance for limiting or mitigating the effects of terrorist attacks, focusing primarily on explosions, but also addressing chemical, biological, and radiological attacks. Checklists of mitigation measures are provided at the end of each major section. Site and layout design guidance is provided in Section 6.1. Important concepts are stand-off distance from the perimeter property line, controlled access zones, and anti-ram barriers, which can be either passive or active. Section 6.2 describes architectural issues and attributes affecting the impact of explosions on buildings. The primary focus is on building shape, placement, exterior ornamentation, and the functional layout of the interior. Structural design issues are discussed in Section 6.3. Topics include (1) methods to prevent progressive collapse; (2) the selection of a building

structural system, including desirable attributes of the system; (3) structural layout (the placement of structural elements); (4) design methods, including the relationship between security design and design for conventional loads; and (5) the design of critical structural elements, focusing on the exterior frame, roof system, floor system, interior columns, and interior walls. Section 6.4 addresses the building envelope; i.e., exterior walls and cladding, window systems, and other openings. Specific guidance is provided on exterior wall and cladding design. Window design is given special consideration, including glass design, mullion design, and frame and anchorage design. Guidance is also given on wall design, multi-hazard considerations, and the design of other openings (doors and louvers). Issues relating to the design and placement of mechanical and electrical systems are described in Section 6.5. Topics addressed include emergency egress routes, air intakes, emergency power systems, fuel storage, ventilation systems, the fire-control center, emergency elevators, the smoke and fire detection and alarm systems, the sprinkler and standpipe system, smoke-control systems, and the communication system. Finally, Section 6.6 addresses issues specific to chemical, biological, and radiological protection. Issues discussed include air intakes, mechanical areas, return air systems, vulnerable internal areas (lobbies, loading docks, and mail sorting areas), zoning of HVAC systems, positive pressurization, air-tightness, filtration systems, detection systems, management of emergency response using the fire/HVAC control center, and evolving technologies for CBR prevention.

Chapter 7 discusses special considerations for multi-family residential buildings, buildings that include retail uses, and light-industrial buildings. Chapter 8 discusses cost issues, including some general suggestions on prioritizing potential security enhancements.

1.3 FURTHER READING

Other recently issued FEMA documents related to man-made hazards are listed below.

Federal Emergency Management Agency, FEMA 426, *Reference Manual to Mitigate Potential Terrorist Attacks Against Buildings.*

Federal Emergency Management Agency, FEMA 428, *Primer for Designing Safe School Projects in Case of Terrorist Attacks.*

Federal Emergency Management Agency, FEMA 429, *Primer for Terrorist Risk Reduction in High Occupancy Buildings.*

Federal Emergency Management Agency, FEMA 430, *Security Component for Architectural Design*.