

**T**he terrorism risk assessment process described in FEMA 452, *Risk Assessment: A How-To Guide to Mitigate Potential Terrorist Attacks Against Buildings*, helps building owners to assess major vulnerabilities in a building and identify mitigation measures to correct such vulnerabilities. The information generated by the application of FEMA 452 and by the methodology provided in this manual are fundamental for implementing an incremental security enhancement process for existing commercial buildings.

The mitigation measures generated by the application of FEMA 452 provide the starting point for the application of this document. This document then demonstrates how a building owner or facility manager categorizes those mitigation measures into increments of terrorism risk reduction, and integrates the increments into ongoing or planned facility maintenance or capital improvement projects.

A building owner or facility manager proceeding through the five steps of FEMA 452 described in Section 2.1 generates a series of physical protection and strengthening measures, as well as operational mitigation measures. In moving from a risk assessment to implementation, the building owner should check the compatibility of the former (physical protection and strengthening), as well as some of the latter (operational), with the maintenance and capital improvement plans. A matrix, as shown in Section 2.3, should be used to highlight opportunities for integration of specific mitigation options with specific maintenance or capital improvement activities.

### 2.1 RISK ASSESSMENT PROCESS

**T**he risk assessment process described in FEMA 452 is based on five critical steps (Figure 2-1). These critical steps identify the best and most cost-effective terrorism mitigation measures for a building's unique security needs.

Conducting a threat assessment to identify, define, and quantify the threats or hazards is the first step of the risk assessment process. For terrorism, the threats are aggressors (people or groups) that are known to exist and that have the capability and a history of using hostile actions, or that have expressed intentions for using hostile actions against potential targets. Current credible information on targeting activity (surveillance of potential targets) or indications of preparation for terrorist acts may be available for these aggressors.

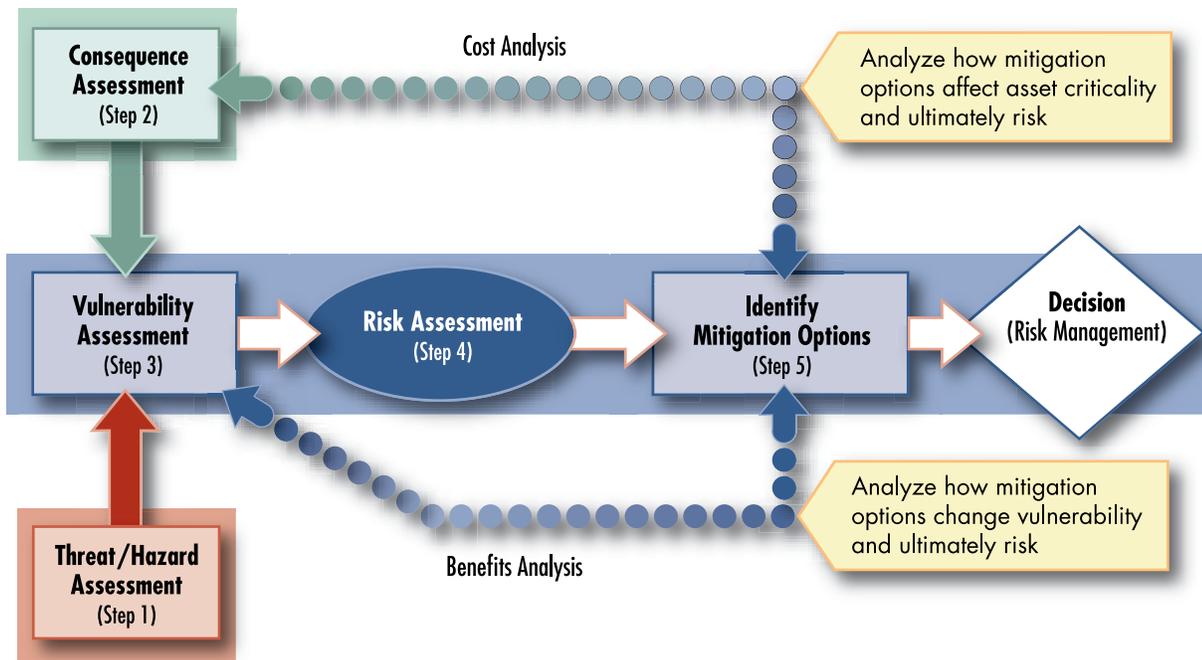


Figure 2-1: Risk assessment process model.

The second step of the risk assessment process is to identify the consequences of the loss of a building that needs to be protected from terrorist attack. Consequences relate to the criticality of the building in terms of the importance of the building operation to the owner and the locality, and can be defined as a degree of debilitation that would be caused by its destruction. This assessment of consequences can be applied to the entire building or significant portions of a very large building. It can also refer to a resource of value requiring protection. Consequences can be tangible (i.e., loss of buildings, facilities, equipment activities, operations, and information) or intangible (e.g., loss of processes or a company’s reputation).

As explained in FEMA 452, “after assessing consequences, the third step is to conduct a vulnerability assessment. A vulnerability assessment evaluates the potential vulnerability of the critical assets against a broad range of identified threats and natural hazards. By itself, the vulnerability assessment provides a basis for determining mitigation measures for protection of the building and its content. The assessment is a bridge in the methodology among threat/hazard, consequences, and the resultant level of risk.

“The fourth step of the process is the risk assessment. The risk assessment analyzes the likelihood or probability of the threat or natural hazard occurring and the consequences of the occurrence. Thus, a very high

likelihood of occurrence with very small consequences may require simple low cost mitigation measures, but a very low likelihood of occurrence with very serious consequences may require more costly and complex mitigation measures. The risk assessment should provide a relative risk profile. High-risk combinations of assets against associated threats, with the identified vulnerability, allow prioritization of resources to implement mitigation measures.

“The fifth and final step is to consider mitigation options that are directly associated with, and responsive to, the major risks identified during Step 4. From Step 5, decisions can be made as to where to minimize the risks and how to accomplish that over time.”

### **2.1.1 LEVELS OF VULNERABILITY ASSESSMENT**

FEMA 452 provides guidance in conducting varied levels of assessments, ranging from screening level assessments to in-depth assessments. As stated in FEMA 452, “the level of assessment for a given building is dependent upon a number of factors such as potential threat, type of building, location, type of construction, number of occupants, economic life, and other owner specific concerns and available economic resources.” FEMA 452 defines a three-tier assessment process as follows:

“**Tier 1.** A Tier 1 assessment is a ‘70 percent’ assessment. It can typically be conducted by one or two experienced assessment professionals in approximately two days. A Tier 1 assessment will likely be sufficient for the majority of commercial buildings and other non-critical facilities and infrastructure.

“**Tier 2.** A Tier 2 assessment is a ‘90 percent’ assessment. It typically requires three to five assessment specialists, can be completed in 3 to 5 days, and requires key building staff participation. A Tier 2 assessment is likely to be sufficient for most high-risk buildings such as iconic commercial buildings, government facilities, schools, hospitals, and other high-value designated infrastructure assets.

“**Tier 3.** A Tier 3 assessment is a detailed evaluation of the building using blast, weapons of mass destruction (WMD), earthquake, flood, and high wind models to determine building response, survivability, and recovery, and the development of mitigation options. The assessment team is not defined for this tier; however, it could be composed of 8 to 12 people. Modeling and analysis can often take several days or weeks and is typically performed for high value and critical infrastructure assets.”

## 2.1.2 THE BUILDING VULNERABILITY ASSESSMENT CHECKLIST

FEMA 452 includes a Building Vulnerability Assessment Checklist, covering explosives, CBR, earthquakes, floods, and high-wind hazards. The checklist can be used to collect and report information related to the building. It compiles many best practices, based on the latest technologies and scientific research, to consider during the design of a new building or renovation of an existing building.

The vulnerability assessment step is supported by the Building Vulnerability Assessment Checklist (FEMA 452, Appendix A), which is organized into 13 sections corresponding to building subsystems:

1. Site
2. Architectural
3. Structural Systems
4. Building Envelope
5. Utility Systems
6. Mechanical Systems
7. Plumbing and Gas Systems
8. Electrical Systems
9. Fire Alarm Systems
10. Communications and IT Systems
11. Equipment Operations and Maintenance
12. Security Systems
13. Security Master Plan

To support the building assessment process, a Risk Assessment Database has been developed as a companion tool to FEMA 452. The database is a stand-alone application with several functions: import files and folders; display digital photos, emergency plans, and digital floor plans; and provide specific GIS tools. The database can be used to collect and report information related to the building.

The 13 sections of the Building Vulnerability Assessment Checklist provide a framework for the categorization of incremental measures of terrorism risk reduction discussed in the following sections.

## **2.2 SCHEDULING INCREMENTS: PHYSICAL PROTECTION AND STRENGTHENING MEASURES AND OPERATIONAL (PROTECTIVE AND CONTROL) MEASURES**

 Once identified, the terrorism risk reduction improvements should be considered in relation to the owner's ongoing facility planning for maintenance and capital improvements (discussed in Section 2.3). Physical protection and strengthening measures and some operational measures can then be integrated with maintenance and capital improvements using this document, and can be scheduled for implementation.

### **2.2.1 PHYSICAL PROTECTION AND STRENGTHENING MEASURES**

The increments of physical protections measures listed on the vertical axes of the integration matrices 1 and 2 in Section 2.3 are presented as an example of measures that might be generated by the FEMA 452 process or others and implemented using this manual. The specific measures included in the matrices were generated for this manual and are discussed in Chapters 3, 4, and 5. Where applicable, the references in parentheses following items in the list refer to the respective discussions in Chapters 3, 4, and 5. The protection measures are presented in the order of the 13 sections of the Building Vulnerability Assessment Checklist in Appendix A of FEMA 452.

### **2.2.2 OPERATIONAL MEASURES**

The list of incremental operational measures is presented in Chapter 5, Section 5.11 as an example of measures that might be generated by the FEMA 452 process or others and implemented using this manual. The specific measures included in the matrices were generated for this manual and are discussed in Chapters 4 and 5. Some of these measures include physical elements and are also included in the list that comprises the vertical axes of the integration matrices in Section 2.3. Where applicable, the references in parentheses following items in both lists (Section 2.3 and Section 5.11) refer to the applicable discussions in Chapters 4 and 5. The measures are presented in the order of the 13 sections of the Building Vulnerability Assessment Checklist in Appendix A of FEMA 452.

## 2.3 IDENTIFYING INTEGRATION OPPORTUNITIES FOR INCREMENTAL BUILDING PROTECTION

**T**ypical maintenance and capital improvement projects in commercial buildings fall into two categories:

- Maintenance and capital improvements that are common to all four types of commercial buildings—office, retail, and multifamily apartment buildings, and hotels.
- Maintenance and capital improvements specific and unique to each of the four types of commercial buildings.

These categories may also vary by building classification (A, B, or C). The following categorizations of maintenance and capital improvements are typical and reflect groupings of building elements, administrative and funding categories, tenant versus public spaces, or other parameters. Owners can substitute their own categories.

### **Common categories of maintenance and capital improvement projects:**

1. Roofing maintenance and repair/reroofing
2. Exterior wall and window maintenance/façade modernization
3. Fire and life safety improvements
4. Public area modernization (Retail: mall public areas; Hotels: public and service areas)
5. Underfloor and basement maintenance and repair
6. HVAC upgrade and energy conservation
7. Hazardous materials abatement
8. Landscaping and site work

### **Occupancy-specific categories of maintenance and capital improvement projects:**

#### Office Buildings:

1. New technology accommodations
2. Tenant alterations and improvements

Retail Buildings:

1. Retail area modernization

Multifamily Apartment Buildings:

1. Kitchen and bathroom modernization

Hotels and Motels:

1. Guestroom finishing, furniture, and equipment (FF&E)
2. Public area FF&E

Both of these respective categories are used as the horizontal axes of the integration matrices presented on the following pages.

**How to Use the Matrices**

In order to identify integration opportunities, a building owner should follow these three steps:

1. Identify the column of the planned maintenance or capital improvement.
2. Identify the physical increments of building protection with a corresponding check mark in the column.
3. Consider integration of the physical increments with the planned maintenance or capital improvement activities.

Matrix 1: Integration Opportunities for Common Categories of Maintenance and Capital Improvement Projects

		Maintenance and Capital Improvement Projects						
		Roofing maintenance & repair	Exterior wall & window work	Fire & life safety improvements	Public area modernization	Underfloor & basement work	HVAC upgrade & energy work	Hazardous material abatement
<b>1. Site</b>								
1.1	Increased standoff distance (3.3)							✓
1.2	Anti-ram vehicle barriers (3.3)							✓
1.3	Speed calming devices (3.3)							✓
1.4	Operable barriers (3.3)							✓
1.5	Security lighting (5.8)							✓
1.6	Detection & assessment measures	1.6.1	Exterior intrusion detection systems (5.2.1)					✓
		1.6.2	Access control systems (5.2.4)					✓
1.7	Interdiction/response measures	1.7.1	Guard force—detection/delay role (5.3.1)					✓
<b>2. Architectural</b>								
2.1	Bracing or reinforcing masonry walls at interior stairs (3.5)			✓	✓			
2.2	Restraint of hazardous materials containers (3.5)			✓	✓	✓	✓	
2.3	Architectural isolation of lobby, mailroom, cloakroom, & loading docks (4.3.2)				✓			
2.4	Architectural measures to isolate mechanical spaces that require large volumes of outside air (4.4.3.2)			✓	✓			
2.5	Vestibules or revolving doors for highly protected zones (4.3.5, 4.3.6)			✓	✓			
2.6	Vestibules or revolving doors for protected zones (4.3.7)			✓	✓			
2.7	Access control systems (5.2.4)			✓	✓			
<b>3. Structural Systems (3.6)</b>								
3.1	Upgrading the structure to make it more ductile		✓	✓	✓	✓	✓	
3.2	Upgrading spandrel beams to achieve catenary response		✓					
3.3	Upgrading slabs to achieve catenary response				✓	✓		
3.4	Standoff distance around vulnerable columns (3.6.1)		✓		✓			
3.5	Localized hardening of vulnerable columns (3.6.1)		✓		✓			
3.6	Floor slab upload resistance (3.6.2)				✓			

Note: The references in parentheses refer to the applicable discussions in Chapters 3, 4, and 5.

Matrix 1: Integration Opportunities for Common Categories of Maintenance and Capital Improvement Projects (continued)

		Maintenance and Capital Improvement Projects							
		Roofing maintenance & repair	Exterior wall & window work	Fire & life safety improvements	Public area modernization	Underfloor & basement work	HVAC upgrade & energy work	Hazardous material abatement	Landscaping
3.7 Load-bearing URM <sup>1</sup> (3.6.3)	3.7.1 Shotcrete		✓	✓	✓	✓	✓	✓	
	3.7.2 Steel sections		✓	✓	✓	✓	✓	✓	
	3.7.3 Stiffened steel-plate wall system		✓	✓	✓	✓	✓	✓	
	3.7.4 Reinforcing		✓	✓	✓	✓	✓	✓	
3.8 Transfer girder retrofit (3.6.4)			✓						
<b>4. Building Envelope</b>									
4.1 Glazing	4.1.1 Fragment retention film (3.4.2)		✓	✓	✓		✓		
	4.1.2 Laminated glass (3.4.3)		✓	✓	✓		✓		
	4.1.3 Blast curtains (3.4.4)			✓	✓		✓		
	4.1.4 Glazing catch cable/bar (3.4.5)			✓	✓		✓		
	4.1.5 Energy absorbing cable systems (3.4.6)			✓	✓		✓		
4.2 URM (3.4.7)	4.2.1 Sprayed-on polymer		✓	✓	✓		✓		
	4.2.2 Geotextile fabric			✓	✓		✓		
	4.2.3 Steel stud and sheetmetal construction			✓	✓		✓		
4.3 Other building envelope retrofits	4.3.1 Bracing parapets, gables, ornamentation, & appendages (3.4.8)	✓	✓						
	4.3.2 Cladding anchorage (3.4.1)		✓						
	4.3.3 Anchorage of masonry veneer (3.4.8)		✓						
	4.3.4 Anchorage of steel stud backup (3.4.8)		✓	✓	✓		✓		
	4.3.5 Anchorage of exterior wythe in cavity walls (3.4.8)		✓						
	4.3.6 Debris catch systems for façade elements (3.4.8)		✓	✓	✓		✓		
	4.3.7 Increasing the roof's resistance to blast (3.6)	✓							
	4.3.8 Upgrading connections of light metal deck roofs to structure (3.6)	✓							
4.4 Sealing measures to tighten the envelope of the building and selected safe rooms (4.3.3)			✓		✓				

Note: The references in parentheses refer to the applicable discussions in Chapters 3, 4, and 5.

1. URM = unreinforced masonry

Matrix 1: Integration Opportunities for Common Categories of Maintenance and Capital Improvement Projects (continued)

		Maintenance and Capital Improvement Projects						
		Roofing maintenance & repair	Exterior wall & window work	Fire & life safety improvements	Public area modernization	Underfloor & basement work	HVAC upgrade & energy work	Hazardous material abatement
<b>5. Utility Systems</b>								
5.1	Light, secure, and monitor water service access points (5.8)				✓		✓	✓
5.2	Intrusion detection sensors for all utility services to the building (5.8)		✓		✓		✓	✓
5.3	Redundant utility systems to support security, life safety, and rescue functions				✓		✓	
5.4	Attachment and bracing of tanks (3.5)	✓			✓	✓	✓	✓
<b>6. Mechanical Systems (HVAC)</b>								
6.1	Fastening and bracing of mechanical equipment above ceilings (3.5)			✓	✓		✓	✓
6.2	Attachment and bracing of boilers and chillers (3.5)						✓	
6.3 Enhanced physical security (4.4.2.2)	6.3.1 Secure air intakes against unauthorized access (5.8.1)	✓	✓				✓	✓
	6.3.2 Secure mechanical rooms & HVAC plenums against unauthorized access				✓		✓	
6.4 Enhanced sheltering in place (4.4.3.2)	6.4.1 Single-switch control of fans for sheltering and purging						✓	
	6.4.2 Automatic dampers for outside air intakes and exhaust fans		✓				✓	
	6.4.3 Separate fans & air streams for ventilation and recirculation for conditioning safe rooms						✓	
	6.4.4 Recirculation filter units in safe rooms			✓	✓		✓	
6.5 Aerosol filtration, medium level (4.4.4.2)	6.5.1 Sealing filter frames to minimize bypass						✓	
	6.5.2 Installation of filters of greater depth/surface area & higher MERV <sup>2</sup> rating						✓	
	6.5.3 Operating at positive internal pressures						✓	
6.6 Gas-phase filtration, medium level (4.4.5.2)	6.6.1 Indoor-air-quality type, low resistance adsorbers						✓	
	6.6.2 Operating at positive internal pressures						✓	
6.7 Aerosol filtration, high level (4.4.6.2)	6.7.1 Installation of ventilation/makeup-air units with HEPA <sup>3</sup> filtration						✓	
	6.7.2 Operating at positive internal pressures						✓	

Note: The references in parentheses refer to the applicable discussions in Chapters 3, 4, and 5.

2. MERV = Minimum Efficiency Reporting Value

3. HEPA = High Efficiency Particulate Air

Matrix 1: Integration Opportunities for Common Categories of Maintenance and Capital Improvement Projects (continued)

		Maintenance and Capital Improvement Projects							
		Roofing maintenance & repair	Exterior wall & window work	Fire & life safety improvements	Public area modernization	Underfloor & basement work	HVAC upgrade & energy work	Hazardous material abatement	Landscaping
6.8 Gas-phase filtration, high level (4.4.7.2)	6.8.1 Ventilation/makeup-air units with high efficiency adsorbers & HEPA filtration						✓		
	6.8.2 Operating at positive internal pressures						✓		
6.9 Secure and monitor exterior mechanical spaces and equipment (5.8)			✓						✓
6.10 Secure and monitor interior HVAC access points (5.8)					✓		✓		
<b>7. Plumbing &amp; Gas Systems</b>									
7.1 Attachment and bracing of sprinkler piping (3.5)				✓	✓		✓	✓	
<b>8. Electrical Systems</b>									
8.1 Attachment and bracing of emergency lighting (3.5)				✓	✓		✓	✓	
8.2 Fastening and bracing of electrical equipment above ceilings (3.5)				✓	✓		✓	✓	
8.3 Attachment and bracing of transformers (3.5)		✓			✓	✓			✓
8.4 Attachment and bracing of emergency generators (3.5)		✓			✓	✓			✓
<b>9. Fire Alarm Systems</b>									
<b>10. Communications and IT Systems</b>									
10.1 Public address system to achieve rapid implementation of emergency actions (4.4.3.2)				✓	✓		✓		
<b>11. Equipment Operations &amp; Maintenance</b>									
<b>12. Security Systems</b>									
12.1 Exterior intrusion detection systems (5.2.1)			✓		✓				✓
12.2 Interior intrusion detection systems (5.2.2)				✓	✓	✓	✓		
12.3 CCTV <sup>4</sup> systems (5.2.3)		✓	✓	✓	✓	✓	✓	✓	✓
12.4 Duress alarms (5.2.6)				✓	✓	✓	✓		
<b>13. Security Master Plan</b>									

Note: The references in parentheses refer to the applicable discussions in Chapters 3, 4, and 5.

4. CCTV = closed circuit television

Matrix 2: Integration Opportunities for Occupancy-Specific Categories of Maintenance and Capital Improvement Projects

		Maintenance and Capital Improvement Projects					
		OFFICE		RETAIL	APARTMENT	HOTEL	
		New Technology	Tenant Alterations	Retail Area Modernization	Kitchen & Bath Modernization	Guestroom FF&E	Public Area FF&E
<b>1. Site</b>							
<b>2. Architectural</b>							
2.1 Bracing or reinforcing masonry walls at interior stairs (3.5)							
2.2 Restraint of hazardous materials containers (3.5)		✓	✓	✓			✓
2.3 Architectural isolation of lobby, mailroom, cloakroom, & loading docks (4.3.2)							
2.4 Architectural measures to isolate mechanical spaces that require large volumes of outside air (4.4.3.2)							
2.5 Vestibules or revolving doors for highly protected zones (4.3.5, 4.3.6)							✓
2.6 Vestibules or revolving doors for protected zones (4.3.7)							✓
2.7 Access control systems (5.2.4)							✓
<b>3. Structural Systems</b>							
3.1 Upgrading the structure to make it more ductile		✓	✓	✓	✓	✓	✓
3.2 Upgrading spandrel beams to achieve catenary response (3.6.2)							
3.3 Upgrading slabs to achieve catenary response (3.6.2)			✓	✓		✓	✓
3.4 Standoff distance around vulnerable columns (3.6.1)				✓			✓
3.5 Localized hardening of vulnerable columns (3.6.1)				✓			✓
3.6 Floor slab upload resistance (3.6.2)			✓	✓		✓	✓
3.7 Load-bearing URM (3.6.3)	3.7.1 Shotcrete	✓	✓	✓	✓	✓	✓
	3.7.2 Steel sections	✓	✓	✓	✓	✓	✓
	3.7.3 Stiffened steel-plate wall system	✓	✓	✓	✓	✓	✓
	3.7.4 Reinforcing	✓	✓	✓	✓	✓	✓
3.8 Transfer girder retrofit (3.6.4)							
<b>4. Building Envelope</b>							
4.1 Glazing	4.1.1 Fragment retention film (3.4.2)		✓	✓		✓	✓
	4.1.2 Laminated glass (3.4.3)		✓	✓		✓	✓
	4.1.3 Blast curtains (3.4.4)		✓	✓		✓	✓
	4.1.4 Glazing catch cable/bar (3.4.5)		✓	✓		✓	✓
	4.1.5 Energy absorbing cable systems (3.4.6)		✓	✓		✓	✓

Note: The references in parentheses refer to the applicable discussions in Chapters 3, 4, and 5.

Matrix 2: Integration Opportunities for Occupancy-Specific Categories of Maintenance and Capital Improvement Projects (continued)

		Maintenance and Capital Improvement Projects					
		OFFICE		RETAIL	APARTMENT	HOTEL	
		New Technology	Tenant Alterations	Retail Area Modernization	Kitchen & Bath Modernization	Guestroom FF&E	Public Area FF&E
4.2 URM (3.4.7)	4.2.1 Sprayed-on polymer		✓	✓		✓	✓
	4.2.2 Geotextile fabric		✓	✓		✓	✓
	4.2.3 Steel stud and sheetmetal construction		✓	✓		✓	✓
4.3 Other building envelope retrofits	4.3.1 Bracing parapets, gables, ornamentation and appendages (3.4.8)						
	4.3.2 Cladding anchorage (3.4.1)						
	4.3.3 Anchorage of masonry veneer (3.4.8)						
	4.3.4 Anchorage of steel stud backup (3.4.8)		✓	✓		✓	✓
	4.3.5 Anchorage of exterior wythe in cavity walls (3.4.8)						
	4.3.6 Debris catch systems for façade elements (3.4.8)		✓	✓		✓	✓
	4.3.7 Increasing the roof's resistance to blast (3.6)						
	4.3.8 Upgrading connections of light metal deck roofs to structure (3.6)						
4.5 Sealing measures to tighten the envelope of the building and selected safe rooms (4.3.3)		✓	✓	✓	✓	✓	
<b>5. Utility Systems</b>							
5.1 Light, secure, and monitor water service access points (5.8)							
5.2 Intrusion detection sensors for all utility services to the building (5.8)							
5.3 Redundant utility systems to support security, life safety, and rescue functions							✓
5.4 Attachment and bracing of tanks (3.5)							
<b>6. Mechanical Systems (HVAC)</b>							
6.1 Fastening and bracing of mechanical equipment above ceilings (3.5)	✓	✓	✓	✓	✓	✓	✓
6.2 Attachment and bracing of boilers and chillers (3.5)							
6.3 Enhanced physical security (4.4.2.2)	6.3.1 Secure air intakes against unauthorized access (5.8.1)						
	6.3.2 Secure mechanical rooms & HVAC plenums against unauthorized access.						✓

Note: The references in parentheses refer to the applicable discussions in Chapters 3, 4, and 5.

Matrix 2: Integration Opportunities for Occupancy-Specific Categories of Maintenance and Capital Improvement Projects (continued)

		Maintenance and Capital Improvement Projects					
		OFFICE		RETAIL	APARTMENT	HOTEL	
		New Technology	Tenant Alterations	Retail Area Modernization	Kitchen & Bath Modernization	Guestroom FF&E	Public Area FF&E
6.4 Enhanced sheltering in place (4.4.3.2)	6.4.1 Single-switch control of fans for sheltering and purging						
	6.4.2 Automatic dampers for outside air intakes and exhaust fans						
	6.4.3 Separate fans & air streams for ventilation and recirculation for conditioning safe rooms						
	6.4.4 Recirculation filter units in safe rooms		✓	✓	✓		✓
6.5 Aerosol filtration, medium level (4.4.4.2)	6.5.1 Sealing filter frames to minimize bypass						
	6.5.2 Installation of filters of greater depth/surface area & higher MERV rating						
	6.5.3 Operating at positive internal pressures						
6.6 Gas-phase filtration, medium level (4.4.5.2)	6.6.1 Indoor-air-quality type, low resistance adsorbers						
	6.6.2 Operating at positive internal pressures						
6.7 Aerosol filtration, high level (4.4.6.2)	6.7.1 Installation of ventilation/makeup-air units with HEPA filtration						
	6.7.2 Operating at positive internal pressures						
6.8 Gas-phase filtration, high level (4.4.7.2)	6.8.1 Ventilation/makeup-air units with high efficiency adsorbers & HEPA filtration						
	6.8.2 Operating at positive internal pressures						
6.9 Secure and monitor exterior mechanical spaces and equipment (5.8)							
6.10 Secure and monitor interior HVAC access points (5.8)			✓	✓		✓	
<b>7. Plumbing &amp; Gas Systems</b>							
7.1 Attachment and bracing of sprinkler piping (3.5)		✓	✓	✓	✓	✓	✓
<b>8. Electrical Systems</b>							
8.1 Attachment and bracing of emergency lighting (3.5)		✓		✓			✓
8.2 Fastening and bracing of electrical equipment above ceilings (3.5)		✓	✓	✓	✓	✓	✓
8.3 Attachment and bracing of transformers							
8.4 Attachment and bracing of emergency generators							

Note: The references in parentheses refer to the applicable discussions in Chapters 3, 4, and 5.

Matrix 2: Integration Opportunities for Occupancy-Specific Categories of Maintenance and Capital Improvement Projects (continued)

	Maintenance and Capital Improvement Projects					
	OFFICE		RETAIL	APARTMENT	HOTEL	
	New Technology	Tenant Alterations	Retail Area Modernization	Kitchen & Bath Modernization	Guestroom FF&E	Public Area FF&E
<b>9. Fire Alarm System</b>						
<b>10. Communications and IT Systems</b>						
10.1 Public address system to achieve rapid implementation of emergency actions (4.4.3.2)	✓					✓
<b>11. Equipment Operations &amp; Maintenance</b>						
<b>12. Security Systems</b>						
12.1 Exterior intrusion detection systems (5.2.1)						✓
12.2 Interior intrusion detection systems (5.2.2)	✓	✓	✓			✓
12.3 CCTV systems (5.2.3)	✓	✓	✓		✓	✓
12.4 Duress alarms (5.2.6)	✓	✓	✓			✓
<b>13. Security Master Plan</b>						

Note: The references in parentheses refer to the applicable discussions in Chapters 3, 4, and 5.