Unit VI

COURSE TITLE Building Design for Homeland Security

TIME 60 minutes

UNIT TITLE Explosive Blast

OBJECTIVES

1. Explain the basic physics involved during an explosive blast event, whether by terrorism or technological accident
2. Explain building damage and personnel injury resulting from the blast effects upon a building
3. Perform an initial prediction of blast loading and effects based upon incident pressure

SCOPE

The following topics will be covered in this unit:

1. Time-pressure regions of a blast event and how these change with distance from the blast
2. Difference between incident pressure and reflected pressure
3. Differences between peak pressure and peak impulse and how these differences affect building components
4. Building damage and personal injuries generated by blast wave effects
5. Levels of protection used by the Department of Defense and the General Services Administration
6. The nominal range-to-effect chart [minimum stand-off in feet versus weapon yield in pounds of TNT-equivalent] for an identified level of damage or injury
7. The benefits of stand-off distance
8. Approaches to predicting blast loads and effects, including one using incident pressure

REFERENCES

1. FEMA 426, *Reference Manual to Mitigate Potential Terrorist Attacks Against Buildings*, pages 4-1 to 4-20
2. Student Manual, Unit VI
3. Case Study, Hazardville Information Company (HIC), for student activities
4. Unit VI visuals

REQUIREMENTS

1. FEMA 426, *Reference Manual to Mitigate Potential Terrorist Attacks Against Buildings* (one per student)
2. Instructor Guide
3. Student Manual (one per student)
4. Overhead projector or computer display unit
5. Unit VI visuals
6. Chart paper, easel, and markers

UNIT VI OUTLINE

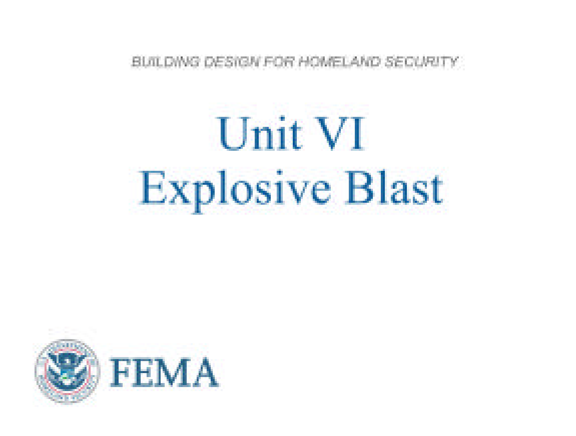
PREPARING TO TEACH THIS UNIT

- **Tailoring Content to the Local Area:** Review the Instructor Notes to identify topics that should focus on the local area. Plan how you will use the generic content, and prepare for a locally oriented discussion.
- **Optional Activity:** There are no optional activities in this unit.

- **Activity:** The students will begin have an instructor led exercise to use the range-to-effects chart, select a Level of Protection, and use the effects charts to evaluate stand-off distances.
- Refer students to their Student Manuals for worksheets and activities.

INSTRUCTOR NOTES	**CONTENT/ACTIVITY**

VISUAL VI-1



Introduction and Unit Overview

This is Unit VI Explosive Blast. Note that we are covering **pages 4-1 to 4-20 in FEMA 426** during this unit.

In the previous units, we determined the various initial ratings during the assessment process.

In this unit, we will examine how explosive blast impacts buildings and people to better understand the design recommendations presented in later units.

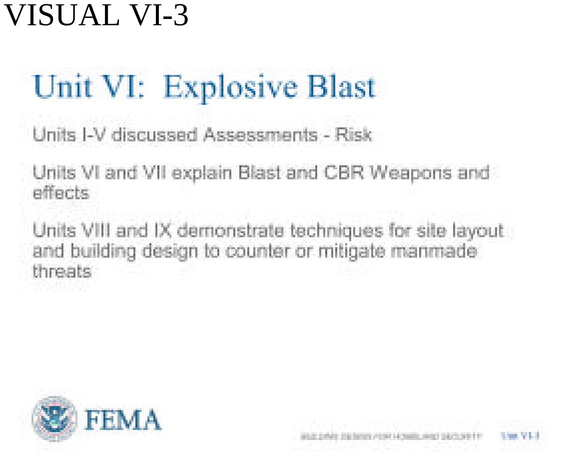
VISUAL VI-2

Unit Objectives

At the end of this unit, you should be able to:

1. Explain the basic physics involved during an explosive blast event, whether by terrorism or technological accident.
2. Explain building damage and personnel injury resulting from the blast effects upon a building.
3. Perform an initial prediction of blast loading and effects based upon incident pressure.

VISUAL VI-3



Explosive Blast

There are a number of similarities between blast loading and building response with earthquake or high wind loading and response, but also significant differences.

Blast loads are high amplitude, low duration (milliseconds) events that create an air pressure wave that acts over the entire building envelope.

Earthquake loads are usually low amplitude, long duration (seconds) events that are transferred through the foundation. High

Many of the mitigation options for seismic and hurricane retrofit such as moment

INSTRUCTOR NOTES | **CONTENT/ACTIVITY**

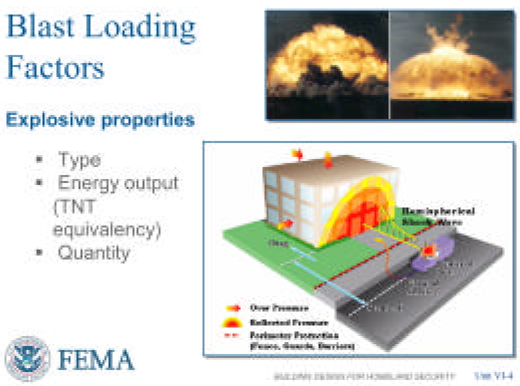
connections and elimination of progressive collapse, laminated glass, and strengthened architectural elements mitigate many explosive blast vulnerabilities.

winds are dynamic and typically affect the envelope.

Blast loadings decay as a cube root of distance; therefore, the key concept in blast is:

STAND-OFF IS YOUR BEST DEFENSE**,** EVERY **FOOT** COUNTS**!**

VISUAL VI-4



Blast Loading Factors

Explosive properties type - is it a high explosive or low-order explosive?

Is it specifically designed for the purpose military grade explosive (C4, landmine, etc.) or a combination of generally available materials (ANFO, black powder)?

The energy output of explosives can be related by TNT equivalency. TNT equivalency is usually considered to be the relative pressure achieved by the explosive compared to TNT (trinitrotoluene). Pressure equivalency can generally range from 0.14 to 1.7.

Aside from TNT equivalency, the larger the quantity of an explosive, the higher the pressures and the larger the impulse.

VISUAL VI-5

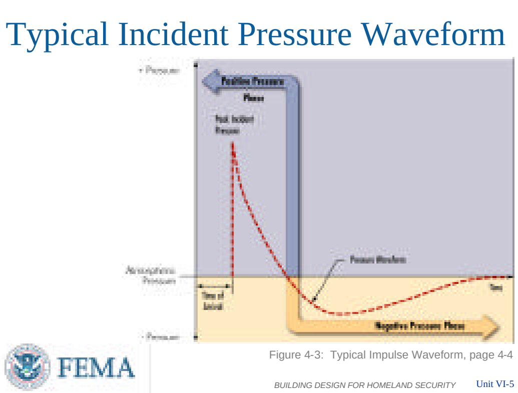


Figure 4-3: Typical Impulse Waveform, page 4-4

Exam Questions #A8 and B6

Typical Incident Pressure Waveform

The explosive detonation generates a bubble of air moving at supersonic speed from the bomb location. About one-third of the explosive material contributes to the detonation.

As it reaches a point in space, such as a person or building, the pressure goes rapidly from atmospheric to peak pressure in very little time. The pressure at this point decays rapidly as the supersonic bubble moves on, its pressure reducing exponentially as the surface area of the bubble increases – expending energy over an ever increasing area. The

INSTRUCTOR NOTES	CONTENT/ACTIVITY

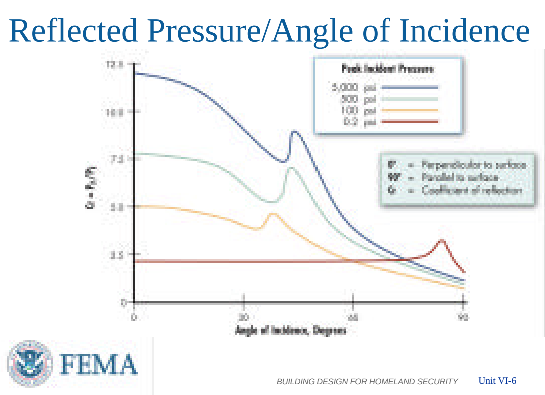
There is also a TNT equivalency based upon impulse and that ranges from 0.5 to 1.8. If the pressure TNT equivalency is above 1.0, this means the explosive achieves a higher pressure (pressure equivalency) than TNT. If the impulse TNT equivalency is above 1.0, then the explosive has a longer push (impulse equivalency) than TNT.

- Peak pressure rapid millisecond rise
- High positive pressure loading drops off
- Negative pressure creates suction on the structure

pressure also drops off due to the completion of the chemical reaction of the explosive mixture (burning of the remaining two-thirds of the material). If the explosion occurs within a confined space, the gases generated by the burning of the explosive are contained and keep the pressure elevated over a longer period of time. [Indicate a longer tail off of the positive phase to illustrate the confined space variation.] Design is typically based on positive pressures.

The negative phase of the blast wave is the ambient air rushing in behind the blast wave to return to a stable pressure. While the negative phase has much less energy than the positive phase, it can hit the structure at the most inopportune moment in its vibration, resulting in unexpected consequences – increased damage or having windows blow OUT of the building rather than into it. Design is based on positive pressure.

VISUAL VI-6



Reflected Pressure versus Angle of Incident

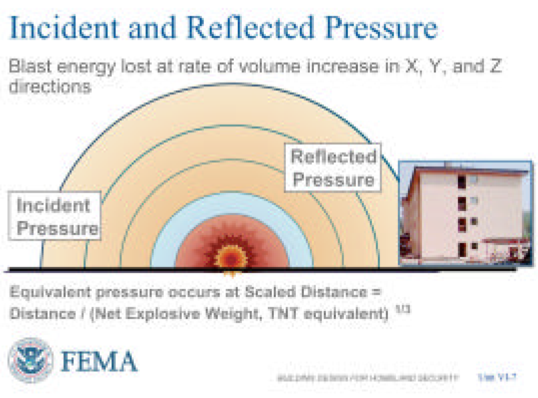
When the blast wave strikes an immovable surface the wave reflects off the surface resulting in an increase in pressure. This reflected pressure actually causes the damage to the building. A very high reflected pressure may punch a hole in a wall or cause a column to fail, while a low reflected pressure will try to push over the whole building.

The worst case is when the direction of travel for the blast wave is perpendicular to the surface of the structure and the incident pressure is very high. The Coefficient of Reflection can be from 12 to 13 for high incident pressures in this case.

By keeping the incident pressure low (by limiting the size of the explosive, maintaining a large distance between the explosive and the building, or both) the reflected pressure can be

INSTRUCTOR NOTES	**CONTENT/ACTIVITY**
	kept low. Keeping the Coefficient of Reflection below 2.5 by keeping the peak incident pressure below 5 psi (pounds per square inch) is a desirable goal.

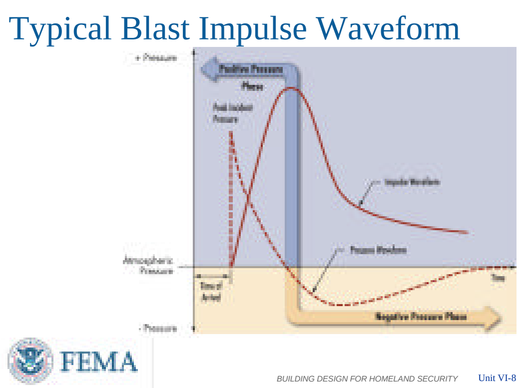
VISUAL VI-7



Incident and Reflected Pressure

When the incident pressure wave impinges on a structure that is not parallel to the direction of the wave's travel, it is reflected and reinforced. The reflected pressure is always greater than the incident pressure at the same distance from the explosion, and varies with the incident angle.

VISUAL VI-8



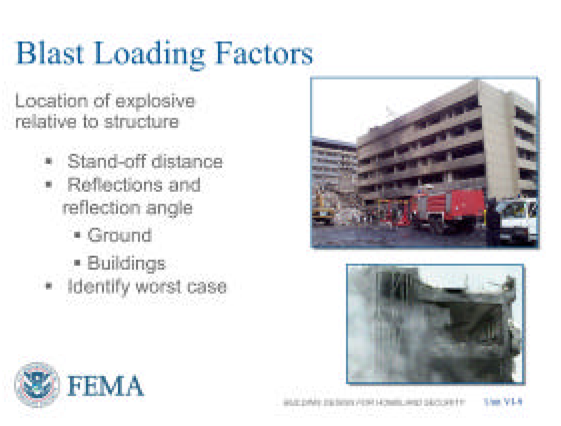
Typical Blast Impulse Waveform

Another consideration is the impulse of the blast wave, which is the integration of the peak incident pressure (both positive phase and negative phase) at the point in question over time.

A general rule of thumb is that brittle materials respond to peak incident pressure and are less affected by impulse. Ductile materials, on the other hand, respond more to impulse (the total push) rather than peak incident pressure (the maximum hit).

INSTRUCTOR NOTES	CONTENT/ACTIVITY

VISUAL VI-9



Blast Loading Factors

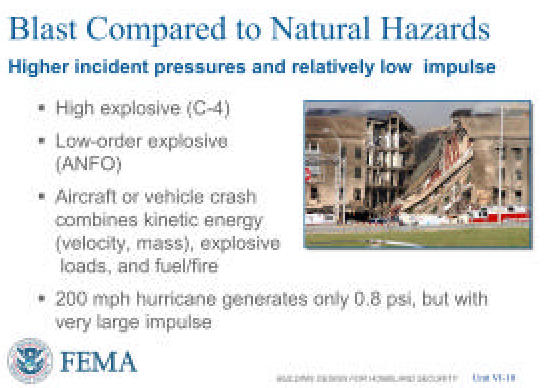
Location Relative to Structure: Stand-off distance is your best friend. The larger the distance between the explosive and the structure, the lower the incident pressure and the lower the resultant reflective pressure. We will investigate this in more detail later.

As we have already seen, the reflection angle at which the blast wave strikes the structure also affects the value of reflected pressure. The ground is also a reflection surface to consider. If the bomb is placed close to the ground, the ground reflection adds a small amount of incident pressure to the situation. If the bomb is elevated (a more difficult task), the ground reflection can become significant, but the reflection off the building surface diminishes.

Identifying the worst case situation begins by finding the closest approach (stand-off distance) between the explosive and the building and then considering the angle of reflection. Or put another way -- place the explosive directly perpendicular to the largest face of the building, with the explosive centered upon the building's face as close as you can get. That is normally the worst case situation.

INSTRUCTOR NOTES | **CONTENT/ACTIVITY**

VISUAL VI-10

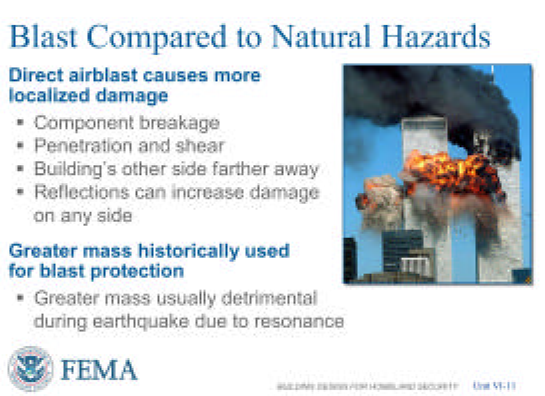


Blast Compared to Natural Hazards (1)

Compared to **other hazards** (earthquake, winds, and floods), high order explosive attack has unique variances:

- Compared to wind, explosive blast pressure is much higher, but also of much shorter duration and, thus, lower impulse.
- High explosives generate high pressures but the impulse lasts for a relatively short duration (in the range of milliseconds).
- Low-order explosives generate less pressure, but the impulse lasts longer than high explosive (in the range of milliseconds).
- Wind has a very low incident pressure, but pushes for a very long time (in the range of seconds or longer).
- A nuclear blast or millions of pounds of high explosives would generate high pressures AND long duration impulse.

VISUAL VI-11



Blast Compared to Natural Hazards (2)

Explosive blast tends to cause localized damage compared to other hazards that may destroy the whole building.

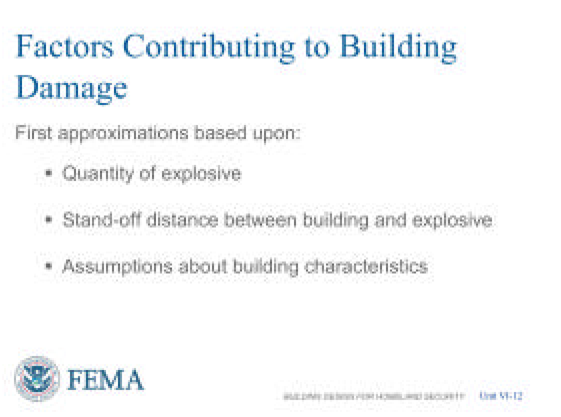
- The first building surface struck will get the greatest pressures, and expect it to receive the greatest damage. The blast may break a building component by punching through it (window or wall) or shearing it (column).
- The other side of the building, due to its greater distance from the explosion, will see lower pressures, unless there are nearby buildings that will reflect the blast wave back to the building in question.
- Reflections can increase damage to the building, but are hard to quantify.
- Greater mass has usually been the design

INSTRUCTOR NOTES | **CONTENT/ACTIVITY**

of choice to protect against explosive blast. The inertia of the mass slows the structural reactions to the point that the impulse is over before the building tends to move.

- Conversely, additional mass is usually undesirable during an earthquake due to the long duration, low frequency forces that can get the mass moving. Earthquake design usually concentrates on lighter structures with great ductility and additional reinforcement at weak points.

VISUAL VI-12



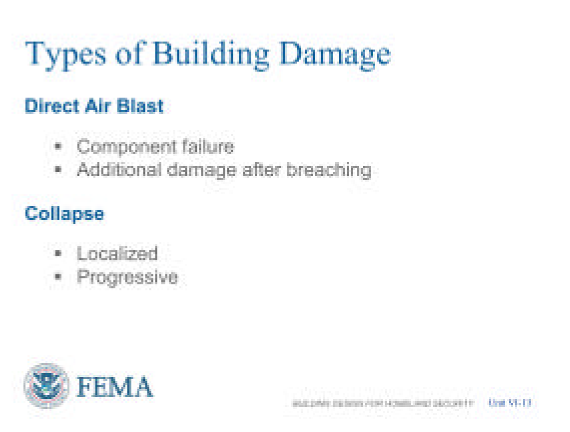
Factors Contributing to Building Damage

Certain prediction of damage to buildings and people during an explosive event is beyond the scope of the reference manual. There are too many variables that would have to be considered and modeling would take many months for analysis by supercomputer. Thus, as in standard building design, we use approaches with safety factors that provide adequate first approximations to estimate response based upon the:

- The amount of explosive usually expressed as TNT equivalent weight.
- The stand-off distance between the explosive and the building or person.
- Assumptions about building characteristics – the exterior envelope construction (walls and windows) and the framing or load-bearing system used.
- The building characteristics provide insight into weaknesses and allow general predictions about how the building will respond.

INSTRUCTOR NOTES	CONTENT/ACTIVITY

VISUAL VI-13

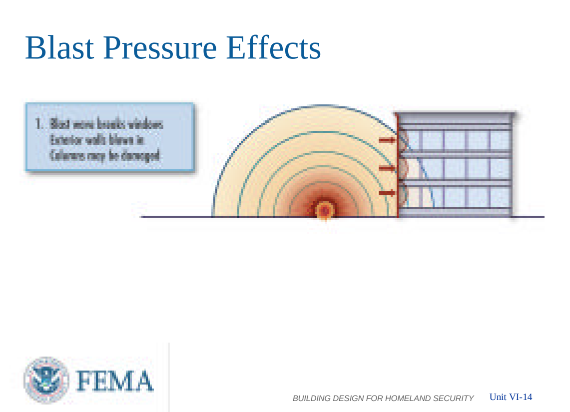


Exam Questions #A9 and B10

Types of Building Damage

- The air blast, especially from explosions close to the building, results in component failure of walls, windows, columns, and beams/girders.
- The pressures experienced by the building can far exceed the building's original design and can occur in directions that were not part of the original design.
- Once the exterior envelope is breached, the blast wave causes additional structural and non-structural damage inside the building.
- Collapse, which is covered in more detail in **Chapter 3 of FEMA 426**, is a primary cause of death and injury in an explosive blast.
- Localized collapse may have a load-bearing wall, or portion thereof, on one side of the building fall to the ground or a single column fails and the surrounding floors fall with it.
- Progressive collapse is more disastrous as a single component failure, like a wall or column, results in the failure of more walls and columns so that more of the building falls to the ground than what the explosive initially affected.

VISUAL VI-14



Blast Pressure Effects

Frame 1

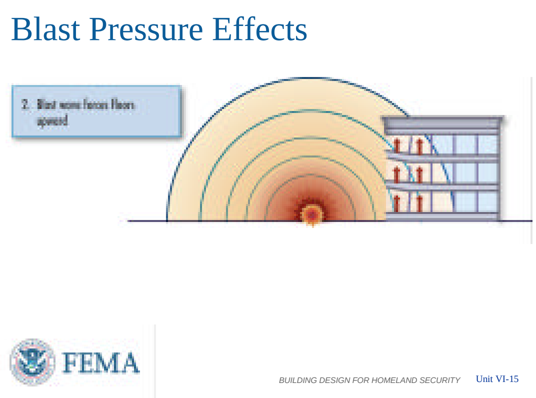
- The air blast strikes the exterior wall, the weakest component will fail first – usually the windows, which saves the walls and columns, but causes much non-structural damage inside the building.
- Note that unreinforced masonry walls can be weaker than windows.
- If the explosive is close enough, the walls can fail and one or more columns can fail in addition to the windows.
- Based upon the reflection angle, one can

INSTRUCTOR NOTES	**CONTENT/ACTIVITY**

expect the lowest or lower floors (1 to 3) to receive the greatest damage.

- If the blast wave strikes the whole surface of the exposed side simultaneously, this is called a laminar situation, and breaching (puncture) of walls and failure of columns is less likely.

VISUAL VI-15

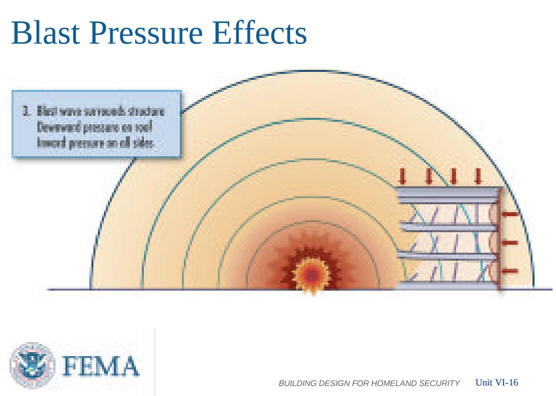


Blast Pressure Effects

Frame 2

- Once the blast wave enters the building, it is trapped and more air enters the building, further increasing the pressure. Structural components like flooring and shear walls now are moving in directions for which they were not designed.
- Floor failure can result in three effects: 1) the raining down of concrete chunks causing injury and possibly death; 2) the whole floor gives way and pancakes downward with obviously more serious consequences; or 3) if flat slab construction was used (the floors act as the beams in the framing system), the floors can disconnect from the columns.

VISUAL VI-16



Blast Pressure Effects

Frame 3

- The blast wave continues to engulf the building. Any building component that traps the blast wave, like an overhanging roof, can expect increased damage, based upon how it is constructed and attached.
- The roof and sides parallel to the blast wave movement will see incident pressure only, which should result in little or no damage.
- Once the blast wave has passed the building, the far side (opposite the side first experiencing the blast wave) will see increased pressure as a slight vacuum forms and the ambient air rushes back in to

INSTRUCTOR NOTES | **CONTENT/ACTIVITY**

achieve equilibrium. Reflections of the blast wave off other buildings behind this one can also increase the pressure impinging the far side.

VISUAL VI-17

Causes of Blast Injuries (1)

Overpressure

- Eardrum rupture
- Lung collapse/failure

Blast Wave

- Blunt trauma, lacerations, and impalement

FEMA

BUILDING DESIGN FOR HOMELAND SECURITY Unit VI-17

Causes of Blast Injuries (1)

- Injuries and casualties occur in three ways during explosive blast – by overpressure, by the motion of the blast wave, and by fragmentation generated by the blast wave.
- The overpressure causes eardrum rupture, which is normally not lethal.
- Overpressure can also overdrive the lungs causing injury or death. The relationship between pressure and impulse is very evident in lung response. An incident pressure of 102 psi for 3 milliseconds is the threshold of lethality as is an incident pressure of 23 psi for 18.5 milliseconds.
- Blunt trauma, lacerations, and impalement injuries occur when the blast wave picks up the person and throws them against a surface or object (translation), or glass and wall fragments cause lacerations or blunt trauma on impact. In relative distance terms, death by translation occurs at a greater distance for the same bomb size than death by lung overpressure.

VISUAL VI-18

Causes of Blast Injuries (2)

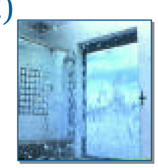
Fragmentation

Bomb or vehicle

Street furniture or jersey barriers

Building component failure

- Glass – predominant
- Walls
- Floors



FEMA

BUILDING DESIGN FOR HOMELAND SECURITY Unit VI-18

Exam Questions #A10 and B9

Causes of Blast Injuries (2)

- Fragmentation from any source can result in blunt trauma, impact, and penetration, or laceration injuries.
- The fragments can come from around the bomb or parts of the vehicle.
- They can be picked up either intact or damaged by the blast wave as it travels along – street furniture or jersey barriers.
- Building component failure also causes material fragments with sufficient velocity to injure or kill. Note that upward of 80 percent of all injuries from explosive blast can be attributed to broken glass. The

INSTRUCTOR NOTES	CONTENT/ACTIVITY

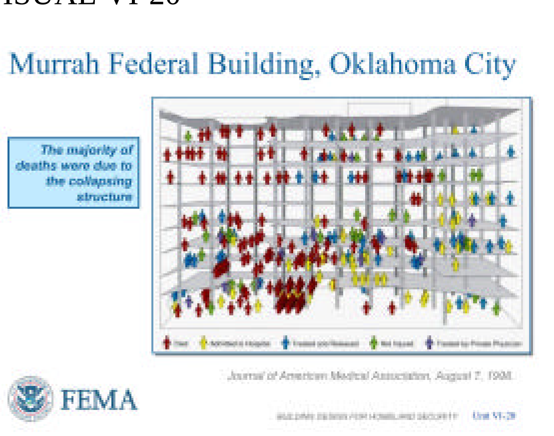
most effective way to reduce injuries during explosive blast is harden the glass and window frame system and/or reduce the amount of glass.

VISUAL VI-19

Murrah Federal Building (1)

The Murrah Federal Building is typical of many commercial properties in the current inventory. The bomb was designed as a shape charge and detonated in the drop-off area, destroying two primary columns and causing the spandrel beam to rotate. The floors above failed in progressive collapse and the blast wave penetrated deeply into the interior.

VISUAL VI-20

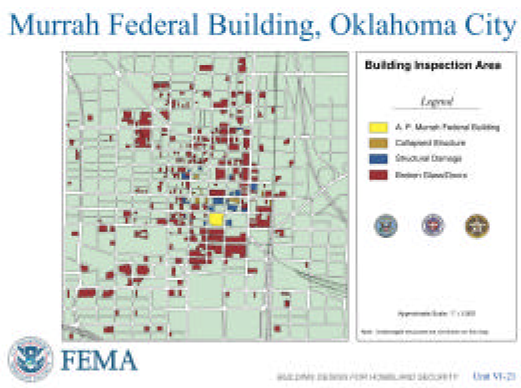


Murrah Federal Building (2)

The majority of deaths were caused by the collapsing structure.

INSTRUCTOR NOTES | **CONTENT/ACTIVITY**

VISUAL VI-21



Murrah Federal Building (3)

The collateral damage zone extended out several thousand feet with extensive glass and debris injuries.

VISUAL VI-22

Levels of Protection (1)

CONVENTIONAL CONSTRUCTION | INCIDENT OVERPRESSURE

Level of Protection	Potential Structural Damage	Potential Door and Glazing Hazards	Potential Injury
Below AT standards	Severely damaged. Frame collapse/massive destruction. Little left standing.	Doors and windows fail and result in lethal hazards. GSA 5	Majority of personnel suffer fatalities.
Very Low psi = 3.5	Heavily damaged - onset of structural collapse. Major deformation of primary and secondary structural members, but progressive collapse is unlikely. Collapse of non-structural elements.	Glazing will break and is likely to be propelled into the building, resulting in serious glazing fragment injuries, but fragments will be reduced. Doors may be propelled into rooms, presenting serious hazards. GSA 4	Majority of personnel suffer serious injuries. There are likely to be a limited number (10 percent to 25 percent) of fatalities.
Low psi = 2.3	Damage – unrepairable. Major deformation of non-structural elements and secondary structural members and minor deformation of primary structural members, but progressive collapse is unlikely.	Glazing will break, but fall within 1 meter of the wall or otherwise not present a significant fragment hazard. Doors may fail, but they will rebound out of their frames, presenting minimal hazards. GSA 3a	Majority of personnel suffer significant injuries. There may be a few (<10 percent) fatalities.

FEMA

BUILDING DESIGN FOR HOMELAND SECURITY Unit VI-22

Levels of Protection (1)

- The Department of Defense (DoD) and the General Services Administration (GSA) call out similar levels of protection that relate building damage and potential injury. This slide and the next summarize these perspectives.
- This slide represents the conventional construction found in most buildings and correlates an estimate of the incident pressure required to cause that damage and injury.
- Note the relatively low values for incident pressure for each level of protection.
- Included also is a cross correlation to the GSA glazing (installed glass) criteria, which will be further defined in Unit IX.
- The Low Level of Protection can be interpreted as the threshold of lethality and is a desirable minimum design goal to achieve. If the risk, such as the likelihood, of experiencing an explosive blast is high, consideration for use of a higher level of protection would be in order.

VISUAL VI-23

Levels of Protection (2)

CONVENTIONAL CONSTRUCTION INCIDENT OVERPRESSURE

Level of Protection	Potential Structural Damage	Potential Door and Glazing Hazards	Potential Injury
Medium psi = 1.8	Damaged – repairable. Minor deformations of non-structural elements and secondary structural members and no permanent deformation in primary structural members.	Glazing will break, but will remain in the window frame. Doors will stay in frames, but will not be reusable. GSA 2	Some minor injuries, but fatalities are unlikely.
High psi = 1.1	Superficially damaged. No permanent deformation of primary and secondary structural members or non-structural elements.	Glazing will not break. Doors will be reusable. GSA 1	Only superficial injuries are likely.

FEMA

BUILDING DESIGN FOR HOMELAND SECURITY Unit VI-23

Exam Questions #A11 and B11

VISUAL VI-24

Nominal Range-to-Effect Chart

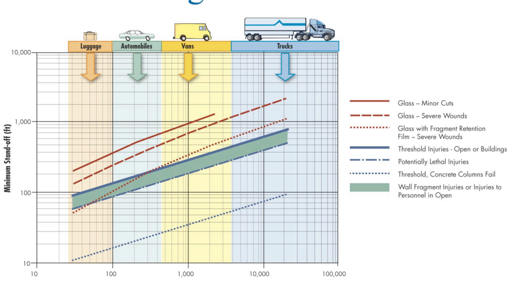


Figure 4-5: Explosive Environments – Blast Range to Effects, page 4-11, FEMA 426

FEMA

BUILDING DESIGN FOR HOMELAND SECURITY Unit VI-24

Direct students' attention to **Figure 4-5 on page 4-11 of FEMA 426**

Levels of Protection (2)

- When greater protection resulting in less damage and injury is desired, this slide indicates that the pressures must be kept low for conventional construction.
- Alternately, the building must be hardened to achieve these lower levels of damage and resultant injury. This is especially necessary when the incident pressure is higher due to the design threat explosive quantity being at a closer stand-off distance than conventional construction can handle.

The building owner selects the Level of Protection, which in turn determines the stand-off distance required.

Nominal Range-to-Effect Chart

- The Nominal Range-to-Effect Chart is a handy way to represent the stand-off distance at which a given bomb size produces a given effect.
- If you are below the curve for the given effect, that effect has the potential to occur. The further below the curve, the more likely it will happen and the greater the expected damage.
- Conversely, an intersection point between range or stand-off distance and weapon yield or bomb size in TNT equivalent weight that is above the curve for the given effect indicates that there is a good chance that that effect will not occur. However, many variables can alter these curves, such as reflections, such that a point above the curve could result in damage occurring.
- The chart also concentrates upon the two prominent concerns during explosive blast – glass injury and progressive building collapse. In most, but not all cases, the glass is the weakest component of the

INSTRUCTOR NOTES	CONTENT/ACTIVITY

glass is the weakest component of the building envelope. Conversely, the columns, whether concrete or steel, are usually the strongest components of the building envelope. [A workable rule of thumb is that steel columns require about twice the stand-off distance compared to concrete columns for the same weapon yield.]

- Ask what the threshold of concrete column failure stand-off distance is for a 300-pound bomb?

ANSWER: Approximately 25 feet.

VISUAL VI-25

Comparison of Stand-off

The Murrah Federal Building and Khobar Towers blasts vividly illustrate the response of a building to a blast event.

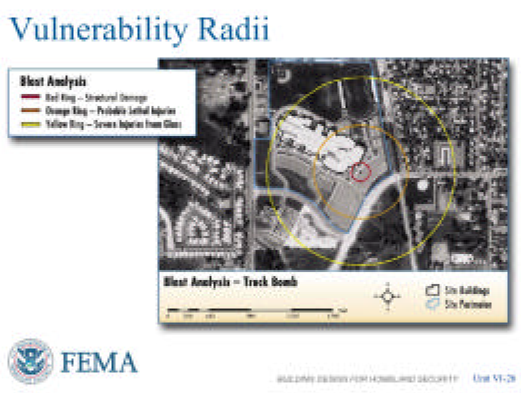
The Murrah Federal Building had less than 20 feet of stand-off and was not designed to prevent progressive collapse.

Khobar Towers was designed using British code to prevent progressive collapse and had approximately 80 feet of stand-off distance.

Notice the size of the weapons. The Murrah Federal Building was unsalvageable and demolished, while Khobar Towers only lost the front façade and was quickly restored and placed back into service.

INSTRUCTOR NOTES | **CONTENT/ACTIVITY**

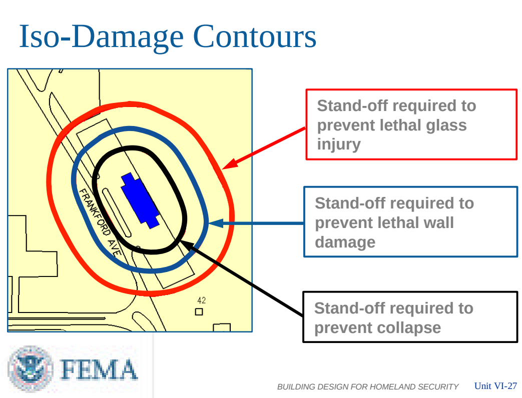
VISUAL VI-26



Vulnerability Radii

- Graphically portraying the information from the Nominal Range-to-Effect Chart can be done in two ways. As shown in **Figures 4-6 and 4-7 in FEMA 426 (page 4-12)**, vulnerability radii show how far a given type of damage will extend from a bomb location for a given weapon yield. The rings indicate where that level of damage starts and whatever is inside the ring will experience that damage. The expected damage increases as you move from the ring to the explosion. Hardening and other mitigation measures can be compared using this representation (for example, existing glass, glass with fragment-retention film installed, or upgraded glass).
- This representation works well when showing the effects of different bomb locations and the extent of the building affected by a bomb at a given location.

VISUAL VI-27

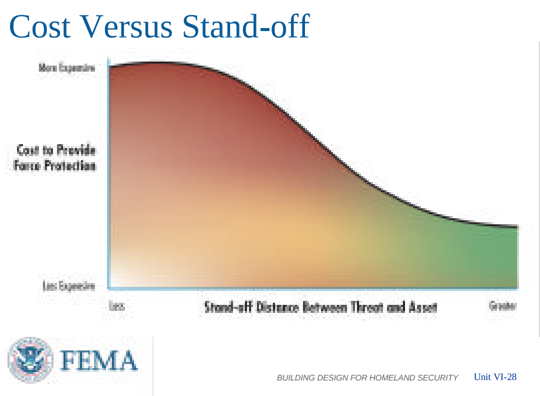


Iso-Damage Contours

- Alternately, the nominal range-to-effect information can be graphically represented as iso-damage contours. For a given weapon yield against a building of known construction, the contour indicates how far the bomb or vehicle must be kept away to prevent the damage indicated in this slide.
- The intent here is to focus on the required stand-off distance to prevent or reduce the weapon effect portrayed by the contour. Thus, to prevent structural collapse, vehicle parking should be eliminated or tightly restricted inside the black contour. Likewise, to prevent lethal glass injury, the vehicle parking should be outside the red contour.

INSTRUCTOR NOTES

VISUAL VI-28



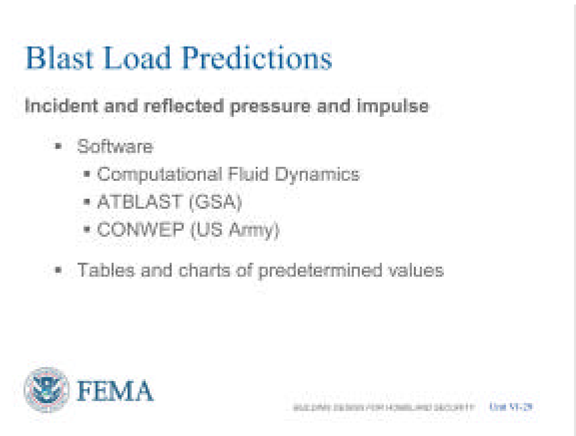
CONTENT/ACTIVITY

Cost versus Stand-off

- As in any design for new construction or renovation, there are trade-offs that must be considered. While increasing the distance between the closest approaches of a vehicle bomb to the building is highly desirable, it is not without a cost.
- The increased distance means more land is needed, which may require considerable time and expense to acquire. The increased land also means a larger perimeter boundary that then requires more perimeter fencing, landscaping, vehicle barriers, lighting, closed-circuit television, etc. Thus, while the increased stand-off allows a less expensive building to be constructed, there are other costs that must be considered in the overall project.
- Where stand-off distance cannot be increased, building hardening is usually necessary to achieve the same level of protection against the Design Basis Threat weapon yield. As the stand-off distance decreases, the cost of hardening significantly increases because the building must now withstand damage that it would not experience at higher stand-off.
- Consider progressive collapse. At large stand-off distance, the design of the building framing and columns should meet basic design to prevent progressive collapse. This would be for the loss of one column, for example. At smaller stand-off distances, the columns may require additional hardening to prevent the failure of more than one column during an explosive blast event.

INSTRUCTOR NOTES | **CONTENT/ACTIVITY**

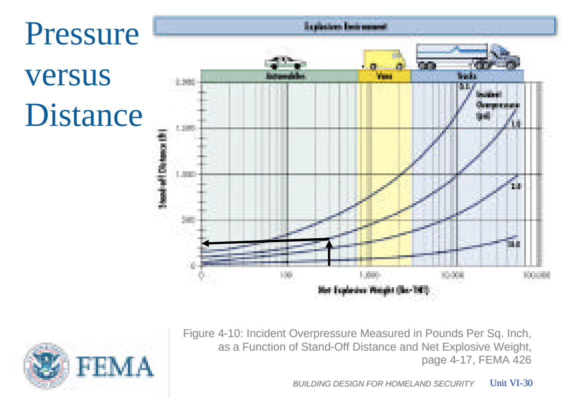
VISUAL VI-29



Blast Load Predictions

- The first step in designing a building for explosive blast is to understand the pressures and impulses the building may experience during the potential blast event. If reflections are a concern, then high-level software, such as Computational Fluid Dynamics, may be in order. As a first effort, simpler software, such as ATBLAST and CONWEP, can give a prediction of incident blast loading values and a prediction for reflected pressure and impulse using simplifying assumptions.
- Pressure versus distance **(Figure 4-10 in FEMA 426, page 4-17)** is another method for predicting the incident pressure as shown in the next slide.

VISUAL VI-30



Direct students' attention to **Figure 4-10, page 4-17 of FEMA 426**

Pressure versus Distance

- Figure 4-10 breaks the blast load estimate into the essential elements of weapon yield or explosive weight in TNT equivalent on the x-axis and stand-off distance on the y-axis to give an incident pressure value that a building can experience.
- Note that the x-axis is logarithmic and the y-axis is linear. If both axes were logarithmic as used on the range-to-effect chart presented earlier, the curves of this chart would be straight lines. In other words, on a log-log scale of explosive weight and stand-off distance, a straight line indicates a pressure relationship (not impulse).
- Ask what stand-off distance is required for a 300-pound bomb to keep the incident pressure at 1.0 psi or lower.

ANSWER: Approximately 250 feet.

INSTRUCTOR NOTES

VISUAL VI-31

Blast Damage Estimates (1)

Assumptions - pressure and material

- Software - SDOF
  - AT Planner (U.S. Army)
  - BEEM (TSWG)
  - BlastFX (FAA)
- Software - FEM
- Tables and charts of predetermined values

FEMA

BUILDING DESIGN FOR HOMELAND SECURITY Unit VI-31

VISUAL VI-32

Blast Damage Estimates (2)

Damage	Incident Pressure (psi)
Typical window glass breakage (1)	0.15 – 0.22
Minor damage to some buildings (1)	0.5 – 1.1
Panels of sheet metal buckled (1)	1.1 – 1.8
Failure of unreinforced concrete blocks walls (1)	1.8 – 2.9
Collapse of wood frame buildings (2)	Over 5.0
Serious damage to steel framed buildings (1)	4 – 7
Severe damage to reinforced concrete structures (1)	6 – 9
Probable total destruction of most buildings (1)	10 – 12

(1) "*Explosive Shocks in Air*" Kinney and Grahm, 1985

(2) *"Facility Damage and Personnel Injury from Explosive Blast"* Montgomery and Ward, 1993; and *"The Effects of Nuclear Weapons, 3rd Edition",* Glasstone and Dolan, 1977

Level of Protection	Incident Pressure (psi)
High	1.2
Medium	1.9
Low	2.3
Very Low	3.5
Below AT Standards	> 3.5

FEMA

BUILDING DESIGN FOR HOMELAND SECURITY Unit VI-32

Direct students' attention to **Table 4-3, page 4-19 of FEMA 426**

CONTENT/ACTIVITY

Blast Damage Estimates (1)

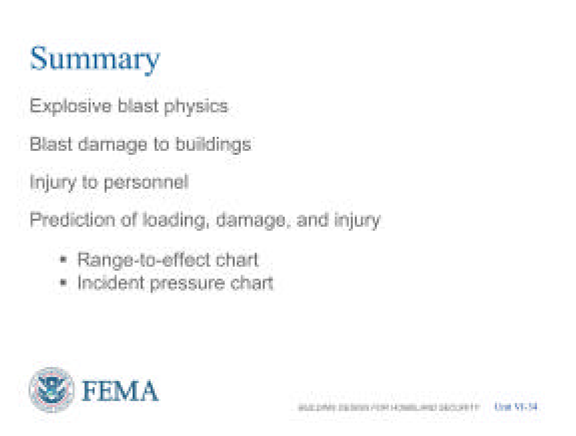
- Whereas normal design usually uses constant loading and linear response, blast loading is very dynamic, as you have seen, and damage of building components enters its nonlinear material range prior to failure.
- Conversely, higher level modeling may result in reduced construction costs due to a better understanding of how the building components will respond during a blast for the given site, layout, and building design parameters selected.

Blast Damage Estimates (2)

- In the slide to the left, you see Damage Approximations for different types of damage and a range of incident pressures at which this damage is expected to occur.
- Note that, logically, higher pressure results in greater damage and the range of incident pressure indicates the construction variation that may be found.

INSTRUCTOR NOTES | **CONTENT/ACTIVITY**

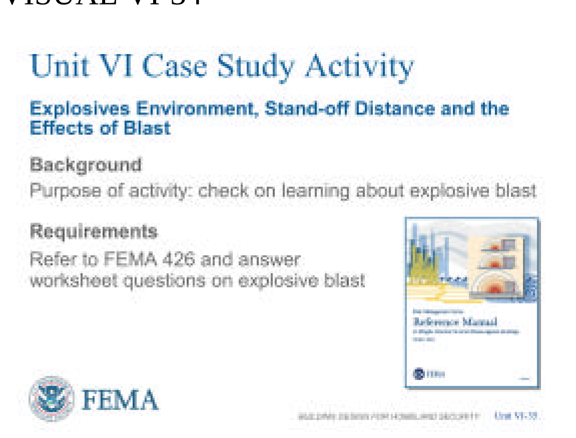
VISUAL VI-33



Summary

- You now have an understanding of the basic physics involved during an explosive blast event.
- You can now explain building damage and injury to people resulting from the blast effects upon a building and injury to people in the open.
- You can perform an initial prediction of blast loading and effects based upon incident pressure using a nominal range-to-effect chart or the incident pressure charts.

VISUAL VI-34



Refer participants to **FEMA 426** and the Unit VI Case Study activity in the Student Manual.

Members of the instructor staff should be available to answer questions and assist groups as needed.

At the end of 15 minutes, reconvene the class and facilitate group reporting.

Student Activity

This activity provides a check on learning about explosive blast.

Activity Requirements

Working in small groups, refer to **FEMA 426** and complete the worksheet questions.

After 15 minutes, solutions will be reviewed in plenary group.

INSTRUCTOR NOTES	CONTENT/ACTIVITY
	Transition Unit VII will cover CBR measures and introduce the basic science needed to understand building protection against chemical, biological, and radiological agents, and complete the assessment and analysis units. Unit VIII will begin the process of reviewing the site, layout, and building design guidance and evaluation of mitigation options.

UNIT VI CASE STUDY ACTIVITY:
STAND-OFF DISTANCE AND THE EFFECTS OF BLAST

The requirements in this Unit's activity are intended to provide a check on learning about explosive blast.

Requirement

1. In the empty cells in the table below, identify whether the adjacent description defines incident pressure or reflected pressure.

Definition	Type of Pressure
Characterized by an almost instantaneous rise from atmospheric pressure to peak overpressure.	***Incident pressure***
When it impinges on a structure that is not parallel to the direction of the wave's travel, the pressure wave is reflected and reinforced.	***Reflective Pressure***

2. Refer to **Figure 4-5 in FEMA 426 (page 4-11)** to answer the following questions regarding the explosives environment:

   - What is the minimum stand-off distance from a 100-pound bomb explosion to eliminate the danger of glass breakage and severe wounds (without fragment retention film)? ***400 feet***

   - What damage will be sustained at 400 feet from a 5,000-pound bomb explosion? ***Wall fragment injuries or injuries to personnel in the open***

3. Refer to **Figure 4-10 and Table 4-3 (pages 4-17 and 4-19, respectively) in FEMA 426** to answer the following questions regarding the explosives environment.

   - What is the minimum stand-off required to limit the incident pressure to under 0.5 psi for a 100-pound bomb? ***Approximately 325 feet***

   - What incident pressure would be expected at 500 feet from a 500-pound bomb and what is the approximate damage? ***Approximately 0.75 psi, minor damage to some buildings***

Unit VII

COURSE TITLE Building Design for Homeland Security

TIME 60 minutes

UNIT TITLE Chemical, Biological, and Radiological (CBR) Measures

OBJECTIVES

1. Explain the five possible protective actions for a building and its occupants
2. Compare filtration and collection mechanisms and applicability to the particles present in chemical, biological, and radiological agents
3. Explain the key issues with CBR detection
4. Identify the indications of CBR contamination

SCOPE

The following topics will be covered in this unit:

1. Five protective actions for a building and its occupants: evacuation; sheltering in place; personal protective equipment; air filtration and pressurization; and exhausting and purging
2. Air filtration and cleaning principles and its application
3. CBR detection technology currently available
4. Indications of CBR contamination that do not use technology

REFERENCES

The following sources will provide information used in this Unit:

1. FEMA 426, *Reference Manual to Mitigate Potential Terrorist Attacks Against Buildings*, pages 5-1 to 5-36
2. Appendix C, Chemical, Biological, and Radiological Glossary
3. Student Manual, Unit VII
4. Case Study – Hazardville Information Company
5. Unit VII visuals

REQUIREMENTS

1. FEMA 426, *Reference Manual to Mitigate Potential Terrorist Attacks Against Buildings* (one per student)
2. Instructor Guide
3. Student Manual (one per student)
4. Overhead projector or computer display unit
5. Unit VII visuals
6. Chart paper, easel, and markers

UNIT VII OUTLINE

WRITTEN EXAM — 1 hour

Exam	30 minutes
Feedback	30 minutes

PREPARING TO TEACH THIS UNIT

- **Tailoring Content to the Local Area:** Review the Instructor Notes to identify topics that may focus on the local area. Plan how you will use the generic content, and prepare for a locally oriented discussion.

  As with Unit VI, the Instructor for this unit will present the characteristics of CBR agents and how a building can be operated or built to reduce the effects of these agents. The principles of air filtration and cleaning and how to apply this equipment are issues to cover in building design. Similarly, the current technology for detecting CBR agents is another building design and operation issue. Finally, the Instructor covers non-technology indications of CBR contamination.

- **Optional Activity:** There are no optional activities in this unit.

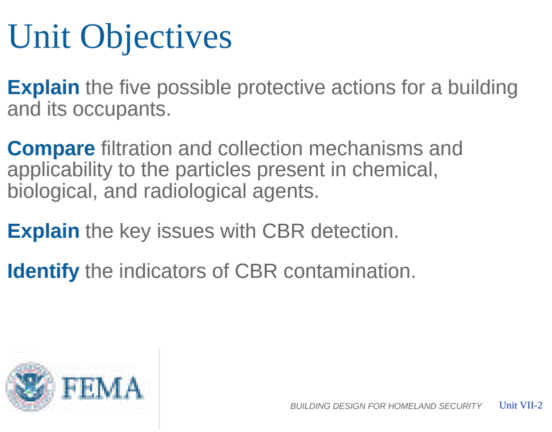
INSTRUCTOR NOTES	CONTENT/ACTIVITY

VISUAL VII-1

Introduction and Unit Overview

This is Unit VII CBR Measures. In this Unit, CBR protective measures and actions to safeguard the occupants of a building from CBR threats are presented. The Unit is based largely on CDC/NIOSH and DoD guidance.

VISUAL VII-2



Unit Objectives

At the end of this Unit, the participant should be able to:

1. Explain the five possible protective actions for a building and its occupants.

2. Compare filtration and collection mechanisms and applicability to the particles present in chemical, biological, and radiological agents.

3. Explain the key issues with CBR detection.

4. Identify the indications of CBR contamination.

INSTRUCTOR NOTES | **CONTENT/ACTIVITY**

VISUAL VII-3

Unit VII: CBR Measures

Units I-V discussed Assessments – Risk.

Units VI and VII explain Blast and CBR Weapons and effects.

Units VIII and IX demonstrate techniques for site layout and building design to counter or mitigate manmade threats.

FEMA BUILDING DESIGN FOR HOMELAND SECURITY Unit VII-3

CBR Measures

This unit is based on guidance from the CDC/NIOSH and the DoD and presents protective measures and actions to safeguard the occupants of a building from CBR threats. Evacuation, sheltering in place, personal protective equipment, air filtration and pressurization, and exhausting and purging will be discussed, as well as CBR detection. Additionally, CBR design mitigation measures are discussed in Chapter 3 of FEMA 426 and Appendix C of FEMA 426 contains a glossary of CBR terms and a summary of CBR agent characteristics.

Recent terrorist events have increased interest in the vulnerability of buildings to CBR threats. Of particular concern are building HVAC systems, because they can become an entry point and distribution system for airborne hazardous contaminants. Even without special protective systems, buildings can provide protection in varying degrees against airborne hazards that originate outdoors.

VISUAL VII-4

CBR Measures: An Overview

FEMA 426, Chapter 5 is based on best practices for safeguarding building occupants from CBR threats. This module is organized into four sections :

- Protective Actions for Buildings and Occupants
- Air Filtration and Cleaning Principles and Technology
- CBR Detection and Technology
- Non-Technology CBR Contamination Indications

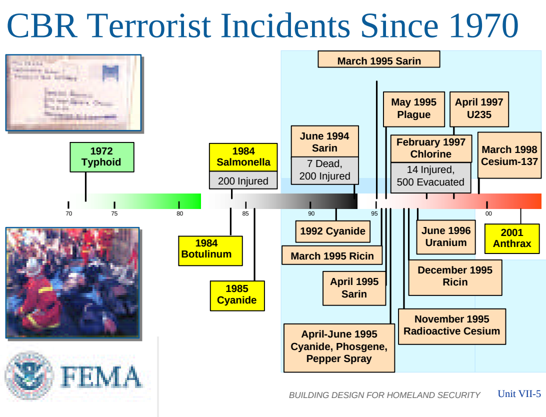
FEMA BUILDING DESIGN FOR HOMELAND SECURITY Unit VII-4

CBR Measures: FEMA 426 Chapter 5 Overview

This Unit draws on the latest research from CDC/NIOSH to present the best practices for detecting CBR agents, and safeguarding building occupants from the effects of CBR contamination. The FEMA 426 chapter on CBR provides an overview on CBR Detection and Current Technology; and Indicators of CBR Contamination, Evacuation, Sheltering in Place, Air Filtration and Pressurization, and Exhausting and Purging.

INSTRUCTOR NOTES | **CONTENT/ACTIVITY**

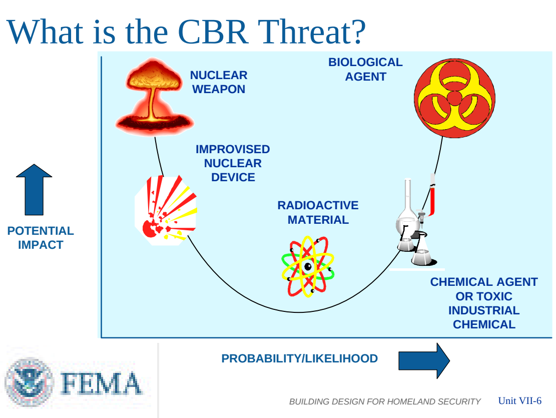
VISUAL VII-5



CBR Terrorist Incidents Since 1970

CBR attacks have been used since ancient times and, in the past 20 years, over 50 attacks have occurred. CBR attacks require the right weather, population, and dispersion to be effective. Recent attacks have had limited effectiveness or have been conducted on a relatively small scale. Future attacks with Weapons of Mass Destruction could occur on a regional or global scale.

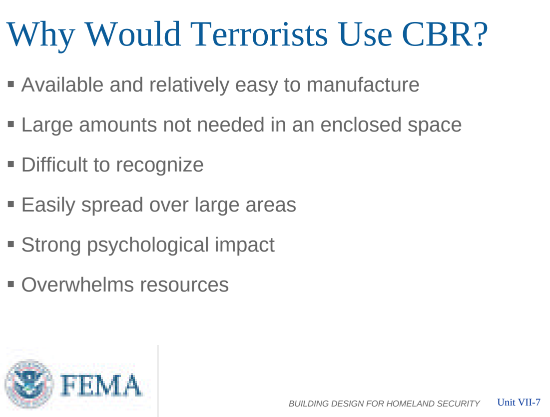
VISUAL VII-6



What is the CBR Threat?

A fundamental question, *What is the CBR threat today?* This slide shows the relationship between the probability or likelihood of threats, and their potential impacts.

VISUAL VII-7



Why Would Terrorists Use CBR?

- Available and relatively easy to manufacture
- Large amounts not needed in an enclosed space
- Difficult to recognize
- Easily spread over large areas
- Strong psychological impact
- Overwhelms resources

INSTRUCTOR NOTES | **CONTENT/ACTIVITY**

VISUAL VII-8

CBR Sources

There are many potential sources of chemical and biological agents, including laboratory and commercial production, and home production in those cases involving low concentrations, and impure and inexpensive materials. Other sources include:

- Industrial facilities
- Foreign military sources
- Medical/university research facilities
- Nuclear facilities

The next series of slides will examine in more detail the properties of chemical and biological agents, **with implications for building design.**

VISUAL VII-9

Limitations of CBR Materials

- Effective dissemination is difficult.
- Delayed effects can detract from impact.
- Counterproductive to terrorists' support.
- Potentially hazardous to the terrorist.
- Development and use require skill.

INSTRUCTOR NOTES | **CONTENT/ACTIVITY**

VISUAL VII-10

Chemical Agents: Characteristics and Behavior

- Generally liquid (when containerized)
- Normally disseminated as aerosol or gas
- Present both a respiratory and skin contact hazard
- May be detectable by the senses (especially smell)
- Influenced by weather conditions

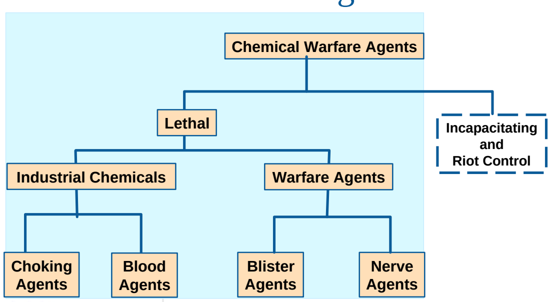
FEMA

BUILDING DESIGN FOR HOMELAND SECURITY

Chemical Agents: Characteristics and Behavior

VISUAL VII-11

Classes of Chemical Agents



FEMA

BUILDING DESIGN FOR HOMELAND SECURITY

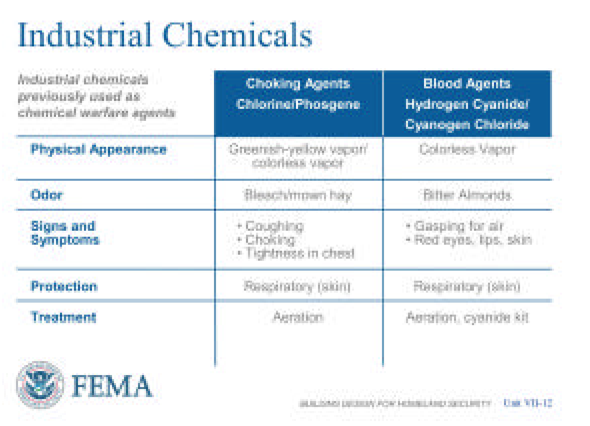
Classes of Chemical Agents

Chemical agents are classified as either lethal or incapacitating and “riot control,” according to their intended use. For the purposes of this presentation, the emphasis has been placed on lethal agents as a consequence of their greater capacity for terrorist mischief.

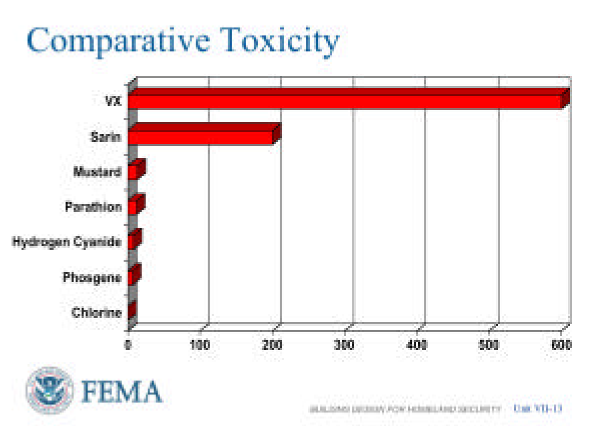
- **Lethal:** These have been subdivided into two categories: industrial materials used or considered as chemical warfare agents, and chemical warfare agents, which have little or no other purpose beyond their intended use as weapons of mass destruction on the battlefield.
- **Incapacitating and Riot Control**: Incapacitating and riot control agents are not considered as primary terrorist threats, due primarily to their relatively short duration of effects and minimal toxicity. Therefore, they are not discussed in detail in this unit.

INSTRUCTOR NOTES | **CONTENT/ACTIVITY**

VISUAL VII-12



VISUAL VII-13



Note: At this point, reinforce the following point …*as we collectively examine and identify opportunities to improve building safety from CBR, it is important to understand the characteristics of CBR, and their potential consequences for the public, and first responders…. detailed information on the properties of these agents can be found in Appendix C of FEMA 426.*

Industrial Chemicals

This chart lists four industrial chemicals that were previously used as chemical warfare agents. These chemicals are used in the sanitation industry, the plastics industry, and the pesticide industry. All of these agents are generally respiratory agents and can be protected against by effective respiratory protection (i.e., self-contained breathing apparatus (SCBA)), although skin contact with concentrated material may cause chemical burns. They are all exceedingly volatile and dissipate rapidly outdoors.

Comparative Toxicity

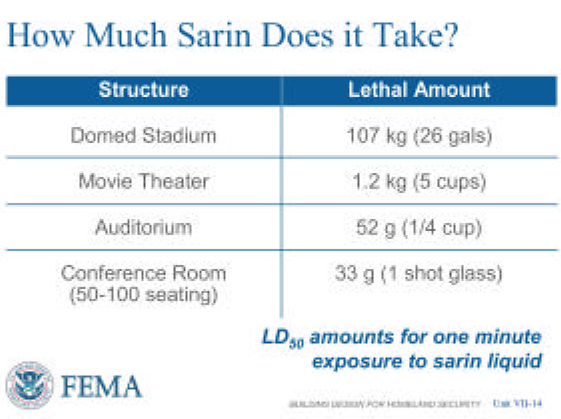
This is a graphical comparison of the approximate lethalities of some chemical agents. They are based relative to Chlorine in terms of respiratory toxicity. If we use Chlorine as a baseline (1.0 on the graph):

- Phosgene (CG) is about 6 times more toxic
- Hydrogen Cyanide (AC) is about 7 times more toxic
- Parathion, an insecticide ingredient, is about 12 times more toxic
- Mustard (H) is about 13 times more toxic
- Sarin (GB) is about 200 times more toxic
- VX is about 600 times more toxic

For skin toxicity, less than a pinhead of mustard agent is required to achieve a small blister. Less than a pinhead of VX can be lethal.

INSTRUCTOR NOTES | **CONTENT/ACTIVITY**

VISUAL VII-14



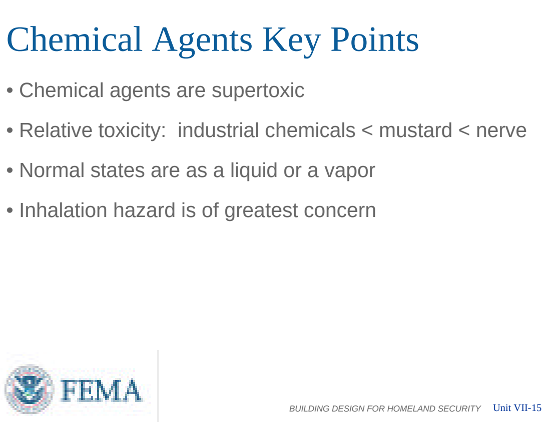
Exam Questions #A15 and B15

How Much Sarin Does it Take?

We have all heard of Sarin, among the most lethal of chemical agents. It is both odorless and colorless in pure form.

These numbers are the Lethal Doses 50 (LD50) amounts for 1 minute of exposure to Sarin liquid. This means that in a 60-second period, it would take approximately 26 gallons of Sarin to kill 50 percent of the people in a domed stadium, 5 cups of Sarin to kill 50 percent of the people in a movie theater, only about 1/4 cup of Sarin to kill 50 percent of the people in an auditorium, and the equivalent of a shot glass to kill 50 percent of the people in a 50-100 person conference room.

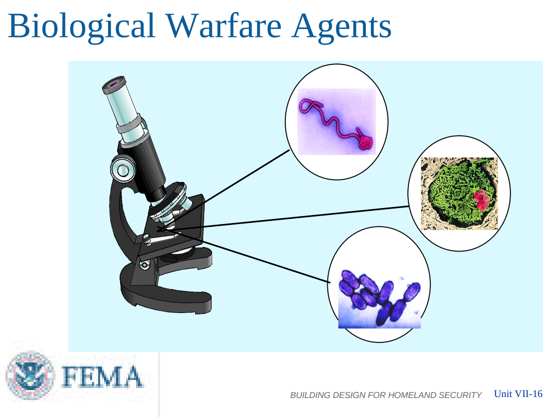
VISUAL VII-15



Chemical Agents Key Points

- Chemical agents are supertoxic: These agents were deliberately developed to cause injury or death to individuals.
- Relative toxicity: industrial chemicals < mustard < nerve: In terms of relative toxicity, the same amount of an industrial chemical is less toxic than a blister agent, and both are less toxic than a nerve agent.
- Normal states are as a liquid or a vapor: These agents are either a liquid or a vapor in their normal state.
- Inhalation hazard is of greatest concern: Nerve and blister agents pose both a skin and inhalation hazard. The inhalation hazard is of greater concern.

VISUAL VII-16

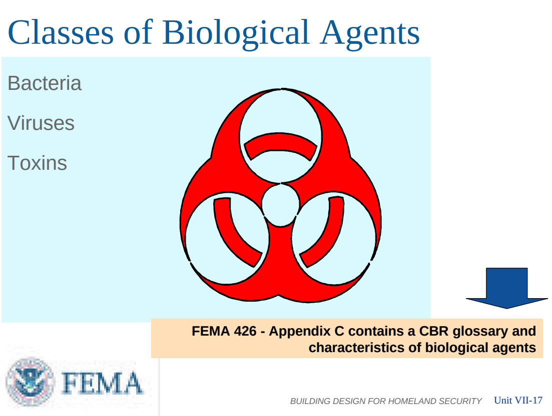


Biological Warfare Agents

Emphasize differences between chemical and biological agents:

- **Delayed effects:** The biggest difference is time. Unlike chemical agents, most of which have an immediate effect, most biological agents have a delayed effect ranging from several hours to days, and in some cases, weeks. In the event of a biological incident, there may be no casualties and nothing significant initially.
- **Toxicity:** By weight, biological agents are generally more toxic than chemical agents. For example, Ricin is 6 to 9 times more toxic than Sarin, and Botulinum, another toxin, is 15,000 to 30,000 times more toxic than Sarin.
- **Human detection:** Biological agents are undetectable by the human senses.

VISUAL VII-17

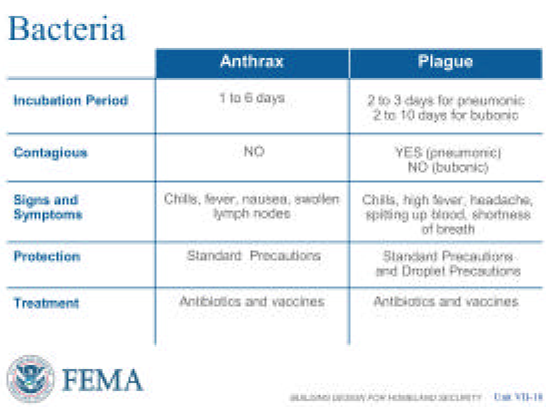


Note: As we look at biological agents, you will see some similarities with what we discussed earlier with chemical agents, but you will also note some significant differences. Selected bacterial, viral, and toxin agents, their characteristics, and treatment are of particular concern when preparing for biological terrorism.

Classes of Biological Agents

- Both **bacteria** and **viruses** are living organisms and, as such, require an environment in which to live and reproduce.
- They can enter the body through inhalation or ingestion, through a break in the skin, or through other body openings or orifices.
- Once the organisms invade the body, they begin to grow and reproduce. They can also produce toxins which may poison the body.
- **Toxins** are poisonous substances produced as a byproduct of pathogens or plants and even some animals.

VISUAL VII-18


Bacteria

	Anthrax	Plague
Incubation Period	1 to 6 days	2 to 3 days for pneumonic 2 to 10 days for bubonic
Contagious	NO	YES (pneumonic) NO (bubonic)
Signs and Symptoms	Chills, fever, nausea, swollen lymph nodes	Chills, high fever, headache, spitting up blood, shortness of breath
Protection	Standard Precautions	Standard Precautions and Droplet Precautions
Treatment	Antibiotics and vaccines	Antibiotics and vaccines

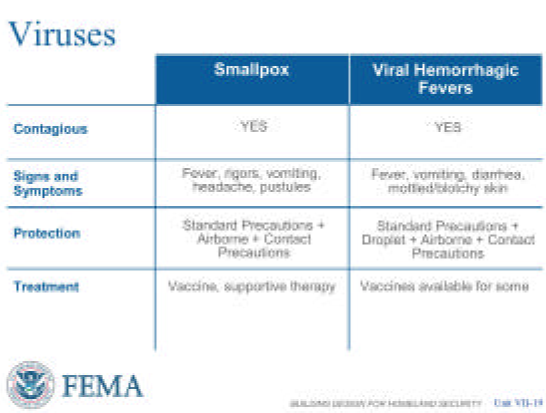
Bacteria

Anthrax and plague are two examples of diseases caused by bacteria. This chart highlights the important characteristics of each, including:

- Incubation period
- Whether they are contagious
- Signs and symptoms
- Protection
- Treatment

Again, a basic understanding of these characteristics will be valuable in developing an **appropriate and effective protective action strategy for your facility**.

VISUAL VII-19


Viruses

	Smallpox	Viral Hemorrhagic Fevers
Contagious	YES	YES
Signs and Symptoms	Fever, rigors, vomiting, headache, pustules	Fever, vomiting, diarrhea, mottled/blotchy skin
Protection	Standard Precautions + Airborne + Contact Precautions	Standard Precautions + Droplet + Airborne + Contact Precautions
Treatment	Vaccine, supportive therapy	Vaccines available for some

Viruses

Two viruses are highlighted: **Smallpox** and **Viral Hemorrhagic Fevers**. Both are contagious, and protective actions include the use of standard and airborne and contact precautions.

INSTRUCTOR NOTES | **CONTENT/ACTIVITY**

VISUAL VII-20

Toxins

	Neurotoxin (Botulinum)	Cytotoxin (Ricin)
Onset of Symptoms	1 to 3 days	4-8 hours after ingestion 12-24 hours after inhalation
Contagious	NO	NO
Signs and Symptoms	Weakness, dizziness, dry mouth and throat, blurred vision, paralysis	Chills, high fever, headache, spitting up blood, shortness of breath
Protection	Standard Precautions	Standard Precautions
Treatment	Supportive care, antitoxins, and vaccines	Supportive oxygenation and hydration

FEMA

Note: There are numerous naturally-occurring toxins. For our purposes, we will group them into two categories.

BUILDING DESIGN FOR HOMELAND SECURITY Unit VII-20

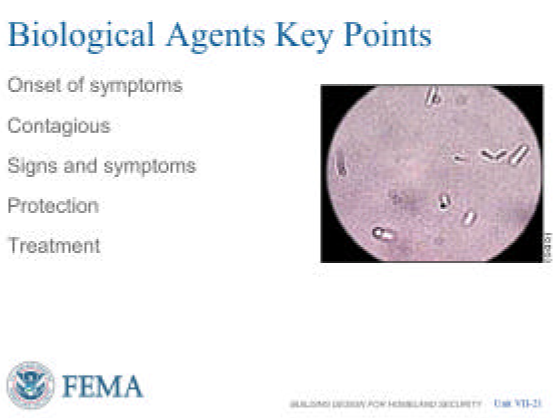
Toxins

Finally, there are numerous naturally-occurring **toxins.** For our purposes, we will group them into two categories:

- **Neurotoxins:** Neurotoxins attack the nervous system. They are fairly fast-acting and can act in a manner opposite to that of the nerve agents because they prevent nerve-to-muscle stimulation.
- **Cytotoxins:** Cytotoxins are cell poisons. They are slower acting and can have a variety of symptoms, including vomiting, diarrhea, rashes, blisters, jaundice, bleeding, or general tissue deterioration.

There are numerous other modes of action of toxins, which are beyond our need to discuss here.

VISUAL VII-21



Biological Agents Key Points

- **Onset of symptoms:** Most biological agents have an incubation period. Delayed effects will make identifying a biological attack more difficult.
- **Contagious**: Only a few biological agents are contagious: plague, smallpox, and viral hemorrhagic fevers (VHF), such as ebola
- **Signs and symptoms**: Signs and symptoms of many biological attacks initially manifest themselves as flu-like; therefore, it may be difficult to identify that an attack has occurred.
- **Protection:** Standard precautions will be adequate protection against most biological agents
- **Treatment:** Some biological agents can be treated with antibiotics, vaccines, and antitoxins; for agents for which there are

Exam Questions #A14 and B13

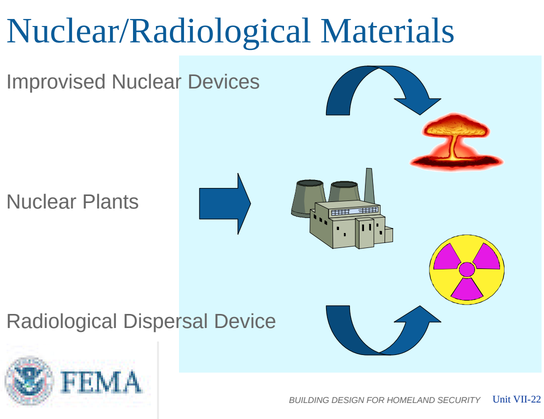
Biological weapons are considered the emerging mass weapon of destruction of choice for terrorists because many agents can be made with standard commercial laboratory or brewing equipment.

INSTRUCTOR NOTES	CONTENT/ACTIVITY

none of the aforementioned treatments, supportive care should be administered.

The recent SARS and Avian Flu outbreaks demonstrate the relative ease by which naturally-occurring biological agents can quickly transmutate and spread across the globe. The flu strain that caused the Flu Pandemic of 1918 is still an active strain.

VISUAL VII-22



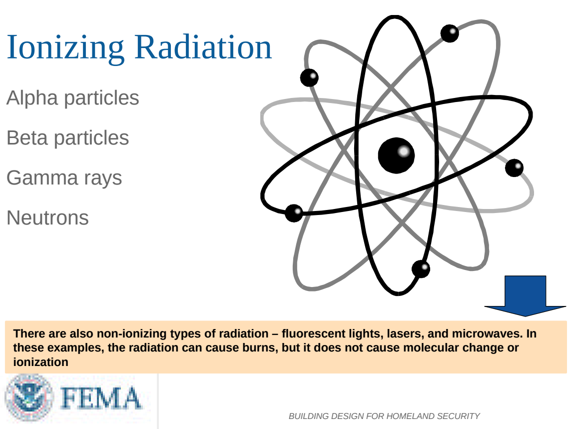
Nuclear/Radiological Materials

Of the three types of threats (chemical, biological, or nuclear/radiological), a **nuclear weapon explosion** is considered the least likely for terrorist use; however, the potential exists for it to happen and even more potential exists for the use of radiological materials.

Possible scenarios:

- The detonation of an **improvised nuclear device** (IND)
- Terrorist attack on a **nuclear plant**
- Use of a **radiological dispersal device** (RDD), or "dirty" bomb - the simple act of spreading the materials

VISUAL VII-23



Exam Questions #A13 and B12

Ionizing Radiation

For our purposes, this radiation can be classified as:

- **Alpha particles**
- **Beta particles**
- **Gamma rays**
- **Neutrons**

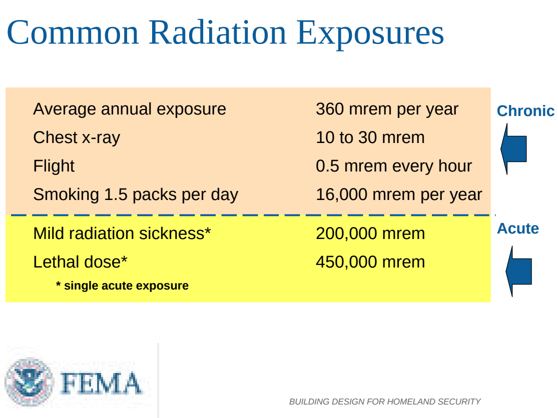
Again, for the purposes of this course, we are primarily concerned with the *hazard*, the *detection* of the hazard, and *protective* actions that we can take.

INSTRUCTOR NOTES

Note: In its simplest definition, radiation can be defined as either electromagnetic or particulate emissions of energy from the disintegration of the nucleus of an atom. This energy, when impacting on or passing through material, including us, can cause some form of reaction.

Radioactive material: Any material that is giving off some form of ionizing radiation.

VISUAL VII-24



Note: Mild radiation sickness (i.e., nausea, vomiting, and diarrhea) may onset after receiving a whole body dose of approximately 200,000 mrem in a short amount of time (generally less than 24 hours). The Lethal Dose (LD), known as the LD50/60, is a single, acute, whole body exposure of around 450,000 mrem. The LD50/60 is defined when 50 percent of all people present at an incident receive 450,000 mrem and die after 60 days after receiving no medical treatment.

CONTENT/ACTIVITY

Ionizing radiation is what causes injury or death, and also a characteristic by which nuclear materials can be measured and identified.

Common Radiation Exposures

This chart reflects naturally-occurring radiation doses (and doses received during normal activities) to provide a point of reference and for comparison. The threshold for any real consequences begins around 200,000 mrem.

The average annual radiation exposure has been calculated as:

Naturally occurring	295 mrem
Medical	52 mrem
Consumer products	10 mrem
Other	3 mrem
Total	*360 mrem*

VISUAL VII-25

Health Hazards in an Incident

- Exposure to radiation source (external)
- Contamination (possible internal and/or external)

FEMA BUILDING DESIGN FOR HOMELAND SECURITY

Note**:** Internal exposure through wounds or broken skin is also possible. Responders should take extra precautions when sharp objects, such as broken glass or jagged metal, are at the scene.

Exam Questions #A24 and B25

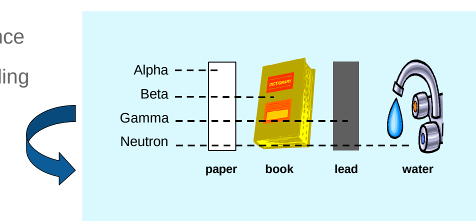
VISUAL VII-26

Protection from Radiation Exposure

Time

Distance

Shielding



FEMA BUILDING DESIGN FOR HOMELAND SECURITY

Note: Do <u>not</u> shield neutron producing sources with lead or dense materials. Neutrons will produce gamma rays in reactions with the material. Use wax, water, or plastic.

Health Hazards

The two radiation concerns at an incident are exposure and contamination by radioactive material. External irradiation occurs when all or part of the body is exposed to penetrating radiation from an external source. Contamination means that radioactive materials in the form of gases, liquids, or solids are released into the environment and get on people externally, get in them, or both.

Incidents involving either an explosion or fire will elevate the potential for internal or external contamination due to the spreading of the radioactive material in the form of small fragments (dust) or smoke. These materials can often be carried long distances downwind.

Radiological materials are both colorless and odorless.

Protection from Radiation Exposure

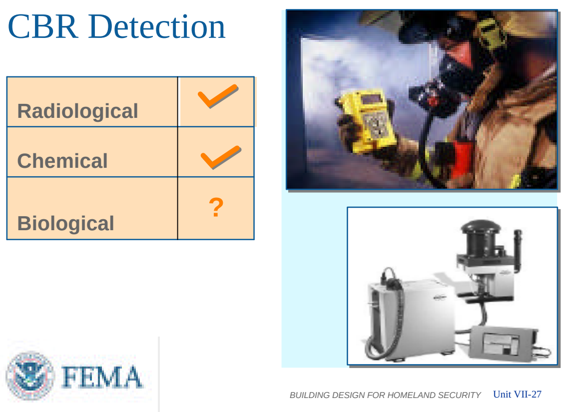
The radiation exposure received will depend on the type and strength of radiation source. This exposure can be reduced by effective use of:

- **Time:** The radiation dose is reduced in proportion to reduction of exposure time.
- **Distance:** Distance is also critical for reducing radiation exposure dose. While alpha particles only travel a little over an inch in air, and beta particles will travel only a few yards in air, gamma rays can travel extensive distances.
- **Shielding:** Radiation can also be blocked or reduced by various materials. Alpha radiation is stopped by a sheet of paper, beta radiation is stopped by aluminum foil or clothing, gamma rays

INSTRUCTOR NOTES	CONTENT/ACTIVITY

are only reduced by dense materials such as lead or earth, and neutrons are slowed or stopped by hydrogenous materials, such as wax or water.

VISUAL VII-27



Exam Questions #A19 and B20

Sources of useful technical information:

- *NBC Products and Services Handbook* contains a catalogue of CBR detection equipment.
- *Guide for the Selection of Chemical Agent and Toxic Industrial Material Detection Equipment for Emergency First Responders*, published by the National Institute of Justice (NIJ), June 2001.
- *An Introduction to Biological Agent Detection Equipment for Emergency First Responders*, published by the NIJ (Guide 101-00: December 2001.

CBR Detection

The underlying theme of this chapter is that effective protection against potential releases of CBR is a function of: 1) effective and timely detection of the agent(s); and 2) a public that is knowledgeable of the most appropriate protective actions to take in the event of a CBR release.

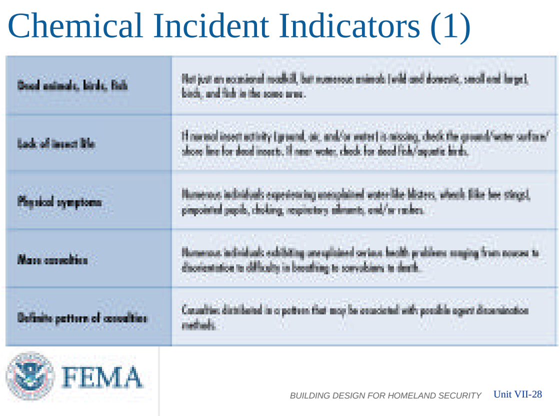
The discussion on **CBR detection** includes:

- CBR detection technology currently available.
- Indications of CBR contamination.
- Most strategies for protecting people from airborne hazards require a means of detection (determining that a hazard exists)
- **Chemical detection** technology has improved vastly since Operation Desert Storm (when many military detection systems experienced high false-alarm rates). Current chemical detectors work in about 10 seconds.
- **Biological detection** technology has not matured as fast; generally require trained specialists to administer; biological signatures can take 30 minutes to detect.

A variety of **radiological detectors** have been developed for the nuclear industry and are commercially available.

INSTRUCTOR NOTES | **CONTENT/ACTIVITY**

VISUAL VII-28

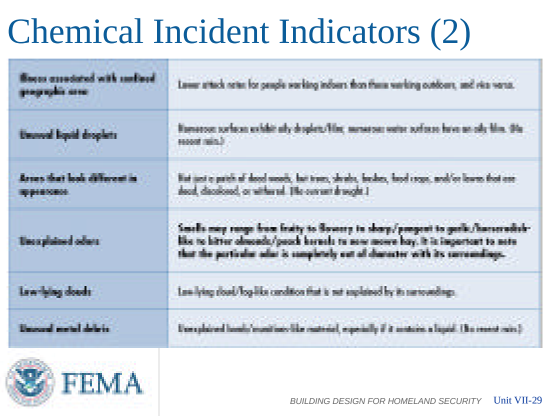


Chemical Incident Indicators (1)

Most hazardous chemicals have warning properties that provide a practical means for detecting a hazard and initiating protective actions. Such warning properties make chemicals perceptible; for example, vapors or gases can be perceived by the human senses (i.e., smell, sight, taste, or irritation of the eyes, skin, or respiratory tract) before serious effects occur.

In the absence of a warning property, people can be alerted to some airborne hazards by observing symptoms or effects in others. This provides a practical means for initiating protective actions, because the susceptibility to hazardous materials varies from person to person.

VISUAL VII-29



Chemical Incident Indicators (2)

This chart depicts the following chemical indicators: definite pattern of casualties; illness associated with a confined geographic area; unused liquid droplets; areas that look different in appearance; unexplained odors; low-flying clouds; and unusual metal debris.

Exam Questions #A16 and B16

INSTRUCTOR NOTES | **CONTENT/ACTIVITY**

VISUAL VII-30

Biological Incident Indicators

Unusual numbers of sick or dying people or animals	Any number of symptoms may occur. As a first responder, strong consideration should be given to calling local hospitals to see if additional casualties with similar symptoms have been observed. Casualties may occur hours to days or weeks after an incident has occurred. The time required before symptoms are observed is dependent on the biological agent used and the dose received. Additional symptoms likely to occur include unexplained gastrointestinal illnesses and upper respiratory problems similar to flu/colds.
Unscheduled and unusual spray being disseminated	Especially if outdoors during periods of darkness.
Abandoned spray devices	Devices will have no distinct odors.

FEMA

BUILDING DESIGN FOR HOMELAND SECURITY Unit VII-30

Biological Incident Indicators

In the case of a biological incident, the onset of symptoms takes days to weeks and, typically, there will be no characteristic indicators. Because of the delayed onset of symptoms in a biological incident, the area affected may be greater due to the migration of infected individuals.

VISUAL VII-31

Radiological Incident Indicators

Unusual numbers of sick or dying people or animals	As a first responder, strong consideration should be given to calling local hospitals to see if additional casualties with similar symptoms have been observed. Casualties may occur hours to days or weeks after an incident has occurred. The time required before symptoms are observed is dependent on the radioactive material used and the dose received. Additional symptoms likely to occur include skin reddening and, in severe cases, vomiting.
Unusual metal debris	Unexplained bomb/munitions-like material.
Radiation symbols	Containers may display a radiation symbol.
Heat emitting material	Material that seems to emit heat without any sign of an external heating source.
Glowing material/particles	If the material is strongly radioactive, it may emit a radioluminescence.

FEMA

BUILDING DESIGN FOR HOMELAND SECURITY Unit VII-31

Radiological Incident Indicators

In the case of a radiological incident, the onset of symptoms also takes days to weeks to occur and typically there will be no characteristic indicators. Radiological materials are not recognizable by the senses because they are colorless and odorless.

VISUAL VII-32

CBR Protection Strategies

Protective Actions:

- Evacuation
- Sheltering in Place
- Personal Protective Equipment
- Air Filtration and Pressurization
- Exhausting and Purging

FEMA

BUILDING DESIGN FOR HOMELAND SECURITY Unit VII-28

CBR Protection Strategies

Once the presence of an airborne hazard is detected, there are five possible **protective actions** for a building and its occupants. In increasing order of complexity and cost, these actions are:

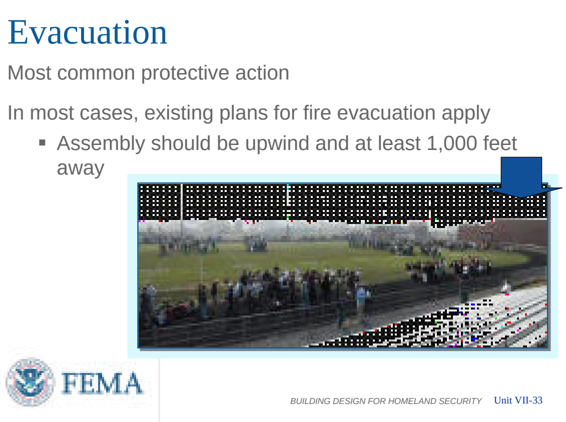
- Evacuation
- Sheltering in Place
- Personal Protective Equipment
- Air Filtration and Pressurization
- Exhausting and Purging

To ensure the protective actions are effective you must have:

- A protective action plan specific to each building
- Training and familiarization for occupants.

Protective actions are discussed in more detail in the following sections.

VISUAL VII-33



Evacuation

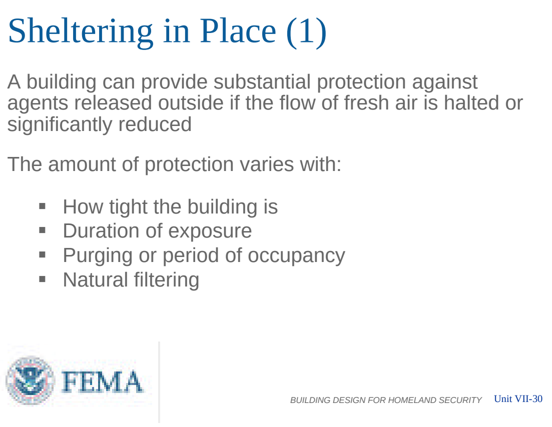
- Evacuation is the most common protective action taken when an airborne hazard, such as smoke or an unusual odor, is perceived in a building.
- Orderly evacuation is the simplest and most reliable action for an internal airborne hazard, but may not be the best action in all situations, especially in the case of an external CBR release, particularly one that is widespread.
- If some agent has infiltrated the building and evacuation is deemed not to be safe, the use of protective hoods may be appropriate.

Two considerations in non-fire evacuation are:

1. Determine if the source of the airborne hazard is internal or external.
2. Determine if evacuation may lead to other risks. Also, evacuation and assembly should be to the upwind side of the building and at least 1,000 feet away, since any airborne hazard escaping the building will be carried downwind.

INSTRUCTOR NOTES | **CONTENT/ACTIVITY**

VISUAL VII-34



Exam Questions #A12 and B14

In most cases, air conditioners and combustion heaters cannot be operated while sheltering in place because operating them increases the indoor-outdoor exchange of air.

Sheltering in place is, therefore, suitable *only for exposures of short duration*, roughly 2 hours or less, depending on conditions.

Because the building slowly releases contaminants that have entered, at some point during cloud passage the concentration inside exceeds the concentration outside. Maximum protection is attained by increasing the air exchange rate after cloud passage or by exiting the building into clean air. The tighter the building, the greater the effect of this natural filtering.

Sheltering in Place (1)

Interrupting the flow of fresh air is the principal applied in the protective action known as sheltering in place.

Advantage: It can be implemented rapidly.

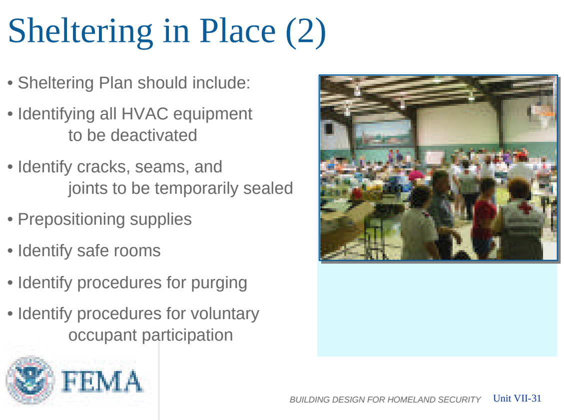
Disadvantage: Protection is variable and diminishes with the duration of the hazard.

The level of protection that can be attained by sheltering in place is substantial, but it is less than can be provided by high-efficiency filtration of the fresh air introduced into the building. The amount of protection varies with:

- **The building's air exchange rate**. The tighter the building (i.e., the lower the air exchange rate), the greater the protection it provides.
- **The duration of exposure.** Protection varies with time, diminishing as the time of exposure increases.
- **Purging or period of occupancy.** How long occupants remain in the building after the hazardous cloud has passed also affects the level of protection.
- **Natural filtering.** Some filtering occurs when the agent is deposited in the building shell or upon interior surfaces as air passes into and out of the building.

INSTRUCTOR NOTES | **CONTENT/ACTIVITY**

VISUAL VII-35



Exam Questions #A20 and B19

Note: Although sheltering is for protection against an external release, it is possible, but more complex, to shelter in place in one or more floors of a multi-story building after an internal release has occurred. In these circumstances, it is critical to isolate stairwells, and not use elevators.

Sheltering in Place (2)

If the office environment is complex, planning and exercises is important. The sheltering plan should include:

- Identifying all air handling units, fans, and the switches needed to deactivate them
- Identifying cracks, seams, and joints, in the building shell to be temporarily sealed
- Prepositioning supplies
- Identifying safe rooms
- Identifying procedures for voluntary occupant participation
- Identifying procedures for purging after an internal release
- Sealing doors with duct tape
- Turning on TV or radio

During an event, the decision to shelter in place is voluntary, but people should enter the designated shelter area within 3-5 minutes.

VISUAL VII-36

Note: This slide depicts individuals wearing universal-fit escape hoods (upper left-hand corner picture and middle picture on the slide)

Personal Protective Equipment

- A wide range of **individual protection equipment** is available, including respirators, protective hoods, protective suits, CBR detectors, decontamination equipment, etc.

- If masks have been issued, ensure that training is conducted on how to put on and wear the masks.

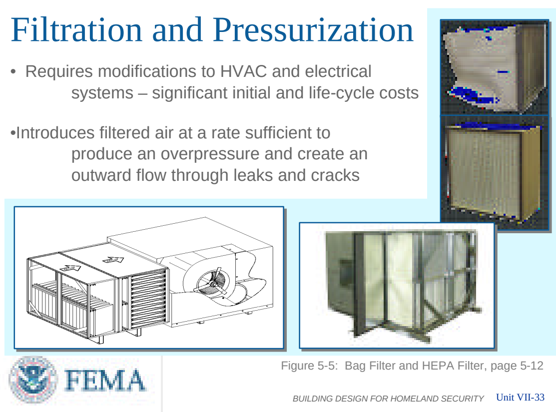
- No selection of personal protective equipment is effective against every possible threat. Selection must be tied to specific threat/hazard characteristics.

that have been developed for short-duration "escape-only" wear to protect against chemical agents, aerosols (including biological agents), and some toxic industrial chemicals. The hoods are compact enough to be stored in desks (see picture in upper left-hand corner of the slide) or to be carried on the belt.

Exam Questions #A21 and B23

- Universal hoods designed for short duration escape wear only protect against chemical agents by using both HEPA and carbon filters.

VISUAL VII-37



Note: Applying external filtration to a building requires modification to the building's heating, ventilation, air conditioning (HVAC) system and electrical system. These changes are necessary to ensure that, when the protective system is in operation, all outside air enters the building through filters. The air exchange that normally occurs due to wind pressure, chimney effect, and operation of fans must be reduced to zero.

Filtration and Pressurization

- Two basic methods of applying air filtration to a building are external filtration and internal filtration. External filtration involves filtering and/or cleaning of the air drawn from the **outside,** while internal filtration involves filtering and/or cleaning of the air drawn from **inside** the building. Both methods require HVAC modifications that can be costly.

- Among the various protective measures for buildings, high efficiency air filtration/cleaning provides the highest level of protection against an outdoor release of hazardous materials.

INSTRUCTOR NOTES

VISUAL VII-38

Air Filtration and Cleaning

Two Types of Collection Systems:

Particulate air filtration

- Principles of collection
- Types of particulate filters
- Filter testing and efficiency ratings

Gas-phase air filtration

- Principles of collection
- Types of gas-phase filters

FEMA

BUILDING DESIGN FOR HOMELAND SECURITY Unit VII-34

Exam Questions #A23 and B21

CONTENT/ACTIVITY

Air Filtration and Cleaning

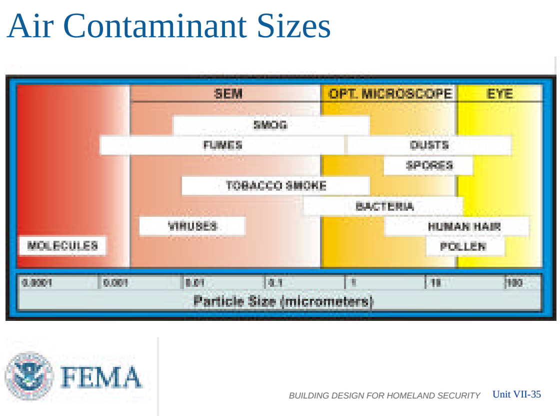
Air filtration is the removal of particulate contaminants from the air. Air cleaning is the removal of gases or vapors from the air. The collection mechanisms for these two types of systems are very different.

Particulate air filtration consists of fibrous materials, which capture aerosols. Their efficiency will depend on the size of the aerosol, the type of filter, the velocity of the air, and the type of microbe. The basic principle of particulate air filtration is not to restrict the passage of particles by the gap between fibers, but by altering the airflow streamlines. The airflow will slip around the fiber, but higher density aerosols and particulates will not change direction as rapidly. Particulate filters are not intended to remove gases and vapors.

Gas-phase air filtration sorbent filters use one of two mechanisms for capturing and controlling gas-phase air contaminants, physical absorption. Both mechanisms remove specific types of gas-phase contaminants in indoor air. Unlike particulate filters, sorbents cover a wide range of highly porous materials, ranging from simple clays and carbons to complex engineered polymers. Activated carbon is the most common sorbent, but does not capture all chemicals.

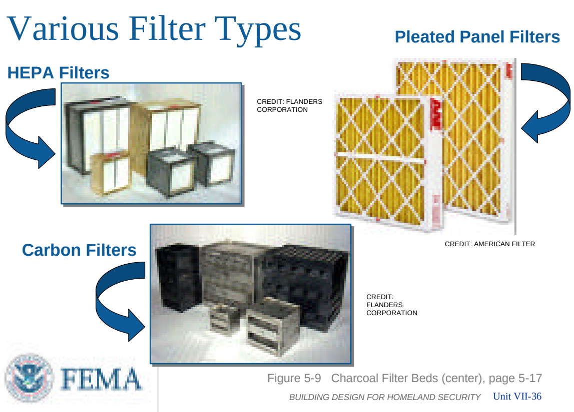
INSTRUCTOR NOTES | **CONTENT/ACTIVITY**

VISUAL VII-39



Exam Questions #A22 and B22

VISUAL VII-40



Air Contaminant Sizes

This chart illustrates the particle size for a number of the chemical, biological, and radiological agents of concern. Viruses are the smallest and most difficult to protect against.

In **FEMA 426, Table 5-1** lists the new ASHRAE 52.2 Standards for particulate filter ratings to remove a given particle size. In most cases, new generation MERV 11 to MERV 13 filters can be used in commercial buildings and effectively remove most particulates of CBR concern.

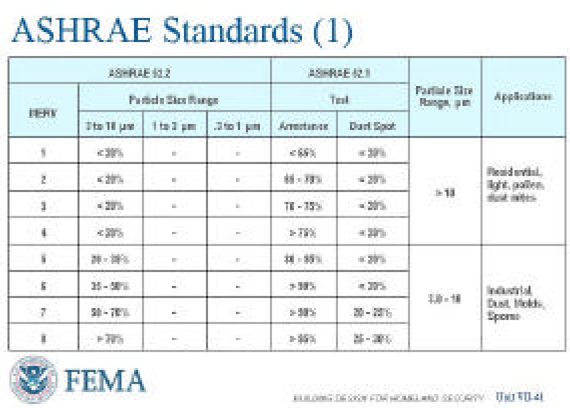
Various Filter Types

A wide variety of filters are available to meet many specialized needs:

- **HEPA** (high efficiency particulate air) **Filters** - high performance filters that are typically rated as 99.97 percent effective in removing dust and particulate matter greater than 0.3 micron in size.
- **Carbon Filters** - sorbent filters (gas-phase) that remove gas and vapors using the thousands of bonding sites on the huge surface area of activated carbon.
- **Pleated Panel Filters** - particulate air filters consisting of fibrous materials that capture aerosols.

INSTRUCTOR NOTES | **CONTENT/ACTIVITY**

VISUAL VII-41

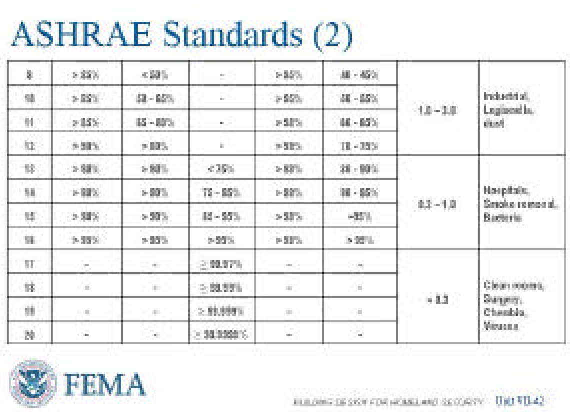


MERV	ASHRAE 52.2 Particle Size Range 3 to 10 µm	1 to 3 µm	.3 to 1 µm	ASHRAE 52.1 Test Arrestance	Dust Spot	Particle Size Range, µm	Applications
1	< 20%	-	-	< 65%	< 20%	> 10	Residential, light, pollen, dust mites
2	< 20%	-	-	65 - 70%	< 20%		
3	< 20%	-	-	70 - 75%	< 20%		
4	< 20%	-	-	> 75%	< 20%		
5	20 - 35%	-	-	80 - 85%	< 20%	3.0 - 10	Industrial, Dust, Molds, Spores
6	35 - 50%	-	-	> 90%	< 20%		
7	50 - 70%	-	-	> 90%	20 - 25%		
8	> 70%	-	-	> 95%	25 - 30%		

ASHRAE Standards (1)

The new ASHRAE Standard 52.2 is a more descriptive test than ASHRAE Standard 52.1. Standard 52.2 quantifies filtration efficiency in different particle size ranges and is more applicable in determining a filter's effectiveness to capture a specific agent. Standard 52.2 reports the particle size efficiency results as a Minimum Efficiency Reporting Value (MERV) rating between 1 and 20. A higher MERV rating indicates a more efficient filter.

VISUAL VII-42

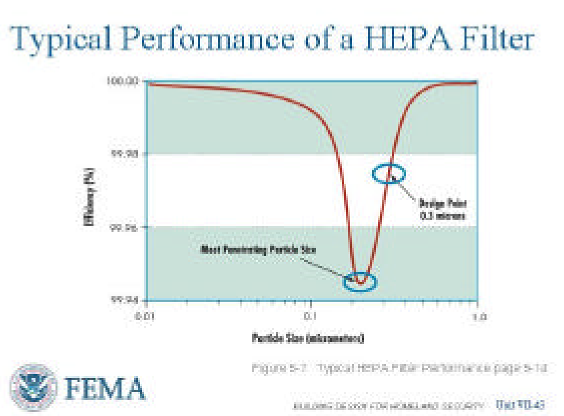


9	> 85%	< 50%	-	> 95%	40 - 45%	1.0 – 3.0	Industrial, Legionella, dust
10	> 85%	50 - 65%	-	> 95%	50 - 55%		
11	> 85%	65 - 80%	-	> 98%	60 - 65%		
12	> 90%	> 80%	-	> 98%	70 - 75%		
13	> 90%	> 90%	< 75%	> 98%	80 - 90%	0.3 – 1.0	Hospitals, Smoke removal, Bacteria
14	> 90%	> 90%	75 - 85%	> 98%	90 - 95%		
15	> 90%	> 90%	85 - 95%	> 98%	~95%		
16	> 95%	> 95%	> 95%	> 98%	> 95%		
17	-	-	≥ 99.97%	-	-	< 0.3	Clean rooms, Surgery, Chembio, Viruses
18	-	-	≥ 99.99%	-	-		
19	-	-	≥ 99.999%	-	-		
20	-	-	≥ 99.9999%	-	-		

ASHRAE Standards (2)

The standard provides a table (depicted on the slide) that shows minimum Particle Size Efficiency (PSE) for three size ranges for each of the MERV numbers 1 through 16. Thus, if the size of a contaminant is known, an appropriate filter with the desired PSE for that particular particle size can be identified.

VISUAL VII-43



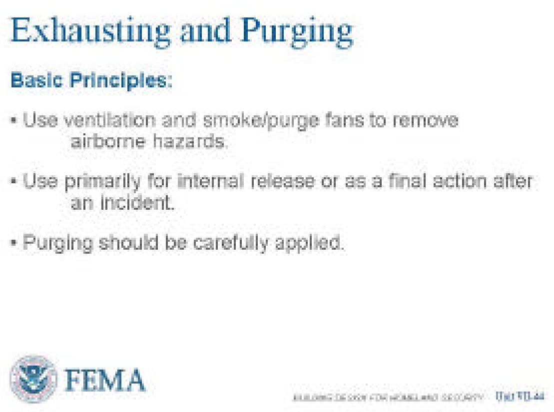
Typical Performance of a HEPA Filter

HEPA filters are typically rated as 99.97 percent effective in removing dust and particulate matter greater than 0.3 micron in size.

A typical HEPA performance curve is depicted on this slide. The dip between 0.1 and 0.3 microns represents the most penetrating particle size. Many bacteria and viruses fall into this size range. Fortunately, microbes in this range are also vulnerable to ultraviolet radiation. For this reason, many

INSTRUCTOR NOTES	CONTENT/ACTIVITY
	facilities couple particulate air filters with ultraviolet germicidal irradiation (UVGI). UVGI will be discussed on slide VII-49.

VISUAL VII-44



Note: Mention that a ventilation system and smoke purge fans can be used to purge the building after an external release after the hazard outdoors has dissipated, and it has been confirmed that the agent is no longer present near the building.

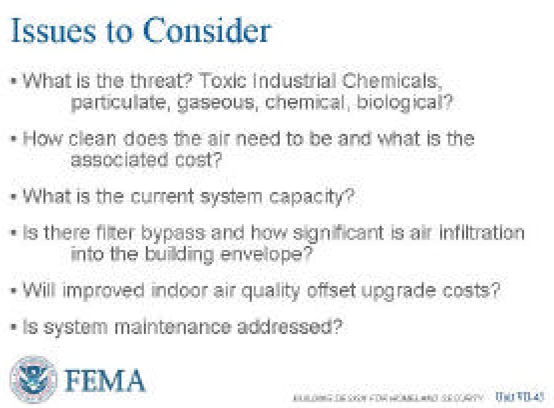
Exam Questions #A25 and B24

Exhausting and Purging

The fifth protective measure for CBR covered in FEMA 426 is **Exhausting and Purging.** Turning on a building's ventilation fans and smoke-purge fans is a protective action for purging airborne hazards from the building and reducing the hazard to which building occupants are exposed, but it is mainly useful when the source of the hazard is indoors.

- Purging must be carefully applied with regard to the location of the source and the time of the release. It must be clear that the source of the hazard is inside the building and, if not, purging should not be attempted.
- If the hazardous material has been identified before release or immediately upon release, purging should not be employed, because it may spread the hazardous material throughout the building or zone. In this case, all air handling units should be turned off to isolate the hazard while evacuating or temporarily sheltering in place. The indoor-outdoor air exchange rate can be increased by opening all windows and energizing all fans.

VISUAL VII-45



Issues to Consider

- What is the threat?
- How clean does the air need to be?
- What is the current system capacity?
- Is there filter bypass?
- Will improved indoor air quality offset upgrade costs?
- Is system maintenance addressed?

VISUAL VII-46

Economic Issues to Consider

In developing, implementing, and sustaining a program to reduce vulnerability to terrorist threats, there are economic issues to consider, including three categories of costs:

- Initial costs
- Operating costs
- Replacement costs

These need to be factored into protection strategies.

VISUAL VII-47

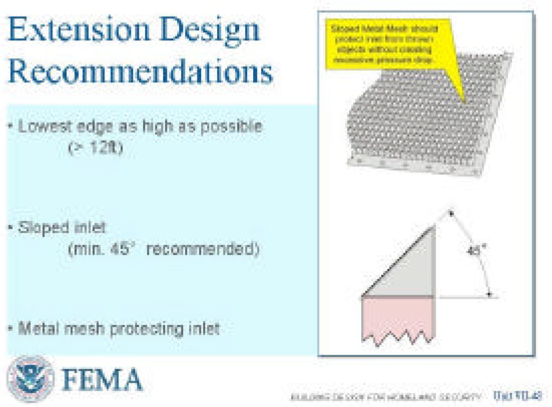
Access to Outdoor Intakes

- Several physical security measures can be applied to reduce the potential for hazardous materials entering a building through the HVAC system.
- One of the most important steps in protecting a building's indoor environment is the security of the outdoor air intakes. Outdoor air enters the building through these intakes and is distributed throughout the building by the HVAC system.
- If relocation of outdoor air intakes is not

feasible, intake extensions can be constructed without creating adverse effects on HVAC performance.

Note: The goal of this protective measure is to minimize public accessibility. In general, this means ***the higher the extensions, the bette***r—as long as other design constraints (excessive pressure loss, dynamic and static loads on structure) are appropriately considered.

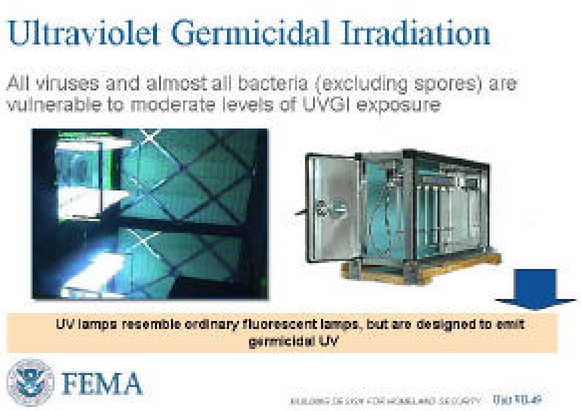
VISUAL VII-48



Extension Design Recommendations

An extension height of 12 feet will place the intake out of reach of individuals without some assistance. Also, the entrance to the intake should be covered with a sloped metal mesh to reduce the threat of objects being tossed into the intake. A minimum slope of 45° is generally adequate. Extension height should be increased where existing platforms or building features (i.e., loading docks, retaining walls) might provide access to the outdoor air intakes.

VISUAL VII-49



Ultraviolet Germicidal Irradiation (UVGI)

A design utilizing a combination of filtration and UVGI can be very effective against biological agents. Smaller microbes, which are difficult to filter out, tend to be more susceptible to UVGI, while larger microbes, such as spores, which are more resistant to UVGI, tend to be easier to filter out.

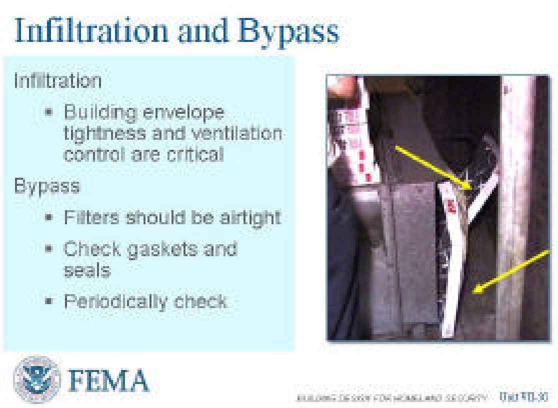
Note: UVGI has long been used in laboratories and health care facilities. Ultraviolet radiation in the range of 2,250-3,020 Angstroms is lethal to microorganisms. All viruses and almost all bacteria (excluding spores) are vulnerable to moderate levels of UVGI exposure. Spores, which are larger and more resistant to UVGI

INSTRUCTOR NOTES | **CONTENT/ACTIVITY**

than most bacteria, can be effectively removed through high efficiency air filtration.

Consequently, most UGVI systems are installed in conjunction with high efficiency filtration systems.

VISUAL VII-50



Note: Building envelopes in residential and commercial buildings are, in general, quite leaky, and significant quantities of air can infiltrate the building envelope with minimal filtration. Field studies have shown that, unless specific measures are taken to reduce infiltration, as much air may enter a building through infiltration as through the mechanical ventilation system.

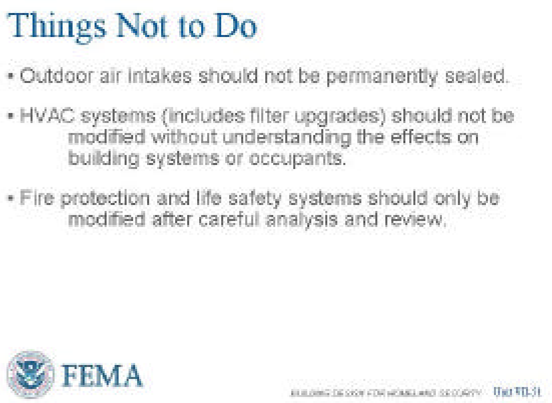
Infiltration and Bypass

Infiltration. Building managers *should not expect filtration alone to protect a building from outdoor releases*, particularly for systems in which no make-up air or inadequate overpressure is present. Filtration, in combination with other steps, such as building pressurization and tightening the building envelope, should be considered to increase the likelihood that the air entering the building actually passes through the filtration and air-cleaning systems.

Bypass. Filter bypass is a common problem found in many HVAC filtration systems. It occurs when air, rather than moving through the filter, goes around it, decreasing collection efficiency and defeating the intended purpose of the filtration system. Filter bypass is often caused by poorly fitting filters, poor sealing of filters in their framing systems, missing filter panels, or leaks and openings in the air handling unit downstream of the filter bank and upstream of the blower. Simply improving filter efficiency without addressing filter bypass provides little, if any, improvement to system efficiency. As a mechanical system loads with particulates over time, its collection efficiency increases, but so does the pressure drop.

INSTRUCTOR NOTES	CONTENT/ACTIVITY

VISUAL VII-51



Things Not to Do

More than anything else, building owners and managers should ensure that any actions they take do not have a detrimental effect on the building systems (HVAC, fire protection, life safety, etc.) or the building occupants under normal building operation. Some efforts to protect the building from a CBR attack could have adverse effects on the building's indoor environmental quality. Building owners and managers should understand how the building systems operate and assess the impact of security measures on those systems.

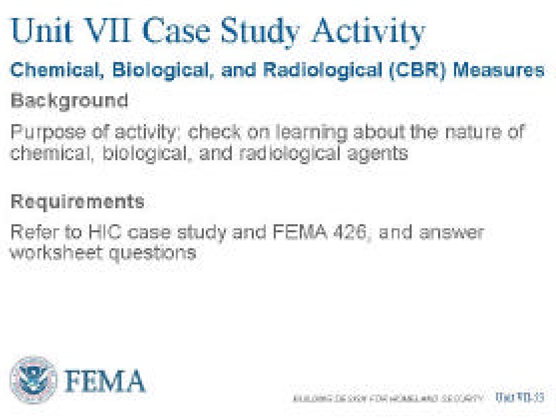
VISUAL VII-52

Summary

- CBR threats are real and growing.
- Industrial chemicals are readily available.
- Military chemicals require specialty expertise.
- Most buildings provide a reasonable level of protection.
- Inside versus outside building release determines evacuation decision.

INSTRUCTOR NOTES

VISUAL VII-53



Refer participants to FEMA 426 and the Unit VII Case Study activity in the Student Manual.

Members of the instructor staff should be available to answer questions and assist groups as needed.

At the end of 10 minutes, reconvene the class and facilitate group reporting.

1. Distribute the exam (Version A or B) and answer sheet. Ask the students to record their name and the date. Remind them that the test is an open book exam.
2. Allow 30 minutes for test completion, then collect the tests and answer sheets.
3. Score the tests.
4. Return the students' tests and answer sheets, and review the correct answers by calling on the students to give the answers. Encourage them to ask questions, and explain (as needed) why each answer is correct.

When finished, **collect the tests and answer sheets.**

CONTENT/ACTIVITY

Student Activity

This activity provides a check on learning about the nature of chemical, biological, and radiological agents.

Activity Requirements

Working in small groups, refer to the HIC Case Study and FEMA 426 to answer the worksheet questions.

Take 10 minutes to complete this activity. Solutions will be reviewed in plenary group.

Transition

This completes the information Units I through VII. A written exam will cover these units. Unit VIII will cover Building Design Guidance. Units VIII through XI will not have a written exam.

WRITTEN EXAM

Two versions of the written exam (with answer sheet) are provided in Appendix B of the Student Manual:

- Version A
- Version B

Use the provided Scoring Sheet.

Correct answers and their sources are listed on the Answer Keys, which follow.

UNIT VII CASE STUDY ACTIVITY:
CHEMICAL, BIOLOGICAL, AND RADIOLOGICAL (CBR) CONSIDERATIONS

The requirements in this Unit's activity are intended to provide a check on learning about the nature of chemical, biological, and radiological agents.

Requirement

1. Review the HIC Case Study and name the prevalent CBR threat(s) to the HIC.

   Chemical - fire and toxic fumes from an explosion at the petroleum tank farm, HazMat spills on the interstate or rail line

   Biological - Anthrax delivered by mail, smallpox by spray mechanism

   Radiological – "dirty" Bomb

Refer to **Table 5-1 on page 5-12 of FEMA 426** and answer the following questions:

2. What size filtration unit (MERV) is required to filter out 75 percent of Legionella and dust particulates (1 to 3 microns) inside the HIC? ***11***

3. What range of MERV is required to remove 85 percent of smoke particles greater than 0.3 micron in size? ***15***

4. What mitigation measure can be used in the HVAC systems to destroy bacteria and viruses? ***UVGI lamps***

Unit VIII

COURSE TITLE	Building Design for Homeland Security **TIME** 150 minutes
UNIT TITLE	Site and Layout Design Guidance
OBJECTIVES	1. Explain the concerns of land use as applied to threats and hazards due to terrorism and technological accidents 2. Identify site planning concerns that can create, reduce, or eliminate vulnerabilities and understand the concept of “Layers of Defense” 3. Compare the pros and cons of barrier mitigation measures that increase stand-off or create controlled access zones 4. Identify the positive and negative aspects of mitigation approaches for entry control and vehicle access, signage, parking, loading docks, lighting, and site utilities 5. Explain the basic concepts of Crime Prevention Through Environmental Design (CPTED) and its applicability to building security against terrorism 6. Apply these concepts to an existing site or building and identify mitigation measures needed to reduce vulnerabilities
SCOPE	The following topics will be covered in this unit: 1. Land use considerations both outside and inside the property line 2. Site planning issues to include site design, layout and form, vehicular and pedestrian circulation, and landscape and urban design 3. Creating stand-off distance using perimeter controls, non-exclusive zones, and exclusive zones along with the design concepts and technology to consider 4. Design considerations and mitigation measures for building security
REFERENCES	1. FEMA 426, *Reference Manual to Mitigate Potential Terrorist Attacks Against Buildings*, Chapter 2 2. Student Manual, Unit VIII 3. Case Study 4. Unit VIII visuals

REQUIREMENTS

1. FEMA 426, *Reference Manual to Mitigate Potential Terrorist Attacks Against Buildings* (one per student)
2. Instructor Guide
3. Student Manual (one per student)
4. Overhead projector or computer display unit
5. Unit VIII visuals
6. Chart paper, easel, and markers

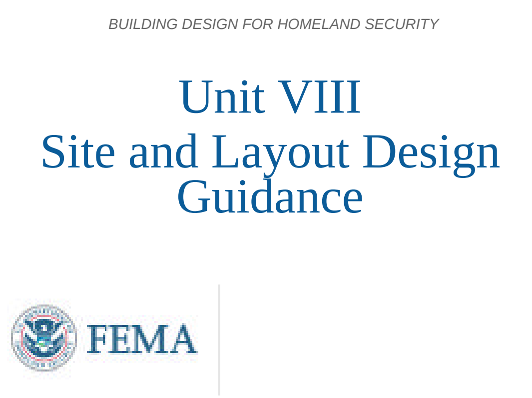
UNIT VIII OUTLINE

PREPARING TO TEACH THIS UNIT

- **Tailoring Content to the Local Area:** Review the Instructor Notes to identify topics that should focus on the local area. Plan how you will use the generic content, and prepare for a locally oriented discussion.
- **Optional Activity:** There are no optional activities in this unit.
- **Activity:** There is no student activity associated with this unit. However, information in this unit will be used during the student activities associated with Chapters 2 and 3.

INSTRUCTOR NOTES	CONTENT/ACTIVITY

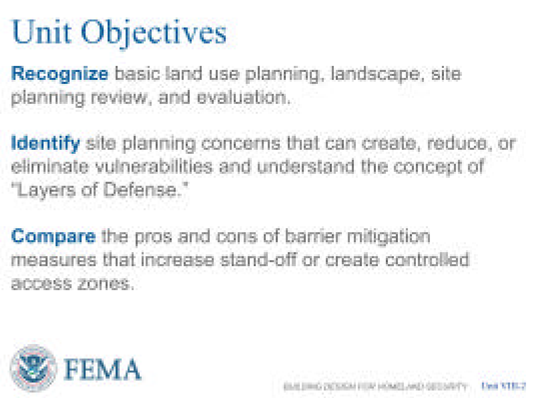
VISUAL VIII-1

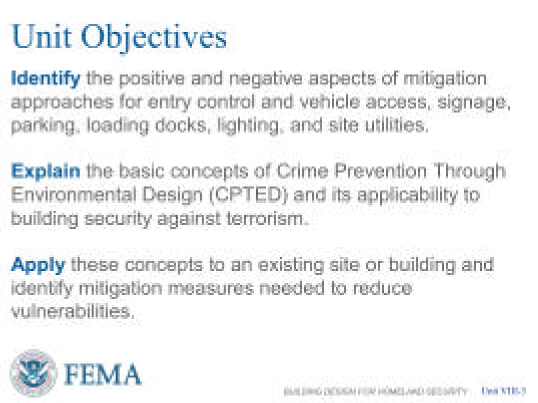


Introduction and Unit Overview

This is Unit VIII Site and Layout Design Guidance. This lecture will examine site level considerations and concepts for integrating land use planning, landscape, architecture, site planning, and other strategies to mitigate the design basis threats. The students will gain an understanding of the myriad options available to enhance site design taking into account many environmental challenges.

VISUAL VIII-2 and 3





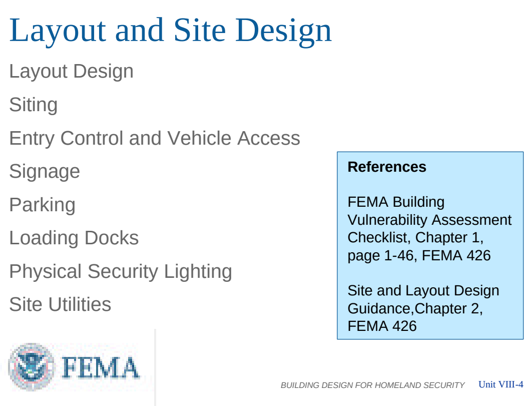
Unit Objectives

At the end of this unit, you should be able to:

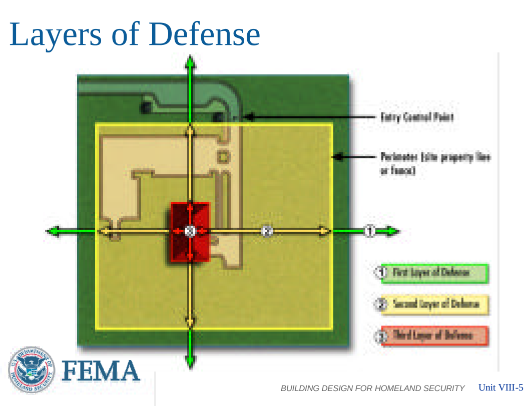
1. Explain the concerns of land use as applied to threats and hazards due to terrorism and technological accidents.
2. Identify site planning concerns that can create, reduce, or eliminate vulnerabilities and understand the concept of “Layers of Defense.”
3. Compare the pros and cons of barrier mitigation measures that increase stand-off or create controlled access zones.
4. Identify the positive and negative aspects of mitigation approaches for entry control and vehicle access, signage, parking, loading docks, lighting, and site utilities.
5. Explain the basic concepts of Crime Prevention Through Environmental Design (CPTED) and its applicability to building security against terrorism.
6. Apply these concepts to an existing site or building and identify mitigation measures needed to reduce vulnerabilities.

INSTRUCTOR NOTES

VISUAL VIII-4



VISUAL VIII-5



Note: Layers of Defense will be used through out the course and in Unit X Electronic Security Systems and illustrate the elements:

- Deter
- Detect
- Deny
- Devalue

Instructors may want to relate to a castle.

CONTENT/ACTIVITY

Site and Layout Design

- Layout Design
- Siting
- Entry Control/Vehicle Access
- Signage
- Parking
- Loading Docks
- Physical Security Lighting
- Site Utilities

Layers of Defense

- First layer starts at the site perimeter and outward
- Second layers between the site perimeter and building
- Third layer is building and interior

It is important to remember that the nature of any threat is always changing. Although indications of potential threats may be scarce during the design stage, consideration should be given to accommodating enhanced protection measures in response to future threats that may emerge. Asset protection must be balanced with other design objectives, such as the efficient use of land and resources, and must also take into account existing physical, programmatic, and fiscal constraints.

INSTRUCTOR NOTES | **CONTENT/ACTIVITY**

VISUAL VIII-6

Identify Adjacent Hazards

First Layer of Defense

Note the large fuel storage and distribution facility in the vicinity of the office building being assessed.

Figure 2-1: Example of Using GIS to Identify Adjacent Hazards, page 2-5

FEMA

BUILDING DESIGN FOR HOMELAND SECURITY Unit VIII-6

Identify Adjacent Hazards

The designer should study the surrounding areas to identify particular threats/hazards. For this purpose, GIS is an excellent resource. Using GIS applications enable designers and building owners to analyze various demographic, hazardous areas, transportation networks, access control points, etc. These applications may depict a true picture of the surrounding threats, allowing decision-makers to take proactive measurements to mitigate potential vulnerabilities.

VISUAL VIII-7

Layout Design

First Layer of Defense

FEMA

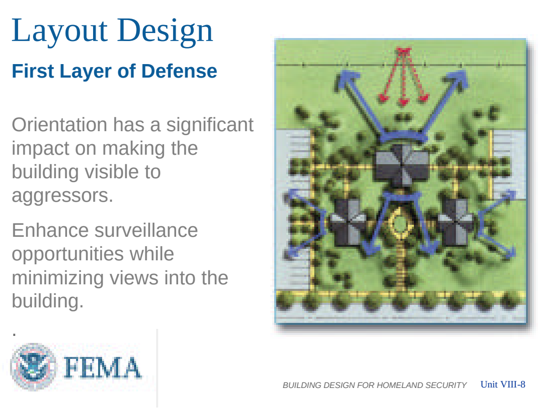
BUILDING DESIGN FOR HOMELAND SECURITY Unit VIII-7

Layout Design

Depending on the site characteristics, the occupancy requirements, and other factors, buildings may be clustered tightly in one area, or dispersed across the site. Both patterns have compelling strengths and weaknesses.

Concentrating people, property, and operations in one place creates a target-rich environment, and the mere proximity of any one building to any other may increase the risk of collateral impacts. Additionally, the potential exists for the establishment of more single-point vulnerabilities in a clustered design than would exist in a more dispersed pattern. However, grouping high risk activities, concentrations of personnel, and critical functions into a cluster can help maximize stand-off from the perimeter and create a “defensible space.”

VISUAL VIII-8



Layout Design

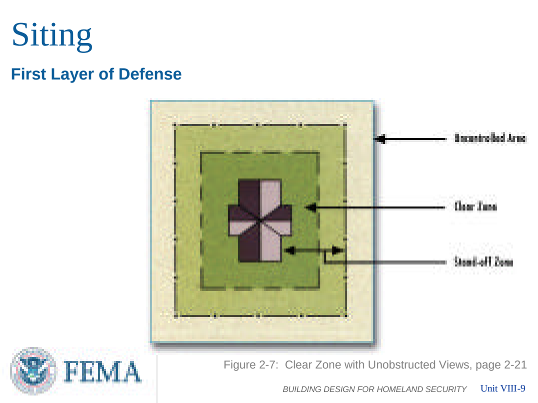
Orientation is the building's spatial relationship to the site, its orientation relative to the sun, and its vertical or horizontal aspect relative to the ground.

The physical positioning of a building relative to its surroundings may seem subtle, but can be a greater determinant of security.

Good site design, orientation and building placement should allow building occupants to look out of the facility while minimizing views into the building.

The proximity of a vulnerable façade to a parking area, street, adjacent site, or other area that is accessible to vehicles and/or difficult to observe can greatly contribute to its vulnerability.

VISUAL VIII-9



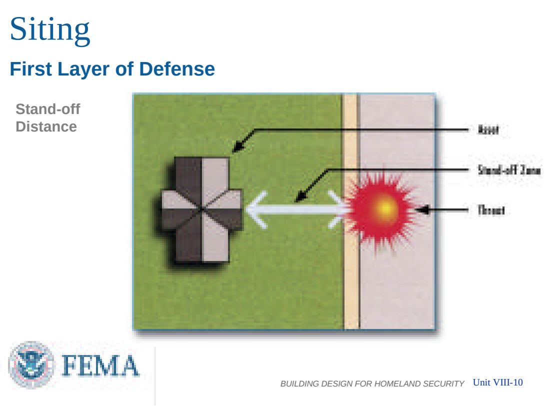
Siting

For high risk buildings, it may be necessary to provide additional protection by creating a clear zone immediately adjacent to the structure that is free of all visual obstructions or landscaping. The clear zone facilitates monitoring of the immediate vicinity and visual detection of attacks. Walkways and other circulation features within a clear zone should be located so that buildings do not block views of pedestrians and vehicles. If clear zones are implemented, it may be necessary to implement other anti-surveillance measures.

A **clear zone** facilitates monitoring of the immediate vicinity and visual detection of attacks.

Walkways and other circulation features within a clear zone should located so that buildings do not block view of pedestrians and vehicles.

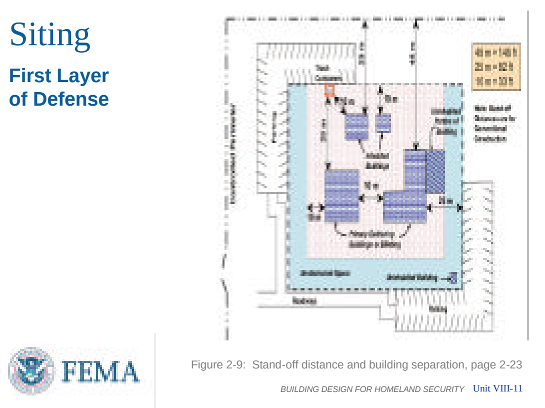
VISUAL VIII-10



Stand-off Distance

The distance between an asset and a threat is referred to as the stand-off distance, as shown in Visual VIII-10. There is no ideal stand-off distance; it is determined by the type of threat, the type of construction, and desired level of protection. The primary design strategy is to keep terrorists away from inhabited buildings. Although sufficient stand-off distance is not always possible in conventional construction, maximizing the distance may be the most cost-effective solution. Maximizing stand-off distance also ensures that there is opportunity in the future to upgrade buildings to meet increased threats or to accommodate higher levels of protection.

VISUAL VIII-11



Siting

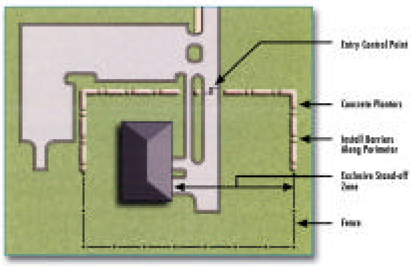
Controlled access zones may be exclusive or non-exclusive. An exclusive zone is the area surrounding a building within the exclusive control of the building. Anyone entering an exclusive zone must have a purpose related to the building. A non-exclusive zone is either a public right-of-way or an area related to several buildings. Someone entering a non-exclusive zone could be headed for any building within that area. Public access areas outside a downtown building would typically be considered non-exclusive.

INSTRUCTOR NOTES | **CONTENT/ACTIVITY**

VISUAL VIII-12

Siting

First Layer of Defense



FEMA

BUILDING DESIGN FOR HOMELAND SECURITY Unit VIII-12

Siting

A number of elements may be used to create a physical barrier, some natural and some manmade. Natural barrier elements include rivers, lakes, waterways, steep terrain, mountains, barren areas, plants, and other terrain features that are difficult to traverse. Manmade elements include fencing, walls, buildings, bollards, planters, concrete barriers, and fountains. Selection of elements must consider the level of security desired and the type of threat most likely to occur.

VISUAL VIII-13

Entry Control/Vehicular Access

Prevent unauthorized access

- Avoid traffic queuing
- Rejection routes
- Search area out of traffic flow

Traffic calming

- Avoid high speed approaches
- Commercial vehicle gate

FEMA

BUILDING DESIGN FOR HOMELAND SECURITY Unit VIII-13

Entry Control/Vehicular Access

Entry control and vehicular access should:

- Prevent unauthorized access
- Provide for traffic calming
- Have commercial vehicle gates if possible
- Have equal capacity for exit

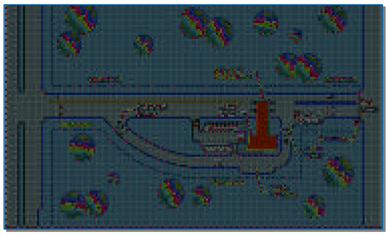
Existing streets can be retrofitted with barriers, bollards, swing gates, or other measures to force vehicles to travel in a serpentine path. Again, high curbs and other measures should be installed to keep vehicles from departing the roadway in an effort to avoid these countermeasures. Less radical than these techniques are traffic calming strategies, which seek to use design measures to cue drivers as to the acceptable speed for an area. These include raised crosswalks, speed humps and speed tables, pavement treatments, build outs, and traffic circles.

INSTRUCTOR NOTES	CONTENT/ACTIVITY

VISUAL VIII-14

Entry Control/Vehicular Access and Roadway Design

First Layer of Defense



FEMA

BUILDING DESIGN FOR HOMELAND SECURITY Unit VIII-14

Entry Control/Vehicular Access and Roadway Design

The design of entry control and access points for vehicular and pedestrian circulation patterns can impact security.

An entry-control point or guard building serves well as the designated point of entry for site access. It provides a point for implementation of desired/required levels of screening and access control. The objective of the entry control point is to prevent unauthorized access while maximizing the rate of authorized access by foot or vehicle.

Location selection for vehicular access and entry control for a building starts with an evaluation of the anticipated demand for access to the controlled site. An analysis of traffic origin and destination, and an analysis of the capability of the surrounding connecting road network, including its capacity to handle additional traffic, should then be performed. Expansion capacity should also be considered. The analysis should be coordinated with the state and local departments of transportation. The existing terrain can have a significant impact on the suitability of a potential entry control point site. Flat terrain with no thick vegetation is generally preferred. A gentle rise in elevation up to the entry control guard building allows for a clear view of arriving vehicles. Consider how existing natural features such as bodies of water or dense tree stands may enhance perimeter security and vehicle containment. Entry control spatial requirements vary, depending on the type, the traffic demand, and the necessary security measures.

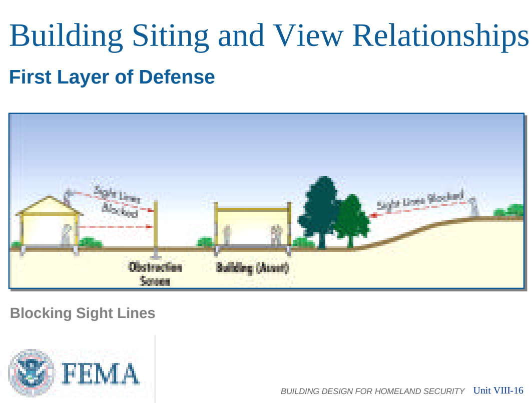
Roadway network design that uses straight-line approaches to buildings may give approaching vehicles the opportunity gather the necessary speed to ram protective barriers and crash into buildings. Possible solution: design approaches to be parallel to the façade, with berms, high curbs, trees, and other measures used to prevent vehicles from departing the roadway.

VISUAL VIII-15

Site Access and Entry Control

Robust vehicle inspection points can be used to inspect vehicles. The covered top provides protection from inclement weather.

VISUAL VIII-16



Building Siting and View Relationships

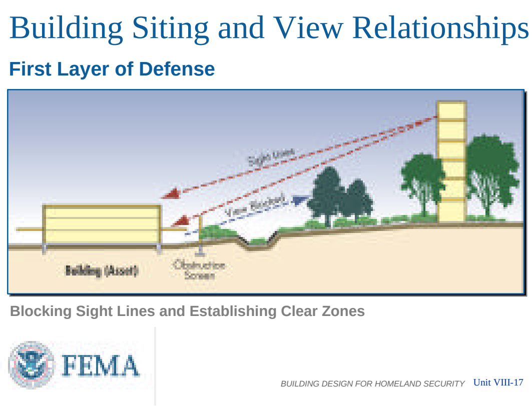
Landscape and urban design inherently define the "line of sight" in a space. Operational security is not a traditional element of master planning, but managing the threat of hostile surveillance is a significant consideration in protecting people, property, and operations. With careful selection, placement, and maintenance, landscape elements can provide visual screening that protects sensitive operations, gathering areas, and other activities from surveillance without creating concealment for covert activity.

These techniques seek to deny aggressors a "line of sight" to a potential target, either from on or off site. This increases the protection of sensitive information and operations by using stand-off weapons. In addition to the use of various screening options, anti-surveillance measures (e.g., building orientation, landscaping, screening, and landforms) can

INSTRUCTOR NOTES	CONTENT/ACTIVITY

also be used to block sight lines.

VISUAL VIII-17

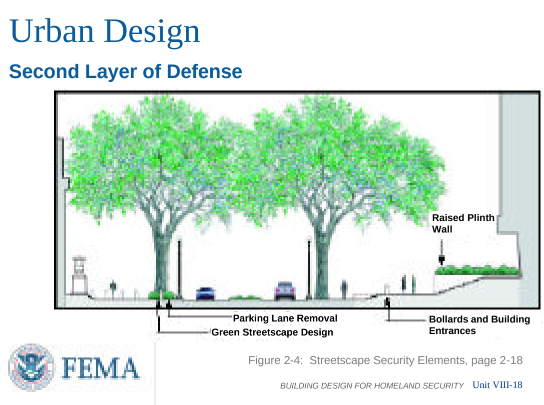


Building Siting and View Relationships

Landforms can have a direct bearing on the security of a facility. They can be either beneficial (e.g., an elevated site that may enhance the surveillance of the surrounding area), or detrimental to anti-surveillance. Generally speaking:

- For security purposes, buildings should not be sited immediately adjacent to higher surrounding terrain.

VISUAL VIII-18



Given that the energy transferred when one object strikes another is a function of its mass and its velocity, a bollard that can stop a 15,000-pound truck moving at 35 miles per hour may not be able to stop the same truck moving at 55 miles per hour. In developing a system of street alignments with protection in mind, the designer cannot determine the size or weight of a vehicle that will travel along the road, because that is a management decision. However, the designer can propose a roadway system to minimize vehicle velocity, thus using the roadway itself as a protective measure.

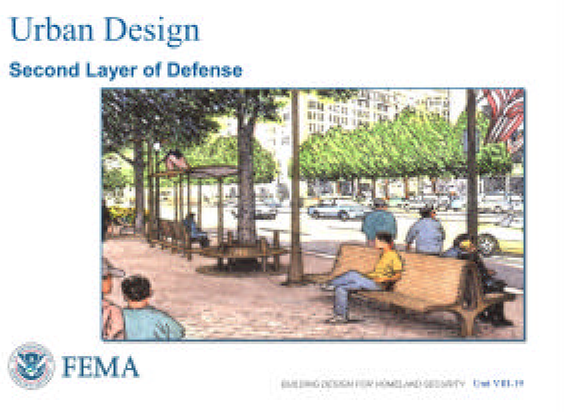
Urban Design (1)

Streets in urban areas can minimize travel time and at the same time maximize safety. Although a straight line may be the most efficient course, designers should use caution when orienting streets relative to buildings.

Most urban building lines are located within 50 feet of the street curb. The street can become the second layer of defense and provide stand-off distance through the use of terrain, curvature, and streetscape furniture to prevent vehicles from approaching the building.

INSTRUCTOR NOTES | **CONTENT/ACTIVITY**

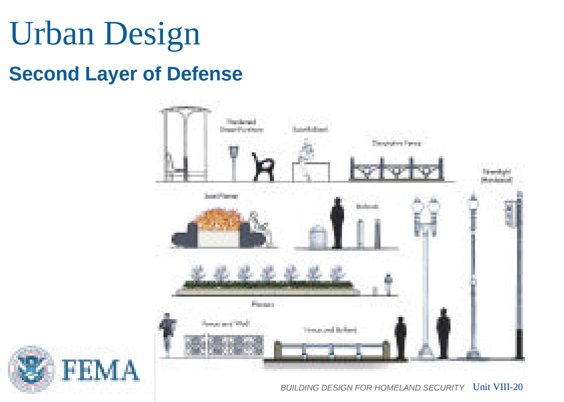
VISUAL VIII-19



Urban Design (2)

Numerous urban design elements present opportunities to provide security. The scale of the streetscape should be appropriate to its primary users, and it can be manipulated to increase the comfort level of desired users while creating a less inviting atmosphere for users with malicious intent. However, even at the pedestrian scale, certain operational requirements must be accommodated. For example, although efficient pedestrian and vehicle circulation systems are important for day-to-day living, they are also critical for emergency response, evacuation, and egress. Furthermore, despite an emphasis on downsizing the scale of the streetscape, it is critical to maintain the maximum stand-off distance possible between vehicles and structures.

VISUAL VIII-20

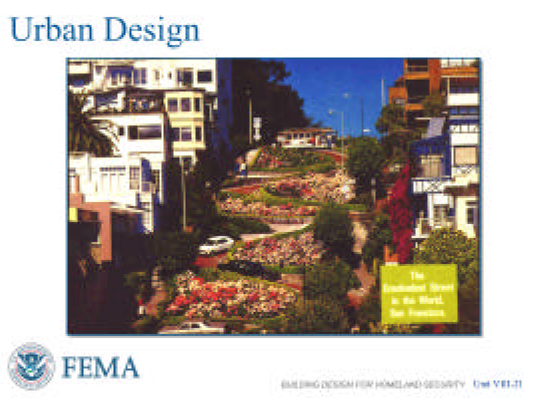


Urban Design (3)

- Street furniture can be used to deter potential damage to buildings.
- It is critical to maintain the maximum stand-off distance possible between vehicles and structures.
- At the site perimeter, walls and fences used for space definition may be hardened to resist the impact of a weapon-laden truck; however, planters, bollards, or decorative boulders could accomplish the same objective in a much more aesthetically pleasing manner.

INSTRUCTOR NOTES | **CONTENT/ACTIVITY**

VISUAL VIII-21



Urban Design (4)

Existing streets can be retrofitted with barriers, bollards, swing gates, or other measures to force vehicles to travel in a serpentine path. Again, high curbs and other measures should be installed to keep vehicles from departing the roadway in an effort to avoid these countermeasures.

VISUAL VIII-22

Explain the advantages of blocking the site of critical assets.

Discuss the advantages of the placement of bollards and raised walls.

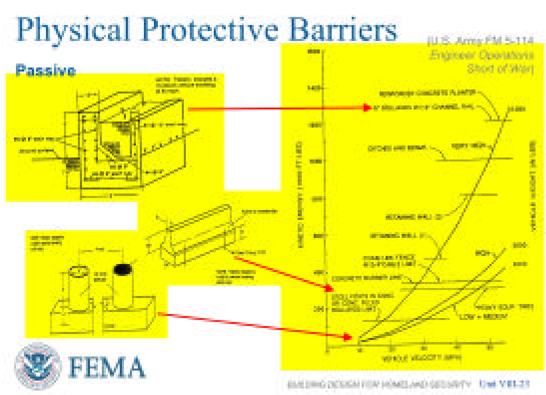
Bollard Applications

Concrete bollards are excellent barriers that can prevent high speed approaches.

These are examples of bollard placement. When placing bollards, make sure you adhere to ADA compliance. Bollards can be appealing streetscapes, depending on the current environment where they are installed.

INSTRUCTOR NOTES | **CONTENT/ACTIVITY**

VISUAL VIII-23



Discuss the vehicle speed and the damage caused by velocity.

Physical Protective Barriers

Passive physical protective barriers can be used in parking lots, garages, next to buildings, and to create separate security zones.

There are three primary types of parking facilities, all of which present security trade-offs.

Surface lots can be designed to keep vehicles away from buildings, but they consume large amounts of land and, if constructed of impervious materials, can contribute greatly to stormwater runoff volume. They can also be hazardous for pedestrians if dedicated pedestrian pathways are not provided.

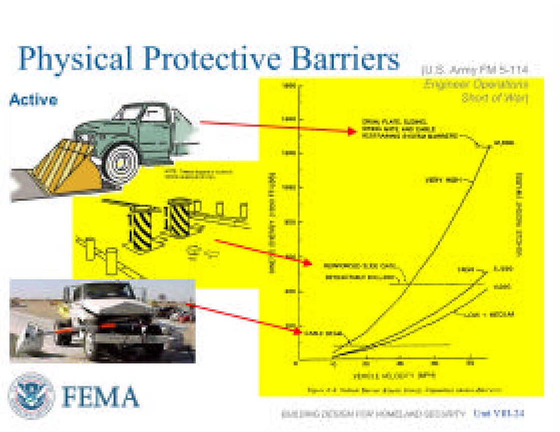
In contrast, non-street parking is often convenient for users and a source of revenue for local governments, but this type of parking may provide little or no setback.

Finally, garage structures provide revenue and can be convenient for users, but they may require structural measures to ensure blast resistance as well as crime prevention measures to prevent street crime.

Although the cost of land suggests that the construction of a garage below a building (either underground or aboveground) may be the most economically viable approach for many developments, they can be highly vulnerable to vehicle-borne weapons, endangering the building above If garages must be used, human security procedures (e.g., vehicle searches) and electronic systems (e.g., closed circuit television) may be necessary.

INSTRUCTOR NOTES | **CONTENT/ACTIVITY**

VISUAL VIII-24



Physical Protective Barriers

An active vehicle barrier is designed using the expected vehicle mass and velocity.

VISUAL VIII-25

Passive Vehicle Barrier Application

A passive vehicle barrier can absorb a significant force and either stop or deflect the vehicle.

VISUAL VIII-26

Active Vehicle Barrier

An active barrier can be activated in seconds and is capable of stopping large vehicles.

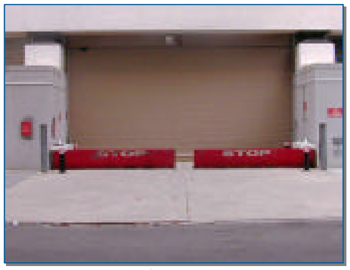
Pop-up barriers can create serious damage to vehicles. These are some examples.

Explain the vehicle impact damage in relation to high speed approaches. Greater force equals greater damage.

INSTRUCTOR NOTES | **CONTENT/ACTIVITY**

VISUAL VIII-27

Active Vehicle Barrier Application



World Bank
Washington, DC

FEMA

BUILDING DESIGN FOR HOMELAND SECURITY Unit VIII-27

Active Vehicle Barrier Application

An example of active barriers is this one at the World Bank. The barriers stay in the down position during normal conditions, but are manned and deployed to the up position at higher threat levels.

This is a typical **pop-up** barrier that is electronically controlled.

VISUAL VIII-28

Temporary Active Vehicle Barriers

FEMA

BUILDING DESIGN FOR HOMELAND SECURITY Unit VIII-28

Temporary Active Vehicle Barriers

There are several temporary active vehicle barriers that can be rapidly deployed and moved into position to control site and parking access, control traffic flow, and provide stand-off distance for buildings.

VISUAL VIII-29

Signage

Additional information

Place warning signs where required by law to enforce restricted areas

Variable message signs

Demarcate controlled perimeter and jurisdiction

Limit

FEMA

BUILDING DESIGN FOR HOMELAND SECURITY Unit VIII-29

Signage

Unless required, signs should **not** identify sensitive areas. A comprehensive signage plan should be tailored to the mission of the facility accompanying the FEMA 426 guidelines.

Minimize signs identifying critical utility complexes such as power plants and water treatment plants.

Warning signs must use both languages in areas where two or more languages are commonly spoken. The wording on the signs

INSTRUCTOR NOTES	CONTENT/ACTIVITY

should denote warning of a restricted area.

Signs should be posted at intervals of no more than 100 feet and should not be mounted on fences equipped with intrusion-detection equipment.

Warning signs should be posted at all entrances to limited, controlled, and exclusion areas. Locate variable message signs, which give information on site/organization special events and visitors, far inside site perimeters.

VISUAL VIII-30

Parking

Maintain stand-off distance

Restrict parking and access between buildings

Consider one-way circulation in parking lots

Locate parking within view of occupied buildings

Restrict parking underneath buildings

Well-lit, with security presence, emergency communications, and/or CCTV

Apply progressive collapse hardening to columns when parking garage is in the building

FEMA

BUILDING DESIGN FOR HOMELAND SECURITY Unit VIII-30

Parking (1)

- Maintain stand-off distance
- Restrict parking and access
- Consider one-way circulation
- Locate within view of occupied buildings
- Restrict parking underneath buildings
- Keep parking areas well lit
- Apply progressive collapse hardening to high risk structures

VISUAL VIII-31

Parking

FEMA

Note the physical barriers that are in place to prevent vehicles entering underground parking areas.

Parking (2)

- Avoid having driveways or parking within or under buildings. Significant structural damage to the walls and ceiling of the loading dock may be acceptable; however, the areas adjacent to the loading dock should not experience severe structural damage or collapse.

- Provide signage to clearly mark separate entrances for deliveries.

- Visitor screening areas, receiving and loading areas, and mailrooms constitute the innermost line of defense, because they may be the first places where people and materials are closely inspected before being introduced into the facility.

VISUAL VIII-32

Loading Docks/Service Access

Ensure separation from critical systems and utility service entrances.

Avoid driving trucks into or under building.

Provide clear signage.

Large truck carrying large bomb could go relatively unnoticed unless access control performed a significant distance from loading dock.

FEMA BUILDING DESIGN FOR HOMELAND SECURITY Unit VIII-32

Loading Docks and Service Access

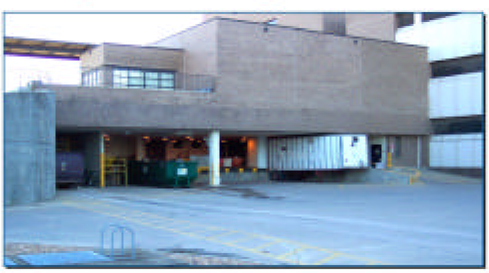
Loading docks and service access areas are commonly required for a building and are typically desired to be kept as invisible as possible. For this reason, special attention should be devoted to avoid undesirable intruders. Design criteria for loading docks and service access include the following:

Separate (by at least 50 feet) loading docks and shipping and receiving areas in any direction from utility rooms, utility mains, and service entrances, including electrical, telephone/data, fire detection/alarm systems, fire suppression water mains, cooling and heating mains, etc.

Loading docks are sometimes located near critical assets just inside the building and a blast effect would be detrimental to the entire building and could result in a progressive collapse.

VISUAL VIII-33

Loading Dock Example



FEMA

Loading Dock Example

Locate loading docks so that vehicles will not be allowed under the building. If this is not possible, the service should be hardened for blast. Loading dock design should limit damage to adjacent areas and vent explosive forces to the exterior of the building.

If loading zones or drive-through areas are necessary, monitor them and restrict height to keep out large vehicles.

Discuss the other vulnerability pictured here. The trash dumpster should be relocated away from the building. Explosive devices can be tossed in the dumpster creating a blast effect.

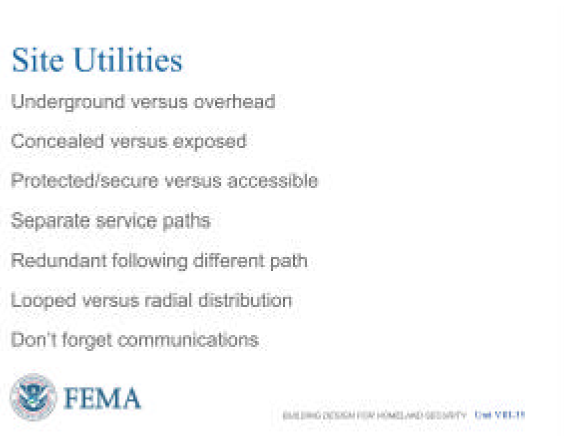
INSTRUCTOR NOTES | **CONTENT/ACTIVITY**

VISUAL VIII-34

Physical Security Lighting

Security lighting should be provided for overall site and building illumination and the perimeter to allow security personnel to maintain visual assessment during darkness. Lighting is desirable around areas such as piers, fence lines, dock, storage areas, and parking lots. At entry points, a minimum surface lighting average of 4 horizontal foot candles will help ensure adequate lighting is recommended.

VISUAL VIII-35



VISUAL VIII-36

Site Utilities (1)

Utility systems can suffer significant damage when subjected to the shock of an explosion. Some of these utilities may be critical for safely evacuating people from the building. Their destruction could cause damage that is disproportionate to other building damage resulting from an explosion.

These are examples of protected utilities; however, some property has exposed natural water and gas lines that can easily be tampered with. A thorough walk-through of the site property should be conducted and proper protection devices should be applied to exposed utilities.

VISUAL VIII-37

Site Utilities (2)

The U.S. utility infrastructure is highly concentrated, utilizing the same rights-of-way, tunnels, underground conduits, and other service points. Examine where the utilities intersect (manholes, poles, city blocks, etc.) to find critical nodes.

Install fencing and if possible, remote monitoring capability at key electrical substations, pumping plants, and communications vaults.

VISUAL VIII-38

Compare and contrast the CPTED principal of single-point visitor control versus the location and placement of parking structures next to buildings.

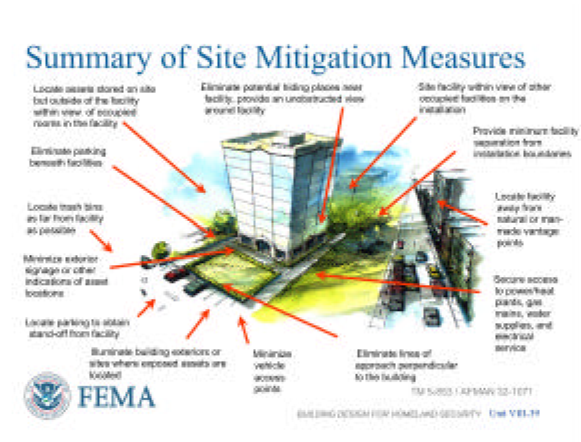
CPTED

The application of CPTED principles starts with a threat and vulnerability analysis to determine the potential for attack and what needs to be protected. Protecting a building from physical attack by criminal behavior or terrorist activity, in many cases, only reflects a change in the level and types of threats.

The CPTED process provides direction to solve the challenges of crime and terrorism with organizational (people), mechanical (technology and hardware), and natural design (architecture and circulation flow) methods.

INSTRUCTOR NOTES | **CONTENT/ACTIVITY**

VISUAL VIII-39



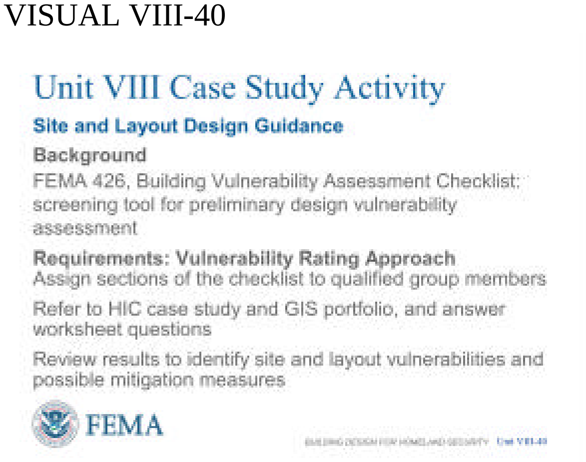
Page 2-52 of FEMA 426 provides a comprehensive list of security/protection measures that can be taken – increasing in *protection, cost, and level of effort* – that complements this graphic on Site Mitigation Measures.

Summary

To summarize:

- A broad spectrum of mitigation actions can be taken – with a wide range of cost, protection provided, and level of effort required by the asset owner.
- This nominal ranking of mitigation measures provides a framework for the identification of short-term and long-term measures that can be taken.

VISUAL VIII-40



Refer participants to FEMA 426, the Unit VIII Case Study activity in the Student Manual, and the GIS portfolio.

Members of the instructor staff should be available to answer questions and assist groups as needed.

Student Activity

The **Building Vulnerability Assessment Checklist in FEMA 426** can be used as a screening tool for preliminary design vulnerability assessment. The checklist includes questions that determine if critical systems will continue to function to enhance deterrence, detection, denial, and damage limitation, and if emergency systems will function during a threat or hazard situation.

Activity Requirements

- Continue working in small groups.
- Assign sections of the checklist to the group member who is most knowledgeable and qualified to perform an assessment of the assigned area.
- Refer to the HIC Case Study and to the GIS portfolio to determine answers to the worksheet questions.

INSTRUCTOR NOTES	CONTENT/ACTIVITY
At the end of 45 minutes, reconvene the class and facilitate group reporting.	• Then review results to identify vulnerabilities and possible mitigation measures. Take 45 minutes to complete this activity. Solutions will be reviewed in plenary group. **Transition** Unit IX will cover Building Design Guidance.

UNIT VIII CASE STUDY ACTIVITY:
SITE AND LAYOUT DESIGN GUIDANCE

The **Building Vulnerability Assessment Checklist in FEMA 426** can be used as a screening tool for preliminary design vulnerability assessment. The checklist includes questions that determine if critical systems will continue to function to enhance deterrence, detection, denial, and damage limitation, and emergency systems function during a threat or hazard situation.

Requirement

Assign sections of the checklist to the group member who is most knowledgeable and qualified to perform an assessment of the assigned area. Refer to the HIC Case Study and to the GIS portfolio to determine answers to the questions. Then review results to identify vulnerabilities and possible mitigation measures.

1. Complete the following components of the Building Vulnerability Assessment Checklist, which address site and layout.

2. Upon completion of these portions of the checklist, refer back to the site risk rating determined in Unit V Case Study Activity and, based on this detailed analysis, decide if the rating is accurate.

3. Select mitigation measures to reduce vulnerability and associated risk from the site and layout perspective.

4. Estimate the new risk ratings for high risk asset-threat pairs based on the recommended mitigation measures.

Section	Vulnerability Questions	Guidance	Observations
1.1	What major structures surround the facility (site or building(s))? What critical infrastructure, government, military, or recreation facilities are in the local area that impact transportation, utilities, and collateral damage (attack at this facility impacting the other major structures or	**Critical infrastructure to consider includes:** **Telecommunications infrastructure** Facilities for broadcast TV, cable TV; cellular networks; newspaper offices, production, and distribution; radio stations; satellite base stations; telephone trunking and switching stations, including critical cable routes and major rights-of-way **Electric power systems** Power plants, especially nuclear facilities; transmission and distribution system components; fuel distribution, delivery, and	There are two Critical Hazard Facilities within 2 miles of the HIC Headquarters, one to the north and the other to the southwest. In addition, there are more than a dozen Tier II HAZMAT Facilities within 3 miles of the building (in all directions). A major interstate highway is located within ¼ mile of the HIC Headquarters. CSX Transportation and Norfolk-Southern Railway

Section	Vulnerability Questions	Guidance	Observations
	attack on the major structures impacting this facility)?	storage **Gas and oil facilities** Hazardous material facilities, oil/gas pipelines, and storage facilities **Banking and finance institutions** Financial institutions (banks, credit unions) and the business district; note schedule business/financial district may follow; armored car services **Transportation networks** Airports: carriers, flight paths, and airport layout; location of air traffic control towers, runways, passenger terminals, and parking areas Bus Stations: Pipelines: oil; gas Trains/Subways: rails and lines, railheads/rail yards, interchanges, tunnels, and cargo/passenger terminals; note hazardous material transported Traffic: interstate highways/roads/tunnels/ bridges carrying large volumes; points of congestion; note time of day and day of week Trucking: hazardous materials cargo loading/unloading facilities; truck terminals, weigh stations, and rest areas Waterways: dams; levees; berths and ports for cruise ships, ferries, roll-on/roll-off cargo vessels, and container ships; international (foreign) flagged vessels (and cargo) **Water supply systems** Pipelines and process/treatment facilities, dams for water collection; wastewater treatment **Government services** Federal/state/local government offices – post offices, law enforcement stations, fire/rescue, town/city hall, local mayor's/governor's residences, judicial offices and courts, military installations (include type-active, Reserves, National	maintain a transportation corridor about ½ mile from HIC. There appear to be no restrictions on the material carried along these rail lines. A leg of the Piedmont Petroleum Pipeline (PPP) runs underneath the office park in the vicinity of HIC Headquarters. Part of Piedmont's regional network, this portion of the pipeline normally carries a variety of refined products, including commercial and military jet fuels, diesel and three grades of gasoline, home heating fuels, etc. Four buried pipes carry approximately 20 million gallons per day. Connected to the pipeline, less than 1 mile from HIC, is a 20-million gallon capacity fuel farm. Operated by the Shellexxico Company, this tank farm stores a variety of petroleum products, primarily gasoline. Two airports are in the vicinity of HIC. One is a major international airport approximately 8 miles away. The other is a small, but busy general aviation airport approximately 2 miles away.

Section	Vulnerability Questions	Guidance	Observations
		Guard) **Emergency services** Backup facilities, communications centers, Emergency Operations Centers (EOCs), fire/Emergency Medical Service (EMS) facilities, Emergency Medical Centers (EMCs), law enforcement facilities **The following are not critical infrastructure, but have collateral damage potential to consider:** **Agricultural facilities**: chemical distribution, storage, and application sites; crop spraying services; farms and ranches; food processing, storage, and distribution facilities **Commercial/manufacturing/industrial facilities:** apartment buildings; business/corporate centers; chemical plants (especially those with Section 302 Extremely Hazardous Substances); factories; fuel production, distribution, and storage facilities; hotels and convention centers; industrial plants; raw material production, distribution, and storage facilities; research facilities and laboratories; shipping, warehousing, transfer, and logistical centers **Events and attractions**: festivals and celebrations; open-air markets; parades; rallies, demonstrations, and marches; religious services; scenic tours; theme parks **Health care system components**: family planning clinics; health department offices; hospitals; radiological material and medical waste transportation, storage, and disposal; research facilities and laboratories, walk-in clinics **Political or symbolically significant sites**: embassies, consulates, landmarks, monuments, political party and	

Section	Vulnerability Questions	Guidance	Observations
		special interest groups offices, religious sites **Public/private institutions**: academic institutions, cultural centers, libraries, museums, research facilities and laboratories, schools **Recreation facilities**: auditoriums, casinos, concert halls and pavilions, parks, restaurants and clubs (frequented by potential target populations), sports arenas, stadiums, theaters, malls, and special interest group facilities; note congestion date and times for shopping centers References: *FEMA 386-7*, *FEMA SLG 101*, *DOJ NCJ181200*	
1.2	Does the terrain place the building in a depression or low area?	Depressions or low areas can trap heavy vapors, inhibit natural decontamination by prevailing winds, and reduce the effectiveness of in-place sheltering. Reference: *USAF Installation Force Protection Guide*	The site is above the tank farm and the rear parking area slopes away from the building to a stream, which allows winds to pass over the structure unhindered.
1.3	In dense, urban areas, does curb lane parking place uncontrolled parked vehicles unacceptably close to a building in public rights-of-way?	Where distance from the building to the nearest curb provides insufficient setback, restrict parking in the curb lane. For typical city streets, this may require negotiating to close the curb lane. Setback is common terminology for the distance between a building and its associated roadway or parking. It is analogous to stand-off between a vehicle bomb and the building. The benefit per foot of increased stand-off between a potential vehicle bomb and a building is very high when close to a building and decreases rapidly as the distance increases. Note that the July 1, 1994, Americans with Disabilities Act Standards for Accessible Design states that required handicapped parking shall be located on the shortest accessible route of travel from adjacent parking to an accessible	With a loading dock on the west side, it is possible for vehicles to park right next to the building. Normal parking for employees is in front; the closest row is 44 feet from the front door.

Section	Vulnerability Questions	Guidance	Observations
		entrance. Reference: *GSA PBS-P100*	
1.4	Is a perimeter fence or other types of barrier controls in place?	The intent is to channel pedestrian traffic onto a site with multiple buildings through known access control points. For a single building, the intent is to have a single visitor entrance. Reference: *GSA PBS-P100*	There is no fence or other type of barrier on the site's perimeter.
1.5	What are the site access points to the site or building?	The goal is to have at least two access points – one for passenger vehicles and one for delivery trucks due to the different procedures needed for each. Having two access points also helps if one of the access points becomes unusable, then traffic can be routed through the other access point. Reference: *USAF Installation Force Protection Guide*	Loading dock on the west side of the building and front entrance with an 8-foot overhang. Additional exits (including mezzanine exits): 4.
1.6	Is vehicle traffic separated from pedestrian traffic on the site?	Pedestrian access should not be endangered by car traffic. Pedestrian access, especially from public transportation, should not cross vehicle traffic if possible. Reference: *GSA PBS-P100 and FEMA 386-7*	Sidewalks at the front of the building allow access to the site without pedestrian/ vehicle interface. However, pedestrians must negotiate the parking lot to access the sidewalk.
1.7	Is there vehicle and pedestrian access control at the perimeter of the site?	Vehicle and pedestrian access control and inspection should occur as far from facilities as possible (preferably at the site perimeter) with the ability to regulate the flow of people and vehicles one at a time. Control on-site parking with identification checks, security personnel, and access control systems. Reference: *FEMA 386-7*	There is no access control to the site; however, security personnel monitor parking areas, and rear parking areas are well lit and monitored by CCTC cameras; front parking areas are lit only. Area proximity card prevent access by unauthorized personnel.
1.8	Is there space for inspection at the curb line or outside the protected perimeter? What is the minimum distance from the inspection location to the building?	Design features for the vehicular inspection point include: vehicle arrest devices that prevent vehicles from leaving the vehicular inspection area and prevent tailgating. If screening space cannot be provided, consider other design features such as: hardening and alternative location for vehicle	The building has no protected perimeter; however, there is adequate space in the rear parking area to conduct truck pre-screening away from the building. 44 feet from first parking space to the building.

Section	Vulnerability Questions	Guidance	Observations
		search/ inspection. Reference: *GSA PBS-P100*	
1.9	Is there any potential access to the site or building through utility paths or water runoff?	Eliminate potential site access through utility tunnels, corridors, manholes, stormwater runoff culverts, etc. Ensure covers to these access points are secured. Reference: *USAF Installation Force Protection Guide*	Unknown without a more detailed on-site assessment.
1.10	What are the existing types of vehicle anti-ram devices for the site or building? Are these devices at the property boundary or at the building?	Passive barriers include bollards, walls, hardened fences (steel cable interlaced), trenches, ponds/basins, concrete planters, street furniture, plantings, trees, sculptures, and fountains. Active barriers include pop-up bollards, swing arm gates, and rotating plates and drums, etc. Reference: *GSA PBS-P100*	There are no anti-ram barriers at the site.
1.11	What is the anti-ram buffer zone stand-off distance from the building to unscreened vehicles or parking?	If the recommended distance for the postulated threat is not available, consider reducing the stand-off required through structural hardening or manufacturing additional stand-off through barriers and parking restrictions. Also consider relocation of vulnerable functions within the building or to a more hazard-resistant building. More stand-off should be used for unscreened vehicles than for screened vehicles that are searched. *Reference: GSA* PBS P-100	There are no anti-ram barriers at the site.
1.12	Are perimeter barriers capable of stopping vehicles? Will the vehicle barriers at the perimeter and building maintain access for emergency responders, including large fire apparatus?	Anti-ram protection may be provided by adequately designed: bollards, street furniture, sculpture, landscaping, walls, and fences. The anti-ram protection must be able to stop the threat vehicle size (weight) at the speed attainable by that vehicle at impact. If the anti-ram protection cannot absorb the desired kinetic energy, consider adding speed controls (serpentines or speed bumps) to limit the speed at impact. If the resultant speed is still too great, the anti-ram protection should be improved.	There are no anti-ram barriers at the site.

Section	Vulnerability Questions	Guidance	Observations
		Reference: *Military Handbook 1013/14 and GSA PBS P-100*	
1.13	Does site circulation prevent high-speed approaches by vehicles?	The intent is to use site circulation to minimize vehicle speeds and eliminate direct approaches to structures. Reference: *GSA PBS-P100*	No, from the main road, there is a parking entrance road that leads directly to the center of the building complex. A vehicle could easily reach 30-40 mph.
1.14	Are there offsetting vehicle entrances from the direction of a vehicle's approach to force a reduction of speed?	Single or double 90-degree turns effectively reduce vehicle approach speed. Reference: *GSA PBS-P100*	Yes. Closing the gap between the last landscape area would eliminate the straightaway.
1.15	Is there a minimum setback distance between the building and parked vehicles?	Adjacent public parking should be directed to more distant or better-protected areas, segregated from employee parking and away from the building. Some publications use the term setback in lieu of the term stand-off. Reference: *GSA PBS-P100*	It is possible for vehicles to park right next to the building near the loading dock. Normal parking for employees is in front; the closest row is 44 feet from the front door.
1.16	Does adjacent surface parking on site maintain a minimum stand-off distance?	The specific stand-off distance needed is based upon the design basis threat bomb size and the building construction. For initial screening, consider using 25 meters (82 feet) as a minimum with more distance needed for unreinforced masonry or wooden walls. Reference: *GSA PBS-P100*	No. minimum stand-off of 44 feet at this location.
1.17	Do stand alone, aboveground parking garages provide adequate visibility across as well as into and out of the parking garage?	Pedestrian paths should be planned to concentrate activity to the extent possible. Limiting vehicular entry/exits to a minimum number of locations is beneficial. Stair tower and elevator lobby design shall be as open as code permits. Stair and/or elevator waiting areas should be as open to the exterior and/or the parking areas as possible and well lighted. Impact-resistant, laminated glass for stair towers and elevators is a way to provide visual openness. Potential hiding places below	No above-ground parking garages exist on site. However the open, ground-level parking provides adequate visibility across the lot.

Section	Vulnerability Questions	Guidance	Observations
		stairs should be closed off; nooks and crannies should be avoided, and dead-end parking areas should be eliminated. Reference: *GSA PBS-P100*	
1.18	Are garage or service area entrances for employee-permitted vehicles protected by suitable anti-ram devices? Coordinate this protection with other anti-ram devices, such as on the perimeter or property boundary to avoid duplication of arresting capability.	Control internal building parking, underground parking garages, and access to service areas and loading docks in this manner with proper access control or eliminate the parking altogether. The anti-ram device must be capable of arresting a vehicle of the designated threat size at the speed attainable at the location. Reference: *GSA PBS-P100*	No above-ground parking garages exist on site.
1.19	Do site landscaping and street furniture provide hiding places?	Minimize concealment opportunities by keeping landscape plantings (hedges, shrubbery, and large plants with heavy ground cover) and street furniture (bus shelters, benches, trash receptacles, mailboxes, newspaper vending machines) away from the building to permit observation of intruders and prevent hiding of packages. If mail or express boxes are used, the size of the openings should be restricted to prohibit the insertion of packages. Reference: *GSA PBS-P100*	Minimal landscaping and the layout of the property provide few if any hiding places.
1.20	Is the site lighting adequate from a security perspective in roadway access and parking areas?	Security protection can be successfully addressed through adequate lighting. The type and design of lighting, including illumination levels, is critical. Illuminating Engineering Society of North America (IESNA) guidelines can be used. The site lighting should be coordinated with the CCTV system. Reference: *GSA PBS-P100*	Both rear and front parking areas are well lit. Rear areas are also monitored by CCTC cameras.
1.21	Are line-of-sight	The goal is to prevent the observation of critical assets by	No. There are clear approximately 300 foot lines

Section	Vulnerability Questions	Guidance	Observations
	perspectives from outside the secured boundary to the building and on the property along pedestrian and vehicle routes integrated with landscaping and green space?	persons outside the secure boundary of the site. For individual buildings in an urban environment, this could mean appropriate window treatments or no windows for portions of the building. Once on the site, the concern is to ensure observation by a general workforce aware of any pedestrians and vehicles outside normal circulation routes or attempting to approach the building unobserved. Reference: *USAF Installation Force Protection Guide*	of sight in all directions.
1.22	Do signs provide control of vehicles and people?	The signage should be simple and have the necessary level of clarity. However, signs that identify sensitive areas should generally not be provided. Reference: *GSA PBS-P100*	There are no parking lots signs.
1.23	Are all existing fire hydrants on the site accessible?	Just as vehicle access points to the site must be able to transit emergency vehicles, so too must the emergency vehicles have access to the buildings and, in the case of fire trucks, the fire hydrants. Thus, security considerations must accommodate emergency response requirements. Reference: *GSA PBS-P100*	Yes.
2	**Architectural**		
2.1	Does the site and architectural design incorporate strategies from a Crime Prevention Through Environmental Design (CPTED) perspective?	**The focus of CPTED is on creating defensible space by employing:** **1. Natural access controls:** Design streets, sidewalks, and building entrances to clearly indicate public routes and direct people away from private/restricted areas Discourage access to private areas with structural elements and limit access (no cut-through streets) Loading zones should be separate from public parking **2. Natural surveillance:** Design that maximizes visibility of people, parking areas, and building entrances: doors and	Site design clearly directs visitors to the front of the building and to clearly marked entrances. Loading areas are separate from public parking.

Section	Vulnerability Questions	Guidance	Observations
		windows that look out on to streets and parking areas Shrubbery under 2 feet in height for visibility Lower branches of existing trees kept at least 10 feet off ground Pedestrian-friendly sidewalks and streets to control pedestrian and vehicle circulation Adequate nighttime lighting, especially at exterior doorways **3. Territorial reinforcement:** Design that defines property lines Design that distinguishes private/restricted spaces from public spaces using separation, landscape plantings; pavement designs (pathway and roadway placement); gateway treatments at lobbies, corridors, and door placement; walls, barriers, signage, lighting, and “CPTED" fences “Traffic-calming” devices for vehicle speed control **4. Target hardening:** Prohibit entry or access: window locks, deadbolts for doors, interior door hinges Access control (building and employee/visitor parking) and intrusion detection systems **5. Closed circuit television cameras:** Prevent crime and influence positive behavior, while enhancing the intended uses of space. In other words, design that eliminates or reduces criminal behavior and at the same time encourages people to "keep an eye out" for each other. Reference: *GSA PBS-P100 and FEMA 386-7*	
2.2	Is it a mixed-tenant building?	Separate high-risk tenants from low-risk tenants and from publicly accessible areas. Mixed uses may be accommodated through such means as separating entryways, controlling access, and hardening shared partitions, as well as through special security	The building site is a multiple-tenant facility; HIC has neighbors on both sides. In addition to other tenants in the building, the site also contains multiple buildings in the same professional park.

Section	Vulnerability Questions	Guidance	Observations
		operational countermeasures. Reference: *GSA PBS-P100*	
2.3	Are pedestrian paths planned to concentrate activity to aid in detection?	Site planning and landscape design can provide natural surveillance by concentrating pedestrian activity, limiting entrances/exits, and eliminating concealment opportunities. Also, prevent pedestrian access to parking areas other than via established entrances. Reference: *GSA PBS-P100*.	Each tenant facility has its own entrance, spreading pedestrian activity across the front of the buildings. Loading docks are likewise spread out across the west side of the building.
2.4	Are there trash receptacles and mailboxes in close proximity to the building that can be used to hide explosive devices?	The size of the trash receptacles and mailbox openings should be restricted to prohibit insertion of packages. Street furniture, such as newspaper vending machines, should be kept sufficient distance (10 meters or 33 feet) from the building, or brought inside to a secure area. References: *USAF Installation Force Protection Guide, DoD Minimum Antiterrorism Standards for Buildings*	No, the dumpster is approximately 50 feet from the rear of the building.
5	**Utility Systems**		
5.1	What is the source of domestic water? (utility, municipal, wells, lake, river, storage tank) Is there a secure alternate drinking water supply?	Domestic water is critical for continued building operation. Although bottled water can satisfy requirements for drinking water and minimal sanitation, domestic water meets many other needs – flushing toilets, building heating and cooling system operation, cooling of emergency generators, humidification, etc. Reference: *FEMA 386-7*	Unknown without a more detailed on-site assessment.
5.2	Are there multiple entry points for the water supply?	If the building or site has only one source of water entering at one location, the entry point should be secure. Reference: *GSA PBS-P100*	Unknown without a more detailed on-site assessment.
5.3	Is the incoming water supply in a secure location?	Ensure that only authorized personnel have access to the water supply and its components. Reference: *FEMA 386-7*	Unknown without a more detailed on-site assessment.
5.4	Does the building or site have storage capacity for domestic water? How many gallons of	Operational facilities will require reliance on adequate domestic water supply. Storage capacity can meet short-term needs and use water trucks to replenish for extended outages.	Unknown without a more detailed on-site assessment.

Section	Vulnerability Questions	Guidance	Observations
	storage capacity are available and how long will it allow operations to continue?	Reference: *Physical Security Assessment for Department of Veterans Affairs Facilities.*	
5.5	What is the source of water for the fire suppression system? (local utility company lines, storage tanks with utility company backup, lake, or river) Are there alternate water supplies for fire suppression?	The fire suppression system water may be supplied from the domestic water or it may have a separate source, separate storage, or nonpotable alternate sources. For a site with multiple buildings, the concern is that the supply should be adequate to fight the worst case situation according to the fire codes. Recent major construction may change that requirement. Reference: *FEMA 386-7*	Unknown without a more detailed on-site assessment.
5.6	Is the fire suppression system adequate, code-compliant, and protected (secure location)?	Standpipes, water supply control valves, and other system components should be secure or supervised. Reference: *FEMA 386-7*	Yes, meets all fire codes.
5.7	Do the sprinkler/standpipe interior controls (risers) have fire- and blast-resistant separation? Are the sprinkler and standpipe connections adequate and redundant? Are there fire hydrant and water supply connections near the sprinkler/standpipe connections?	The incoming fire protection water line should be encased, buried, or located 50 feet from high risk areas. The interior mains should be looped and sectionalized. Reference: *GSA PBS-P100*	Unknown without a more detailed on-site assessment.
5.8	Are there redundant fire water pumps (e.g., one electric, one diesel)? Are the pumps located apart from each other?	Collocating fire water pumps puts them at risk for a single incident to disable the fire suppression system. Reference: *GSA PBS-P100 and FEMA 386-7*	Unknown without a more detailed on-site assessment.
5.9	Are sewer systems accessible?	Sanitary and stormwater sewers should be protected from	Unknown without a more detailed on-site assessment.

Section	Vulnerability Questions	Guidance	Observations
	Are they protected or secured?	unauthorized access. The main concerns are backup or flooding into the building, causing a health risk, shorting out electrical equipment, and loss of building use. Reference: *Physical Security Assessment for the Department of Veterans Affairs Facilities*	
5.10	What fuel supplies do the building rely upon for critical operation?	Typically, natural gas, propane, or fuel oil are required for continued operation. Reference: *Physical Security Assessment for the Department of Veterans Affairs Facilities*	Heating for the HIC building is provided by a combination of natural gas and electricity.
5.11	How much fuel is stored on the site or at the building and how long can this quantity support critical operations? How is it stored? How is it secured?	Fuel storage protection is essential for continued operation. Main fuel storage should be located away from loading docks, entrances, and parking. Access should be restricted and protected (e.g., locks on caps and seals). References: *GSA PBS-P100 and Physical Security Assessment for the Department of Veterans Affairs Facilities*	Emergency power is provided by a single diesel generator, located in a shed in the rear parking lot. The generator has a 50-gallon day tank, maintained at 80 percent capacity. The 2,000-gallon main tank is buried under the parking lot, near the generator.
5.12	Where is the fuel supply obtained? How is it delivered?	The supply of fuel is dependent on the reliability of the supplier. Reference: *Physical Security Assessment for the Department of Veterans Affairs Facilities*	Natural gas enters the building through two meters under the loading dock staircase and goes through the overhead to the mechanical and electrical (M&E) room at the building's southwest corner. Branches split off for two gas powered space heaters in the high bay area by the loading dock. The main gas line goes to the main heater in the M&E room. Main power for the HIC office is provided by Dominion Electric Power Company through two transformers outside the building. Two sets of buried transmission lines deliver 12,470 volt (12.47KV) power to the building from a nearby substation.

Section	Vulnerability Questions	Guidance	Observations
			The two 12.47KV feeders lead to two separate transformers outside the building, one near the north side, and the other near the south side
5.13	Are there alternate sources of fuel? Can alternate fuels be used?	Critical functions may be served by alternate methods if normal fuel supply is interrupted. Reference: *Physical Security Assessment for the Department of Veterans Affairs Facilities*	Emergency power is provided by a single diesel generator, located in a shed in the rear parking lot. The generator has a 50-gallon day tank, maintained at 80 percent capacity. The 2,000-gallon main tank is buried under the parking lot, near the generator. Batteries to support the UPS are in a small room next to the UPS room.
5.14	What is the normal source of electrical service for the site or building?	Utilities are the general source unless co-generation or a private energy provider is available. Reference: *Physical Security Assessment for the Department of Veterans Affairs Facilities*	Main power for the HIC office is provided by Dominion Electric Power Company through two transformers outside the building. Two sets of buried transmission lines deliver 12,470 volt (12.47KV) power to the building from a nearby substation.
5.15	Is there a redundant electrical service source? Can the site or buildings be fed from more than one utility substation?	The utility may have only one source of power from a single substation. There may be only single feeders from the main substation. Reference: *Physical Security Assessment for the Department of Veterans Affairs Facilities*	Unknown without a more detailed on-site assessment.
5.16	How may service entry points does the site or building have for electricity?	Electrical supply at one location creates a vulnerable situation unless an alternate source is available. Ensure disconnecting requirements according to NFPA 70 (National Fire Protection Association, National Electric Code) are met for multiple service entrances.	Unknown without a more detailed on-site assessment.

Section	Vulnerability Questions	Guidance	Observations
		Reference: *Physical Security Assessment for the Department of Veterans Affairs Facilities*	
5.17	Is the incoming electric service to the building secure?	Typically, the service entrance is a locked room, inaccessible to the public. Reference: *Physical Security Assessment for the Department of Veterans Affairs Facilities*	Unknown without a more detailed on-site assessment.
5.18	What provisions for emergency power exist? What systems receive emergency power and have capacity requirements been tested? Is the emergency power collocated with the commercial electric service? Is there an exterior connection for emergency power?	Besides installed generators to supply emergency power, portable generators or rental generators available under emergency contract can be quickly connected to a building with an exterior quick disconnect already installed. Testing under actual loading and operational conditions ensures the critical systems requiring emergency power receive it with a high assurance of reliability. Reference: *GSA PBS-P100*	Emergency power is provided by a single diesel generator, located in a shed in the rear parking lot. The generator has a 50-gallon day tank, maintained at 80 percent capacity. The 2,000-gallon main tank is buried under the parking lot, near the generator. Batteries to support the UPS are in a small room next to the UPS room.
5.19	By what means do the main telephone and data communications interface the site or building?	Typically communication ducts or other conduits are available. Overhead service is more identifiable and vulnerable Reference: *Physical Security Assessment for the Department of Veterans Affairs Facilities*	HIC has invested in NEC DS2000 telephone systems. It comes with an 8-slot cabinet, that can handle 32 lines from 48 stations.
5.20	Are there multiple or redundant locations for the telephone and communication service?	Secure locations of communications wiring entry to the site or building are required. Reference: *Physical Security Assessment for the Department of Veterans Affairs Facilities*	Unknown without a more detailed on-site assessment.
5.21	Does the fire alarm system require communication with external sources? By what method is the alarm signal sent to the responding agency: telephone, radio, etc.?	Typically, the local fire department responds to an alarm that sounds at the station or is transmitted over phone lines by an auto dialer. An intermediary control center for fire, security, and/or building system alarms may receive the initial notification at an on-site or off-site location. This center may	Yes, the local fire department and the security company over telephone lines.

Section	Vulnerability Questions	Guidance	Observations
	Is there an intermediary alarm monitoring center?	then determine the necessary response and inform the responding agency. Reference: *Physical Security Assessment for the Department of Veterans Affairs Facilities*	
5.22	Are utility lifelines aboveground, underground, or direct buried?	Utility lifelines (water, power, communications, etc.) can be protected by concealing, burying, or encasing. Reference: *GSA PBS-P100 and FEMA 386-7*	Utilities lines are buried at this location.